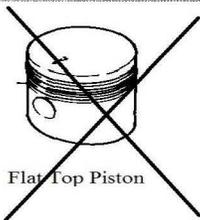


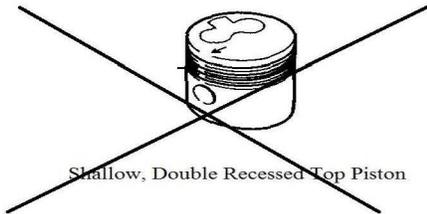
MITSUBISHI DIESEL ENGINE

K3G Manual

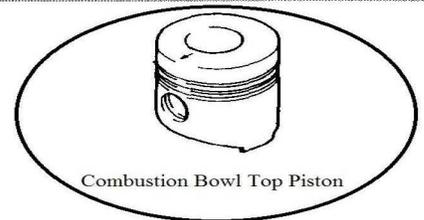
K3G



Flat Top Piston



Shallow, Double Recessed Top Piston

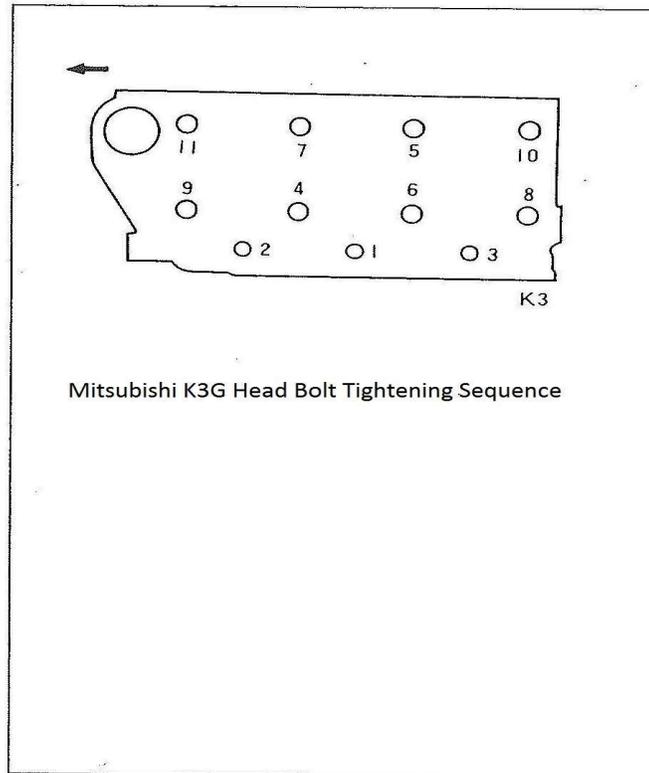


Combustion Bowl Top Piston

This manual is for use with engines with the combustion bowl top pistons.
If your engine has flat top pistons or shallow, double recessed top pistons please contact us
for the applicable information
Worldwide Parts Source LLC , email: Parts@WwPartsSource.com

Mitsubishi K3G Cylinder Head Gasket Installation Information with Head Bolt Torque Values and Sequence, With Valve Lash Settings .

Cylinder head bolts	M12 Bolt Size	11,5 ~ 12,5 (Wet) = 87 Ft Lbs
	M10 Bolt Size	6,5 ~ 8,0 (Wet) = 50 Ft Lbs



Valve clearances (intake and exhaust)	0,25 (at cold)		
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Mitsubishi K3G Cylinder Head Gasket Installation Information with Head Bolt Torque Values and Sequence, With Valve Lash Settings .

Courtesy of Worldwide Parts Source LLC

Source for hard to find engine gasket sets, pistons and rings sets, and engine overhaul kits.

Phone : 269 673 2313

email : Parts@WwPartsSource.com



■ Tightening Torque

Description	Tightening torque (kgm)
Cylinder head bolts { M12 main bolts ----- M10 sub bolts -----	11.5 ~ 12.5 (Wet) = 87 Ft Lbs 6.5 ~ 8.0 (Wet) = 50 Ft Lbs
Rocker cover bolts (M8) standard -----	1.0 ~ 1.3
Rocker stay bolts (M10) standard -----	3.0 ~ 4.2
Thermo-switch (PT3/8) at cylinder head -----	2.0 ~ 3.0
Blind plug for gear case governor shaft hole (PT1/2), for both FC and A & L Crankshaft pulley nut (M18) -----	4.0 ~ 5.0 15 ~ 20
Main bearing cap bolts -----	5 ~ 5.5 = 36 Ft Lbs
Connecting rod cap nuts -----	3.2 ~ 3.5 = 23 Ft Lbs
Flywheel mounting bolts -----	13 ~ 14
Oil pan drain plug (M18) -----	5 ~ 6
Oil relief plug (M18) -----	4.0 ~ 5.0
Oil filter -----	1.1 ~ 1.3
Fuel injection pipe nuts (M12) -----	2.5 ~ 3.5
Fuel injection pump Delivery valve holders -----	4 ~ 5
Nozzle holder Holder tightening bolts (M8) -----	2.0 ~ 2.5
Holder body retaining nuts -----	3 ~ 4
Glow plugs (M10) -----	1.5 ~ 2.0
Glow plug lead wire nuts (M4) -----	0.1 ~ 0.15
Key-OFF stop solenoid nuts (M30) -----	4.0 ~ 5.0

Worldwide Parts Source LLC - Source for hard to find gasket sets , engine overhaul kits and engine repair parts.

Email: Parts@WwPartsSource.com Alternate email: wwparts@gmail.com

Phone: 269 673 2313 Fax: 269 673 7226



Group
No.

8-03 TIGHTENING TORQUE AND SEALANT

Standard screws tightening torque

Thread dia.	Head mark		
	4	7	
M6	0.3 ~ 0.5	0.8 ~ 1.0	
M8	1.0 ~ 1.3	1.5 ~ 2.2	
M10	1.8 ~ 2.5	3.0 ~ 4.2	
M12	3.0 ~ 4.2	5.5 ~ 7.5	
M14	5.0 ~ 7.0	8.0 ~ 11.0	

Taper screws tightening torque

Size	To aluminum	To cast iron
NPTF 1/16	0.5 ~ 0.8	0.8 ~ 1.2
PT 1/8	0.8 ~ 1.2	1.5 ~ 2.2
PT 1/8, NPTF 1/4	2.0 ~ 3.0	3.5 ~ 4.5
PT 3/8	—	5.5 ~ 7.5

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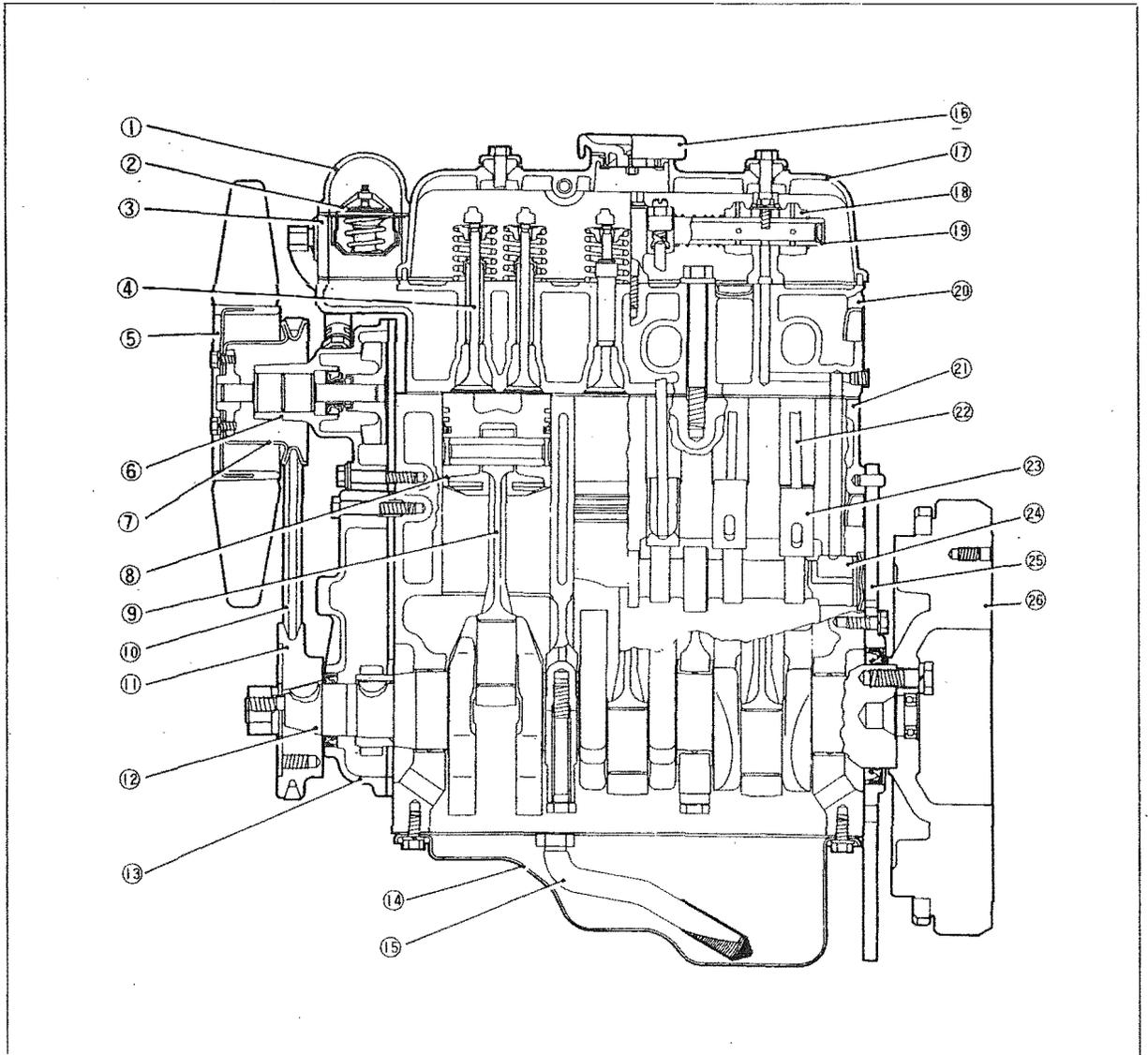


Group No.

0-02 SECTIONAL VIEWS OF ENGINE

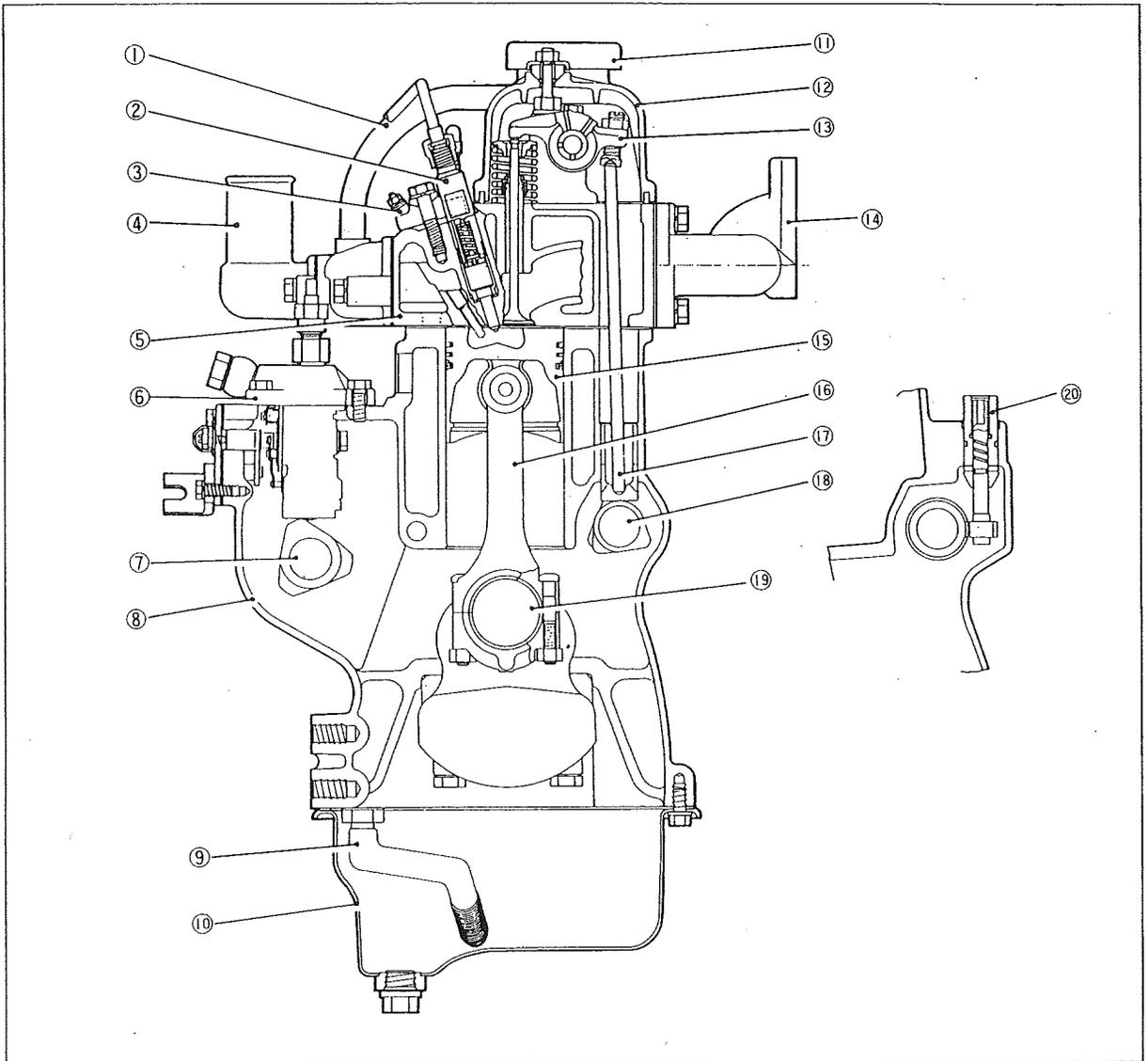
Group No.

0-02



Longitudinal Sectional View of K3 Engine

- | | | |
|------------------------|---------------------|------------------|
| ① Water outlet fitting | ⑩ Fan belt | ⑲ Rocker shaft |
| ② Thermostat | ⑪ Crankshaft pulley | ⑳ Cylinder head |
| ③ Thermostat fitting | ⑫ Crankshaft | ㉑ Cylinder block |
| ④ Inlet valve | ⑬ Gear case | ㉒ Push rod |
| ⑤ Cooling fan | ● Oil pan | ㉓ Tappet |
| ⑥ Water pump | ⑮ Oil screen | ㉔ Camshaft |
| ● Water pump pulley | ⑯ Oil filler cap | ㉕ Rear plate |
| ⑧ Piston | ⑰ Rocker cover | ㉖ Flywheel |
| ● Connecting rod | ⑱ Rocker arm | |



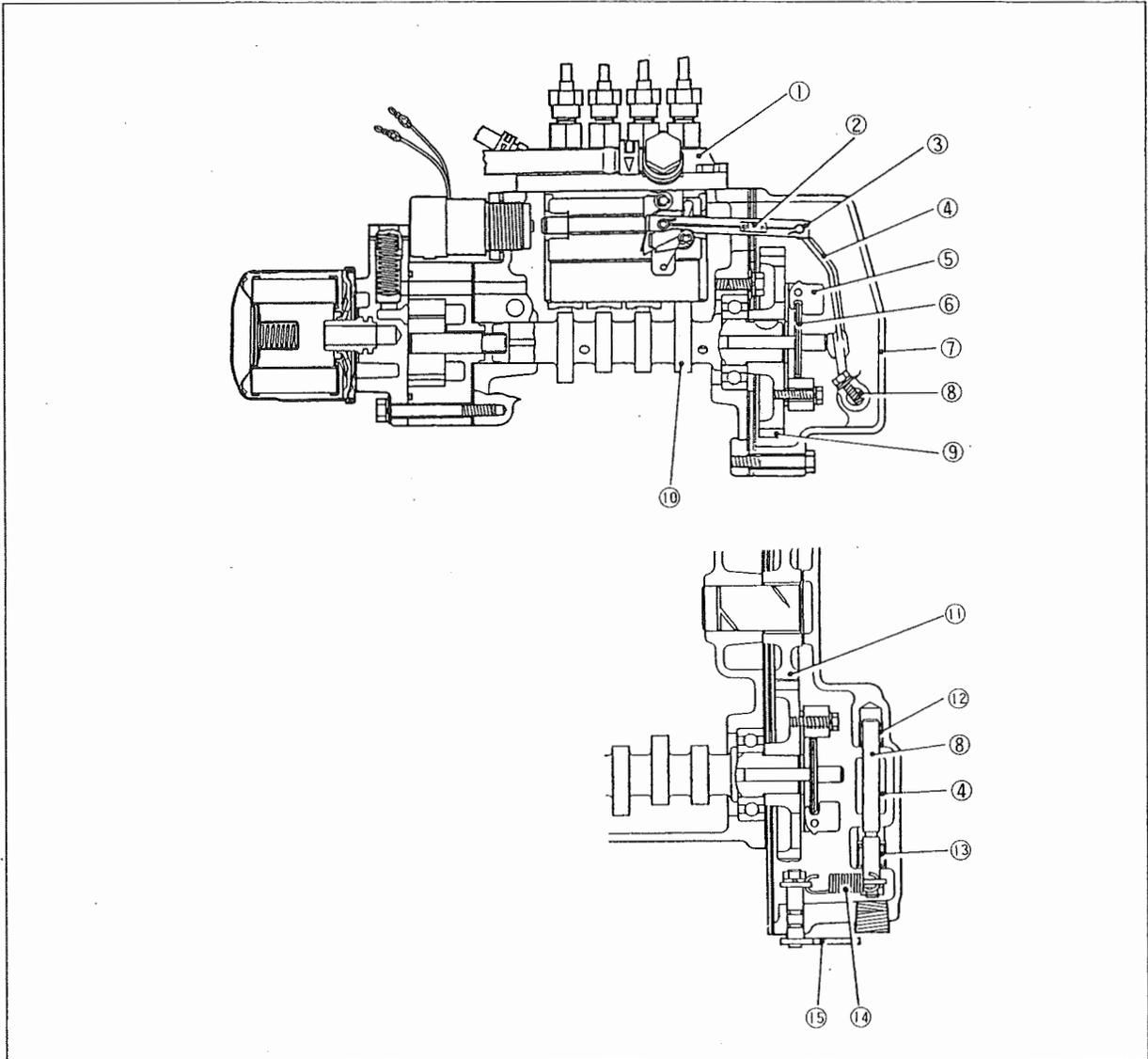
Cross Section of K3 and K4 Engines

- | | | |
|---------------------|--------------------|--------------------------|
| ① Air breather pipe | ⑧ Cylinder block | ⑮ Piston |
| ② Nozzle holder | ⑨ Oil screen | ⑯ Connecting rod |
| ③ Glow plug | ⑩ Oil pan | ⑰ Push rod |
| ④ Inlet pipe | ⑪ Oil filler cap | ⑱ Valve camshaft |
| ⑤ Cylinder head | ⑫ Rocker cover | ⑲ Crankshaft |
| ⑥ Injection pump | ⑬ Rocker arm | ⑳ Speedmeter driven unit |
| ⑦ Pump camshaft | ⑭ Exhaust manifold | |



Group
No.

0-02 SECTIONAL VIEWS OF ENGINE



Governor System of K3 and K4 Engines

- | | | |
|-------------------|------------------|--------------------------|
| ① Injection pump | ⑥ Sliding shaft | ⑪ Idle gear |
| ② Tie rod spring | ⑦ Gear case | ⑫ Needle bearing (inner) |
| ③ Tie rod | ⑧ Governor shaft | ⑬ Needle bearing (outer) |
| ④ Governor lever | ⑨ Pump gear | ⑭ Governor spring |
| ⑤ Governor weight | ⑩ Pump camshaft | ⑮ Speed control lever |

Group
No.

0-04 SPECIFICATIONS

Group
No.

0-04



Item		Model	K3G			
General	Type	4-cycle, water-cooled, vertical diesel engine				
	Firing order	1-3-2				
	Compression ratio	18				
	Combustion chamber	Direct injection				
	Engine weight	134				
Cylinder	Number of cylinders	3				
	Bore x Stroke (mm)	82 X 78				
	Total displacement	1,236 Liters				
Performance	Max. horsepower (ps/rpm)	Specified in each separate specification				
	Max. torque (kgm/rpm)					
	No load max. speed (rpm)					
	Fuel consumption (g/ps-hr)					
Stability angle	Back and forth, right and left inclination (Lower limit of oil level)	25° during continuous operation,				
		30° during short-time (less than 30 minutes) operation				
Fuel system	Injection pump	Bosh M type				
	Nozzle	Hole type				
	Governor	Centrifugal flyweight type				
	Fuel	Diesel fuel				
Lubrication system	Type	Forced lubrication (trochoid pump)				
	Oil filter	Filter paper (full flow type)				
	Oil capacity : Standard type (ℓ)	Upper limit : 3.0, Lower limit : 1.8 (except 0.5 ℓ for oil filter)				
Cooling system	Type	Pressurized, forced recirculation with radiator				
	Coolant capacity (ℓ)	3.0 (except for radiator and hoses)				
Electrical system	Starter motor	12V-1.6kW				
	Alternator	12V-35A or 12V-40A				
	Battery	12V-60AH min.				



Group No.

0-05 MAINTENANCE

Group No.

0-05



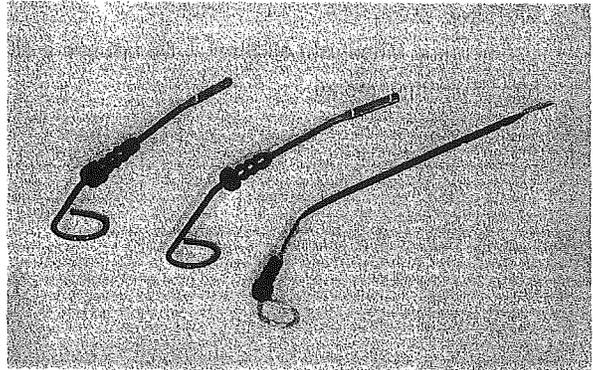
■ Engine Oil and Oil Filter

1. Engine Oil Level Check

- (1) Place the engine upright on level ground.
- (2) Check the oil level with the dipstick. Add the oil up to the upper level mark if the level is near the lower level mark.

CAUTION

- Recheck the oil level after adding the oil.
- Add the same oil as which is used in the engine.
- If the engine is not used for long period, check the oil condition and level and replace or add if necessary. Operate the engine for several minutes and recheck the oil level.



Oil Level Gauge

2. Oil Replacement Period

Engine oil should be replaced after first 50 hours operation and every 100 hours operation.

Replace the oil filter every 200 hours operation.

3. Engine Oil Recommendation

Use engine oil certified to meet or exceed API service Classification CC and with the proper viscosity according to the ambient temperature as shown in the table.

API Service Classification	Ambient temperature	Oil viscosity SAE
CC or above	Above 20°C	30 or 10W-30
	5-20°C	20 or 10W-30
	Below 5°C	10W-30

Note : Use API CD coil when the engine is used under high load range and for engine with turbo-charger.



Group
No.

0-05 MAINTENANCE

4. Oil Filter

Use genuine Mitsubishi oil filter. Do not use a oil filter for other model.

5. Engine Oil Replacement

After warming up the engine, remove the drain plug and drain the engine completely. Install and tighten the drain plug and fill the engine with the recommended grade oil through the oil filler.

- Oil pan drain plug tightening torque :
5~6 kgm
- Oil capacity : Oil capacities are different for respective engine models. Fill the engine upto the upper level on the oil dipstick of the engine. Oil capacity for the oil filter and oil line is approximately 0.5 liter.

6. Oil Filter Replacement

- (1) Remove the oil filter with an appropriate tool such as a filter wrench, etc.
- (2) Clean the installation surface of the filter bracket before installing a new filter. Coat clean engine oil lightly to the O-ring of the oil filter and tighten the oil filter securely by hands. (Tightening torque : 1.1~1.3kgm)

CAUTION

- Take care not to shift the O-ring.



Oil Filter

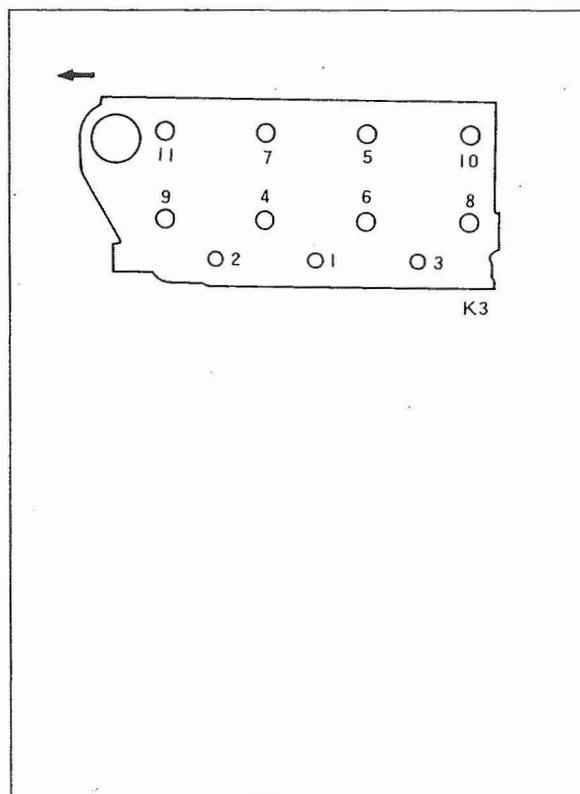


- (3) Run the engine for several minutes and make sure that there is no oil leakage.
- (4) Stop the engine, check the oil level and add engine oil if necessary.

■ Cylinder Head bolt Re-tightening

I. When re-tightening the cylinder head bolts, loosen the bolt slightly, then tighten to the specified torque.

- (1) Remove the rocker cover and air breather hose.
- (2) Remove the rocker shaft assembly.
- (3) Tighten the cylinder head bolts.
 - Cylinder head bolt tightening torque :
 - (M12) : 11,5~12,5 kgm (Wet)
 - (M10) : 6,5~8,0 kgm (Wet)

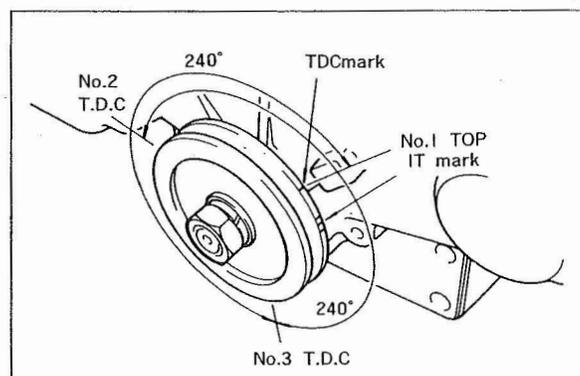


Cylinder Head Bolt Re-tightening

■ Valve Clearance Adjustment

CAUTION

- Adjust valve clearance after re-tightening the cylinder head bolts.
- (1) Adjust valve clearance with the piston at T. D. C. of the compression stroke.
 - (2) Measure the valve clearance with a feeler gauge. If adjustment is required, loosen the rocker arm nut and adjust by turning the adjusting screw.
 - (3) Hold the adjusting screw and tighten the lock nut.



T. D. C. of Compression Stroke (K3, series)



Group
No.

0-05 MAINTENANCE

■ Fan Belt Adjustment

Push the fan belt midway between the alternator and crankshaft pulleys and measure the deflection. Adjust by moving the alternator so that the deflection may be 10~12 mm. Belt depression force : Approx. 10kg

■ Fuel Injection Timing Adjustment

- (1) Close the fuel filter cock.
- (2) Remove the injection pipes.
- (3) Remove the fuel pump No.1 delivery valve holder, delivery valve and delivery valve spring.
- (4) Re-install the delivery valve holder and tighten it.
- (5) Open the fuel filter cock.
- (6) Turn the crankshaft pulley clockwise slowly until the fuel flow stops.

CAUTION

- The control lever should be set in the midway.

- (7) The injection timing mark on the crankshaft pulley should align with the index mark on the gear case when the fuel flow stops.

Injection timing (B. T. D. C.)

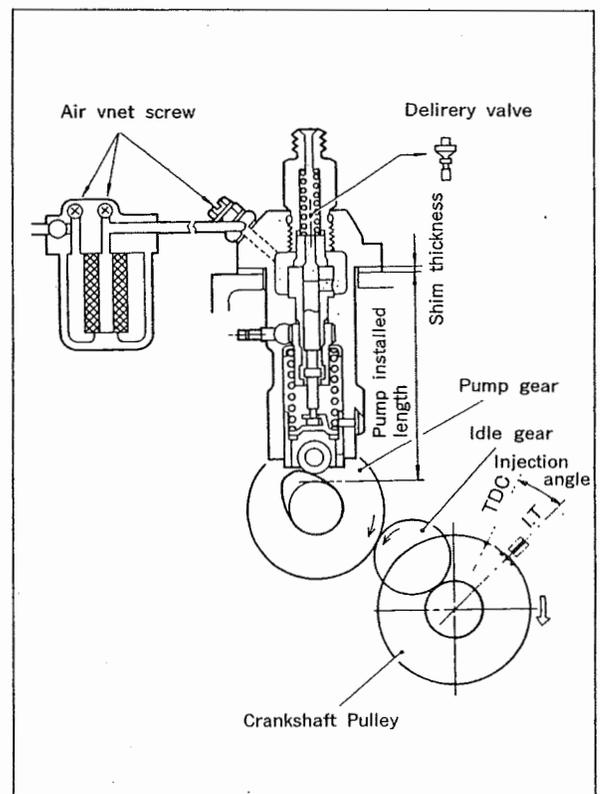
For agricultural use : 19

For industrial use : 20

For exports : 20

- (8) If injection timing is out of specification, adjust by increasing or decreasing the thickness of the fuel injection pump mounting shim after removing the pump.

To remove the fuel injection pump, remove the tie rod cover on the side of the cylinder block, tie rod connecting the control rack to the governor, and tie rod spring. Then, remove the fuel injection mounting bolts and the pump assembly.



Fuel Injection Timing Inspection by Removing the Delivery Valve



- (9) Injection timing is changed by about 1° when thickness of the shim is changed by 0,1 mm.

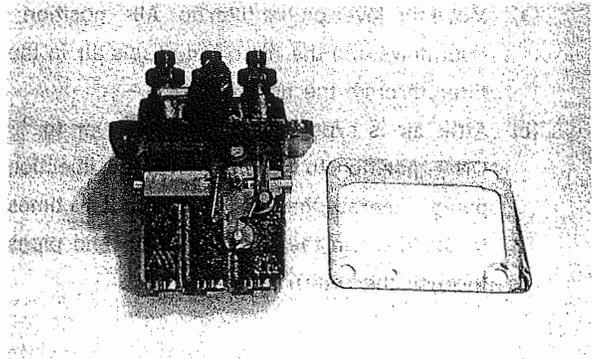
Caution

- Injection timing advances when shim thickness is increased, and retards when shim thickness is decreased.

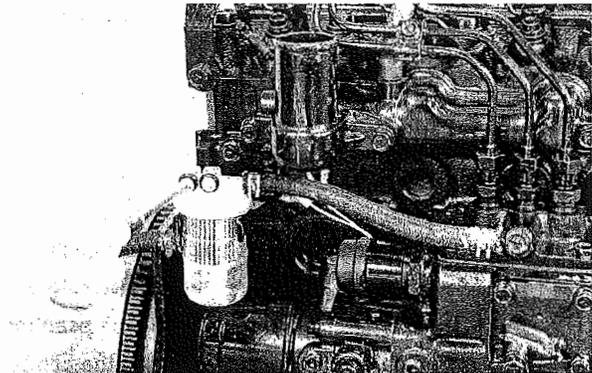
- (10) Install the fuel injection pump in the reverse order of removal.
- (11) If around the delivery valve is excessively dirty, check injection timing at the No. 1 injection pipe without removing the delivery valve.
- Loosen the nozzle end of the No. 1 injection pipe.
- Set the control lever at the middle and open the fuel cock.
- Turn the crankshaft pulley clockwise slowly until the fuel at the end of the injection pipe just expands.
- When the fuel just expands, injection timing is approximately 1° retarded from actual injection timing.

■ **Fuel System Air Bleeding**

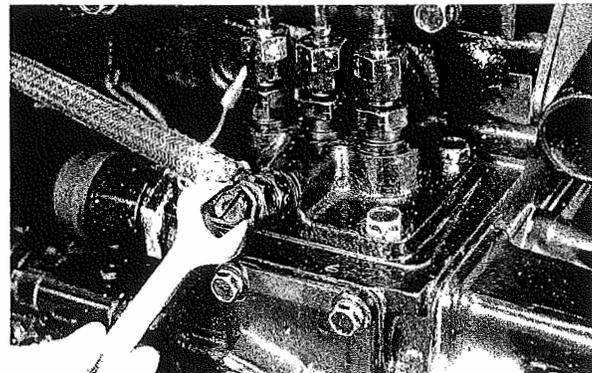
- (1) Loosen the air bleeder screw on the fuel filter.
- (2) On the drop type, fuel enters into the fuel filter by dropping itself naturally. Tighten the air bleeder screw on the fuel filter after weighting until fuel flows out of the screw.
- (3) On the electromagnetic type, feed fuel by turning the key ON, loosen air bleeder screw on the fuel filter to bleed the air in the filter and tighten the screw.
- (4) Bleed air in the fuel pipes and injection pump by loosening the bleeder screw on the injection pump.
- (5) Air in the injection pipes and nozzles is bled by cranking the engine.
- (6) Bleed air from the filter with fuel (air bleeder) cock and with hand pump by the procedure as follows.



Injection Pump and Adjusting Shims



Air Bleeding from Fuel Filter



Air Bleeding from Injection Pump



Group
No.

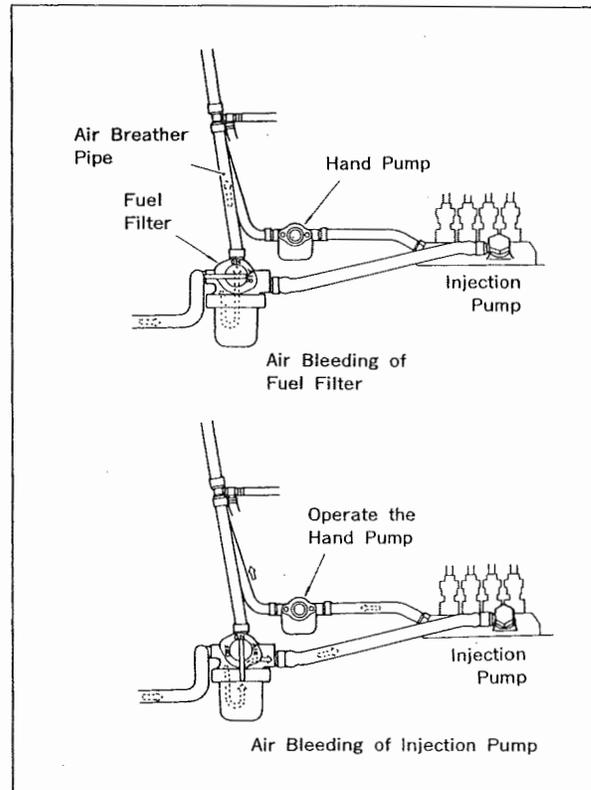
0-05 MAINTENANCE

- (a) Move the lever on the filter to "AIR" position. Fuel flows into the filter and expels air in the filter through the upper pipe.
- (b) After air is expelled, move the lever to "ON" position to flow fuel into the injection pump. Operate the hand pump about 15 times to bleed air in the injection pump and pipes through the return pipe.

■ Fuel Filter Replacement

- (1) Cartridge type
Replace the filter as an assembly if dust and water are accumulated in the element. Replace the element every 400 operating hours.
 - (2) Filter with cock (Separate type)
Close the filter cock, loosen and remove the ring nut. Clean or replace the element.
 - (3) Electromagnetic pump filter (Plunger pump)
An element is installed on the electromagnetic pump. If this element is clogged, fuel feed will be restricted. Clean or replace the element same as the fuel filter.
After replacing the element, check for operation and fuel leakage.
- Electromagnetic pump delivery : 0.9 l/min ,
at 20°C , 12 V

Reference : The diaphragm type electromagnetic pump has no fuel element. Therefore, a separate fuel filter should be used for cleaning before fuel is fed to the pump.



Air Bleeding of Injection Pump with Hand Pump



Idle Speed Adjustment

Before adjustment, make sure of the following conditions :

- (a) The engine has been warmed up until engine coolant temperature increases above 60°C.
 - (b) All of valve clearances, injection, timing, and injection nozzles are normal.
- (1) Adjusting slow-idle speed

Loosen the slow-idle adjusting screw locknut. Turn the adjusting screw to set the slow-idle speed within specification. Tighten the locknut to lock the adjusting screw at that position. For the slow-idle specification, see 9-02.

- (2) Adjusting fast-idle speed

- (a) Engines without damper spring or of damper-free specification—Loosen the fast-idle adjusting screw locknut.

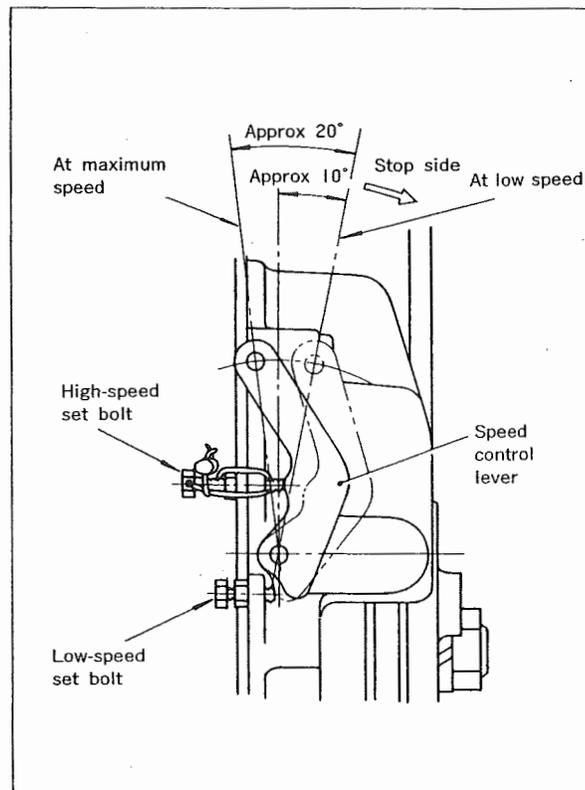
Turn the adjusting screw to set the fast-idle speed within specification. Tighten the locknut to lock the adjusting screw at that position. For the fast-idle specification, see 9-02.

- (b) Engines with damper set—Follow the adjusting procedure described below. For the fast-idle specification, see 9-02.

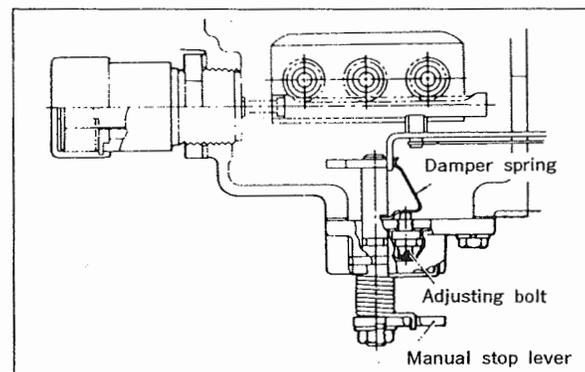
- (1) Release the damper spring (by loosening the spring adjusting screw). Loosen the fast-idle adjusting screw locknut. Turn the adjusting screw to set the fast-idle speed at the specified "A" rpm. Tighten the locknut to lock the adjusting screw as that position.

- (2) Turn in the damper spring adjusting screw to increase fast-idle speed to the extent of "A" + 20 ± 10rpm. Tighten the locknut to lock the spring adjusting screw at the position. (Coat the spring adjusting screw threads with SUPER THREE-BOND # 20.)

Check that engine speed is now within specification of "B" rpm.



Idle Speed Adjusting Screws



Adjusting Damper Spring



Group
No.

0-05 MAINTENANCE

- (3) Seal the spring adjusting screw with the sealing cap.

Seal the fast-idle adjusting screw with the lock wire and sealing metal.

■ Nozzle Inspection

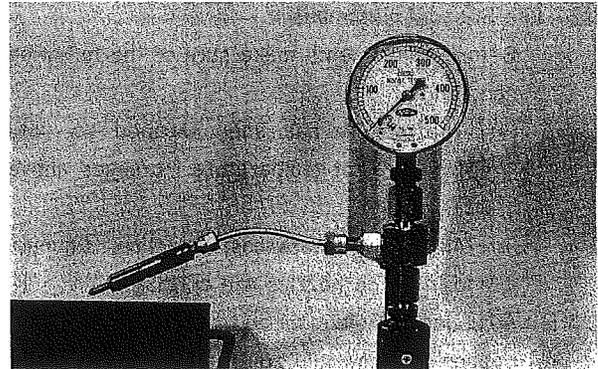
Perform the following inspection and repair or replace if necessary.

I. Injection Start Pressure Test

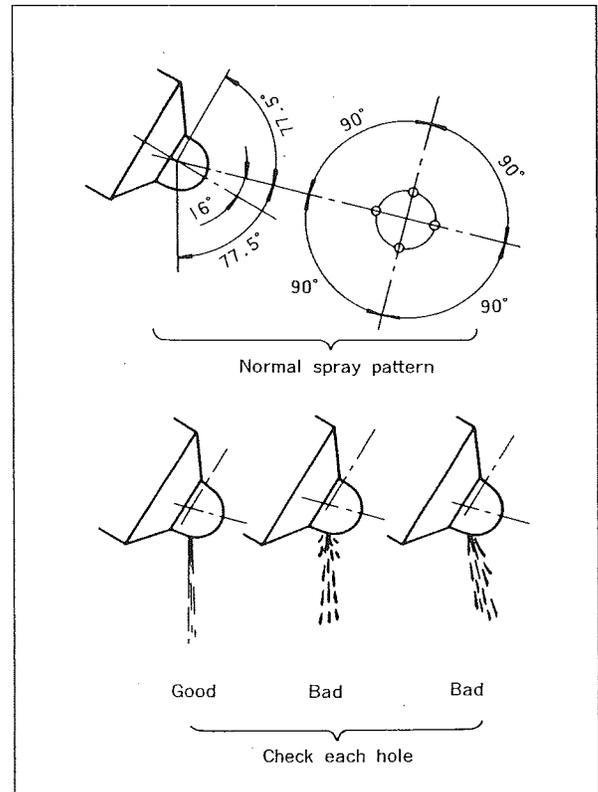
- (1) Install the nozzle on the nozzle tester and bleed air from the nozzle by operating the handle up and down several times.
- (2) Stroke the nozzle tester handle quickly (more than 60 strokes per minute) and read the pressure gauge.
Pressure should increase slowly and the indicator needle should swing during injection. Injection start pressure is the reading at the needle just at the time of starting to swing.
- (3) If injection start pressure is low, disassemble the nozzle and adjust by changing the shim thickness.

2. Chattering Test

- (1) Stroke the tester handle slowly (1 stroke per minute).
 - Needle valve
Injection should be done with peculiar snarl and vibration of the needle valve should be felt with the handle during stroking the handle.
 - Spray form
Spray form should be as shown in figure A. Other spray forms are not acceptable. In the case fuel is injected straight with coarse particles and remains at the holes after injection, this often occurs during this test and function of the nozzle will be normal.
- (2) Stroke the tester handle quickly (4 to 6 strokes per second).
Fuel should be injected exactly equally from the four holes with fine spray.



Injection Start Pressure test



Chattering Test



- (3) Nozzle leak test
- Using the nozzle tester, pressurize the nozzle and maintain to 200~210 kg/cm². Check the nozzle tip for fuel leakage.
 - Tightening torque of nozzle retaining nut :
3~4 kgm
 - Tightening torque to the cylinder head :
2.0~2.5 kgm

■ Compression Pressure Test

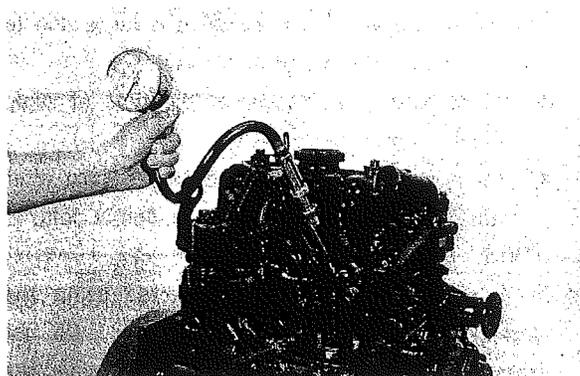
1. Preparation of Test

Make sure the following condition before testing.

- (1) Engine oil, air cleaner, starter and battery are in good condition.
- (2) Engine should be warm (coolant temperature : above 50 °C).

2. Test

- (1) Move the control lever to the stop position.
 - (2) Remove all glow plugs. Install the compression gauge adaptor and gauge to the cylinder.
 - (3) Crank the engine until the gauge reading stops rising and read the gauge.
 - (4) After measurement, remove the compression gauge and adaptor and install the glow plugs and glow plug wires.
- Glow plug tightening torque : 1.5~2.0 kgm



Compression Pressure Measurement

Item	Standard value
Engine speed	270 rpm
Compression pressure	29 kg/cm ²
Difference between cylinders	3 kg/cm ² max.



Group
No.

0-05 MAINTENANCE

■ Troubleshooting

I. Description

Troubles of the diesel engine occur usually as the result of plural causes which affect each other. Therefore, it is very difficult to diagnose the cause of the problem from the symptom. Careful consideration is necessary especially when diagnosing the problem concerned with the injection pump, nozzle and compression pressure because their faulty will fall into the same symptom.

For above reasons, the troubleshooting charts in this chapter start diagnosis from the items with high possibility or easy to check in order.

Perform the troubleshooting after fully understanding the following features of the diesel engine.

- The diesel engines produce combustion noise of their own (diesel knock) respectively under normal condition.
- Some black smoke will be exhausted under high loaded condition.
- Torque vibration of the engine is large due to high compression and high torque.
- Slight hunting will occur at the time of rapid deceleration.
- Some white smoke will be exhausted just after starting the engine when the engine is cold.

CAUTION

- **The injection pump must be adjusted using the pump tester after removing the pump. Do not disassemble or adjust when performing the troubleshooting.**
 - **To check the combustion condition for each cylinder, loosen one of the injection pipes at a time to stop the injection for that cylinder and compare rpm drop with other cylinders.**
-

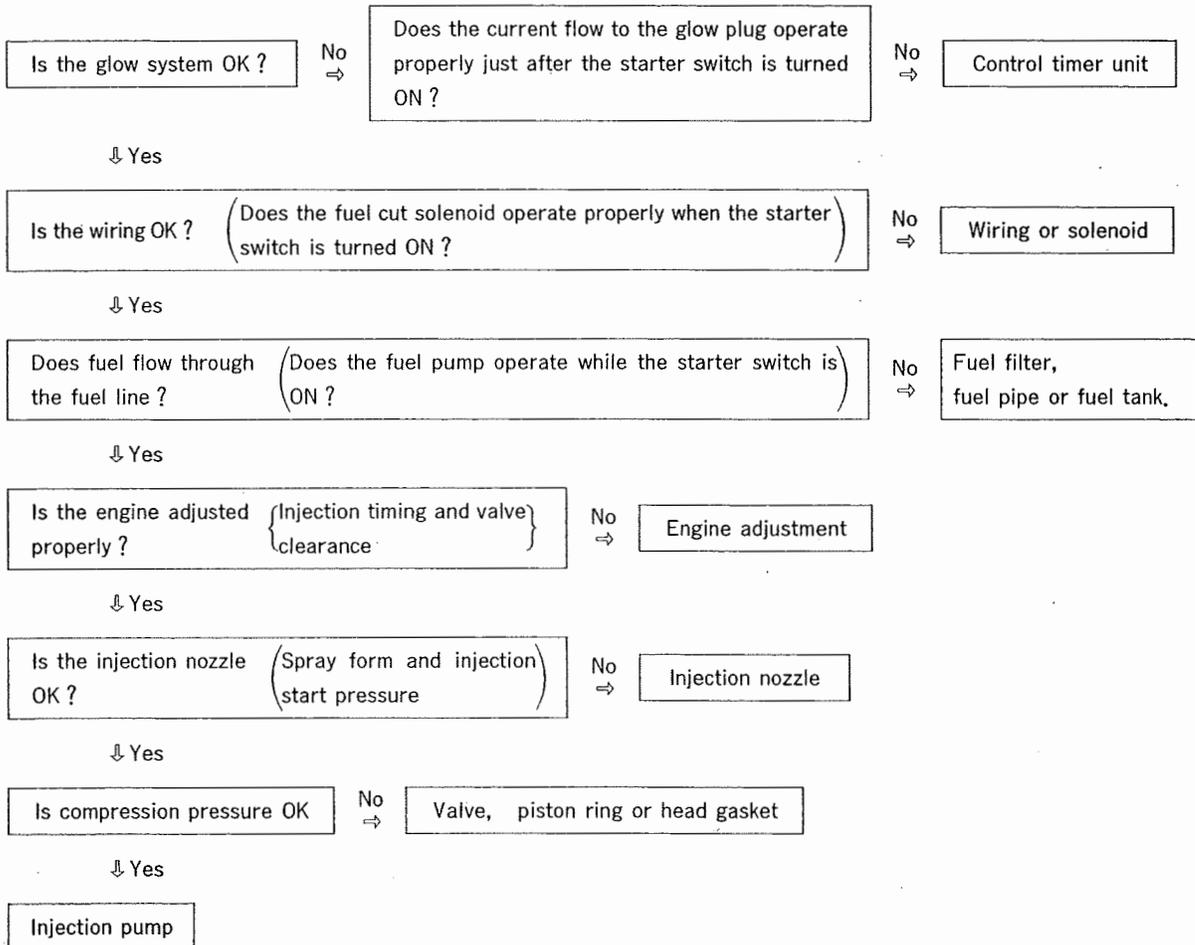


2. Hard starting

(1) Check the following before diagnosing.

- Clogged air cleaner element
- Engine oil viscosity
- Improper fuel
- Low cranking speed

(2) Inspection





Group
No.

0-05 MAINTENANCE

3. Knocking

The diesel engines produce combustion noise of their own respectively due to their combustion method. This knocking noise is normal unless it is excessive.

(1) Check the following before diagnosing.

- Clogged air cleaner
- Improper fuel

(2) Inspection

Is injection timing correct? (Too advanced injection timing) No → Injection timing adjustment

↓ Yes

Is control lever normal? (Solenoid switch) No → Solenoid switch

↓ Yes

Is injection nozzle OK? (Low injection start pressure) No → Injection nozzle adjustment

↓ Yes

Is compression pressure OK? No → Valve, piston ring or head gasket

↓ Yes

Injection pump

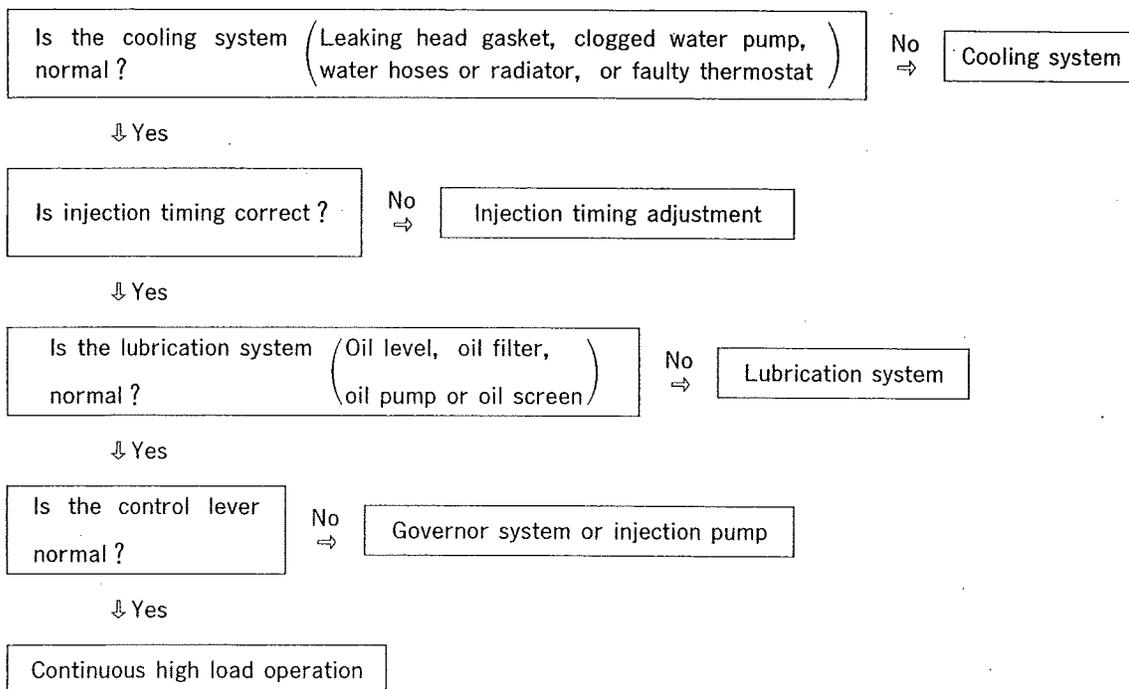


4. Overheat

(1) Check the following before diagnosing.

- Coolant level and leakage
- Loosen fan belt
- Clogged radiator fins

(2) Inspection



In many cases, overheat problems are caused by improper matching of the engine and the machine. Therefore, if the system overheats, measure coolant temperature and compare it with ambient temperature. If the temperature difference is more than 60°C, the cause should be investigated beside the engine.



Group
No.

0-05 MAINTENANCE

5. Excessive black smoke

(1) Check the following before diagnosing.

- Clogged air cleaner element
- Improper fuel

(2) Inspection

Is the engine adjusted (Excessive valve clearance or advanced injection timing) correctly?

No
⇒

Engine adjustment

↓ Yes

Is the injection nozzle (Spray form or high injection start pressure) normal?

No
⇒

Injection nozzle

↓ Yes

Is compression pressure normal?

No
⇒

Valve, piston ring or head gasket

↓ Yes

Injection pump



6. Irregular idling

(1) Check the following before diagnosing.

- Engine control system
- Engine oil viscosity
- Improper fuel

(2) Inspection

Is the engine adjusted (Valve clearance or injection timing) correctly? No ⇒ Engine adjustment

↓ Yes

Is injection nozzle (Spray form or uneven injection) normal? (start pressure) No ⇒ Injection nozzle

↓ Yes

Is compression pressure OK? (Difference between the cylinders) No ⇒ Valve, piston ring or head gasket

↓ Yes

Injection pump



Group No.

0-05 MAINTENANCE

7. Poor performance

(1) Check the following before diagnosing.

- Seized engine
- Too high engine oil viscosity
- Improper fuel
- Clogged air cleaner element
- Clogged exhaust muffler
- Faulty power take off

(2) Inspection

Is the engine adjusted (Valve clearance or fuel injection timing) correctly? No ⇒ Engine adjustment

↓ Yes

Does fuel flow through the fuel line? (Does fuel pump operate when the key switch is turned ON?) No ⇒ Fuel tank, fuel filter or fuel pipe

↓ Yes

Is the control lever normal? No ⇒ Governor system

↓ Yes

Is injection nozzle normal? (Spray form or injection start spressure) No ⇒ Injection nozzle

↓ Yes

Is compression pressure OK? No ⇒ Valve, piston ring or cylinder head gasket

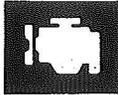
↓ Yes

Injection pump

Group 1	ENGINE PROPER	
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01	Description	28
02	Rocker Arm and Rocker Shaft.....	31
03	Inlet and Exhaust Manifolds	34
04	Valve and Valve Spring	35
05	Cylinder Head	39
06	Gear Case	45
07	Timing Gear	48
08	Camshaft (Valve and Pump)	51
09	Piston and Connecting Rod	55
10	Crankshaft and Flywheel	61
11	Cylinder Block	66

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Group
No.

1-01 DESCRIPTION

■ Specifications (K3)

Item		Model	K3G
Cylinder head	Material Combustion chamber Intake and exhaust ports		Special cast iron Direct injection chamber type Cross flow type
Rocker arm	Material Intake and exhaust		Special malleable cast iron Common to intake and exhaust (No mark)
Valve	Face angle Identification mark : Intake : Exhaust		45° I E
Valve spring	Type Identification color		Variable pitch Red (Upper side)
Cylinder head gasket	Material		Grafoil
Cylinder head bolt	Material		Special steel
Cylinder block	Cylinder bore Cylinder liner Water jacket		82 Monobloc casting Full jacket
Crankshaft	Material Surface treatment Identification Journal dia, × pin dia.		Special steel Hardening Normal machined metal surface (glaze) 52 × 42
Piston	Connection to connect- ing rod Piston—head shape		Full floating With cavity
Piston ring	No. 1 No. 2 Oil		
Camshaft	Material Drive		Special steel Gear
Oil pump	Type Drive		Trochoid type Directly connected to injection pump camshaft

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Group
No.

1-01 DESCRIPTION

■ Special Tools

Use	Tool name	Sketch	Ref. page
Removing/pressing piston pin (For K3C and D)	Piston pin setting tool ST332301		Pages 58
Removing/pressing camshaft bushing	Camshaft bush installer ST332340		Page 70
Measuring cylinder compression	Compression gauge adaptor ST333060		Page 19
Removing/installing oil pressure switch	Oil pressure switch socket wrench MD998054		Page 72
Refacing valve seat	Valve seat cutter 45° (Seat cutting) 60° (interior cutting) 30° (Flat cutting) Valve seat cutter pilot φ6.6 (Except K4M) φ8.0 (For K4M)		Page 42



Group
No.

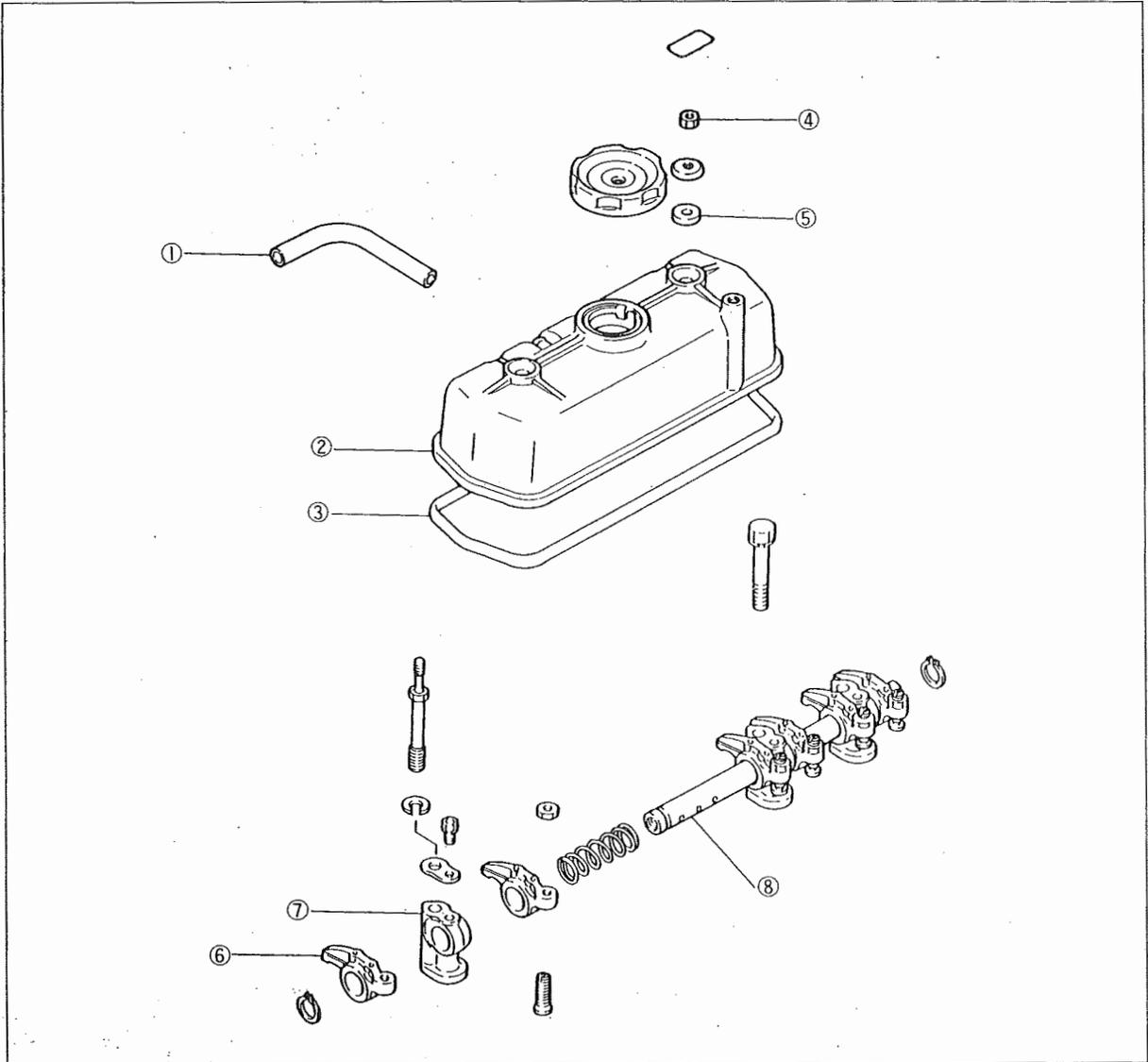
1-02 ROCKER ARM AND ROCKER SHAFT

Group
No.

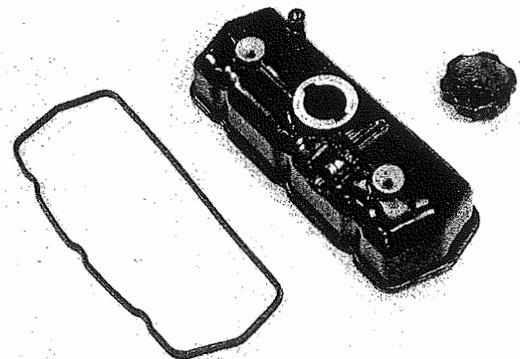
1-02



Components



- | | |
|-----------------------|----------------|
| ① Breather hose | ⑤ Seal |
| ② Rocker cover | ⑥ Rocker arm |
| ③ Rocker cover gasket | ⑦ Rocker stay |
| ④ Nut | ⑧ Rocker shaft |



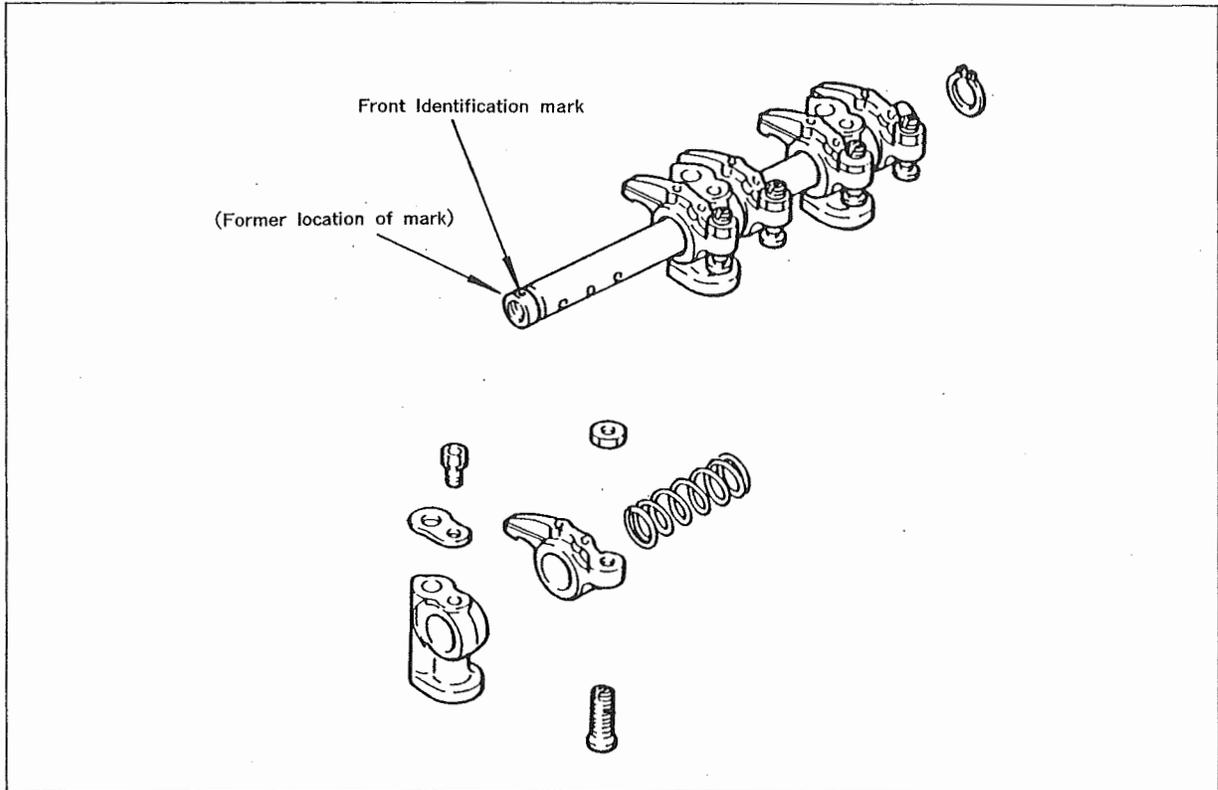
Rocker Cover



Group
No.

1-02 ROCKER ARM AND ROCKER SHAFT

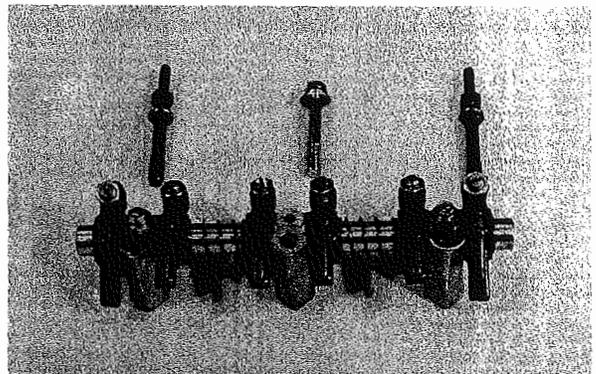
■ Removal and Installation



Rocker Arm Installation Direction

CAUTION

- Before removing the rocker shaft assembly, turn the crankshaft to bring each cylinder to compression stroke as much as possible.
- After installation, always adjust valve clearance.

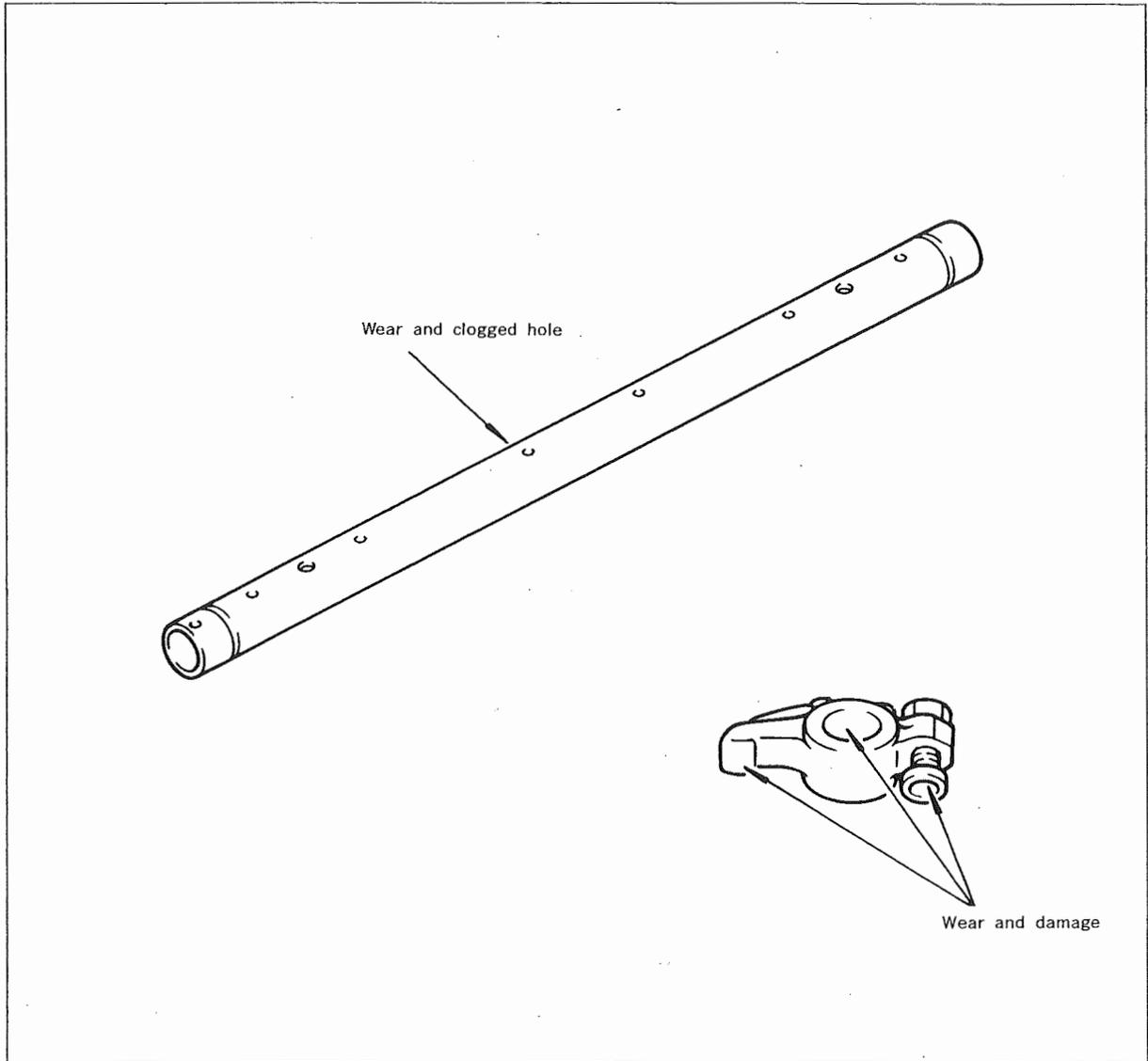


Removing Rocker Shaft Assembly



■ Inspection

Replace the parts if necessary.



Rocker Arm and Rocker Shaft Inspection



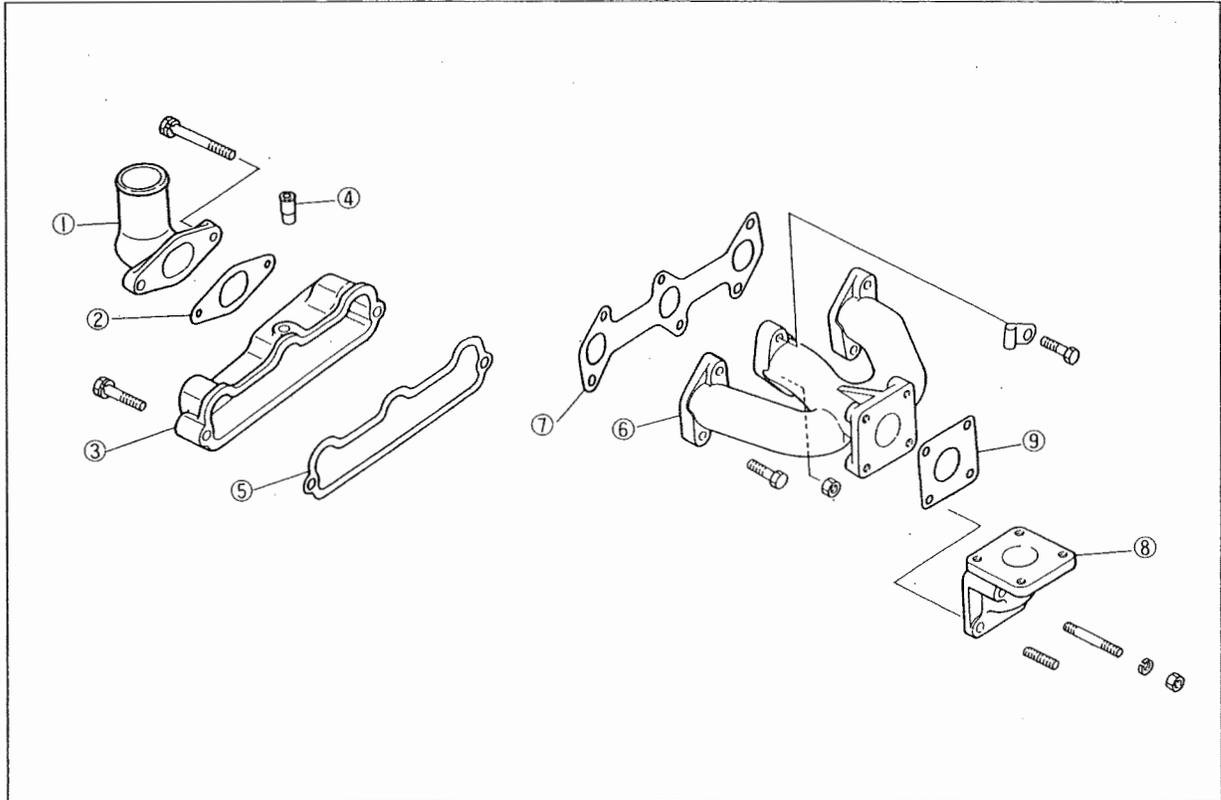
Group
No.

1-03 INLET AND EXHAUST MANI FOLD

Group
No.
1-03



■ Components



① Inlet pipe

② Inlet pipe gasket

③ Inlet manifold

④ Air breather nipple

⑤ Manifold gasket (IN)

⑥ Exhaust manifold

⑦ Manifold gasket (EX)

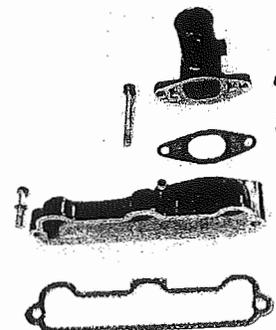
⑧ Exhaust elbow

⑨ Gasket

■ Inspection

Perform the following inspection and replace the parts if necessary.

- (1) Check if warp of the mating surface to the cylinder head is less than 0.15mm.
- (2) Check the manifolds for corrosion, cracks or damage.



Manifold Inspection



Group
No.

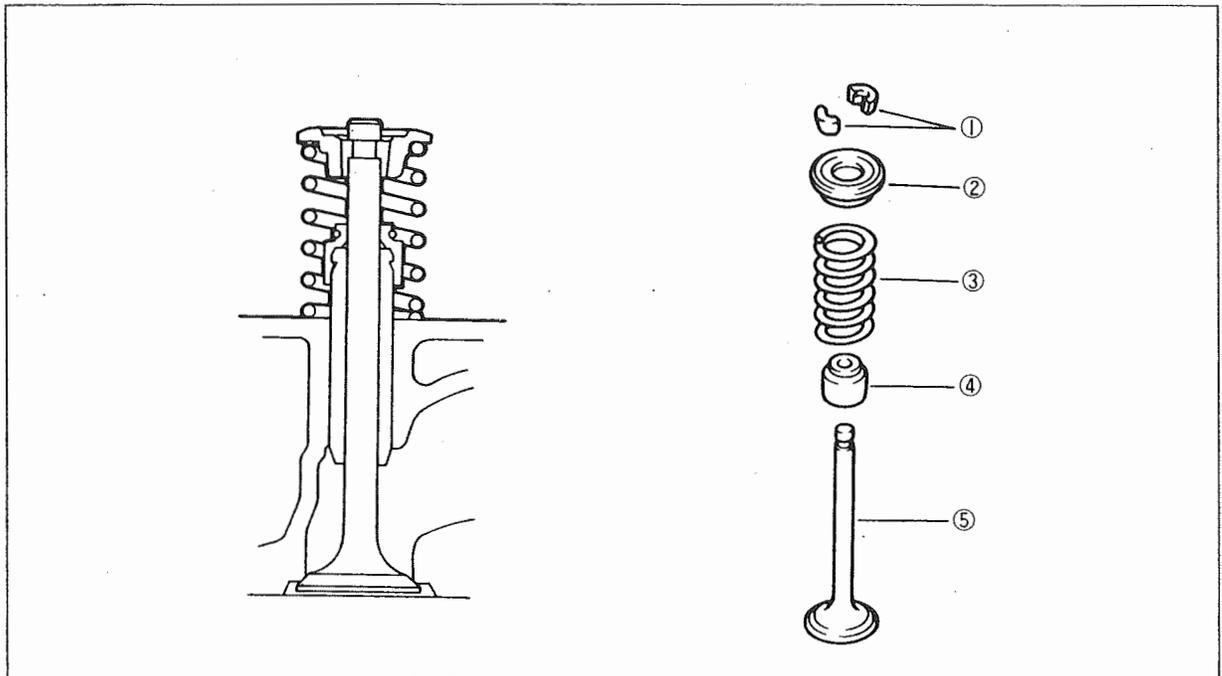
1-04 VALVE AND VALVE SPRING

Group
No.

1-04



■ Components



- ① Retainer lock
- ② Valve spring retainer
- ③ Valve spring

- ④ Valve stem seal
- ⑤ Valve

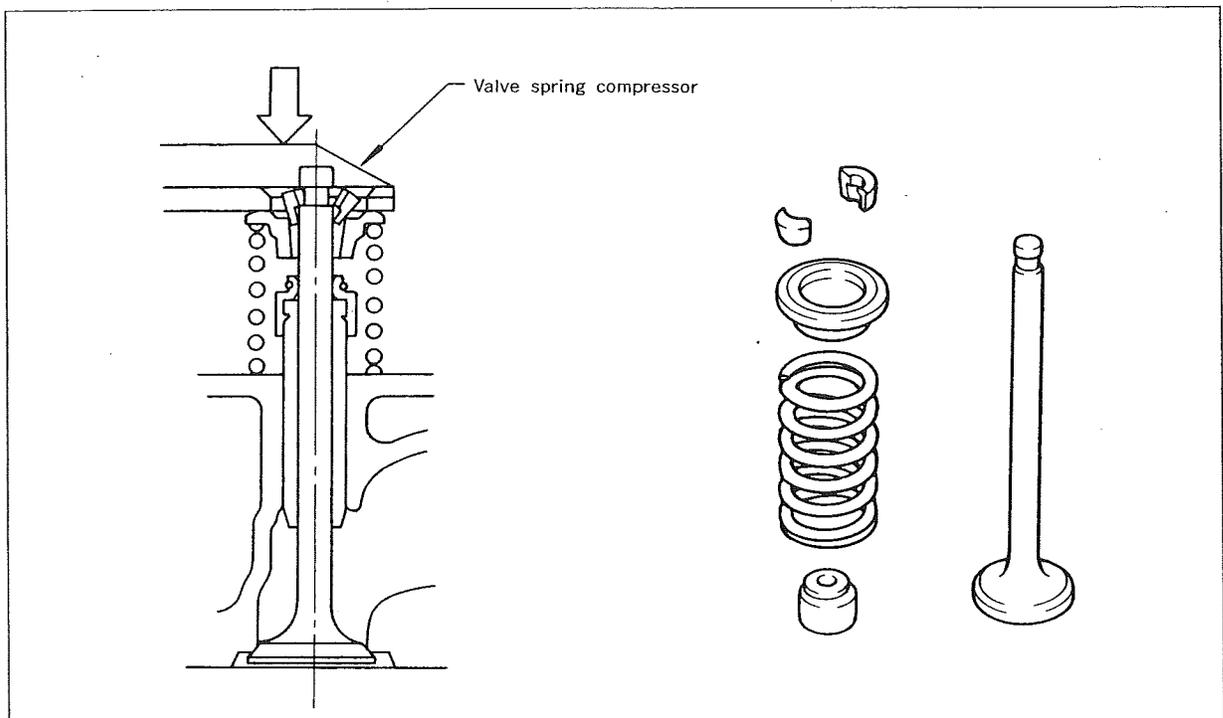


Group
No.

1-04 VALVE AND VALVE SPRING

■ Removal

- (1) Remove the cylinder head assembly.
- (2) Remove each part as follows and put in order for each cylinder.



Removing Valve Spring

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■ Inspection and Repair

Repair or replace the parts if necessary.

(1) Valve refacing

If the valve face is worn, reface the face with a valve refacer. However, if the margin of the valve face exceeds the service limit after refacing, replace the valve.

Description	Standard value	Service limit
Margine	1, 0	0, 5

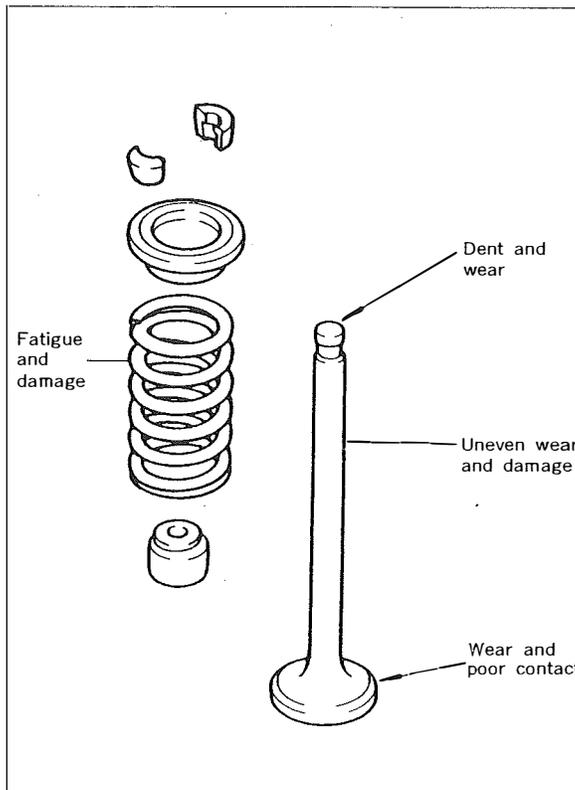
(2) Valve stem end refacing

If the valve stem end is worn or pitting, the end should be ground with the valve refacer or an oil-stone. However, if the margin after such refacing exceeds the limitation, the valve should be replaced.

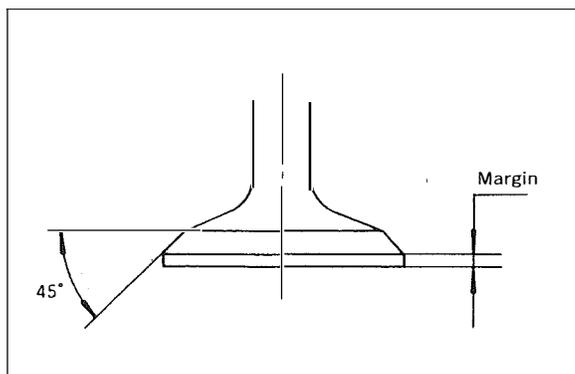
(3) Valve spring inspection

Check the valve spring for cracks or damage. Measure the free length, tension and squareness of the valve spring.

Description		Standard value	Service limit
Free length (mm)		43	- 1, 0
Load (kg)		14 ± 0, 7 (at 36mm)	- 15%
		29, 8 ± 2 (at 28mm)	
Squareness		2° or less	3°



Valve and Valve Spring Inspection



Valve Refacing

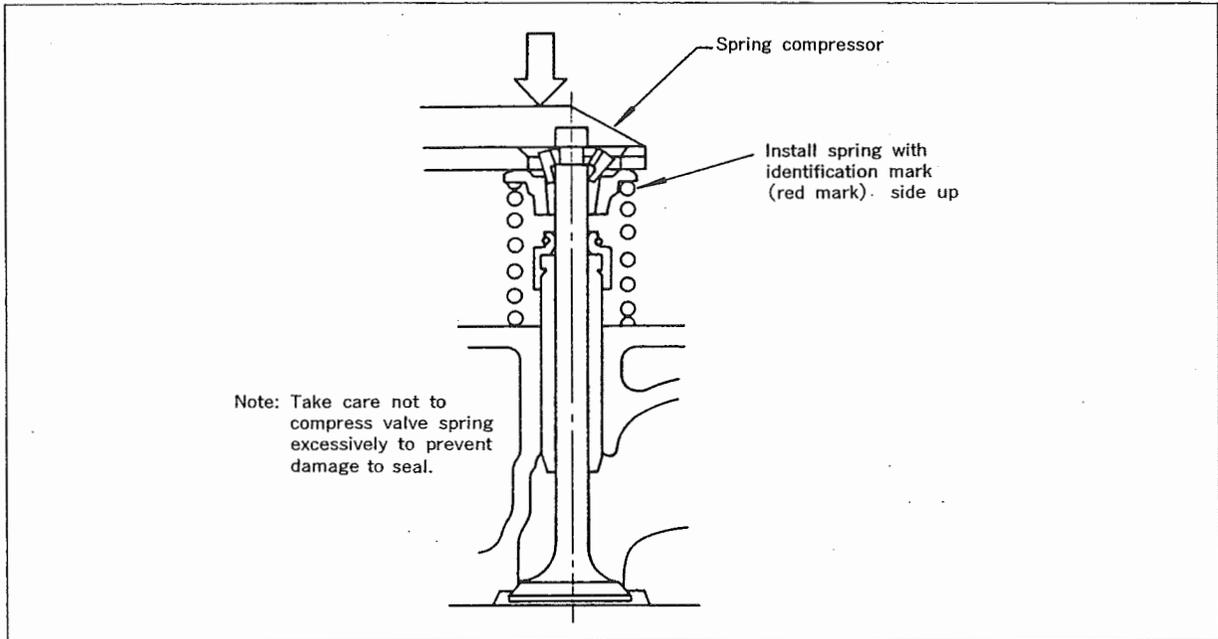


Group
No.

1-04 VALVE AND VALVE SPRING

■ Installation

- (1) Note the following items when installing the valves and valve springs.



- (2) Install the cylinder head assembly.
- (3) Install the rocker shaft assembly.
- (4) Adjust the valve clearance.



Group No.

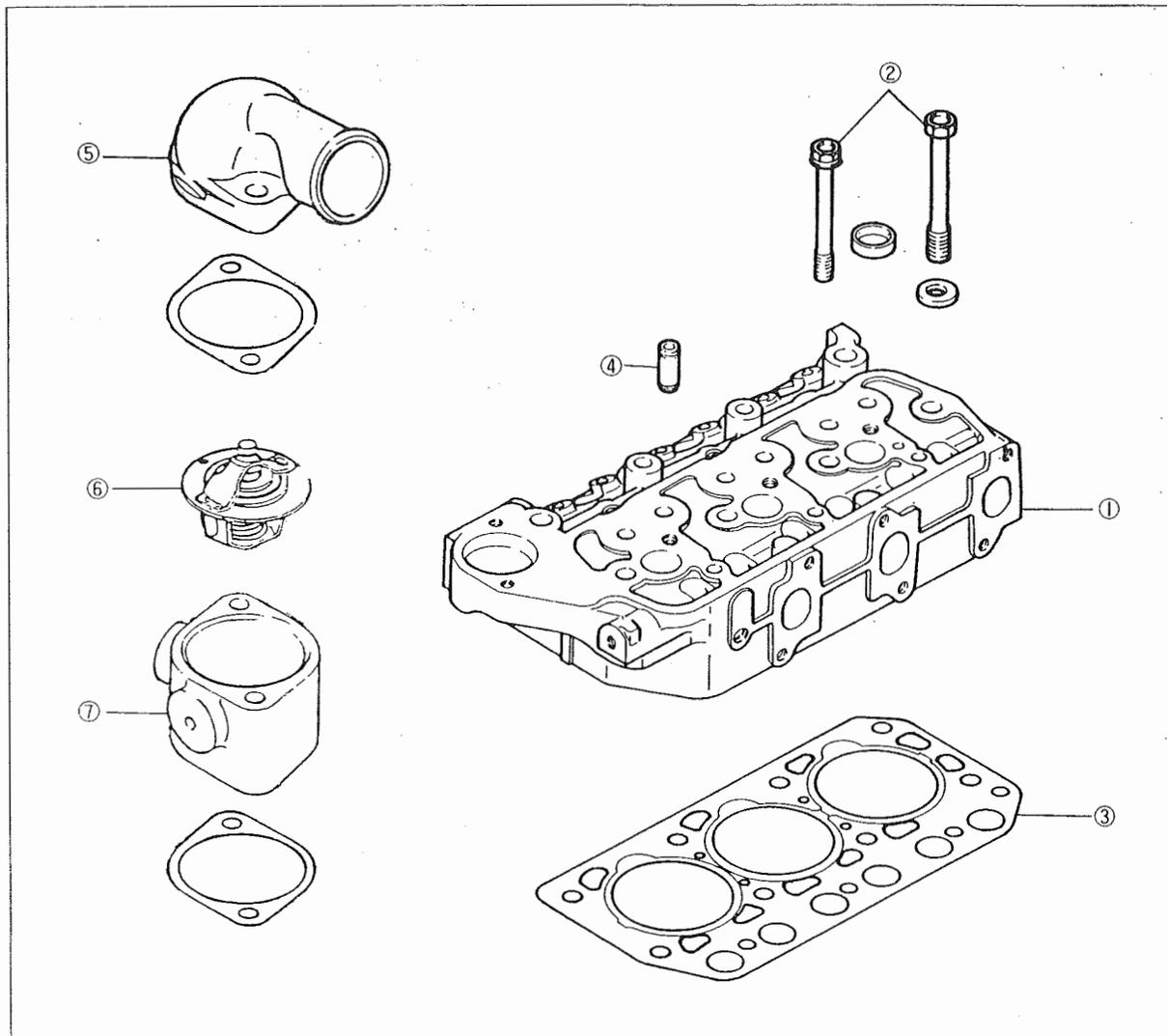
1-05 CYLINDER HEAD

Group No.

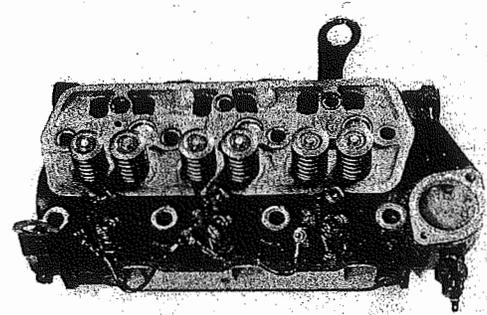
1-05



■ Components



- ① Cylinder head
- ② Cylinder head bolt
- ③ Cylinder head gasket
- ④ Valve guide
- ⑤ Water outlet fitting
- ⑥ Thermostat
- ⑦ Thermostat case



Cylinder Head Assembly (K3)



Group
No.

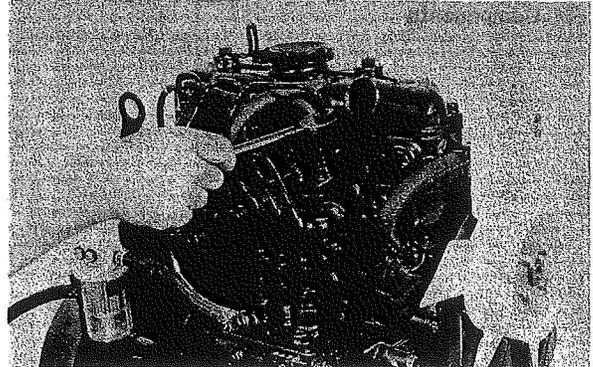
1-05 CYLINDER HEAD

■ Removal

- (1) Remove the injection pipe assembly.
When loosening the injection pipe nuts, counterhold the nozzle or delivery valve holder with a spanner.

Caution

- After removing the injection pipes, plug the openings of the nozzle holders and delivery valve holders to prevent them from entering dust.



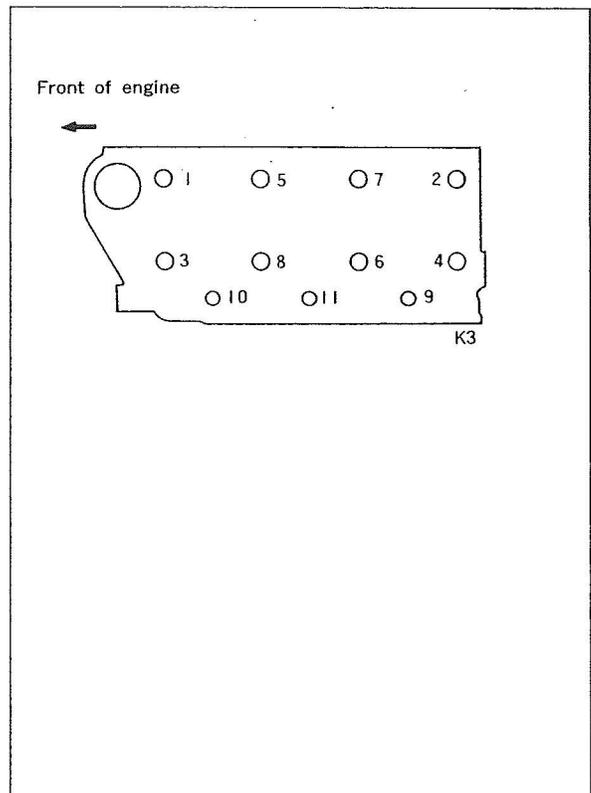
Removing Injection Pipe

- (2) Remove the rocker cover, rocker shaft and push rods.
- (3) Remove the alternator brace.
- (4) Remove the water hose (outlet side).
- (5) Remove the connectors on the intake and exhaust manifolds.
- (6) Disconnect the wires from the glow plugs.
- (7) Loosen and remove the cylinder head bolts.

Caution

- Loosen the cylinder head bolts in the sequence shown in the figure in 2 to 3 steps.

- (8) Remove the cylinder head.
- (9) Remove the cylinder head gasket.



Cylinder Head Bolt Loosening Sequence

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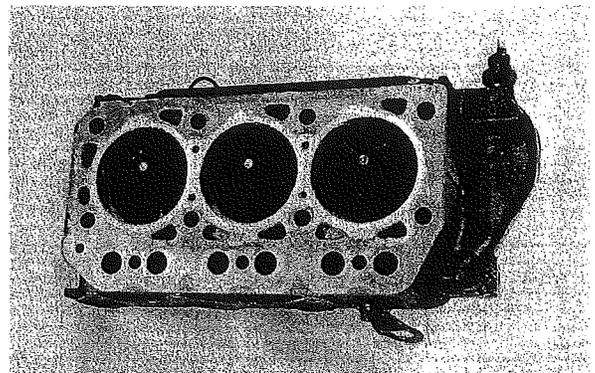
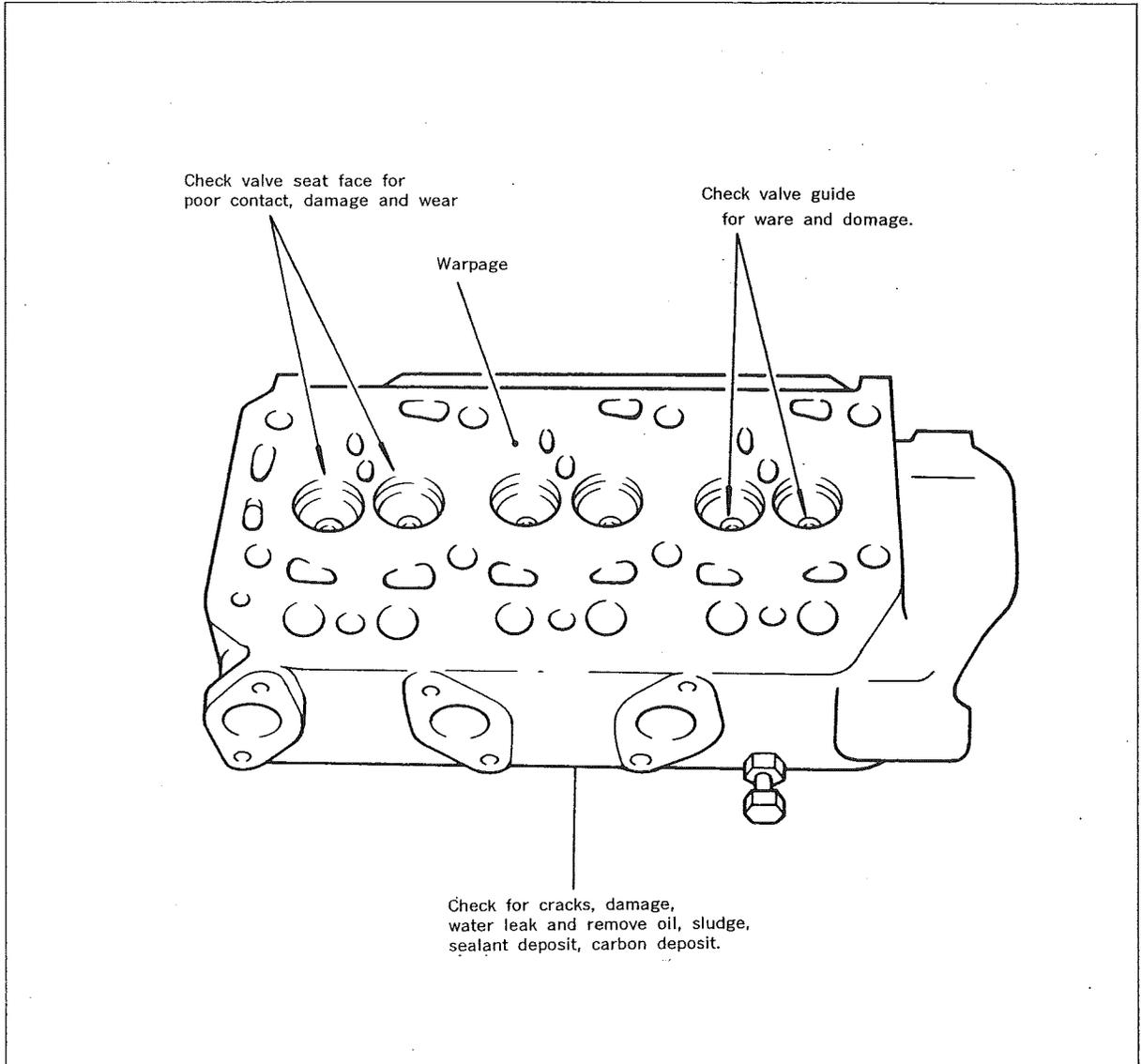
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■ Inspection and Repair

Repair or replace the parts if necessary.



Cylinder Head Inspection (K3)



Group
No.

1-05 CYLINDER HEAD

■ Valve Guide Replacement

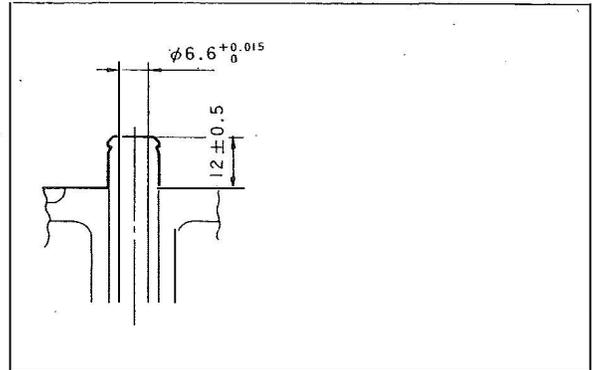
Replace the valve guide if it is worn or damaged.
Remove the valve guide by pressing it from the upper side to the lower (seat) side with a press.

Description		Standard value
Valve guide pressing height (A)		12 ± 0.5

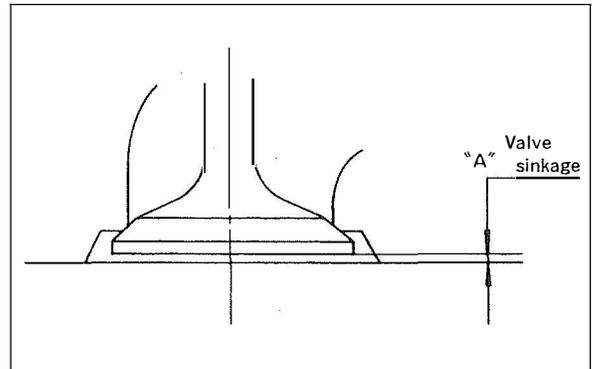
■ Valve Seat Refacing

Refer or replace the valve seat if necessary.

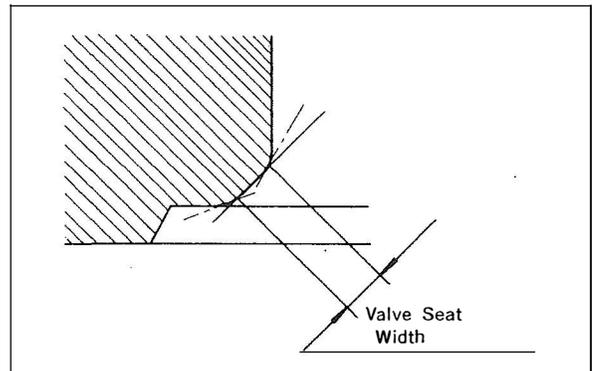
Description	Standard value	Service limit
Sinkage of valve (A)	0.5 ± 0.35	1.5



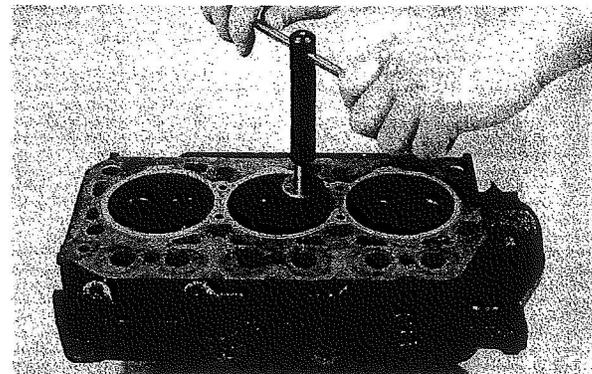
Valve Guide Pressing Height



Valve Head Depth



Valve Seat Width



Valve Seat Refacing



■ Installation

Install the cylinder head in the reverse order of removal while following the items below.

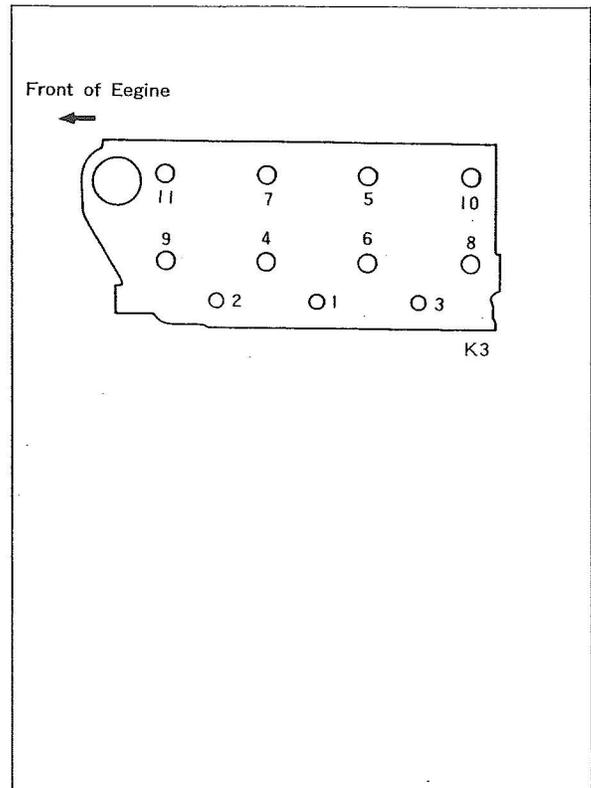
- (1) Use a new cylinder head gasket which is selected as described on the next page. Do not use a liquid sealant.
- (2) Tighten the cylinder head bolts to the specified torque values in the sequence shown in 2 to 3 steps.

Tightening torque

(M10) 6.5 ~8.0 (Wet)

(M12) 11.5 ~12.5 (Wet)

- (3) Loosen the injection pipe clamp and install the pipes. Take care not to allow dust to enter the fuel lines and passages.
- (4) Install the push rods and rocker arm assembly and adjust the valve clearance.



Cylinder Head Bolt Tightening Sequence

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Group
No.

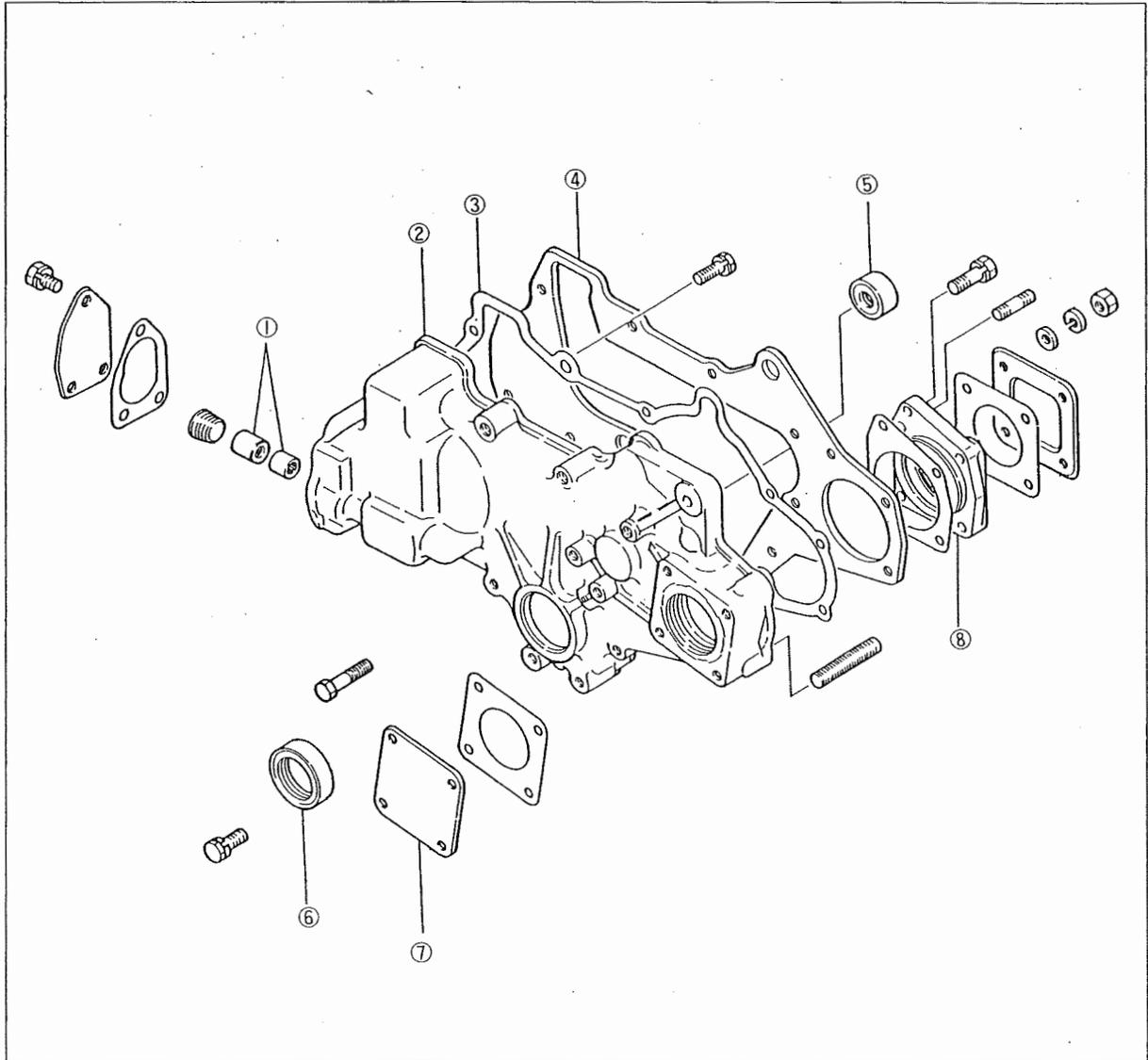
1-06 GEAR CASE

Group
No.

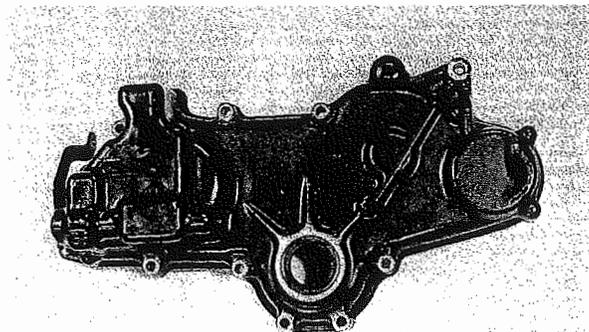
1-06



■ Components



- ① Needle bearing
- ② Gear case
- ③ Gear case gasket
- ④ Front plate
- ⑤ Thrust plug
- ⑥ Oil seal
- ⑦ Oil pump cover
- ⑧ Pump gear housing



Gear Case Assembly



Group
No.

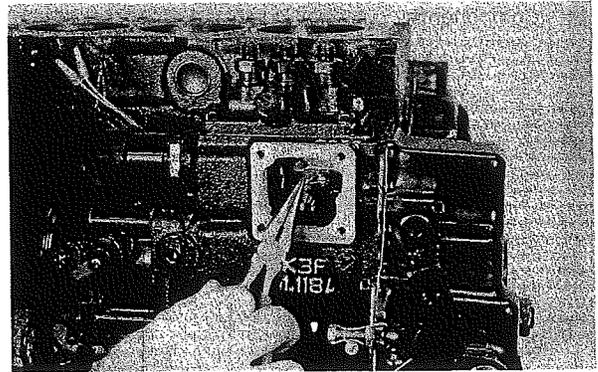
1-06 GEAR CASE

■ Removal

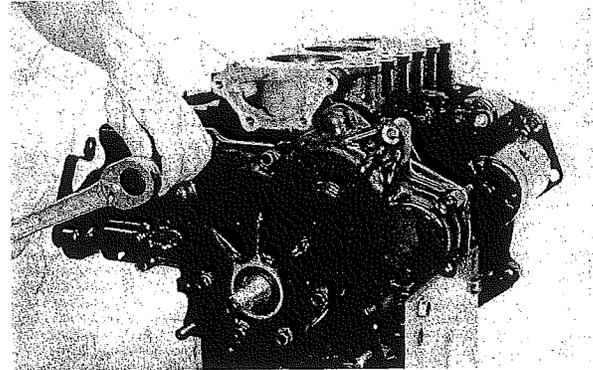
- (1) Remove the fan belt.
- (2) Remove the crankshaft pulley.
- (3) Disconnect the adjusting rod if the engine is equipped with the speed control solenoid for the cooler unit system, etc.
- (4) Remove the tie rod cover and disconnect the tie rod and tie rod spring which are connected to the injection pump control rack.
- (4) Remove the high pressure pump of the machine side.
- (6) Remove the alternator.
- (7) Remove the gear case.

Caution

- When removing the gear case, do not tap out the front plate together. The front plate is also bolted inside of the gear case.



Tie Rod Removing



Gear Case Assembly Removing

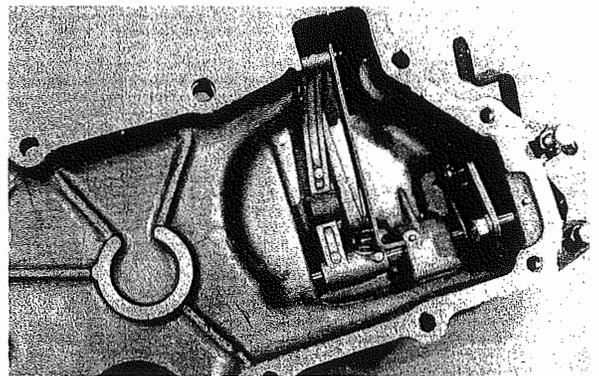
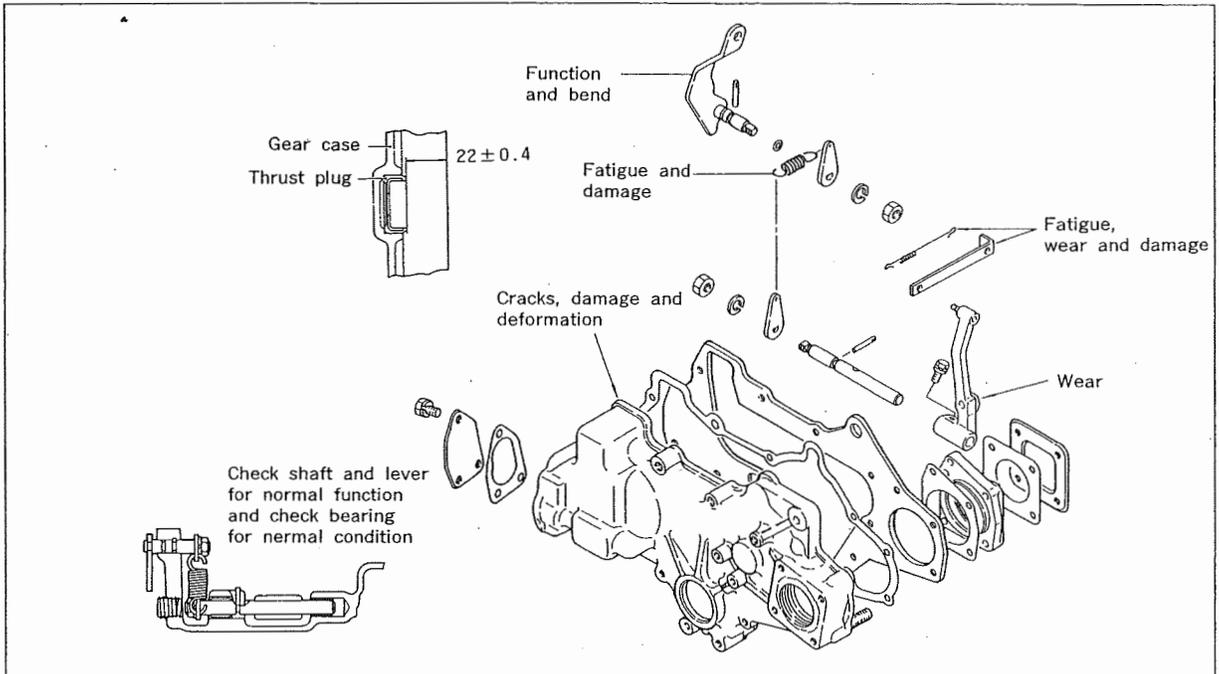
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■ Inspection



Gear Case Inspection

■ Installation

Install the gear case in the reverse order of removal.

Caution

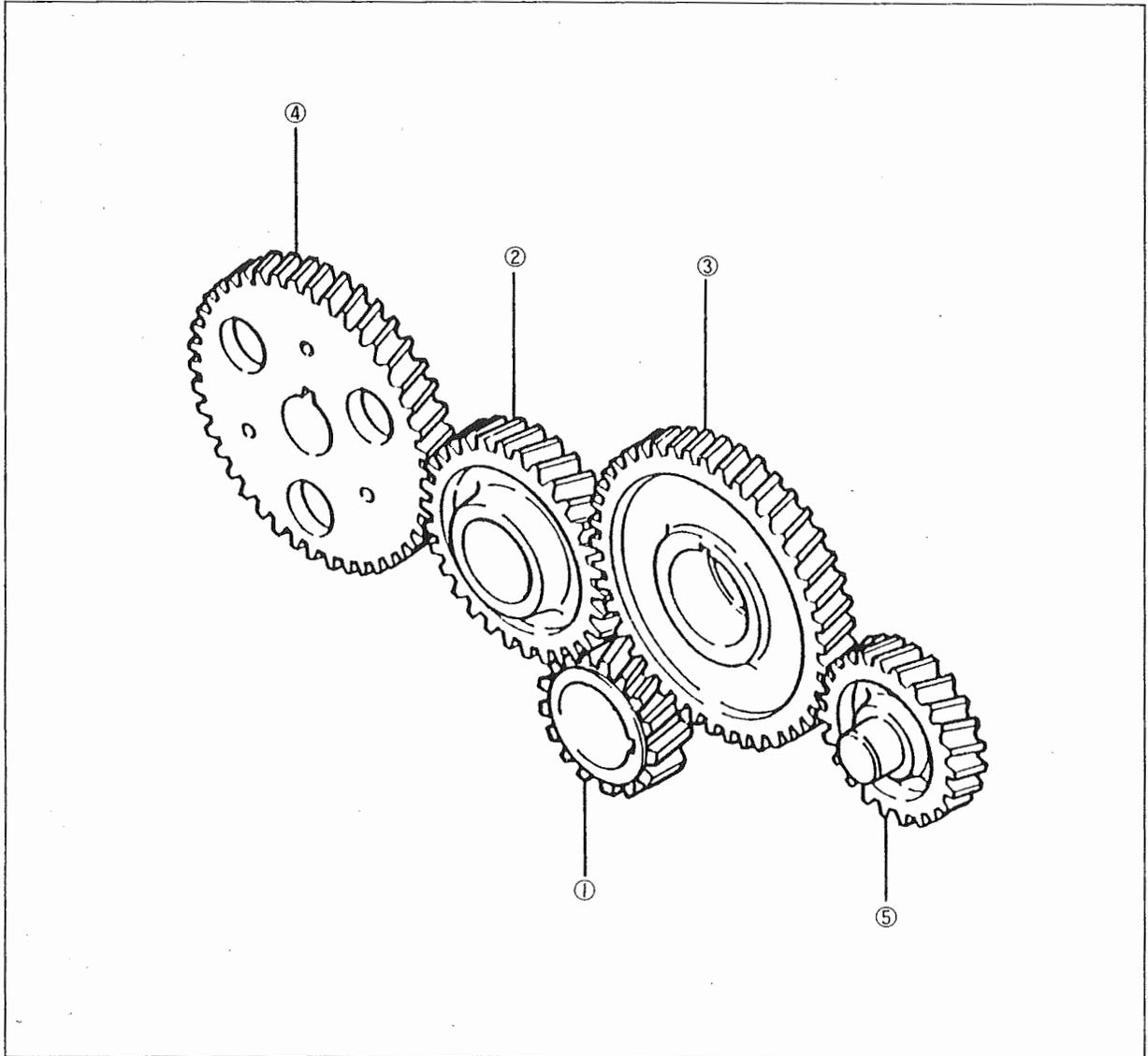
- (1) Attach the gear case gasket with adhesive or sealant to prevent it from slipping off.
- (2) Install the tie rod and tie rod spring by inserting them into the hole in the block.
- (3) Apply engine oil or grease to the lip of the oil seal and install the seal taking care of not giving damage to the seal lip.



Group
No.

1-07 TIMING GEAR

■ Components



① Crankshaft gear

③ Camshaft gear

⑤ High pressure pump

② Idle gear

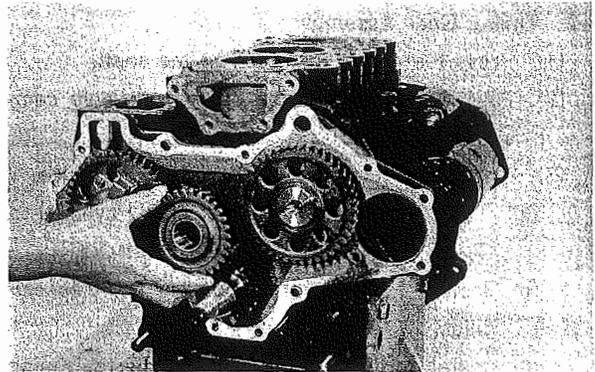
④ Injection pump gear



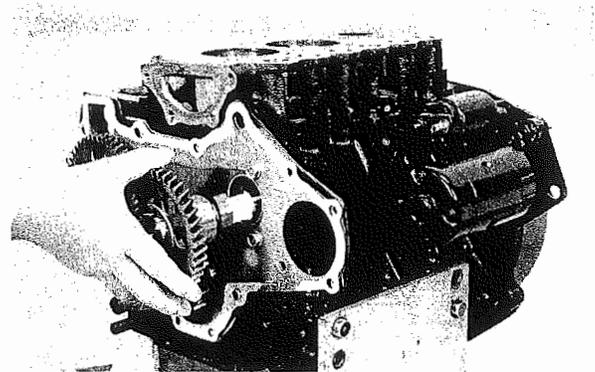
■ Removal

Remove the timing gears after removing the gear case, cylinder head, tappet, injection pump, etc.

- (1) Remove the snap ring and idle gear.
- (2) Remove the camshaft gears (for valve and pump cams) after removing the camshaft assembly because the gears are press fitted.
- (3) Remove the crankshaft gear after removing the crankshaft because it is also press fitted.



Idle Gear Removing



Camshaft Removing

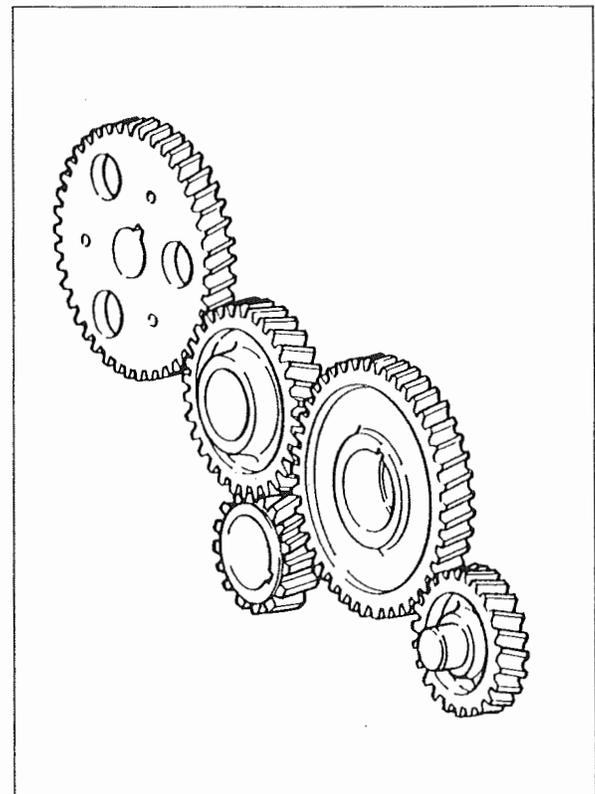
■ Inspection

Replace the gear if necessary.

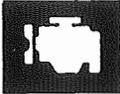
Description	Standard value	Service limit
Idle gear bush - to - shaft clearance	0.03~0.07	0.2

Gear backlash after assembly

Description	Standard value	Service limit
Crankshaft - to - idle	0.01~0.14	0.3
Idle - to - valve cam		
Idle - to - injection pump cam		



Timing Gear Inspection



Group
No.

1-07 TIMING GEAR

■ Timing Gear Assembly

- (1) Press the crankshaft gear on the shaft.
- (2) Press the gears on the pump and valve camshafts.
- (3) Install the gears in the following procedure.
 - (a) Turn the crankshaft until the No. 1 cylinder is T. D. C. of the compression stroke.
 - (b) Install the pump and valve camshaft assemblies.
 - (c) Install the idle gear while aligning the timing marks.
 - (d) Re-check the timing gear mark alignment.



Group No.

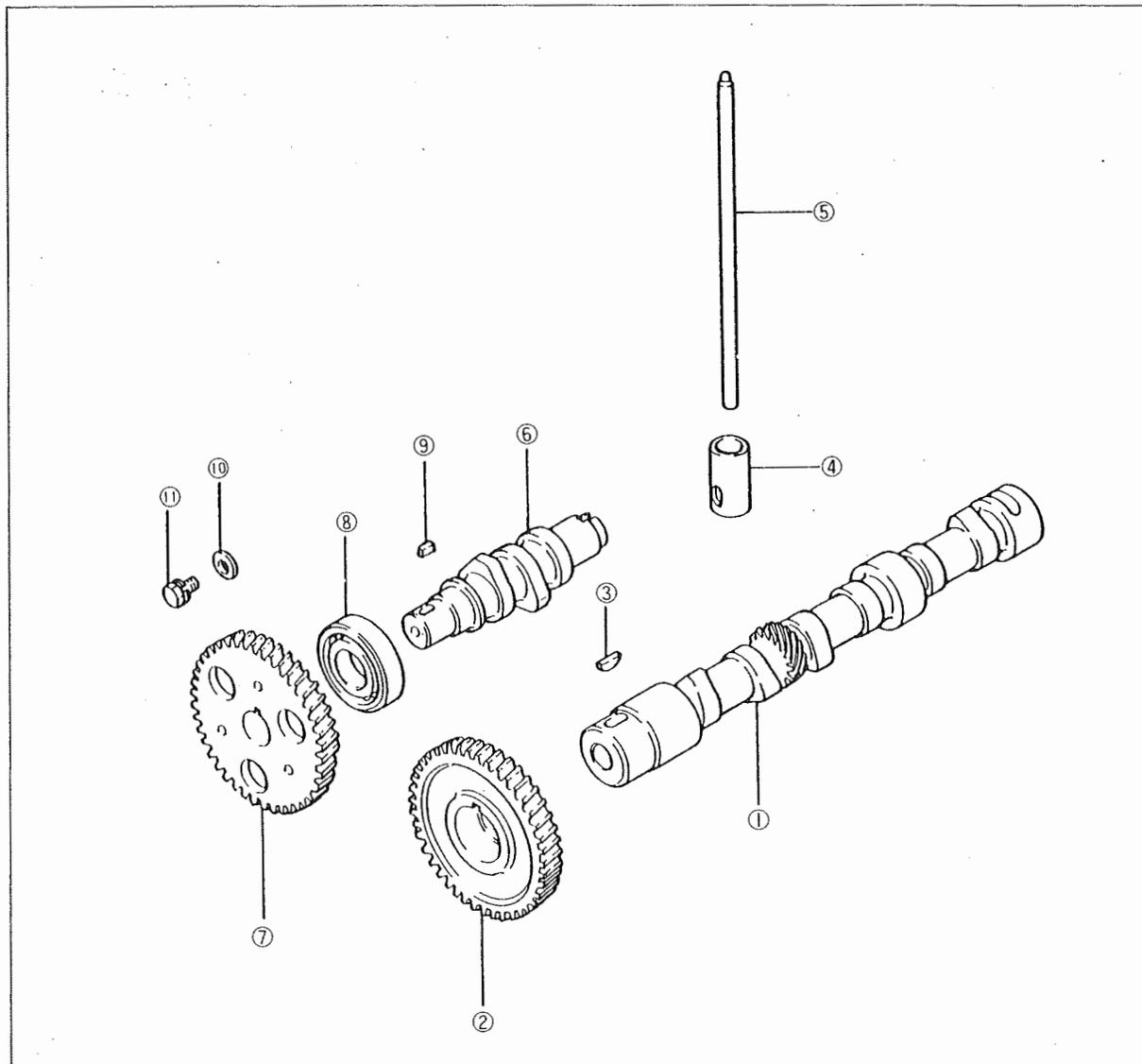
1-08 CAMSHAFT (Valve and Pump)

Group No.

1-08



Components



- | | | |
|--------------------|-----------------------------|-------------------------|
| ① Camshaft (valve) | ⑤ Push rod | ⑨ Sunk key |
| ② Cam gear | ⑥ Camshaft (injection pump) | ⑩ Thrust stopper washer |
| ③ Woodruff key | ⑦ Pump cam gear | ⑪ Bolt |
| ④ Tappet | ⑧ Ball bearing | |



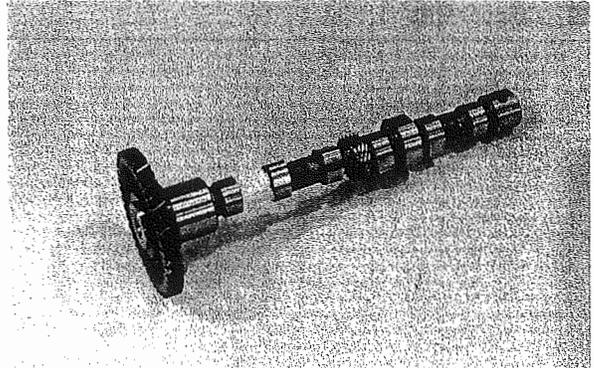
Group
No.

1-08 CAMSHAFT (Valve and Pump)

■ Valve Camshaft Removal

1. Valve Camshaft Removal

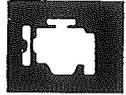
- (1) Remove the cylinder head assembly.
- (2) Remove the push rods.
- (3) Remove the tappets.
- (4) Remove the gear case assembly.
- (5) Remove the camshaft stopper bolt.
- (6) Remove the camshaft assembly.



Valve Camshaft Removal

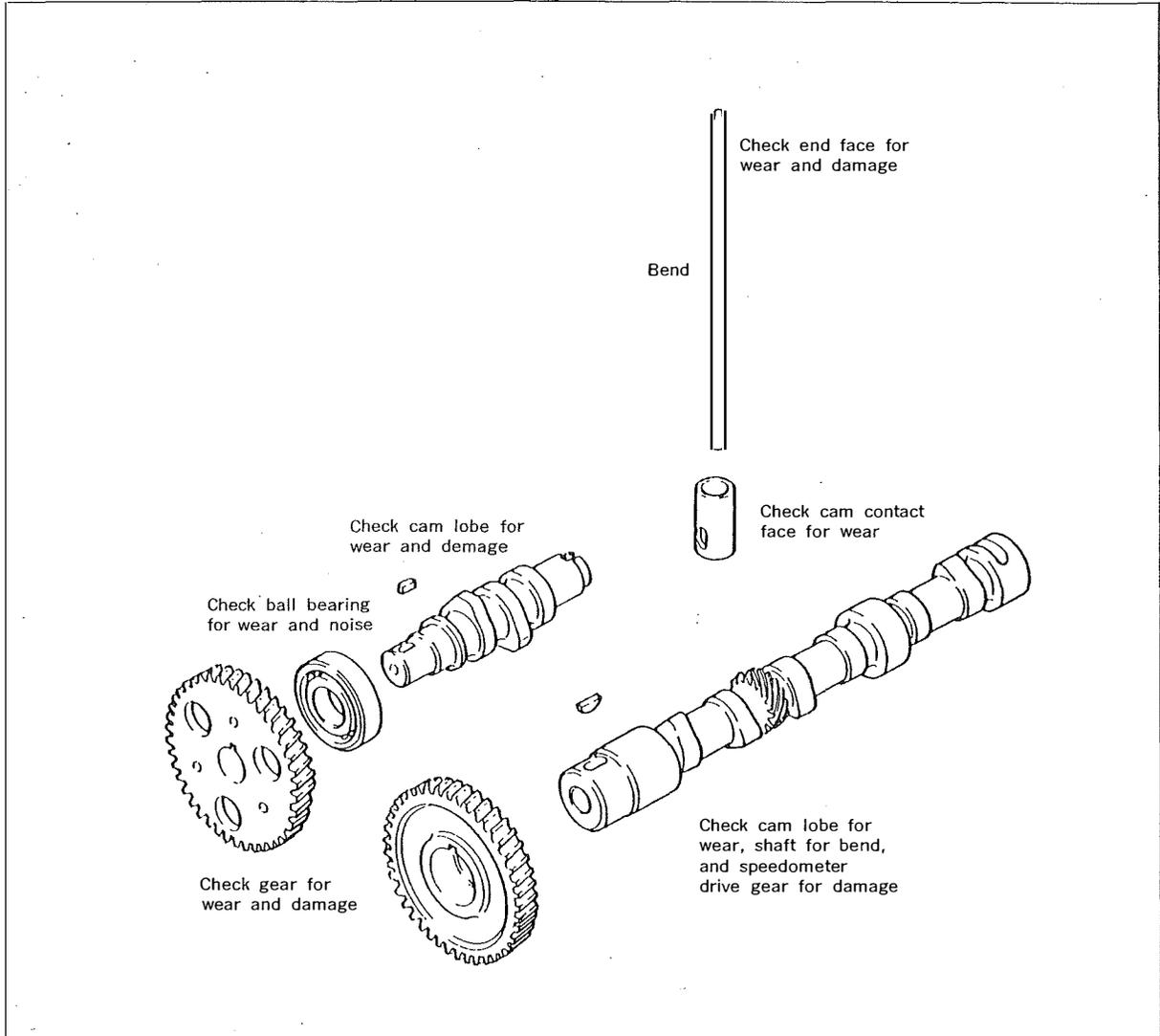
2. Pump Camshaft Removal

- (1) Remove the injection pipes.
- (2) Remove the injection pump assembly.
- (3) Remove the gear case assembly.
- (4) Loosen and remove the stopper bolt.
- (5) Remove the camshaft from the front side.



■ **Inspection**

Repair or replace the parts if necessary.



Valve camshaft		
Description	Standard value	Service limit
Front journal O. D.	45	
Center journal O. D.	44	
Rear journal O. D.	34	
Cam height (base O. D. + lift)	35.72	-1.0
	Former*	34.69

Pump camshaft		
Description	Standard value	Service limit
Rear journal O. D.	25	
Coupling groove width	5	-0.5
Cam height (base O. D. + lift)	44	-1.0



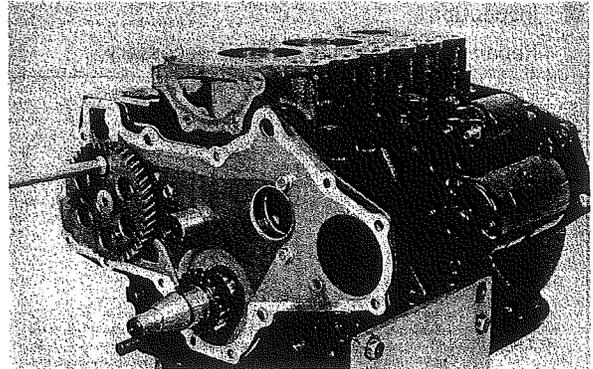
Group
No.

1-08 CAMSHAFT (Valve and Pump)

■ Installation

Install the camshaft while noting the following items.

- (1) Apply engine oil to the all bearings and cams.
- (2) Install the camshaft in the reverse order of removal.
- (3) Re-check the timing marks.
- (4) After installation, check and adjust the injection timing and valve clearance.



Installing Pump Camshaft

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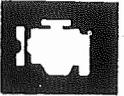


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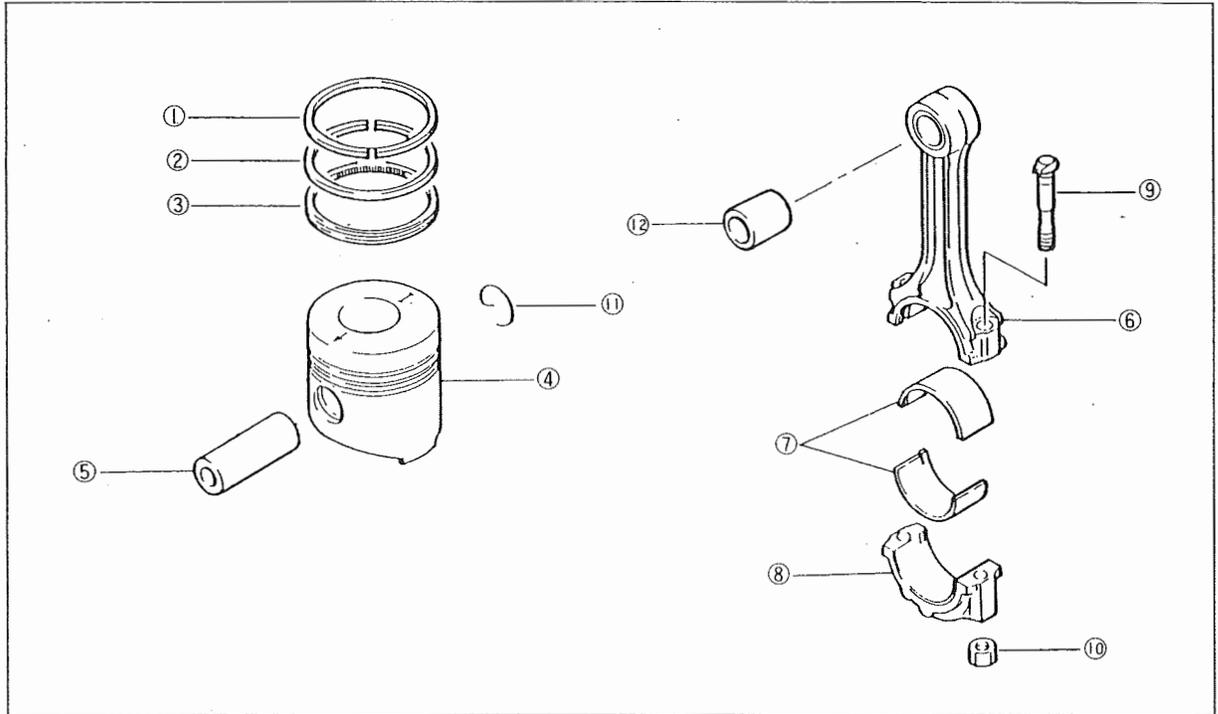
1-09 PISTON AND CONNECTING ROD

Group No.

1-09



■ Components

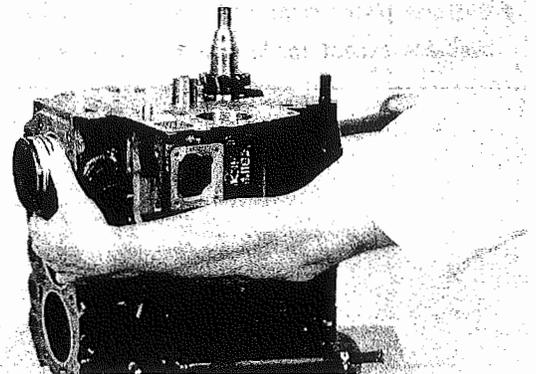


Piston and connecting rod components

- | | | |
|---------------------|--------------------------|--------------------------------------|
| ① No. 1 piston ring | ⑤ Piston pin | ⑨ Connecting rod bolt |
| ② No. 2 piston ring | ⑥ Connecting rod | ⑩ Connecting rod nut |
| ③ Oil ring | ⑦ Connecting rod bearing | ⑪ Snap ring (Not used for K3C and D) |
| ④ Piston | ⑧ Connecting rod cap | ⑫ Small end bush |

■ Removal

- (1) Remove the cylinder head assembly.
- (2) Remove the oil pan and oil screen.
- (3) Mark the cylinder number on the big end of the connecting rod.
- (4) Remove the connecting rod cap and remove the piston and connecting rod assembly from the top of the cylinder block taking care of not giving damage to the cylinder and crankpin with the connecting rod.



Removing Piston and Connecting Rod Assembly

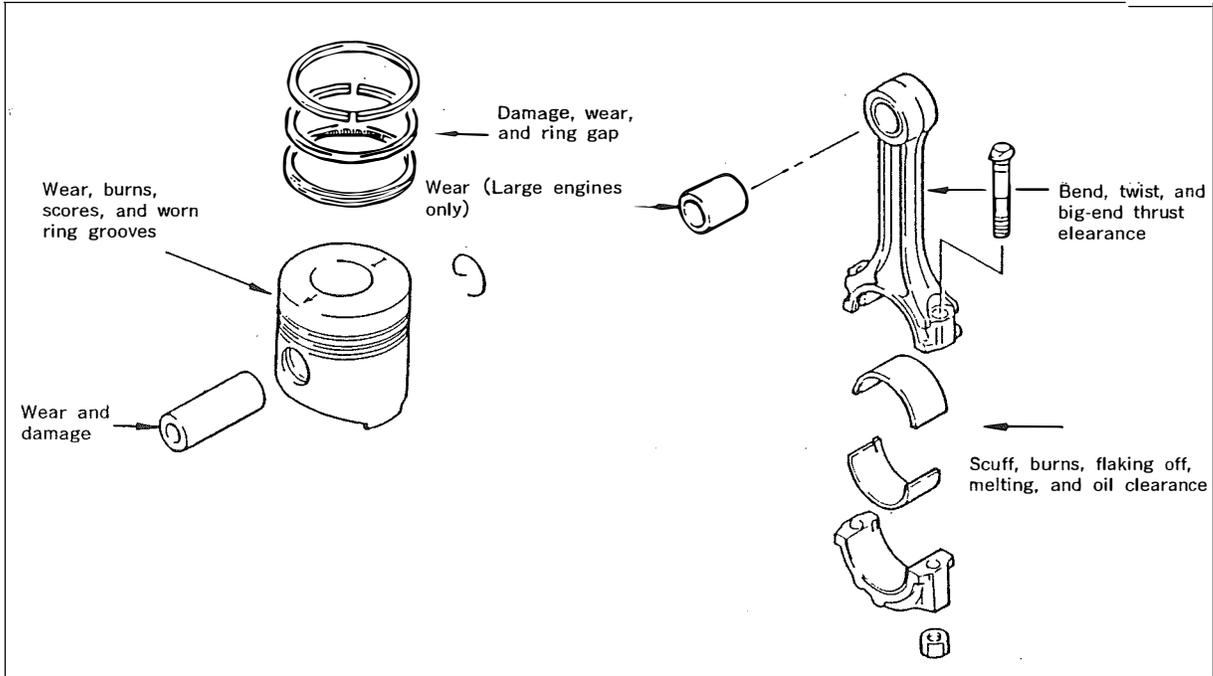


Group No.

1-09 PISTON AND CONNECTING ROD

■ Inspection

Repair or replace the parts if necessary.

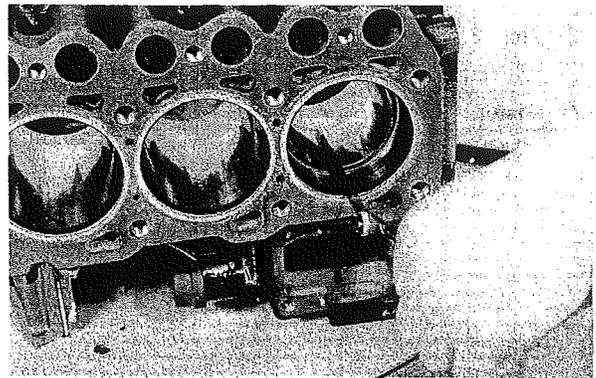


1. Piston Ring Gap Inspection

Using a piston, push the piston ring into the cylinder squarely and measure the ring gap with a feeler gauge. Replace the piston ring if the gap exceeds the service limit.

Caution

- The ring must be fitted to the diameter at the lower limit of ring travel which has the minimum diameter.
- When replacing the rings, use correct sized new rings for the piston.
-



Piston Ring Gap

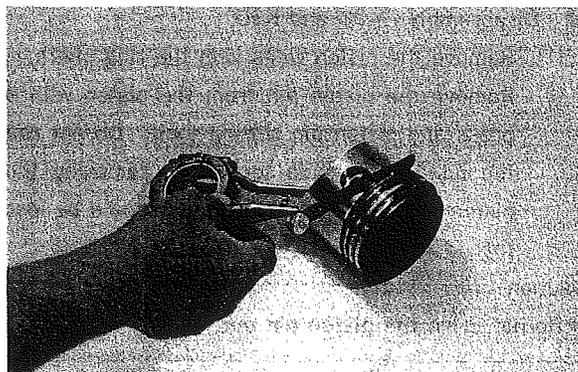
Piston ring gap		
Description	Standard value	Service limit
No. 1	0.2~0.4	1.5
No. 2		
Oil ring	0.3~0.45	



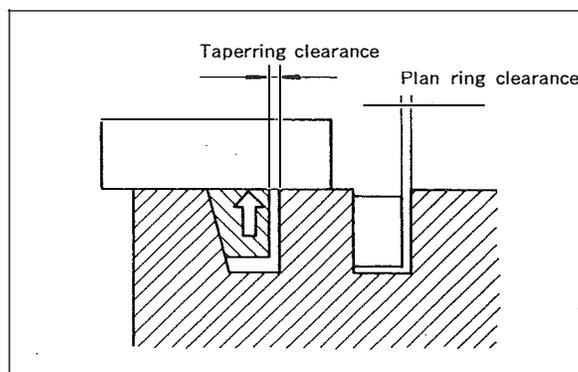
2. Piston Ring-to-Groove Clearance Inspection

- (1) Measure the piston ring-to-groove clearance. If the clearance exceeds the service limit, replace the ring with a new one and re-check the clearance.
- (2) If the clearance still exceeds the service limit, replace the piston with a new one.

Piston ring-to-groove clearance		
Description	Standard value	Service limit
No.1	0.06	0.3
No.2	0.07	0.2
Oil ring	0.05	0.2



Measuring Piston Ring-to-Groove Clearance



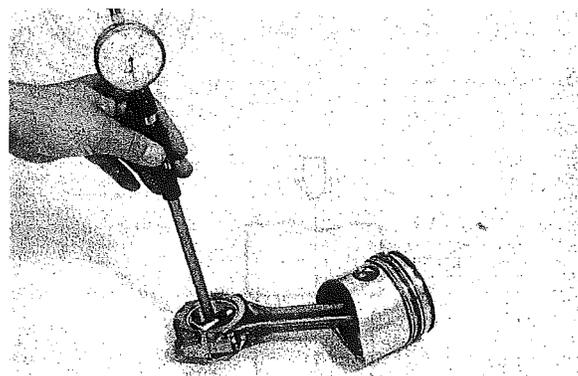
Measuring Semi-keystone Piston Ring-to-Groove Clearance

3. Connecting Rod Big End Bearing Inspection

Install the big end bearings and cap to the connecting rod, tighten the rod cap to the specified torque and measure the bearing I. D.

Caution

- Oil clearance between the big end bearing and the crankpin can be measured with a plastic gauge.
- If the oil clearance does not fall within the service limit with new bearings, refer to the crankshaft chapter and use undersize bearings.



Measuring Rod Big End Bearing I. D.

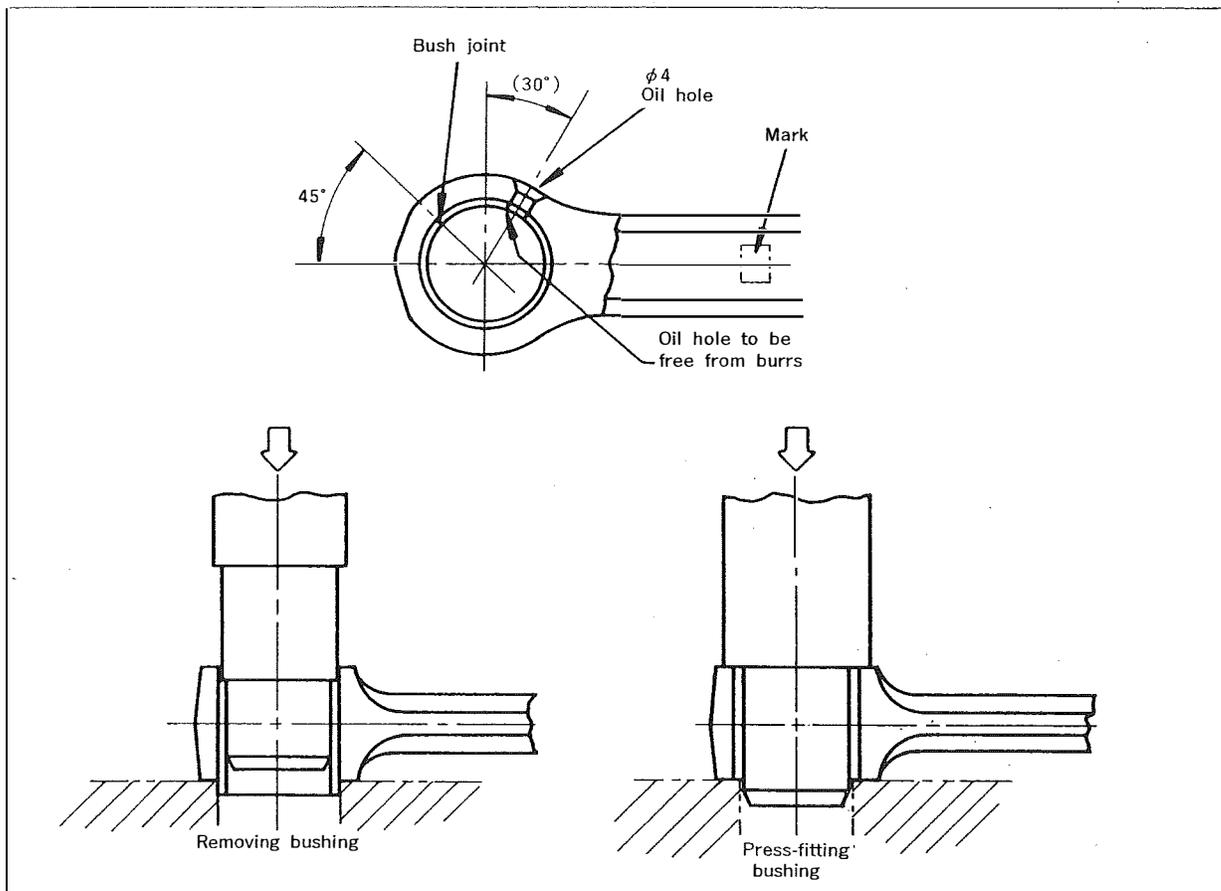
Description	Standard value	Service limit
Rod big end bearing I. D. (Standard)	42	+0.15
		+0.15
Rod big end bearing oil clearance	0.025~0.080	0.15
		0.15
Cap nut tightening torque (kgm)	3.2 - 3.5	

Group
No.

1-09 PISTON AND CONNECTING ROD

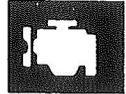
■ Connecting Rod Small End Bush Replacement

Replace the connecting rod small end bush in the following manner.



*If the bush I. D. is smaller than the standard value after pressing it in, ream the I. D. to the standard value with.

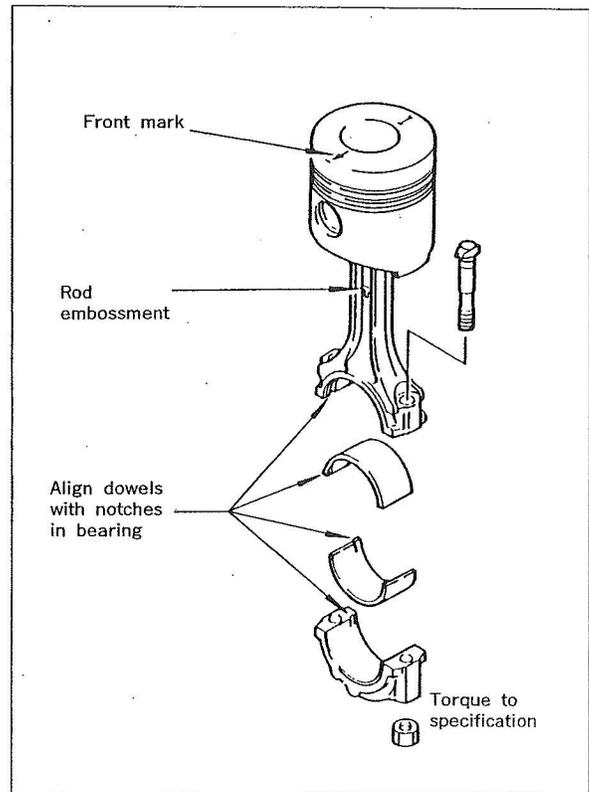
Description	Standard value
Rod small end bush I. D.	$23^{+0.041}_{+0.005}$



■ Installation

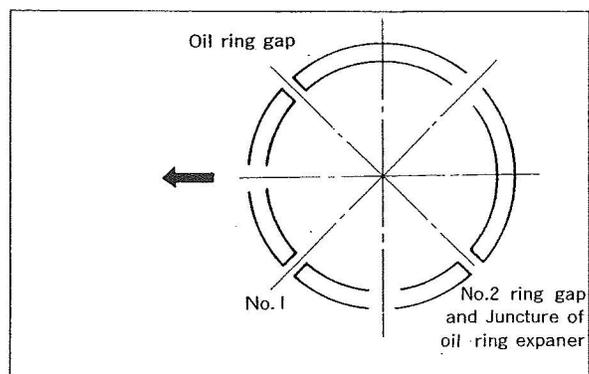
- (1) Assemble the piston and connecting rod while noting the following items,

Apply oil to the snap ring groove and install the snap ring in the groove by the fingers securely.



Installation Direction of Piston and Connecting Rod

- (2) Position the ring gaps as shown in the figure and apply engine oil to the piston and cylinder wall,



Piston Ring Gap Position

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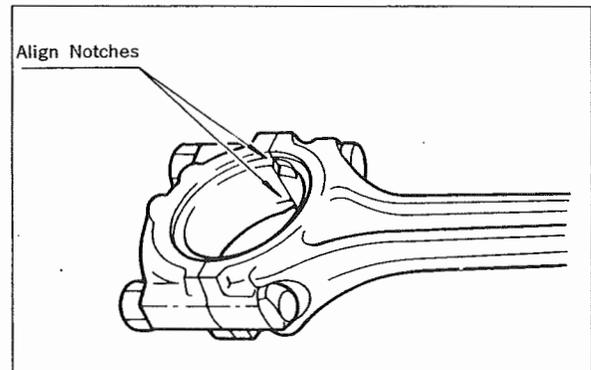


Group
No.

1-09 PISTON AND CONNECTING ROD

- (3) Compress the piston rings with the piston band. Face the front marks on the piston and connecting rod to the front of the engine and insert the piston/connecting rod assembly into the cylinder from the top. Do not drive the piston head with too much blow to insert the piston for fear of possible ring breakage.

- (4) Apply engine oil to the connecting rod cap bearing and install the cap aligning the cylinder numbers on the rod and cap marked at the time of disassembly. If the connecting rod is replaced with a new one, face the bearing stop notches to the same direction as shown in the figure.



Installing Connecting Rod Cap



Group
No.

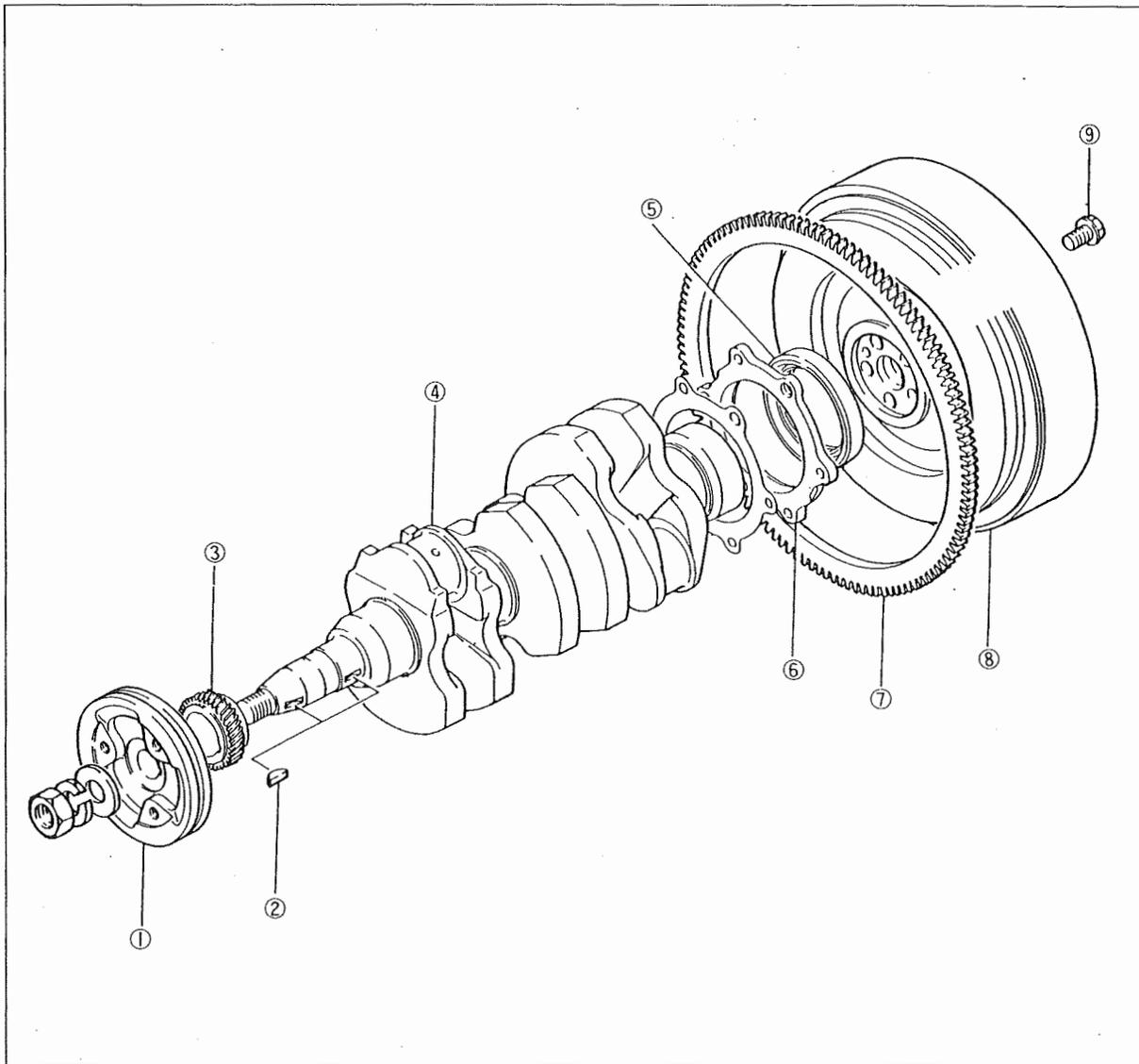
1-10 CRANKSHAFT AND FLYWHEEL

Group
No.

1-10



Components



Crankshaft and flywheel components

- ① Crankshaft pulley
- ② Key
- ③ Crankshaft gear

- ④ Crankshaft
- ⑤ Rear oil seal
- ⑥ Rear oil seal case

- ⑦ Ring gear
- ⑧ Flywheel
- ⑨ Flywheel bolt



Group
No.

1-10 CRANKSHAFT AND FLYWHEEL

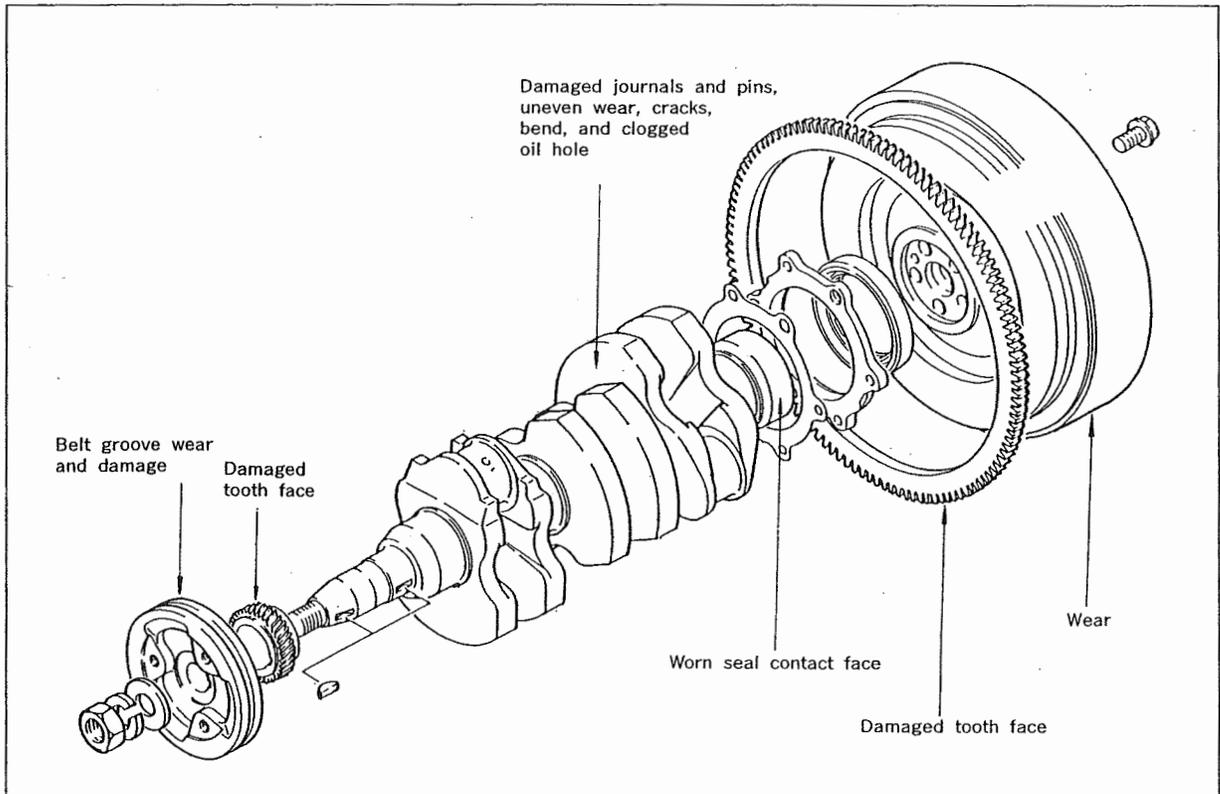
■ Removal

Remove the cylinder head assembly, oil pan, pistons, connecting rods and gear case before removing the flywheel and crankshaft.

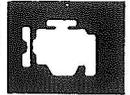
- (1) Remove the flywheel mounting bolts and the flywheel.
- (2) Remove the rear oil seal case.
- (3) Remove the front plate.
- (4) Remove the main bearing caps.
- (5) Remove the crankshaft.

■ Inspection

Repair or replace the parts if necessary.



Crankshaft and Flywheel Inspection

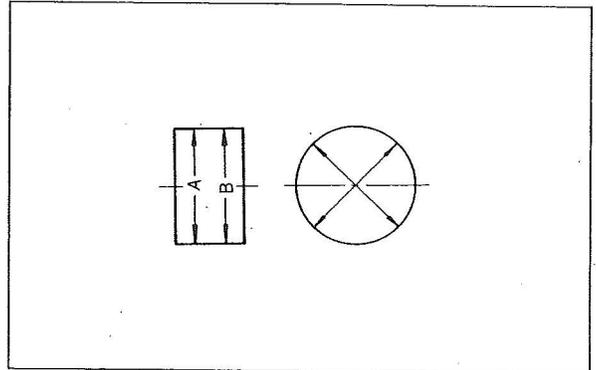


I. Crankshaft Wear Inspection

- (1) Crankshaft journal and pin O. D. measurement
Measure the journal and pin O. D. at two places (front and rear) in A and B directions as shown in the figure. If the measured value exceeds the service limit, ground the crankshaft to the undersize.

CAUTION

- If the crankshaft main or journal bearings are seized due to lacking of oil etc., the crankshaft can not be re-used.



Measuring Crankshaft Journal O. D.

Description	Standard value		Service limit
Journal O. D. (standard)	52		-0.15
Pin O. D. (standard)	42		-0.15

- (2) Grounding crankshaft to undersize
When grounding the crankshaft journals or pins to the undersize, finish them to the same size within the tolerance shown in the table. Also the fillet radii should be ground to 2.5R.

Description		Standard finished value	
Journal O. D.	0.25US	51.75	$^{0}_{-0.015}$
	0.55US	51.50	$^{0}_{-0.015}$
	0.75US	51.25	$^{0}_{-0.015}$
Pin O. D.	0.25US	41.75	$^{0}_{-0.050}$
	0.50US	41.50	$^{0}_{-0.050}$
	0.75US	41.25	$^{0}_{-0.050}$
Grounding limit (each)		-0.15	

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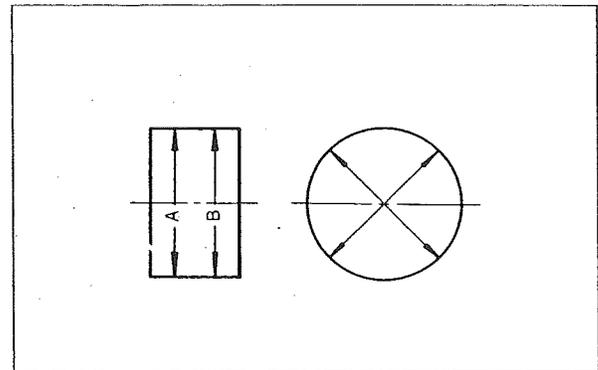
Group
No.

1-10 CRANKSHAFT AND FLYWHEEL

(3) Crankshaft oil clearance inspection

Measure the I. D. of the bearing at two places (front and rear) in A and B directions as shown in the figure.

Calculate the oil clearances of the journal and pin by subtracting the O. D. from the I. D. of the bearing.

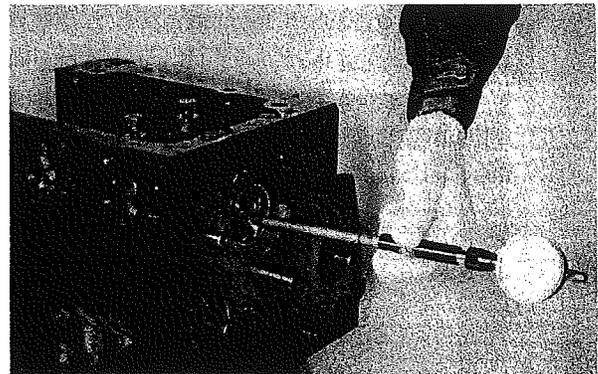


Measuring Bearing I. D.

Oil clearance

Description	Standard value	Service limit
Main bearing	0.040~0.101	0.15
Rod bearing	(See Group 1-09.)	

- (4) If the oil clearance still exceeds the service limit by using new bearings, grind the crankshaft to the undersize and use the undersize bearings. Undersize bearings are available in the following sizes :
- 0.25, 0.50, and 0.75 US

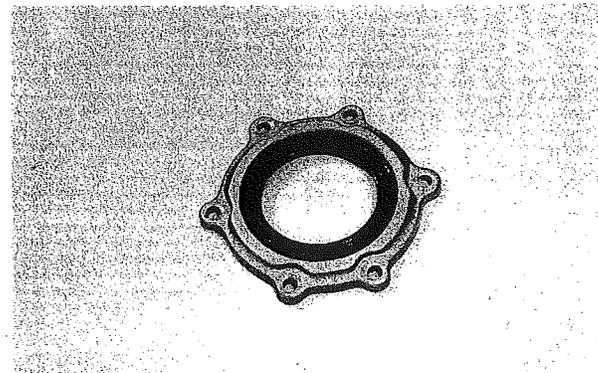


Inspecting Main Bearing

(5) Crankshaft rear oil seal replacement

- Remove the oil seal.
- Drive a new oil seal squarely into the oil seal case.

Take care not to drive it in aslant.

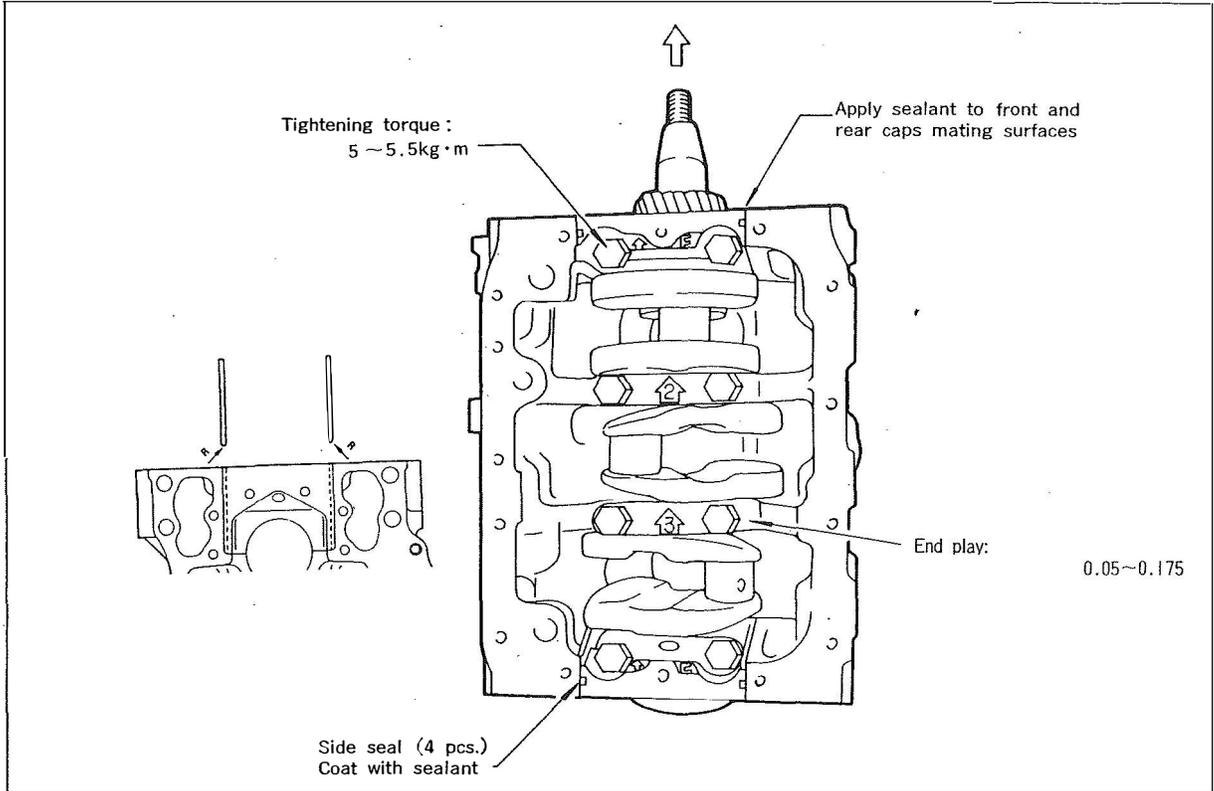


Driving Oil Seal

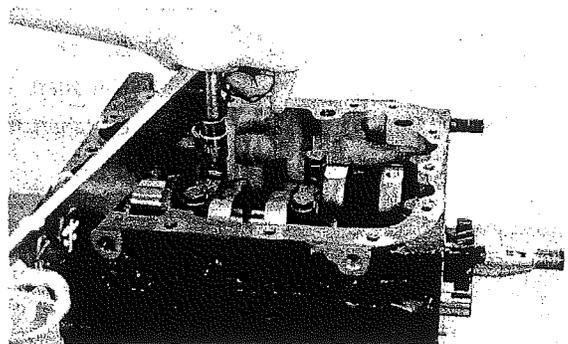


■ Installation

(1) Install the parts while noting the following items.



(2) Proper main bearing cap No. and direction of arrow (pointing the front of the engine) are shown in the figure.



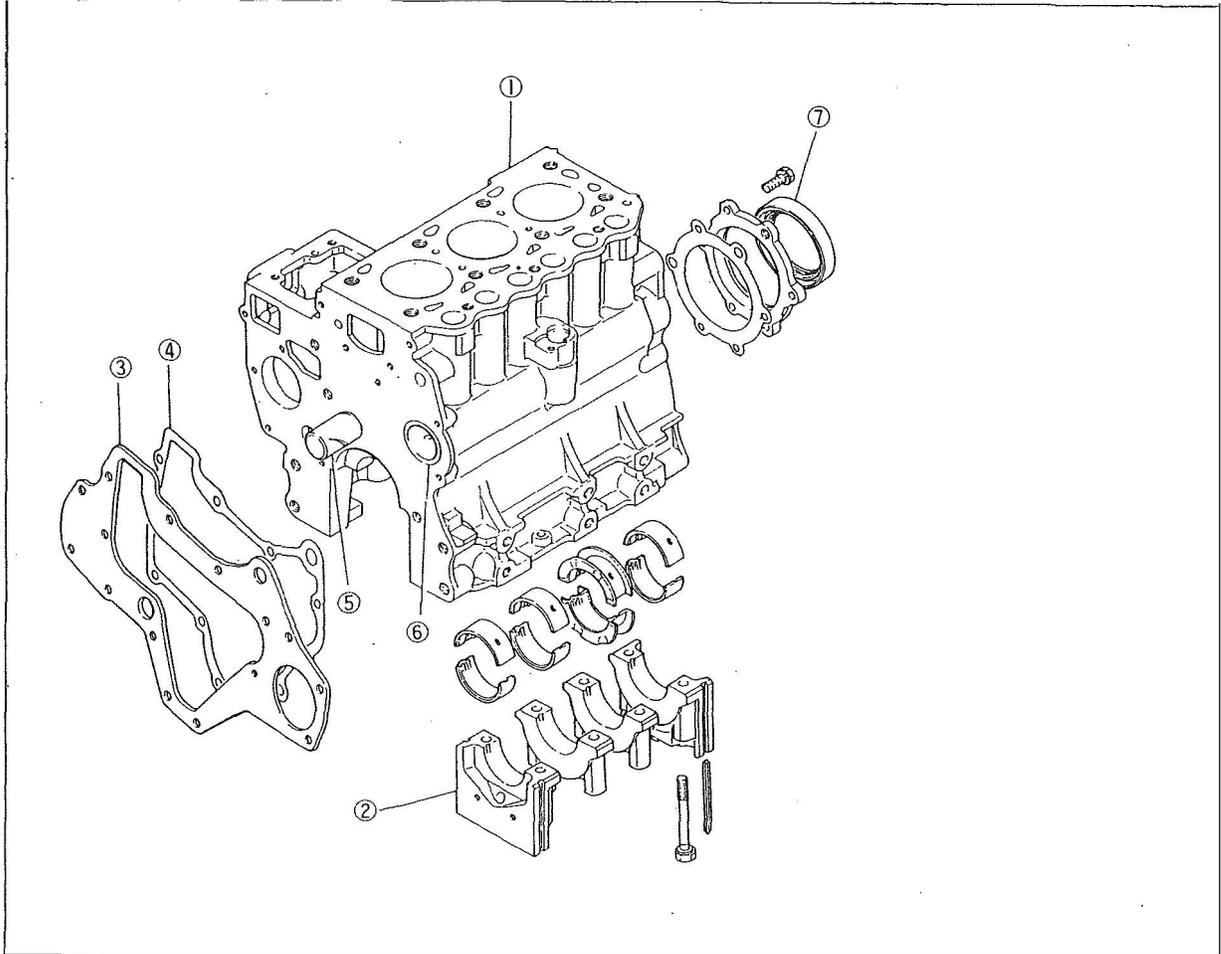
Installing Crankshaft



Group
No.

1-11 Cylinder Block

■ Components



① Cylinder block

② Main bearing cap

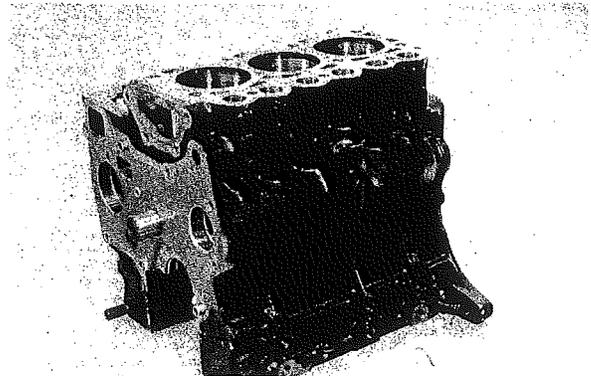
③ Front plate

④ Gasket

⑤ Idle shaft

⑥ Camshaft front bush

⑦ Rear oil seal

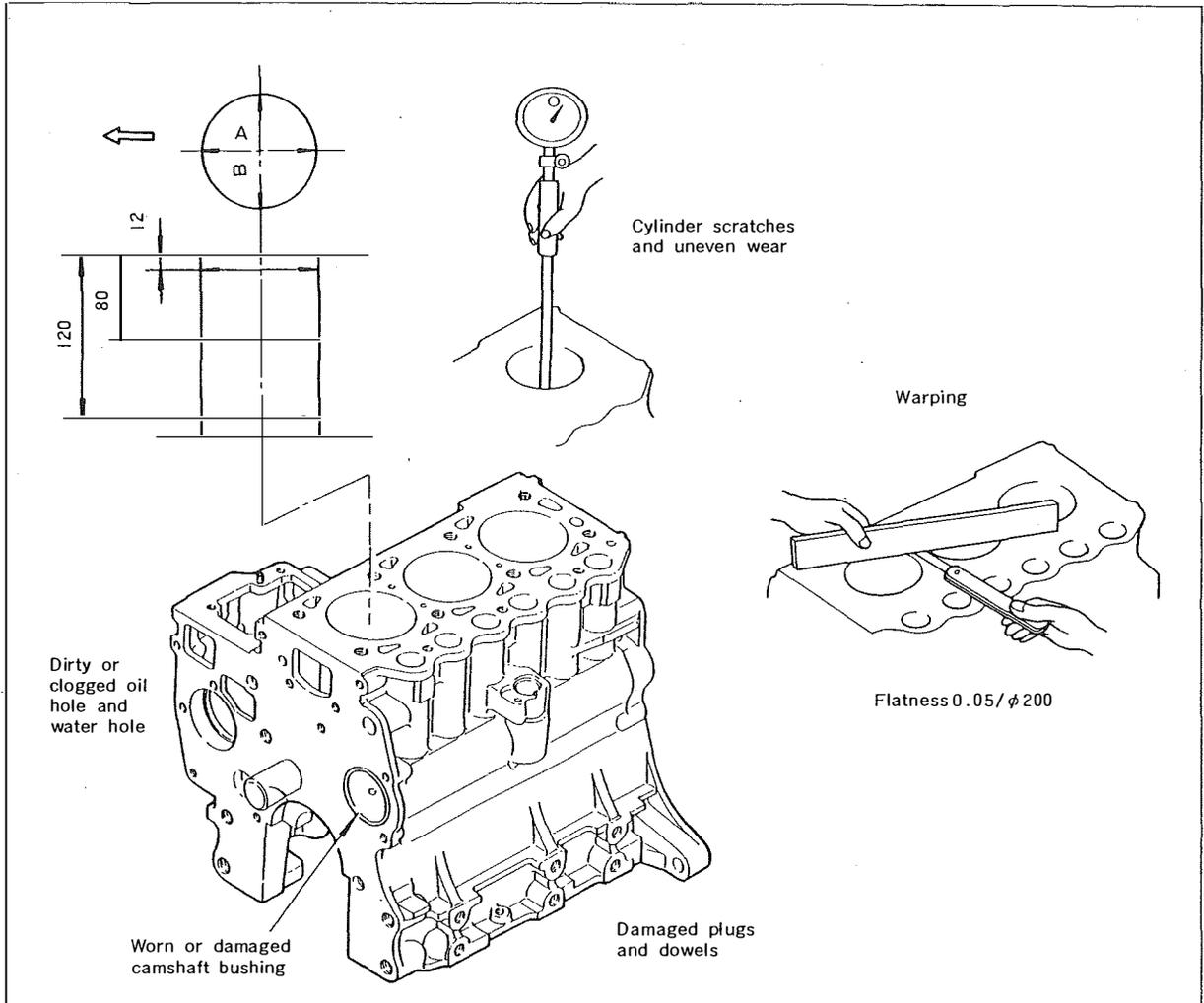


Cylinder Block Assembly

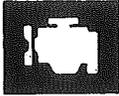


■ Inspection

Repair or replace the cylinder block if necessary.



Description	Standard value				Service limit
Cylinder I. D.	STD			82	-0.25
	0.250S			82.25	
	0.500S			82.50	
	0.750S			82.75	
Camshaft front bush I. D.	45				
Camshaft front bush oil clearance	0.050~0.125				
Camshaft center bush I. D.	44				
Camshaft rear bush I. D.	34				



Group
No.

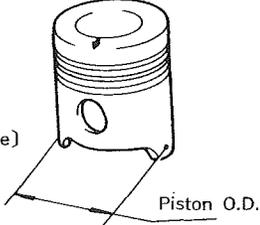
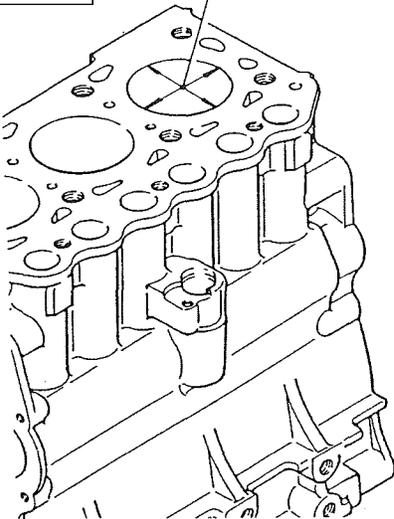
1-11 Cylinder Block

Honing Cylinders

Perform the honing in the following manner.

Size	Size mark
STD	Not available
OS 0.25	0.25
OS 0.55	0.50
OS 0.75	0.75

① Determination of boring finish size
[O.D. of oversize piston] + [Clearance]
- [Honing allowance (0.02 mm)]

② Clearance (between piston and cylinder), standard:
0.035 - 0.086

CAUTION

● All cylinders should be honed to the same oversize.

- (1) Oversize pistons are available in the following size :
0.25, 0.50 and 0.75
- (2) Honing allowance
The cylinder must be finished to the size called for by the piston to be installed within the tolerance shown below under consideration of 0.02 mm of honing allowance.
- (3) Honing tolerance

Nominal dia.	Tolerance
Nominal dia. of oversize piston to be installed	+0.03 0

Example : 0.50

Nominal dia. = 82.50 mm Tolerance = $82.50^{+0.03}_0$



Group
No.

1-11 CYLINDER BLOCK

■ Camshaft Front Bush Replacement

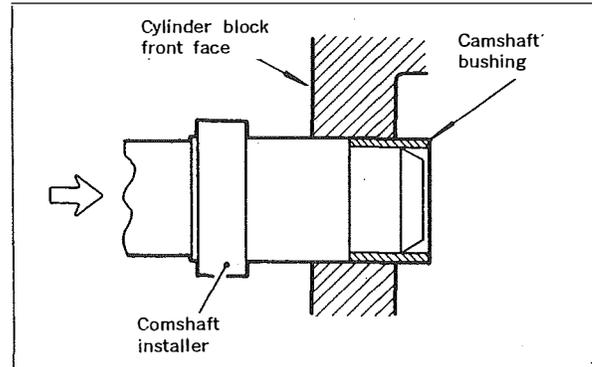
Replace the camshaft bush with the special tool and press the bush in the location and direction as shown in the figure.

(1) Bush removal

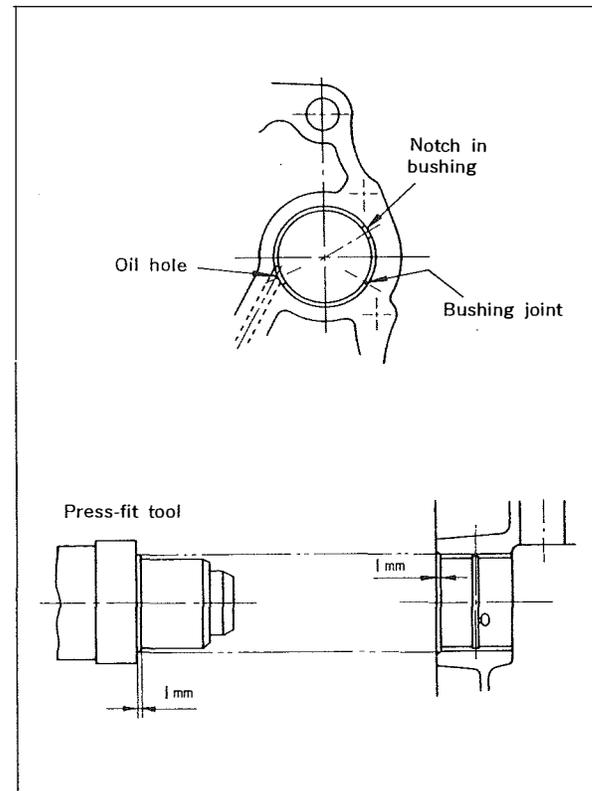
Use the drive outside of the tool and remove it into the inside of the block. Crush the bush to be taken out from the inside of the block with an enough care of not giving damage to the edge of the tappet hole.

(2) Pressing bush in

Press a new bush into proper location from the direction shown.



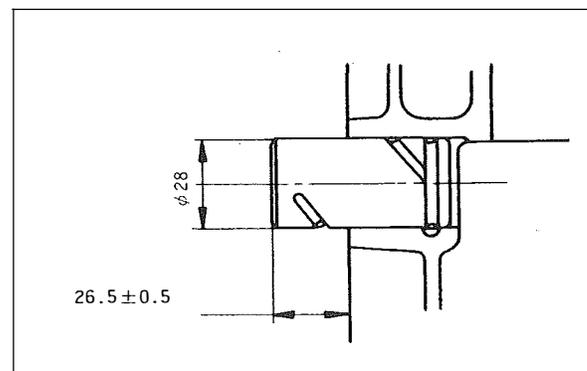
Driving Camshaft Bush Out



Pressing-in of Camshaft Bush

■ Pressing-in of Idle Gear Shaft

Pressing-in the idle gear shaft according to the dimension as shown in the figure.



Pressing-in of Idle Gear Shaft

Group 2	LUBRICATION	
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01 GENERAL72

02 OIL PUMP AND OIL FILTER73





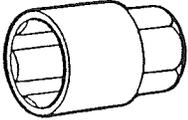
Group
No.

2-01 GENERAL

■ Specifications

Item	Specification
Lubrication and filtration	Forced lubrication, full-flow filtration type
Oil type	API service classification CC or severer
Oil capacity	3.0 or 7.0 (upper limit), oil filter oil capacity 0.5 or 0.7
Oil pump : Type Drive	Trochoid pump Driven by injection pump camshaft
Relief valve opening pressure	4.0 kg/cm ²
Oil pressure switch closing pressure	0.5 kg/cm ²
Oil filter	Paper-element cartridge type

■ Special Tools

Use	Tool name (Part number)	Sketch
Removing/installing oil pressure /switch	Oil pressure switch wrench (26) MD998054	



Group No.

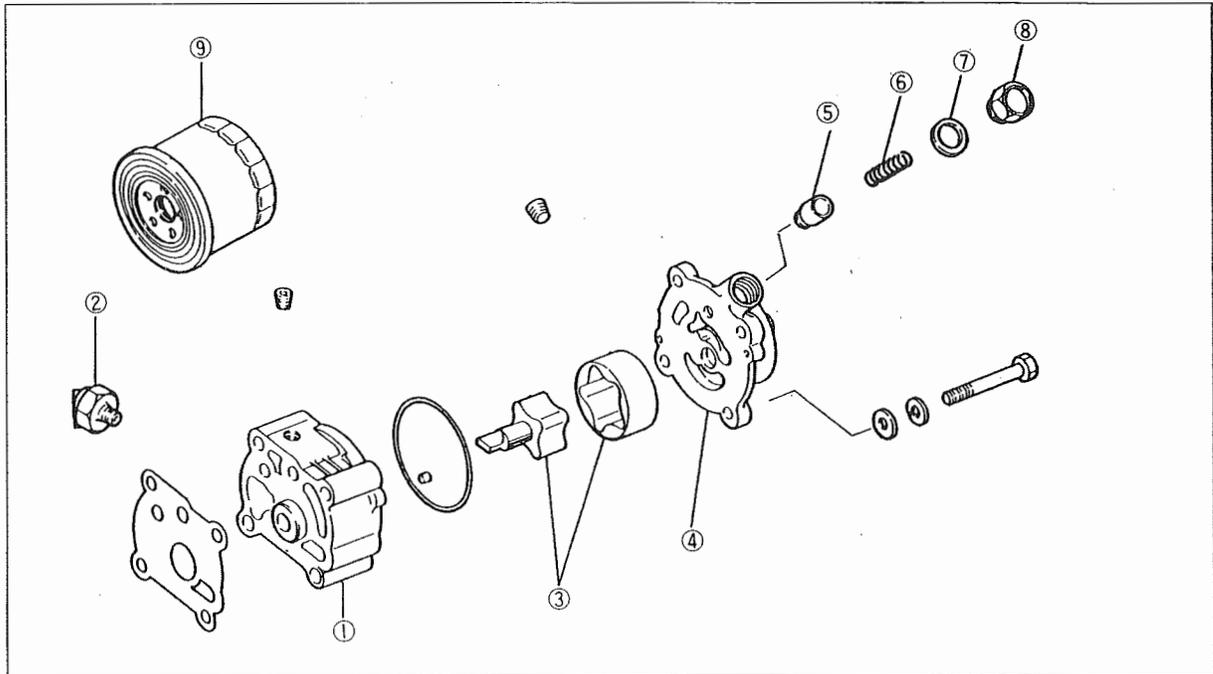
2-02 OIL PUMP AND OIL FILTER

Group No.

2-02



■ Components



- ① Oil pump body
- ② Oil pressure switch
- ③ Oil pump rotor

- ④ Oil pump cover
- ⑤ Relief valve
- ⑥ Relief valve spring

- ⑦ Gasket
- ⑧ Plug
- ⑨ Oil filter

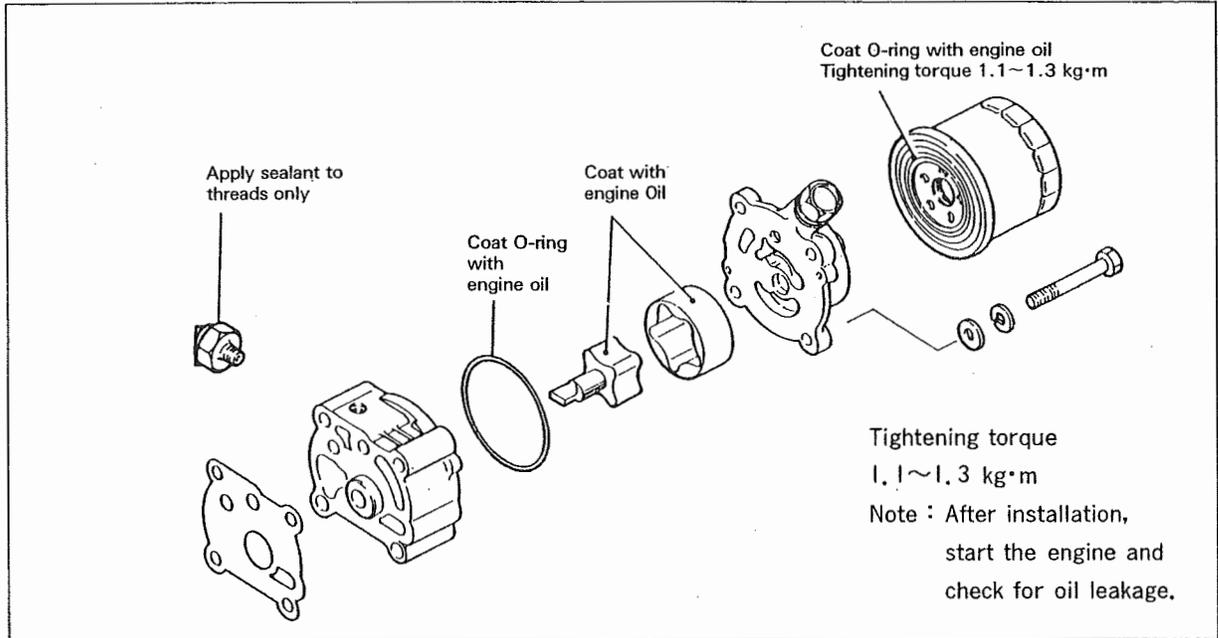


Group No.

2-02 OIL PUMP AND OIL FILTER

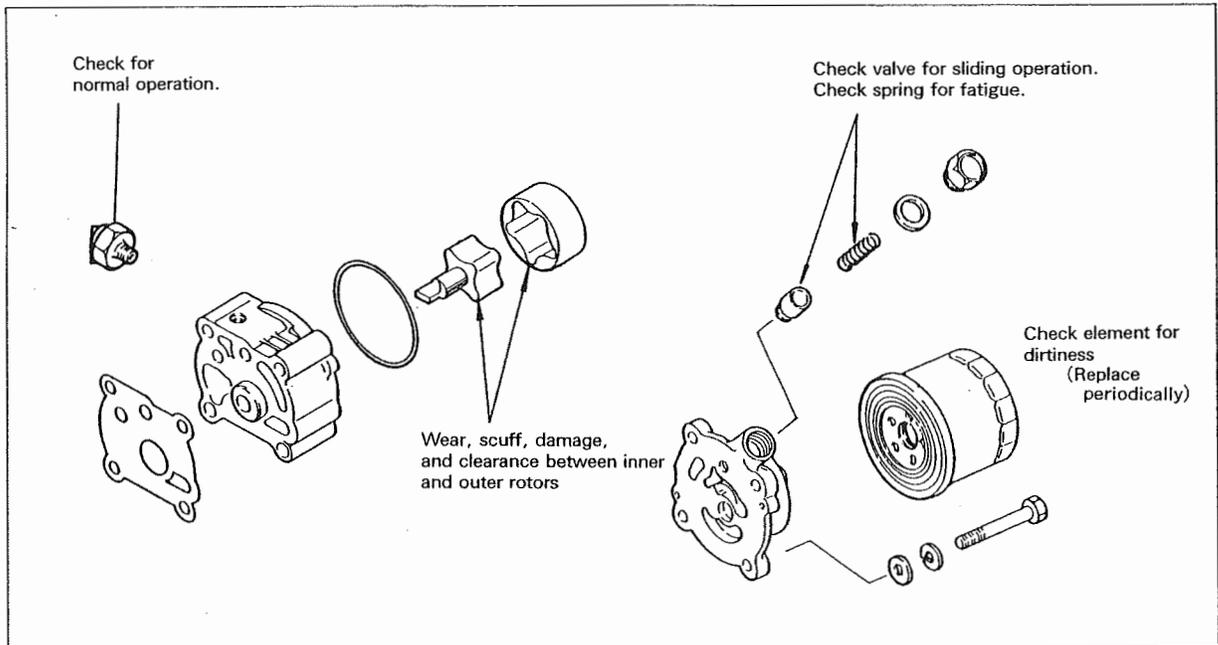
■ Removal/Installation

Follow the directions below for reassembly.



■ Inspection

Check the following parts for faulty condition. Replace if necessary.



Group 3	FUEL SYSTEM	
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01	GENERAL	76
02	FUEL INJECTION PUMP	79
03	INJECTION NOZZLE	84
04	FUEL FILTER	89
05	FUEL PUMP	91





Group
No.

3-01 GENERAL

Group
No.

3-01



■ Specifications for K3 Series

Item		Model	K3G 6.5				K3G 7.0	
Injection Pump	Type	Bosch M type						
	Model	ND-PFR3M						
	Plunger dia.	$\phi 6.5$				$\phi 7.0$		
	MS retard (Crank angle)	4°						
	Delivery valve	Silt type or Bosch						
	New device	With		Without		With		
	Air bleeder screw	Without						
	Injection amount	See group 9 Reference.						
Nozzle	Type	Hole type						
	Model	DLL-P						
	Nozzle opening pressure(kg/cm ²)	220 ⁺¹⁰ ₀						
	Nozzle hole dia.	$\phi 0.20$				$\phi 0.22$		
Fuel Filter	Type	Paper-element type						
	Element mesh	30 μ						
	Filtration area	129cm ² min.						
	Air bleeder screw	Without	With	Without	With			
Fuel Pump	Type	Electromagnetic diaphragm type	Without	Electromagnetic diaphragm type	Without			
	Pump delivery (at 12V DC, 20°C)	370cc/minute min.		370cc/minute min.				
	Filter element	Without		Without				

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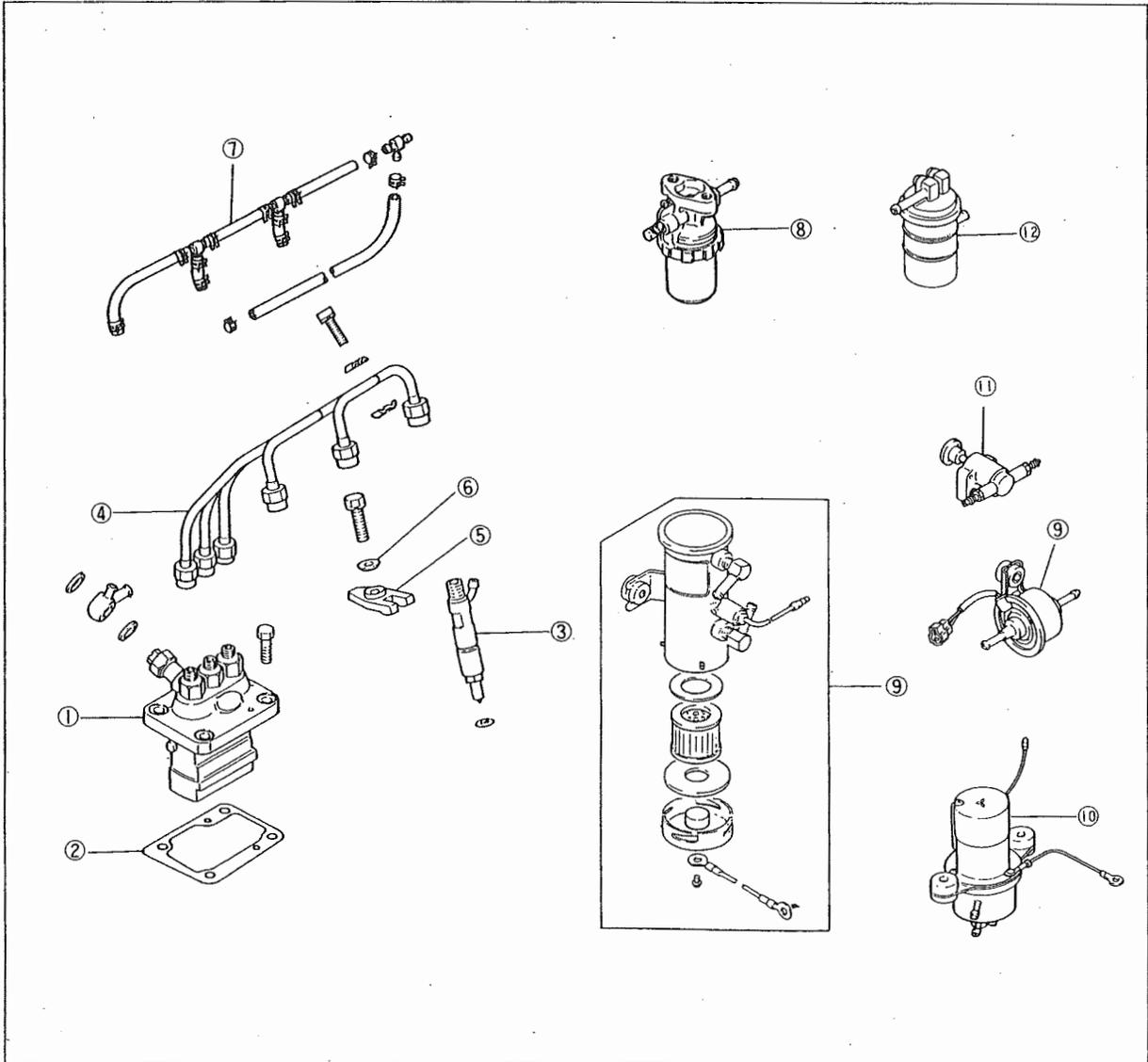
Email: Parts@WwPartsSource.com



Group
No.

3-01 GENERAL

■ Components

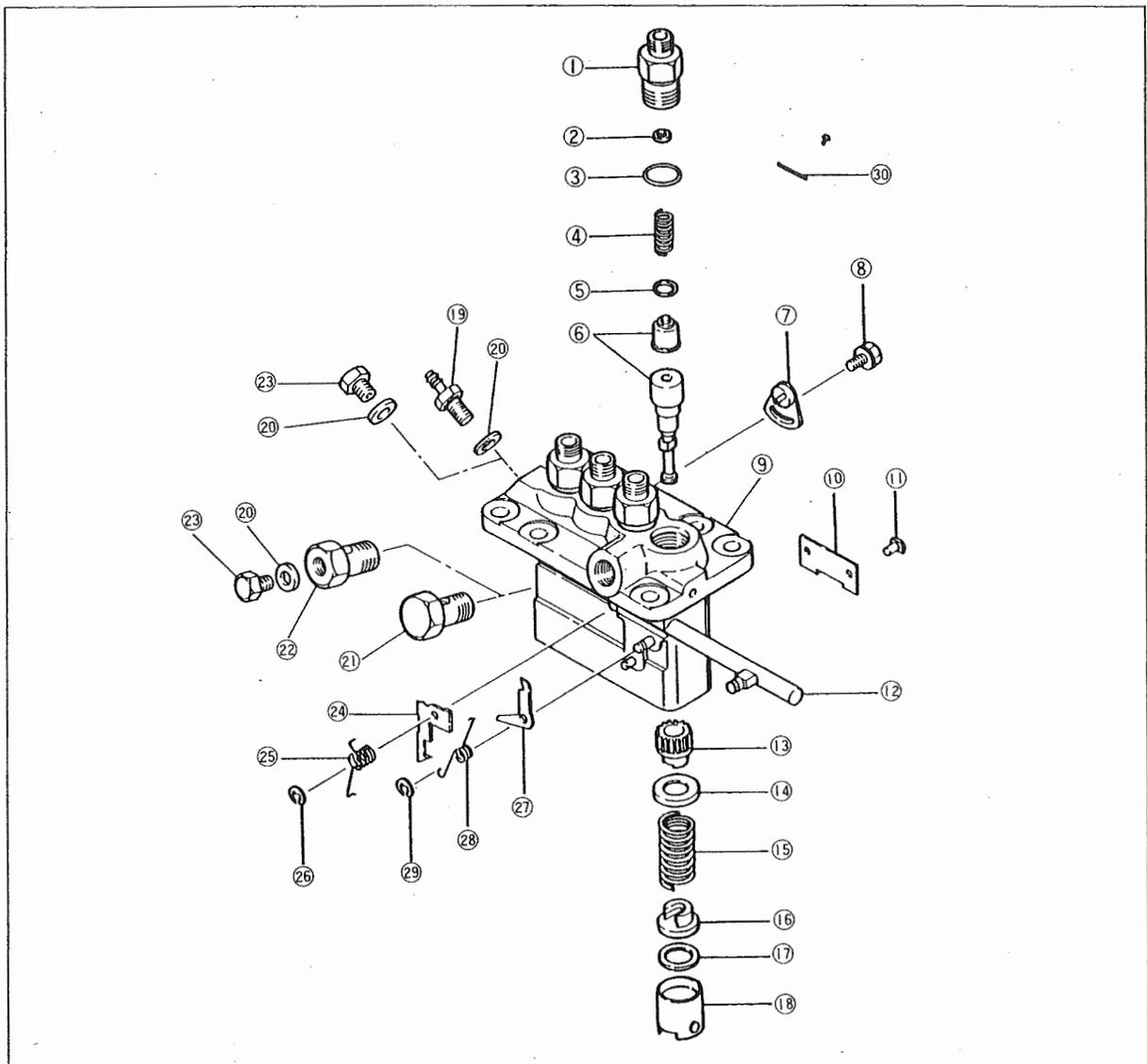


- ① Fuel injection pump
- ② Shim
- ③ Nozzle holder assembly
- ④ Fuel injection pipes
- ⑤ Nozzle support
- ⑥ Special washer

- ⑦ Fuel return pipe
- ⑧ Fuel filter
- ⑨ Fuel pump (plunger type)
- ⑩ Fuel pump (diaphragm type)
- ⑪ Hand fuel pump
- ⑫ Fuel filter (cartridge type)



■ Components



- | | | |
|----------------------------|-------------------------|---------------------------------------|
| ① Delivery valve holder | ⑪ Tappet guide pin | ⑳ Hollow screw |
| ② Shim washer | ⑫ Rack | ㉑ Hollow screw (for air bleeder plug) |
| ③ O-ring | ⑬ Sleeve | ㉒ Air bleeder plug |
| ④ Delivery valve spring | ⑭ Spring upper seat | ㉓ Stopper |
| ⑤ Delivery valve gasket | ⑮ Plunger spring | ㉔ Return spring |
| ⑥ Plunger element assembly | ⑯ Spring lower seat | ㉕ E-ring |
| ⑦ Adjusting plate | ⑰ Tappet adjusting shim | ㉖ Ungleich set plate |
| ⑧ Bolt | ⑱ Tappet | ㉗ Ungleich set spring |
| ⑨ Pump body | ㉘ Fuel leakage nipple | ㉙ E-ring |
| ⑩ Lock plate | ㉚ Washer | ㉛ Name plate |



Group
No.

3-02 FUEL INJECTION PUMP

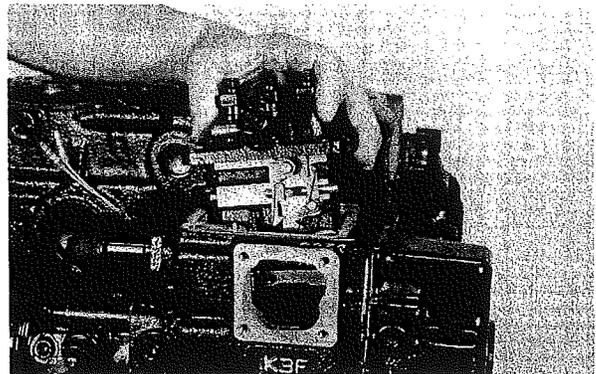
■ Inspection on the Engine

Do not try to disassemble the injection pump unnecessarily. It is recommended to replace the pump as an assembly when it is fault.

Item	Inspection	Criterion
Low idle speed	Measure engine rpm	Standard for agricultural engine : 970^{+30} rpm Standard for industrial and export engines : 935 ± 25 rpm
Exhaust color	1) Accelerate the engine speed rapidly under no load and observe the exhaust color. 2) Apply load and observe the exhaust color.	Black smoke should not be excessively exhausted.
Nozzle injecting condition	Remove the nozzle assembly. Connect the nozzle to the injection pipe with its needle valve pointing the outside and make sure the injecting condition by cranking the engine with the starter.	Fuel spray should be good condition.

■ Removal

- (1) Remove the fuel injection pipes.
- (2) Remove the tie rod cover.
- (3) Remove the tie rod and tie rod spring.
- (4) Remove the injection pump assembly.



Removing Injection Pump



■ Injection Pump Disassembly

Caution

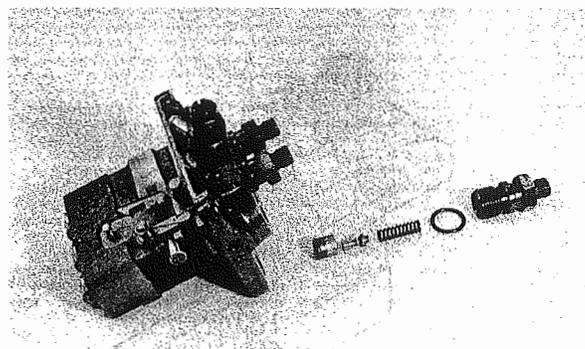
- When replacing the plunger barrel, delivery valve, etc., do not loosen the adjusting plate between the cylinders.
- After these parts are replaced, measure injection amount with a pump tester cam box.

■ Disassembly

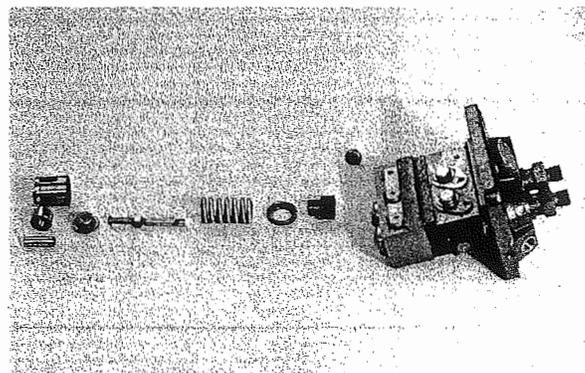
- (1) Remove the delivery valve holders, delivery valves, and delivery valve springs.
- (2) Remove the tappet roller stopper pins.
- (3) Remove the tappet plunger springs, etc.
- (4) Remove the plungers and plunger barrels.

Caution

- All parts should be put in order for each cylinder and kept immersed in clean fuel oil.



Removing Delivery Valve



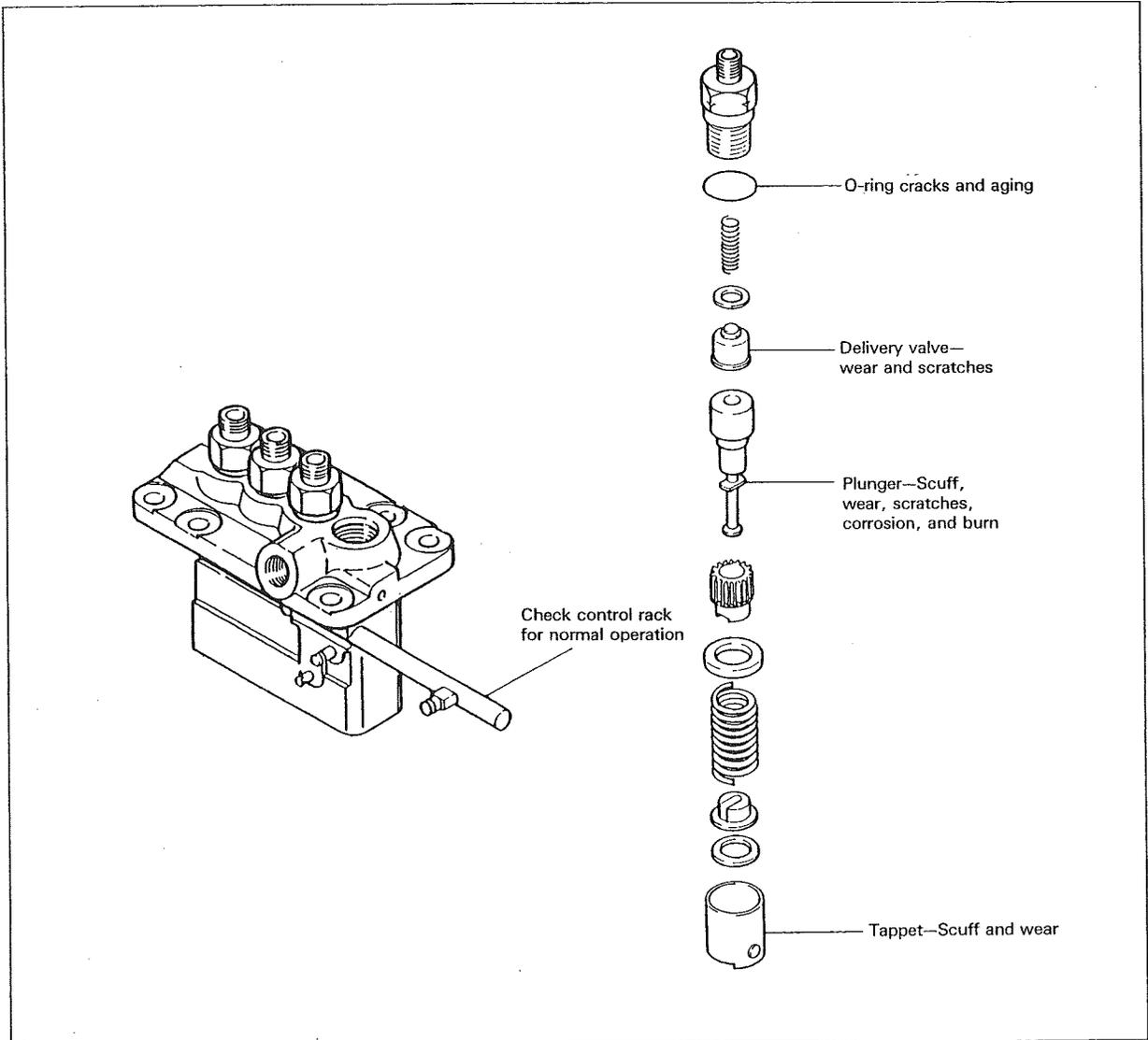
Removing Tappet and Tappet Roller



Group
No.

3-02 FUEL INJECTION PUMP

■ Inspection



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■ Assembly

- (1) Insert the plunger barrels in the housing.

Caution

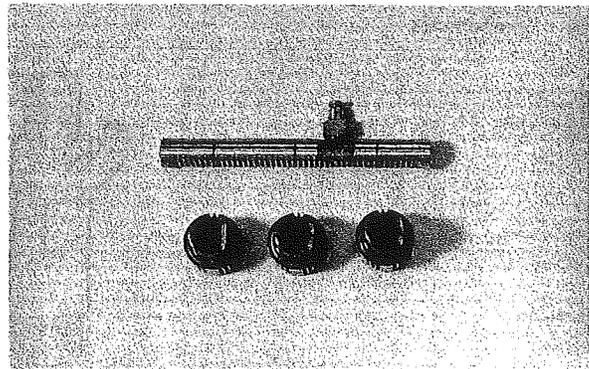
- Align the dowel pin with the groove in the barrel.

- (2) Install the delivery valves and delivery valve springs and tighten the holders temporarily.
- (3) Insert the control rack.
- (4) Insert the control pinions. Align the alignment marks on the control racks and pinions.
- (5) Install the plunger upper seats.
- (6) Install the plunger springs.
- (7) Install the lower seats on the plungers and install them in the barrels.

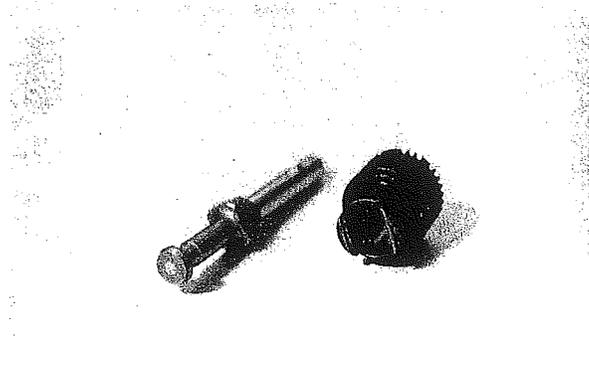
Caution

- Position the notch in the plunger flange oppositely to the control rack so that the feed hole faces the plunger lead.

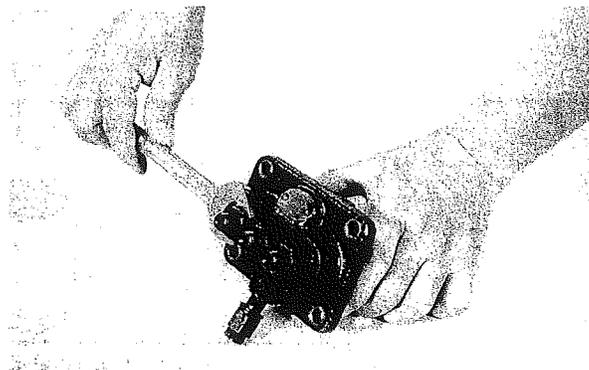
- (8) With the tappet roller assembly grasped, insert the stopper pin.
- (9) Tighten the delivery holder.
Tightening torque : 4~5kg·m



Control Rack and Pinions



Plunger Installation Direction



Tightening Delivery Holder

■ Installation

Install the injection pump in the reverse order of removal.

Caution

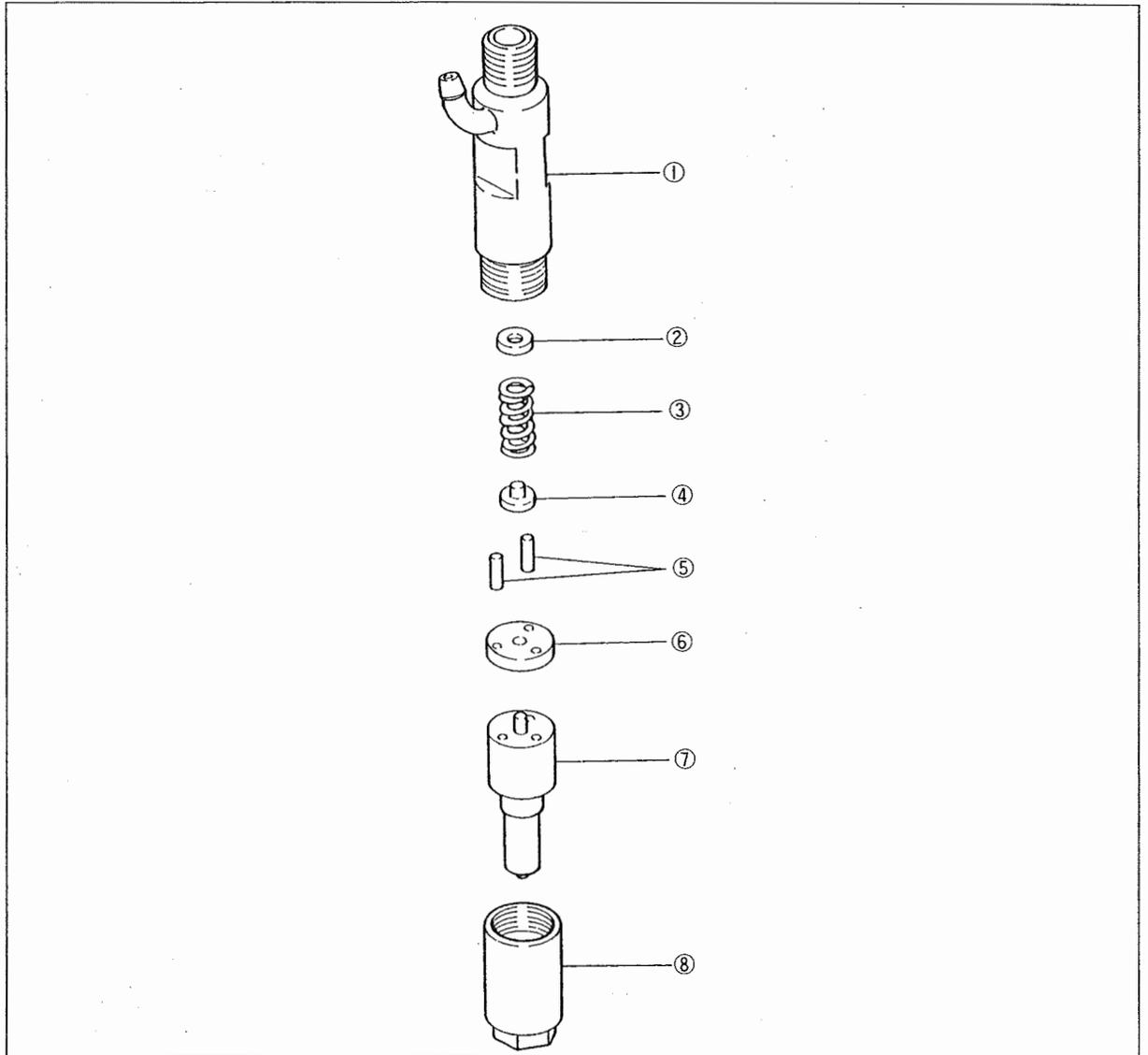
- Check for injection timing after installation.



Group
No.

3-03 INJECTION NOZZLE

■ Components



① Body sub-assembly

② Washer

③ Spring

④ Pressure pin

⑤ Pin

⑥ Packing

⑦ Nozzle assembly

⑧ Retaining nut



■ **Removal**

- (1) Remove the injection pipe and fuel return pipe.
- (2) Remove the injection nozzle assembly from the cylinder head.

Caution _____

- **Attach cylinder No. tags to the injection nozzles removed.**
 - **Plug the fuel passages and combustion chambers to prevent dust, water or other foreign matter from entering there.**
-

■ **Disassembly**

If an injection nozzle is found by inspection to be out of order, disassemble it to repair or replace the faulty parts.

- (1) Vise the nozzle holder body and loosen the retaining nut. Do not grip the retaining nut to prevent deformation of it.
- (2) Remove the pressure spring, shim, distance piece and nozzle tip.

Caution _____

- **Remove carbon deposits from the nozzle parts with a wooden scraper and keep the parts immersed in clean fuel oil. Take special care not to damage the needle valve at the tip of the nozzle.**
-

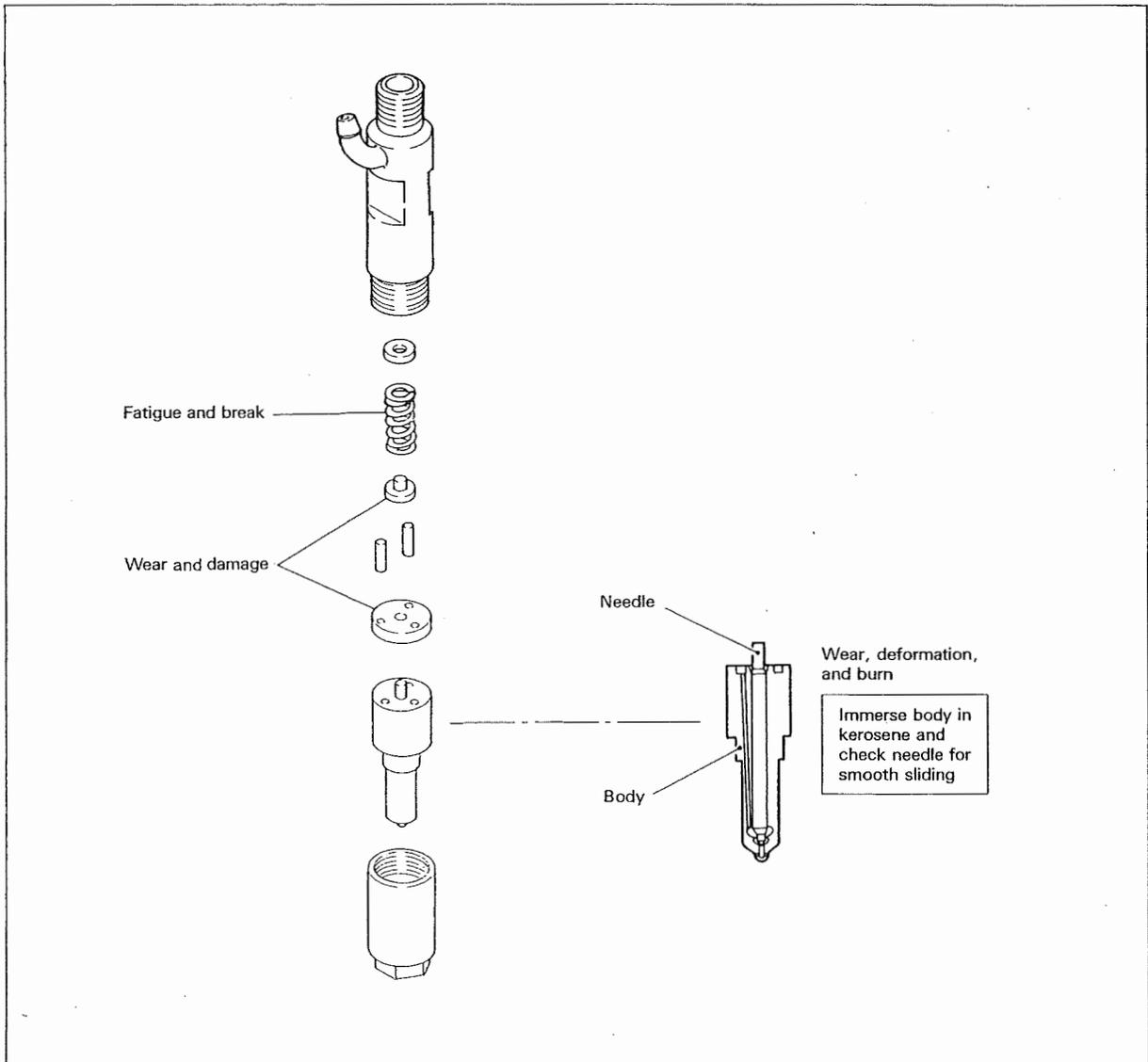


Group
No.

3-03 INJECTION NOZZLE

■ Inspection

Check the parts of disassembled nozzle for faulty condition.



■ Assembly

- (1) Insert the nozzle tip into the retaining nut.
- (2) Install the distance piece, retaining pins, pressure spring and shim.
- (3) Tighten the nozzle holder body fully by hand.
- (4) Grip the nozzle holder body in the vise and retighten the retaining nut.

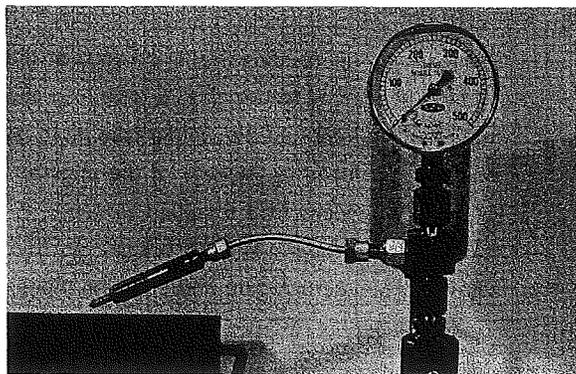


■ Adjustment

Adjust the injection starting pressure of the nozzle. The pressure varies 15 kg/cm² for every 0.1 mm increment in thickness of the shim.

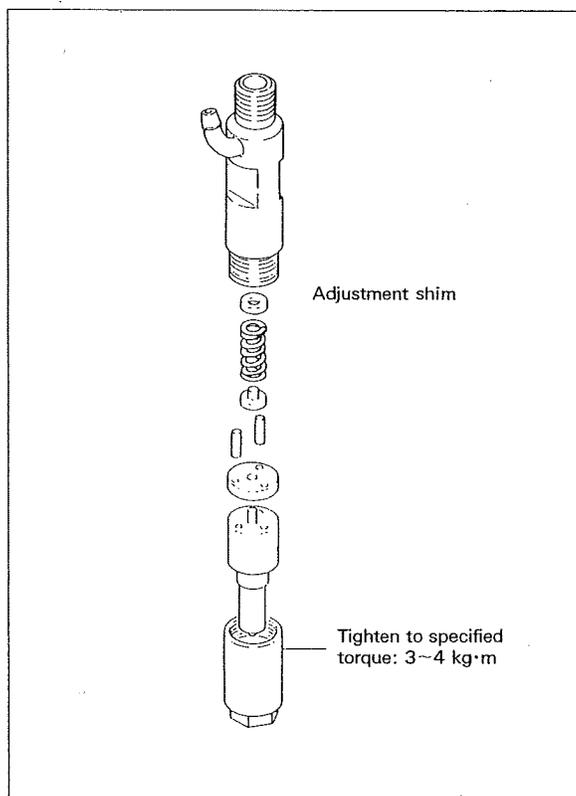
Shim thickness :

13 kinds of shims from 1.20 to 1.80 mm in 0.05 mm step are available. Refer to 0-05 Nozzle Inspection for detailed inspection and adjustment procedure.



Nozzle Injection Test

Injection starting pressure	
Standard value	220 ⁺¹⁰ ₀ kg/cm ²
Service limit	200 kg/cm ² max.



Installing Nozzle Holder

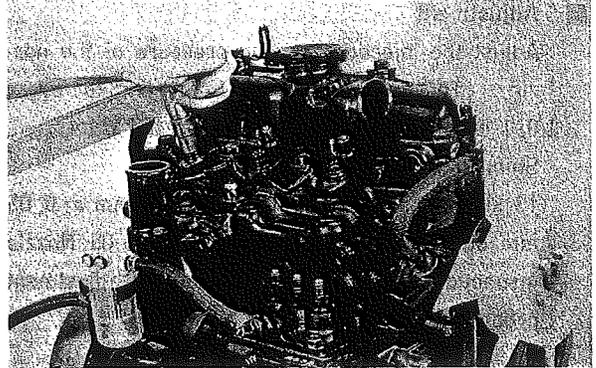


Group
No.

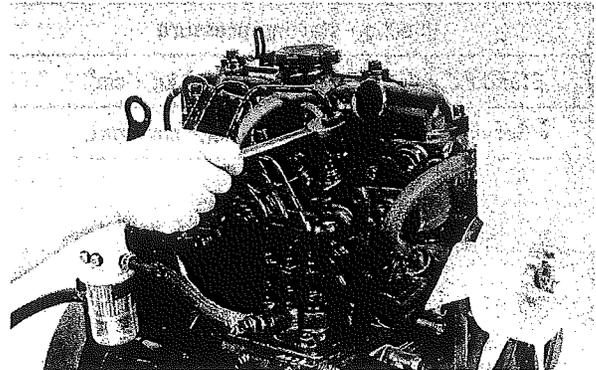
3-03 INJECTION NOZZLE

■ Installation

- (1) Clean the nozzle holder installation area of the cylinder head. With the gasket fitted on the nozzle, install the nozzle holders so that its return nipple faces to the rear of the engine. Tighten the holders to a specified torque.
 - Tightening torque : 2.0~2.5 kgm
- (2) Install the fuel return pipe and injection pipes.



Installing Nozzle Holder



Installing Injection Pipe

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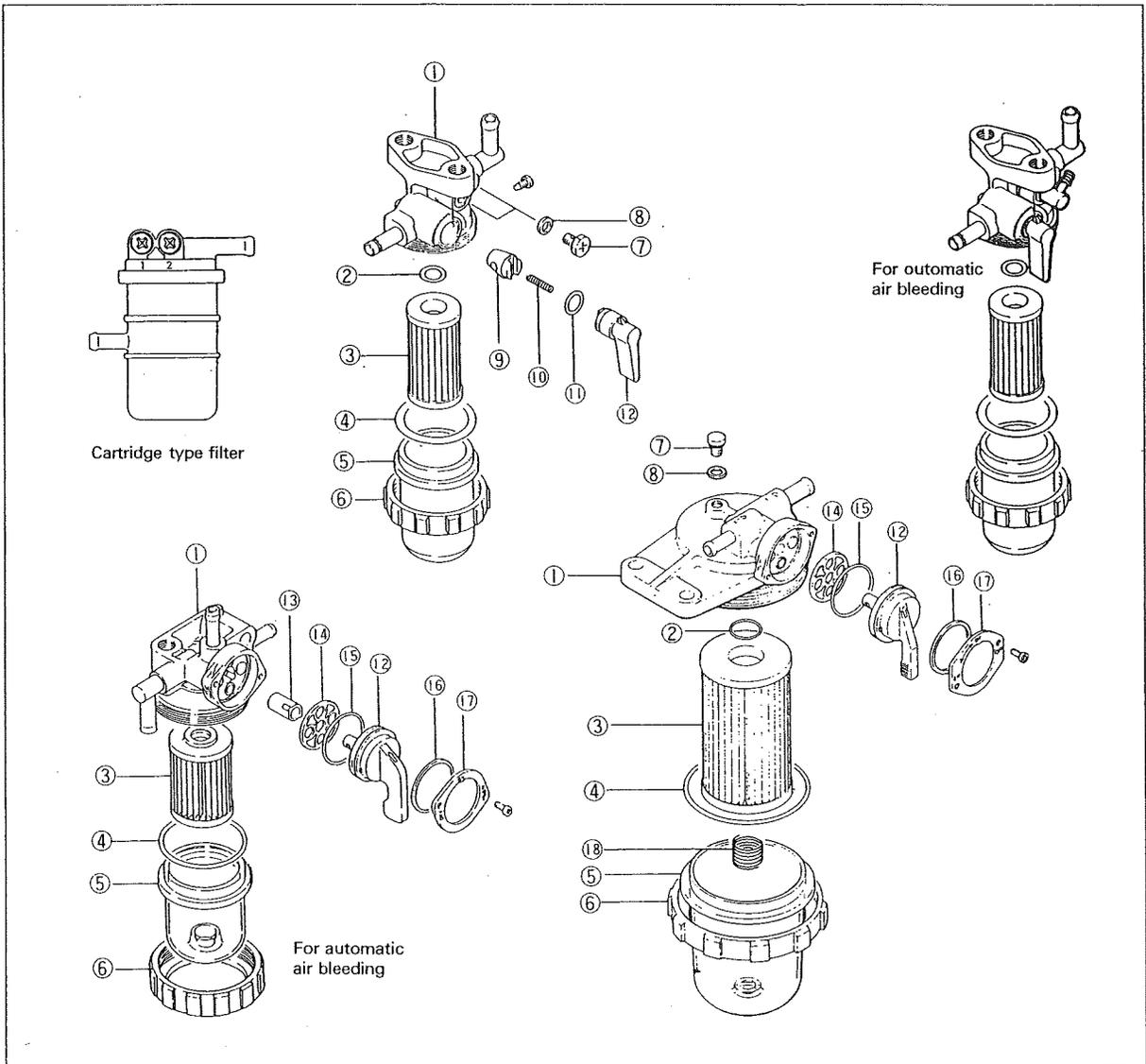
3-04 FUEL FILTER

Group No.

3-04



■ Components



Cartridge type filter

For automatic air bleeding

For automatic air bleeding

- | | | |
|-----------------|------------------|------------------|
| ① Filter body | ⑦ Air vent screw | ⑬ Valve seat |
| ② O-ring | ⑧ Packing | ⑭ Valve packing |
| ③ Element | ⑨ Valve | ⑮ O-ring |
| ④ O-ring | ⑩ Spring | ⑯ Wave washer |
| ⑤ Cup | ⑪ O-ring | ⑰ Lever plate |
| ⑥ Retaining nut | ⑫ Cock lever | ⑱ Element spring |

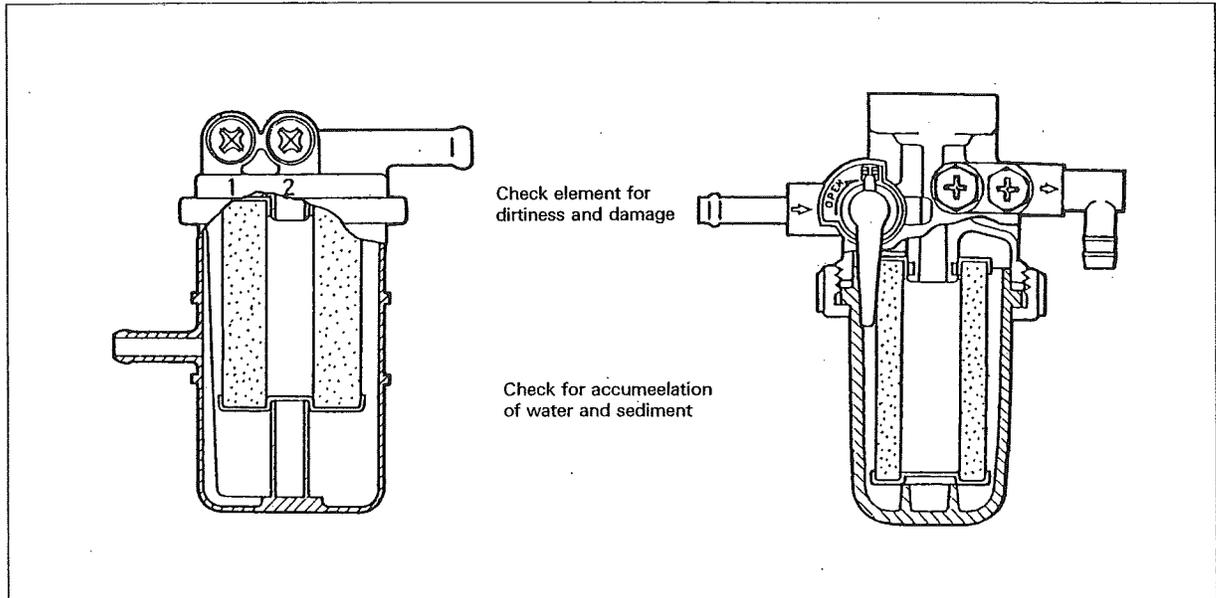


Group
No.

3-04 FUEL FILTER

■ Inspection

Check the fuel filter for dirt or damage. For the disassemble-type filter, periodically remove and clean the element.



■ Precautions for Disassembly/Assembly

- (1) Disassemble the filter only for removal of the element. Do not remove the cock lever unless it is necessary.
- (2) Do not remove the fuel inlet, outlet and air bleeder nipple.
- (3) When reinstalling the cock lever (the lever-plate installation type only) which has been removed for the purpose of cleaning, coat its O-ring with silicone and wave washer with grease.



Group No.

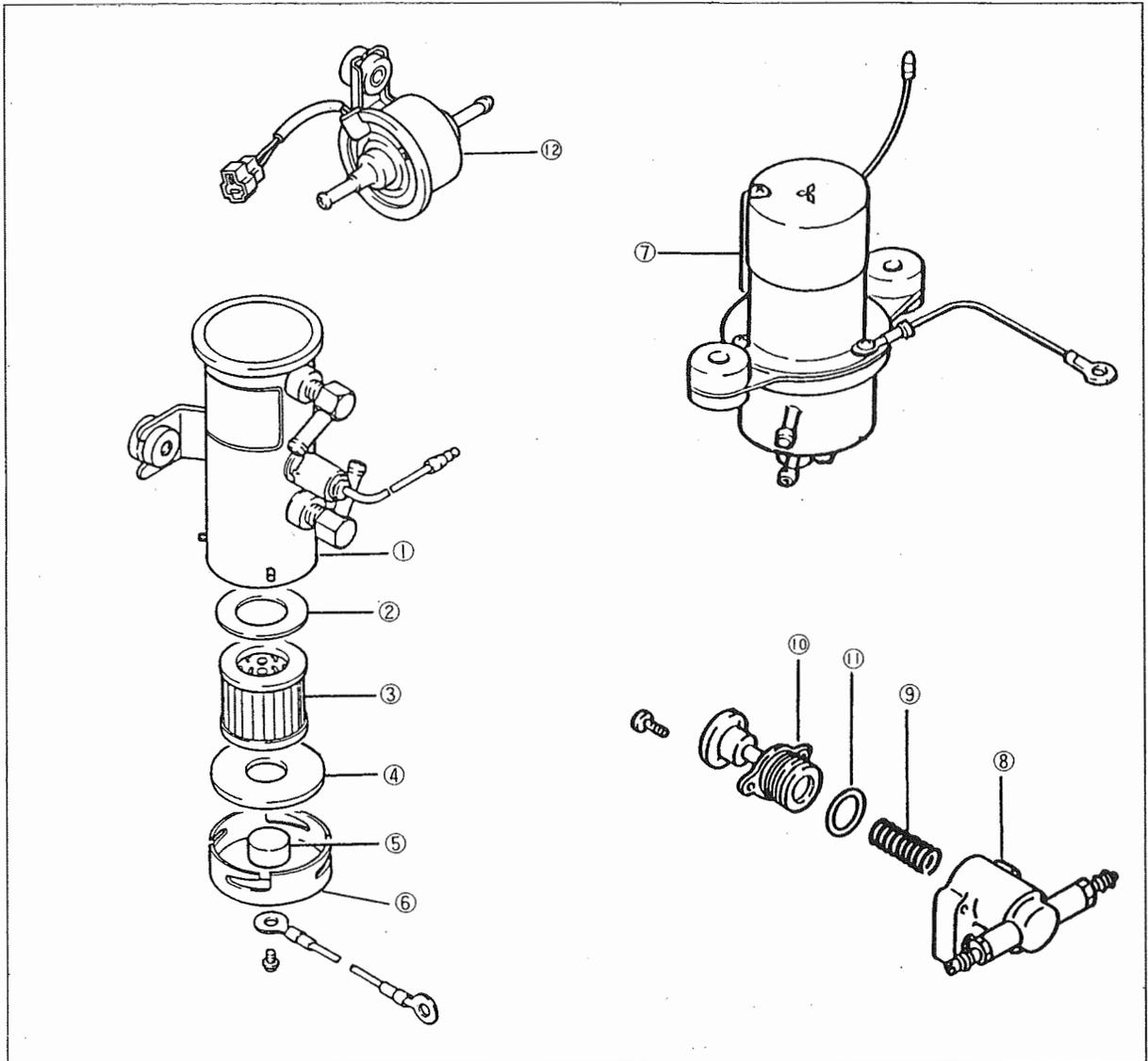
3-05 FUEL PUMP

Group No.

3-05



■ Components



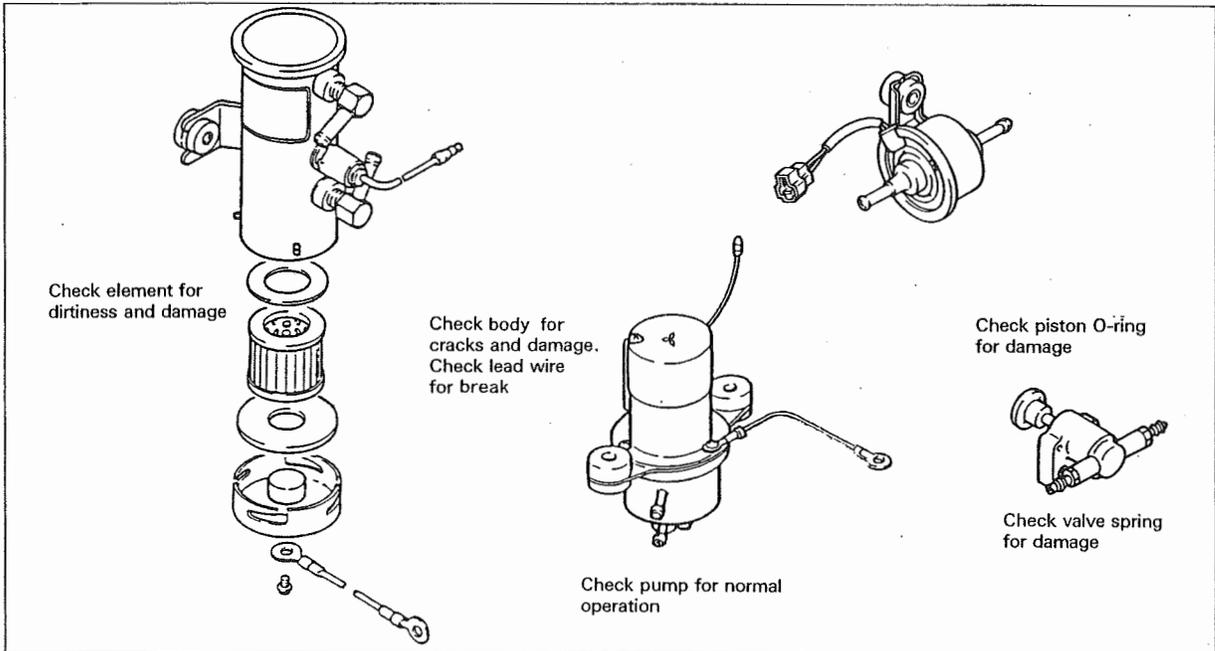
- | | | |
|-------------------|-----------------------|----------------------------|
| ① Pump body | ⑤ Magnet | ⑨ Spring |
| ② Packing (upper) | ⑥ Cover | ⑩ Piston assembly |
| ③ Element | ⑦ Diaphragm type pump | ⑪ O-ring |
| ④ Packing (lower) | ⑧ Hand pump body | ⑫ Fuel pump (compact type) |



Group
No.

3-05 FUEL PUMP

■ Inspection



Item	Standard value			
	Plunger type pump		Diaphragm type pump	Hand pump
	Normal type	Compact type		
Power source	12V DC	12V DC	12V DC	(Manual operation)
Delivery	900cc/minute min.	400cc/minute min.	370cc/minute min.	—
Delivery pressure at shut-off	0.35 _{-0.07} kg/cm ²	0.35kg/cm ² max.	0.18 _{-0.5} kg/cm ²	—
Pump capacity	—		—	4.5cc/stroke

■ Precautions for Disassembly/Assembly

- (1) Do not try to disassemble the diaphragm type pump. Check the pump for external damage and delivery function only.
- (2) The plunger type pump has a filter element which can be replaced. Disassemble the pump only when replacement of the element is necessary.
- (3) Do not disassemble the inlet and outlet nipples of the hand fuel pump.
- (4) After reassembling a pump, make sure that no fuel leaks under pressure.
- (5) Install the compact fuel pump for the models K4 F-D12A and D13A so that its wire leads face the fuel inlet side.

Group 4	GOVERNOR SYSTEM	
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01 GENERAL	94
02 GOVERNOR PARTS	95





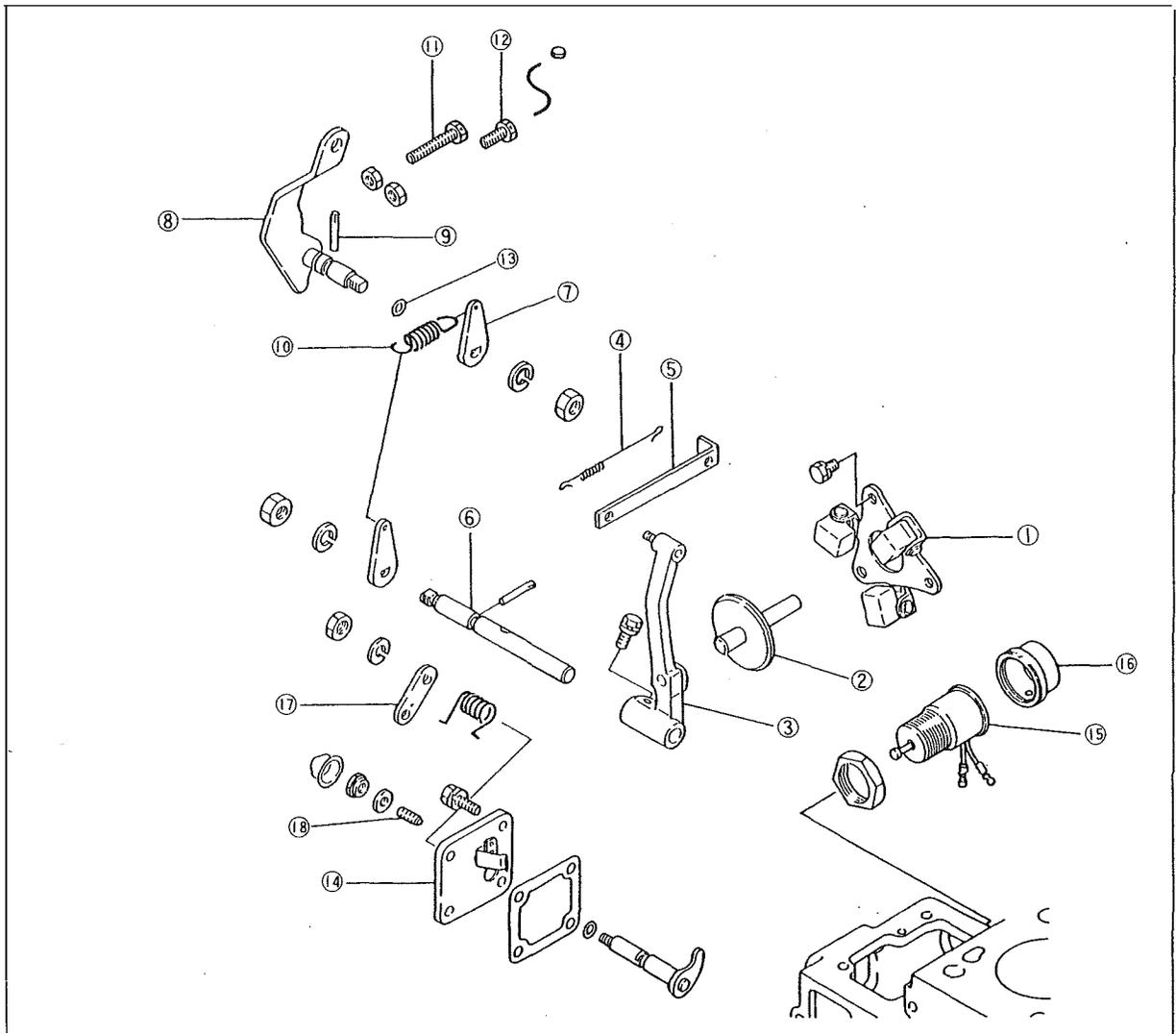
Group
No.

4-01 GENERAL

■ Specifications

Item	Specification
Governor type	Centrifugal weight type
Governor spring	One stage type (Except K3 series for tractor)
	Two stage type (K3 series for tractor)

■ Components



① Weight assembly

② Sliding shaft

③ Governor lever assembly

④ Tie rod spring

⑤ Tie rod

⑥ Governor shaft

⑦ Spring lever

⑧ Speed control lever

⑨ Pin

⑩ Governor spring

⑪ Speed set bolt (high)

⑫ Speed set bolt (low)

⑬ O-ring

⑭ Tie rod cover

⑮ Solenoid

⑯ Solenoid cap

⑰ Manual stop lever

⑱ Damper adjust screw



Group
No.

4-02 GOVERNOR PARTS

Group
No.

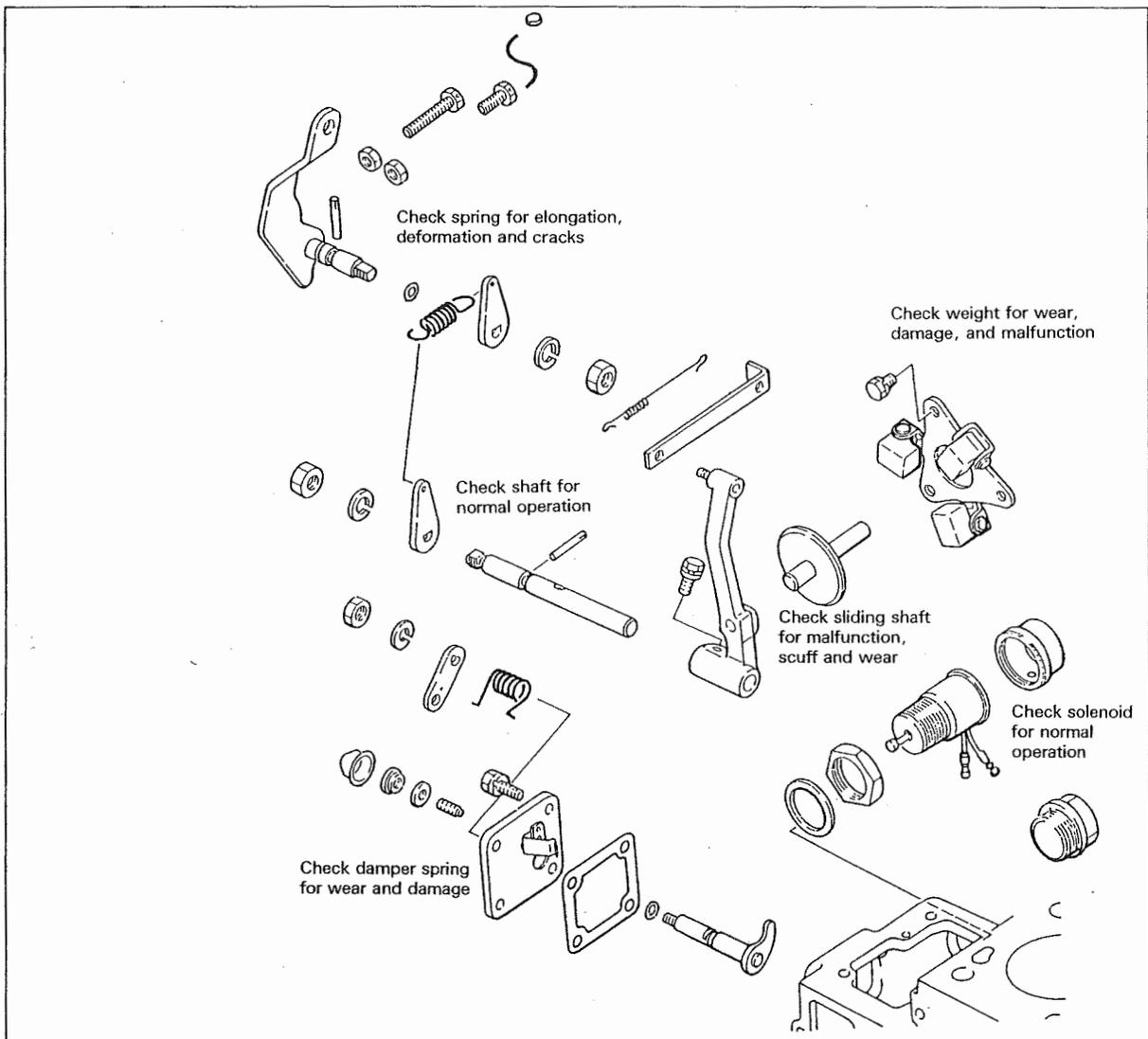
4-02



■ Inspection

Remove the gear case and inspect the governor parts. Before removing the gear case, remove the tie rod cover at the injection pump side and disconnect the tie rod from the rack. Refer to 0-06 Gear case for other information.

Check the governor parts in the following manner and replace the faulty parts.





Group
No.

4-02 GOVERNOR PARTS

■ Removal/Installation

(Refer to the Engine Group 1, Gear Case.)

■ Removal

(1) Lever removal

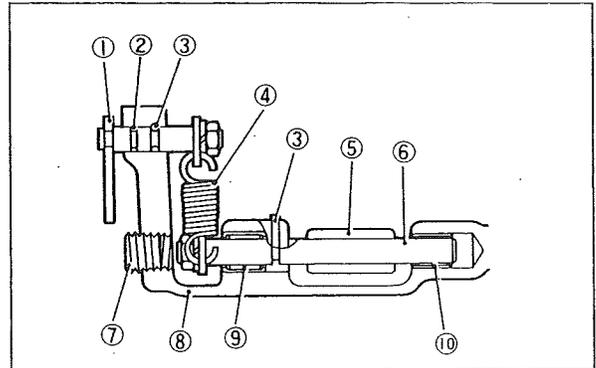
- Remove the grooved pins from the governor lever and speed control lever.
- Loosen bolts fastening the levers and shafts.
- Remove the shaft from the gear case.

(2) Installation

Install the governor parts while making sure that all levers and shafts operate smoothly.

Caution

- Check shafts for smooth operation after driving in grooved pins.
- Apply oil to the O-rings when assembling.
- Do not slacken the governor spring when installation.



Installing Governor Shaft

- | | |
|-----------------------|--------------------------|
| ① Speed control lever | ⑥ Governor shaft |
| ② O-ring | ⑦ Taper screw |
| ③ Pin | ⑧ Gear case |
| ④ Governor spring | ⑨ Needle bearing (large) |
| ⑤ Governor lever | ⑩ Needle bearing (small) |

Group 5	COOLING SYSTEM	
--------------------	-----------------------	---

01	GENERAL	98
02	FAN AND FAN BELT	100
03	WATER PUMP	101
04	THERMOSTAT	102
05	WATER TEMPERATURE GAUGE	103



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Group
No.

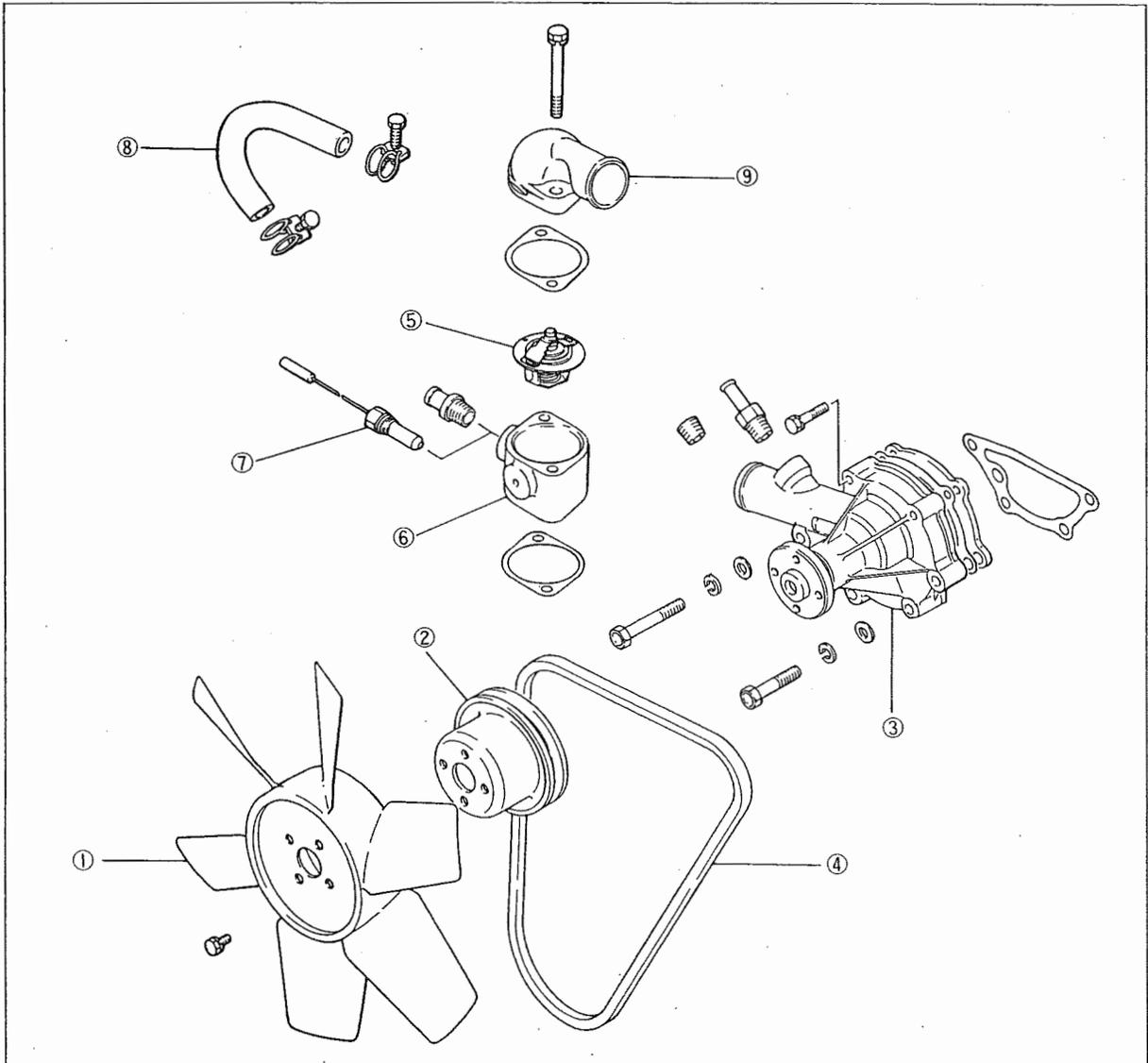
5-01 GENERAL

■ Specifications

Item		Specification
Fan belt	For agricultural and industrial engines	LL or HM type (Belt width 10, 7, V angle 38°) Periphery length : 932, 940, 964, 980
Cooling fan	Suction type	5 blades : $\phi 320$: $\phi 340$ 6 blades : $\phi 290$: $\phi 310$ 7 blades : $\phi 360$
	Suction type	6 blades : $\phi 360$: $\phi 390$
Water pump		Centrifugal impeller
Thermostat	82°C	Wax type Valve opening temperature : $82 \pm 1,5^\circ\text{C}$ Full opening temperature : 90°C (at approx. 8 mm valve lift)
	76,5°C	Wax type Valve opening temperature : $76,5 \pm 1,5^\circ\text{C}$ Full opening temperature : 90°C (at approx. 8 mm valve lift)
Thermo switch	111°C	Bimetal type Closing temperature : $111 \pm 3^\circ\text{C}$ Resistance between terminals : $1,0 \pm 0,4\Omega$
	108°C	Bimetal type Closing temperature : $108 \pm 3^\circ\text{C}$ Resistance between terminals : $1,0 \pm 0,4\Omega$
Thermo unit	More than 70°C	Thermistor type Temp./Resistance ($^\circ\text{C}/\Omega$) : $70/104 \pm 13,5$, $115/23,8 \pm 2,5$
	More than 50°C	Thermistor type Temp./Resistance ($^\circ\text{C}/\Omega$) : $50/350 \pm 20$, $90/81 \pm 5$, $120/36,2 \pm 2,5$



■ Components



- | | | |
|-----------------------|----------------------|------------------------|
| ① Cooling fan | ④ V-belt | ⑦ Thermo switch |
| ② Water pump pulley | ⑤ Thermostat | ⑧ Bypass hose |
| ③ Water pump assembly | ⑥ Thermostat fitting | ⑨ Water outlet fitting |

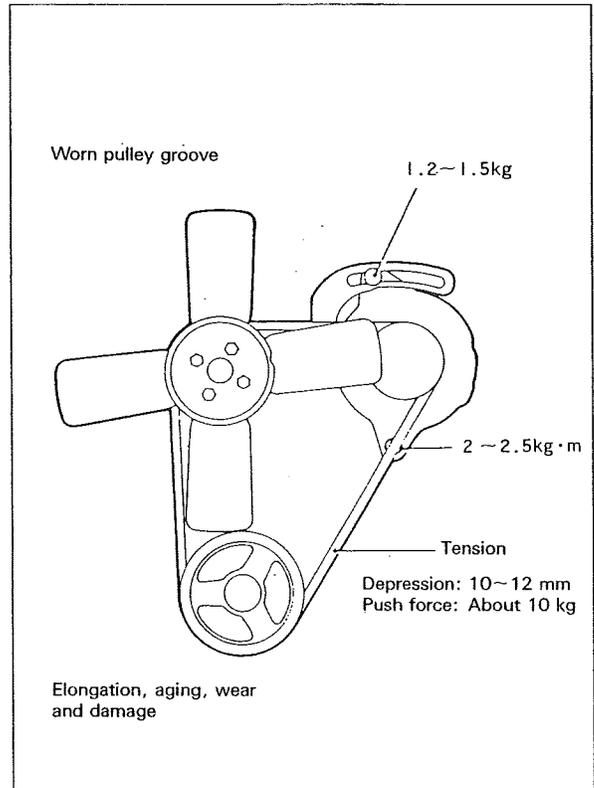


Group
No.

5-02 FAN AND FAN BELT

■ Fan Belt Inspection

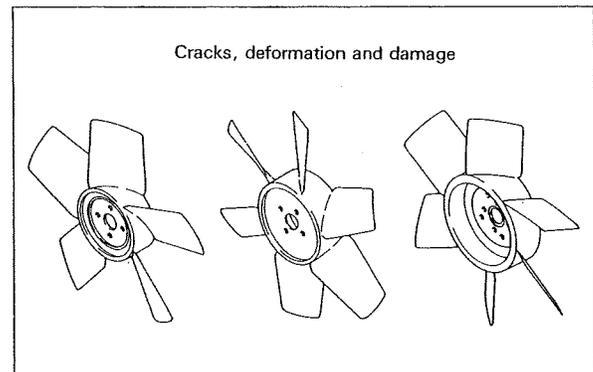
Refer to "Group 0, Maintenance" for fan belt tension.



Fan Belt Inspection

■ Fan Inspection

Check the fan for abnormality. It necessary, replace.



Fan Inspection



Group
No.

5-03 WATER PUMP

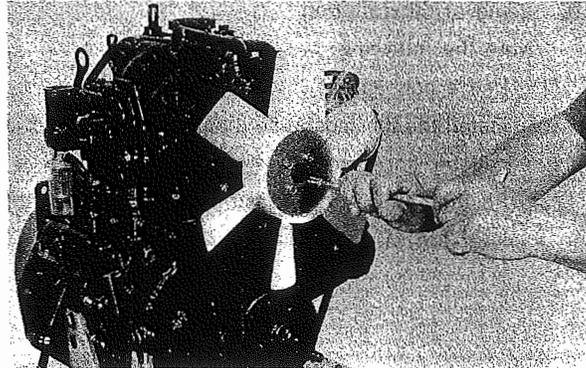
Group
No.

5-03



■ Removal/Installation

- (1) Remove the fan and fan belt.
- (2) Remove the water pump.
- (3) Install the water pump in the reverse order of removal.



Installing Fan

■ Inspection

Check the water pump for water leakage, irregular run, cracks, and other damage. Replace the water pump assembly if necessary.



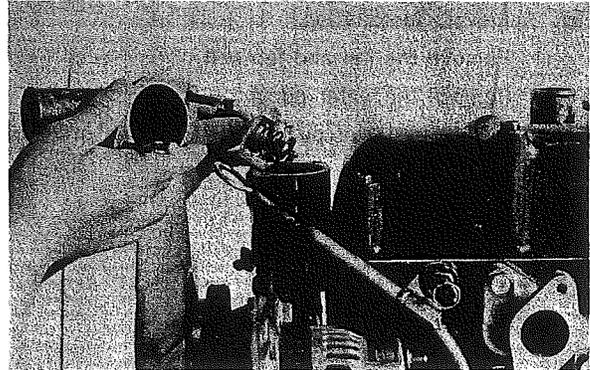
Group
No.

5-04 THERMOSTAT

■ Removal/Installation

Note the following.

- (1) Use a new gasket.
- (2) Install the thermostat so that its flange seats the counter bore properly.
- (3) Position the thermostat so that its stay does not interfere with the water temperature gauge.



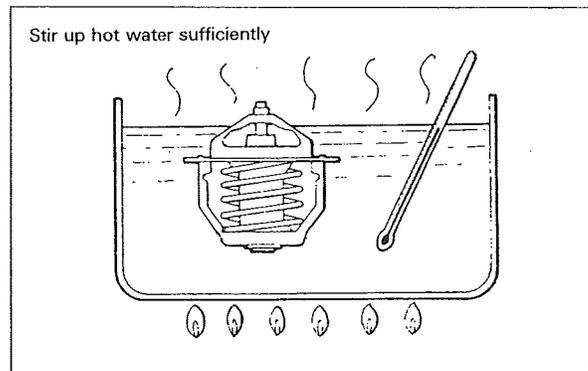
Installing Thermostat

■ Inspection

Replace the thermostat if it is faulty.

Start to open : 76.5 °C

Full open (at 8 mm lift) : 90 °C



Thermostat Inspection

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Group
No.

5-05 WATER TEMPERATURE GAUGE UNIT

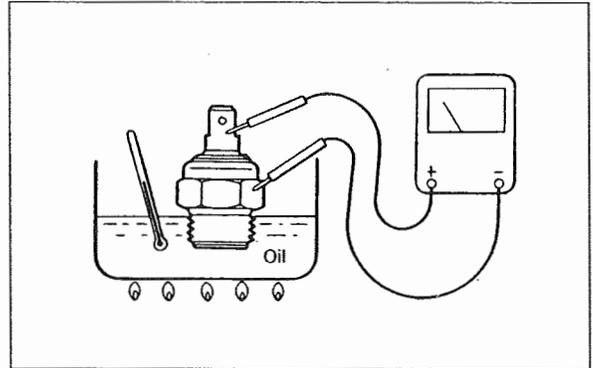
Group
No.

5-05



■ Thermo Switch Inspection

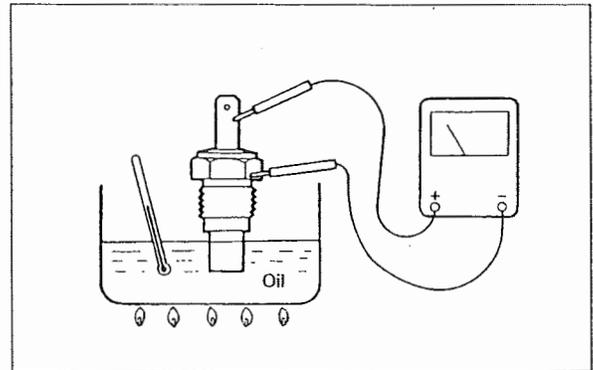
Replace the thermo switch if it is faulty.
Refer to the specification in this chapter for closing temperature and resistance between the terminals.



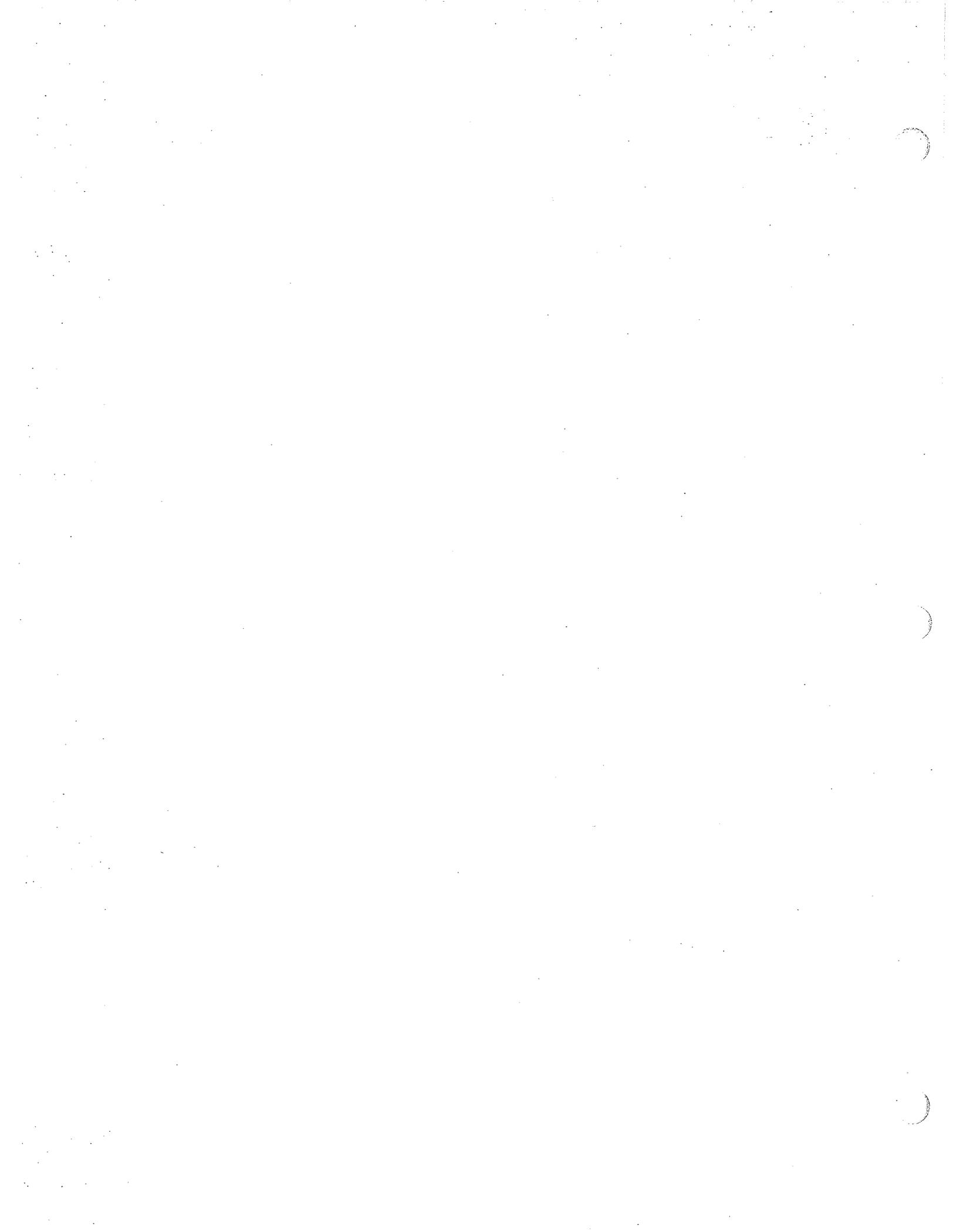
Thermo Switch Inspection

■ Thermo Unit Inspection

Refer to the specification in this chapter for the specified temperature/resistance.



Thermo Unit Inspection



Group 6	AIR CLEANER	
------------	-------------	---

01 AIR CLEANER106

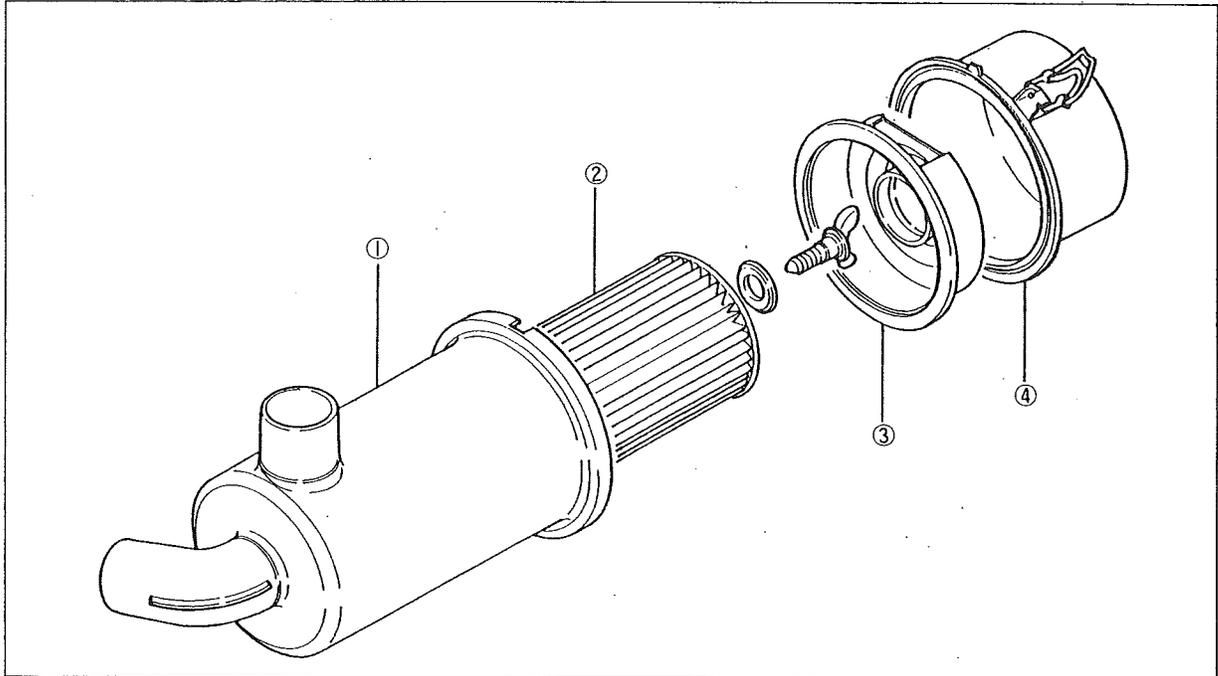




Group
No.

6-01 AIR CLEANER

■ Components



- | | |
|--------------------|---------------------|
| ① Body assembly | ③ Plate |
| ② Element assembly | ④ Dust pan assembly |

■ Inspection

- (1) Check the body and cover for distortion, corrosion and damage. Repair or replace if necessary.
- (2) If sealing of the body and cover is insufficient, dust will enter the engine and the cylinder and piston may be worn early. Check the inside of the body for traces of entering dust and repair if necessary.
- (3) Check the element and packing for air leakage or damage and replace if necessary.
- (4) Clean or replace the element if it is clogged or damaged.
- (5) Check the intake hose for damage and cracks. Replace if necessary.

Group 7	ELECTRICAL SYSTEM	
--------------------	--------------------------	---

01	General	108
02	Starter	113
03	Alternator	120
04	Regulator (Separate type)	130
05	Glow Plug	131
06	Key-Off Stop System	132
07	Auto-Glow Timer System	134



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Group
No.

7-01 GENERAL

Specifications

Item			Specification			
Starter	Model		M2T5038I	M2T5627I	M2T56272	
	Type		DC electromagnetic push-in type (with reduction gear)	←	←	
	Output		12V-1.6kW	12V-2.0kW	←	
	Performance (at 20°C)	No load characteristic	Terminal voltage	11.5V	11V	←
			Current	100A max.	130A max.	←
			Speed	3000 rpm min.	3850 rpm min.	←
Alternator	Model		AR2115Z ₂	AH2035M ₄	A0T2517I and A0T2527I	
	Type		AC (Separate regulator)	AC (Separate regulator)	AC (Built-in IC regulator)	
	Output		12V-15A	12V-35A	12V-40A	
	Performance (at 20°C)	With out	Terminal voltage	14V	←	
			Current	0A (at cold)	←	
			Speed	1300 rpm max.	←	
		With load	Terminal voltage	14V	←	13.5V
			Current	15A min. (at cold)	30A min. (at cold)	21A (at hot)
			Speed	2500 rpm max.	←	←
	Terminal voltage				13.5V	
		Current			37A (at hot)	
		Speed			5000 rpm max.	
	Regulating voltage				14.7±0.3V	
	Regulator	Model		RQB2220D ₄ (Separate type)		
Type		Tirril type 2-element				
Regulating voltage		14.8V				
Pilot lamp		Off voltage	4.2 ~ 5.2V			
	On voltage	0.5 ~ 3.0 V				
Glow plug	Model		Y-142T			
	Type		Sheathed type (immediately heating type)			
	Rated voltage		10.5V			
	Current		9.7A±1.0A (rated voltage applied for 30 seconds)			
	Resistance at normal temperature		0.16Ω			
Glow lamp	Model		DH-139V-29		Not applied to engines with glow relay	
	Type		Red heat type (immediately heating type)			
	Rated current		29A			
	Voltage between terminals		1.7±0.2V			



Item		Specification	
Glow timer	Model	S81NJ	
	Rated voltage	12V DC	
	Initial characteristic	6 sec. (at normal temperature and humidity, $V_{cc}=12V$)	
Glow relay	Model	G7ISP	
	Rated voltage	12V DC	
	Continuous rating	1 minute	
	Coil resistance	13 Ω	
Timer unit control	Model	YM-1B	
	Input voltage range	9 ~ 15V DC	
	Load	Solenoid (coil resistance 1.7 Ω min.)	
Solenoid	Model	YMS-1	
	Type	Push type	
	Coil resistance	1.8 \pm 10% (at 20°C)	
	Stroke	13.5mm	
	Voltage	10 ~ 15V DC	
Electric service indicator	Model	REX00-8690	
	Source voltage	12 \pm 1V DC	
	Operating temperature range	-40°C ~ +80°C	
	Adaptable load	12V DC, 3W (lamp)	
	Operating resistance	Continuity at more than 508 mm H ₂ O	
Battery	For standard	K 3	12-60AH min.
		K 4	12V-70A min.



Group
No.

7-01 GENERAL

■ Wiring Diagram

1. The nominal size of the low voltage wire for automobile (JIS, C3406) is indicated on each wire lead.
2. The wiring diagrams for the standard, engines, the key-OFF stop engines, and the engines with glow timer are indicated. When modifying the electrical wiring for an engines-driven machine, the following should be taken into careful consideration.

CAUTION

- The G and R wires for the control timer unit should be minimized in their wiring resistance to prevent influence noises (voltage variation, etc.) of other electrical equipment.
- Note the polarity of the diode between the key switch and the alternator L terminal. (If the diode is connected in the reverse polarity, the key-OFF stop will not operate.)

3. Operating combination of the key-OFF stop system (solenoid)

Engine	Engine key	Oil pressure switch	Solenoid	Injection pump control rack	Function
Starting	ON	ON	ON	STOP	
	START	OFF	OFF	MS	Increase for starting
Running	ON	OFF	OFF	(SS)	Normal run
	ON	ON	ON	STOP	Emergency stop at abnormal oil pressure
	OFF	OFF	ON	STOP	Key-OFF engine stop

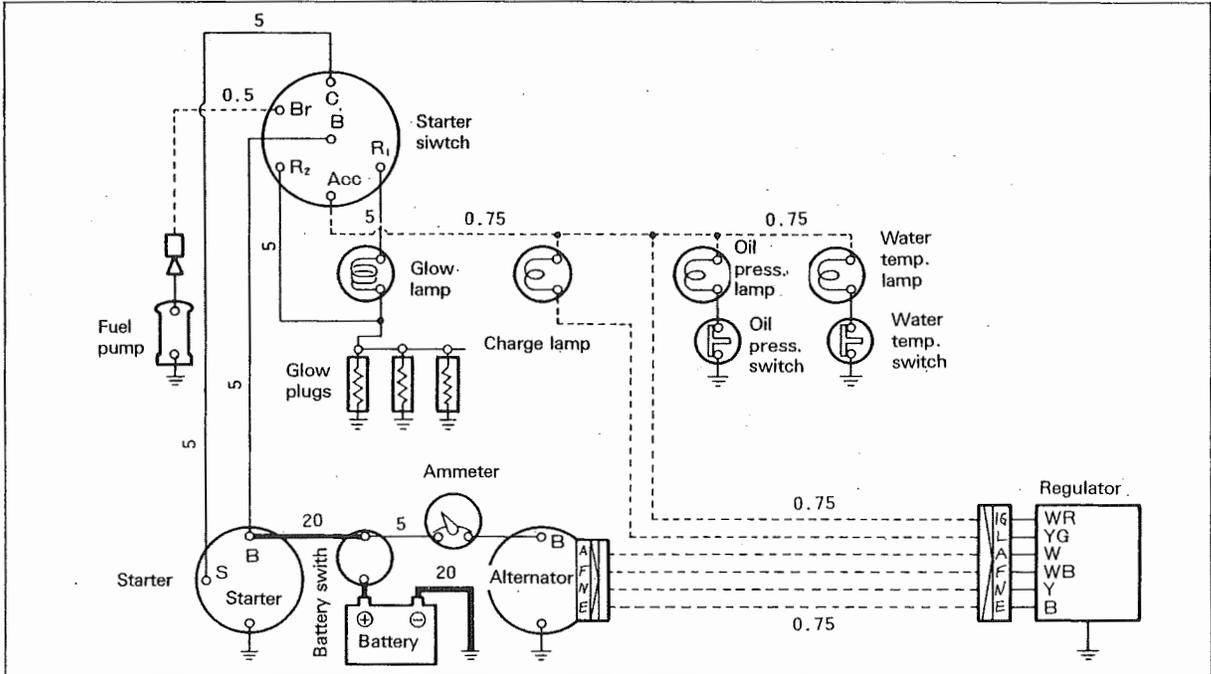
4. Key switch connection of key-OFF stop system (auto glow type)

Key switch	Connection	Remarks
OFF	B-OFF	
ON	B-ON	Current flows to glow circuit for a fixed period (6 sec.) when key is ON. (Lamp comes on)
ST	B-ST-ON	Current flows to glow circuit at starting. (Lamp comes on)

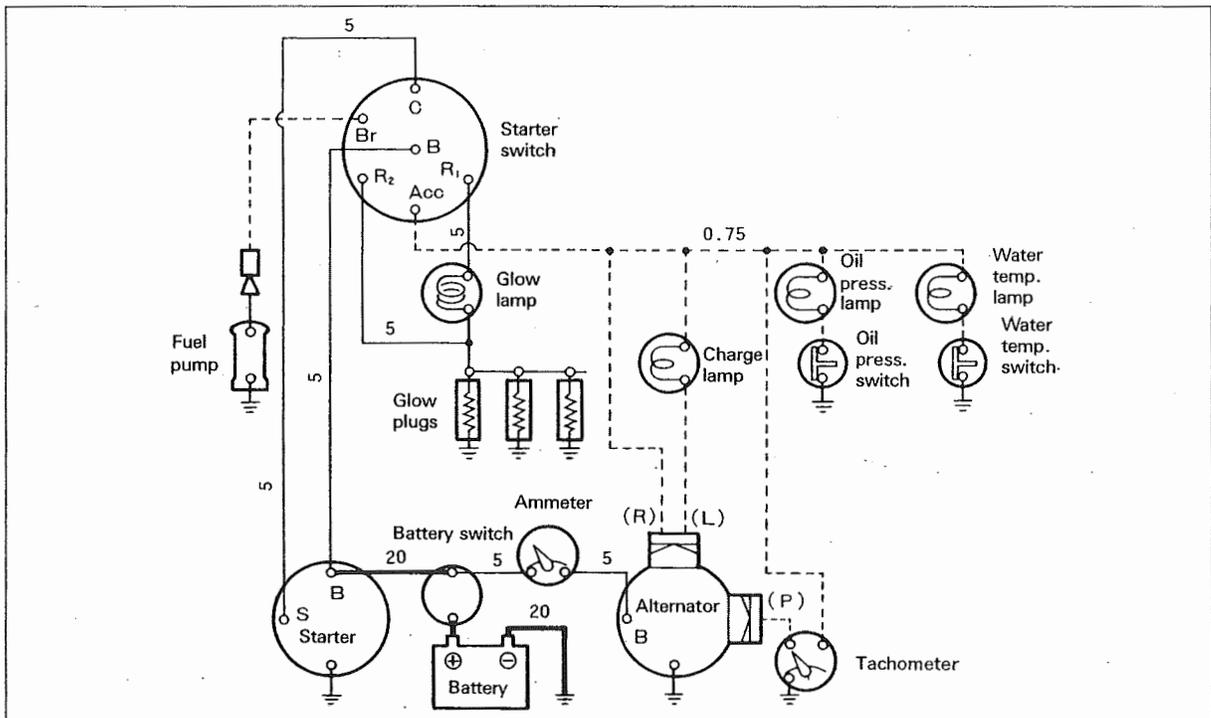


5. Wiring diagrams

(1) Standard type (Having alternator and separate regulator)



(2) Standard type (Having alternator with built-in IC regulator)

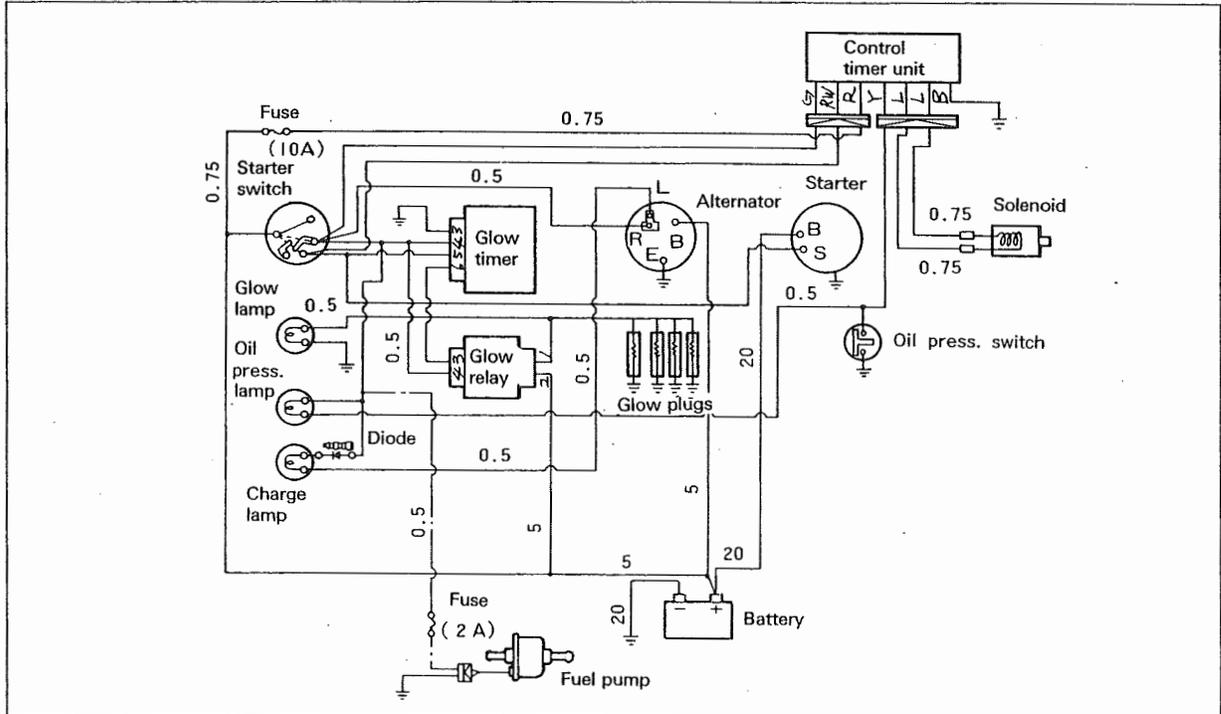




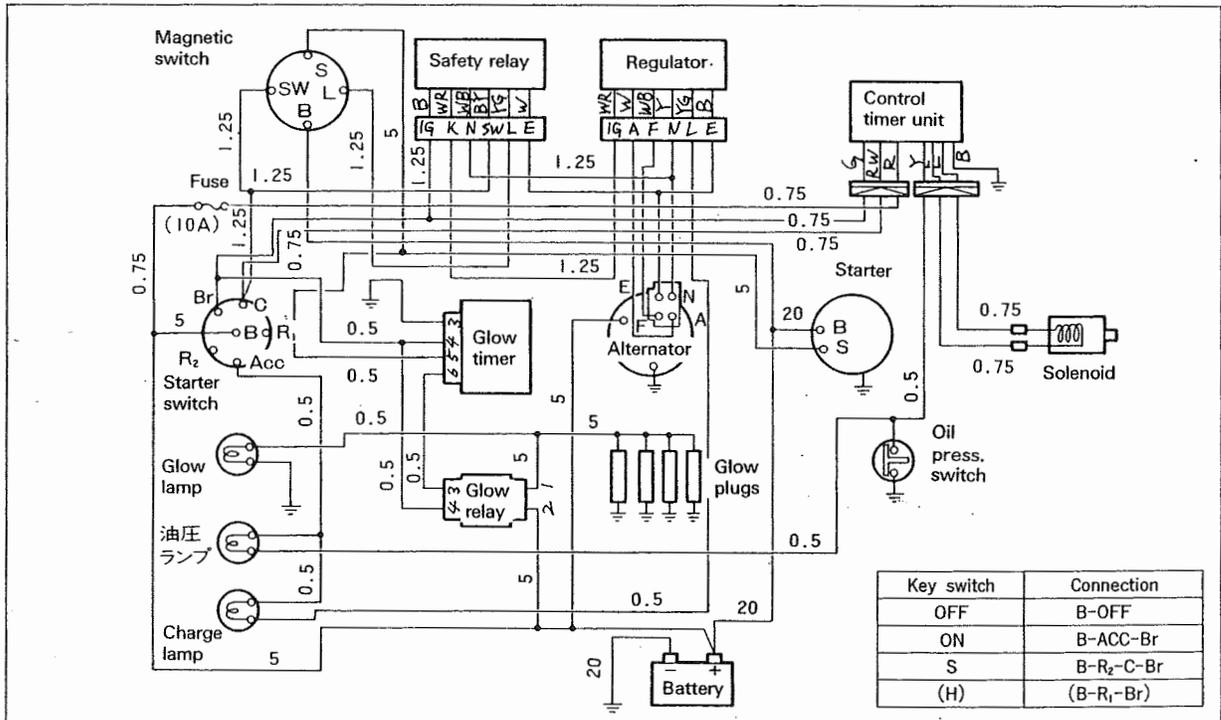
Group No.

7-01 GENERAL

(3) Key-OFF stop type



(4) Key-OFF stop type with glow timer and safety relay





Group
No.

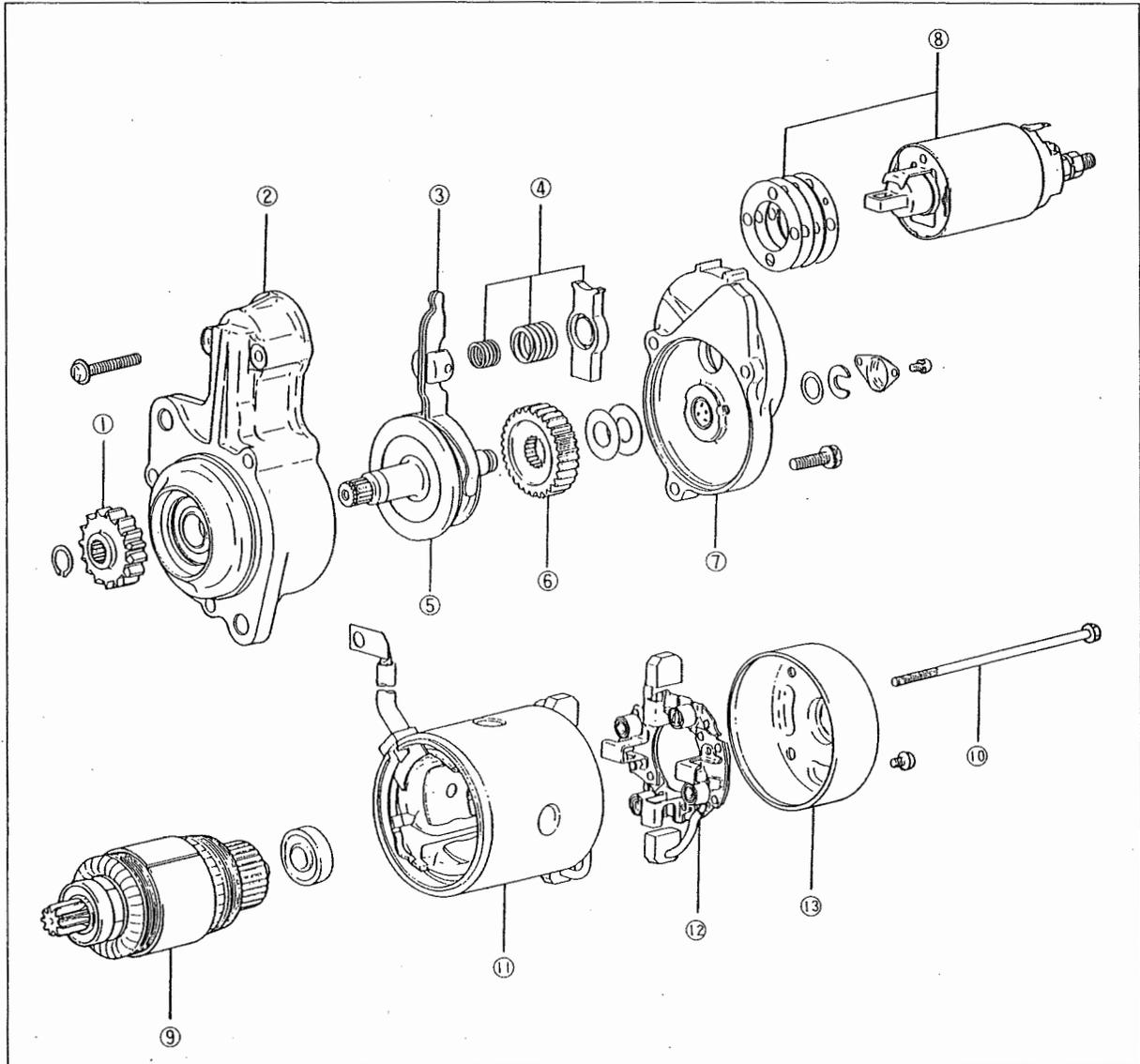
7-02 STARTER

Group
No.

7-02



■ Components



- | | | |
|--------------------------|---------------------------|-------------------------|
| ① Pinion gear | ⑥ Gear | ⑪ Yoke assembly |
| ② Front bracket assembly | ⑦ Center bracket assembly | ⑫ Brush holder assembly |
| ③ Lever assembly | ⑧ Switch assembly | ⑬ Rear bracket |
| ④ Spring set | ⑨ Armature | |
| ⑤ Pinion shaft assembly | ⑩ Through bolt | |



Group No.

7-02 STARTER

Starter Assembly Inspection

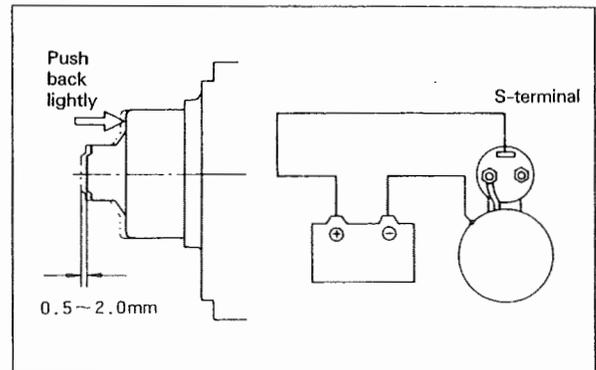
(1) Pinion gap

- (a) Connect the S terminal of the starter to the positive (+) terminal of the 12V battery and the M terminal to the negative (-) terminal to slide out the pinion.

Caution

- Do not apply voltage continuously for more than 10 seconds.

- (b) Push back the pinion with finger and measure this gap.
- (c) If the gap is not within 0.5 ~ 2.0 mm, adjust it by increasing or decreasing the number of shims at the switch. Increasing of the number of shims will reduce the pinion gap.



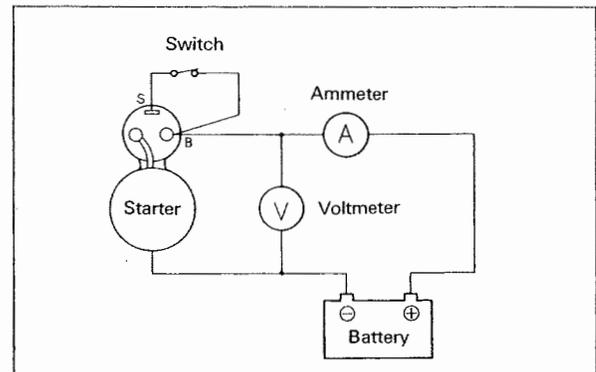
Pinion Gap Inspection

(2) No-load test

- (a) Connect the ammeter, voltmeter and battery as shown in the figure.
- (b) The pinion will be pushed out and starter turn smoothly at specified rpm or more when the switch is turned ON. If the current or rpm is not within specification, disassemble the starter and inspect it.

Caution

- Use lines as thick as possible and tighten each terminal securely.
- Rotating noise of the reduction type starter may be loudly as compared with pinion direct driven type starter.
- In the case of measuring rpm at the end of the pinion, take care of protrusion of the pinion when the switch is turned ON.



No-Load Test

Description		Standard value		
		M2T50381	M2T56271	M2T56272
Starter model		M2T50381	M2T56271	M2T56272
Nominal output (V-kW)		12-1.6	12-2.0	12-2.0
No-load characteristic	Terminal voltage (V)	11.5	11	11
	Current (A)	100 max.	130 max.	130 max.
	Speed (rpm)	3000 min.	3850 min.	3850 min.



(3) Magnetic switch

Disconnect the M terminal connector of the magnetic switch and perform the following inspection. Replace the magnetic switch assembly if it is faulty.

(a) Attraction test

The pinion must be pushed out when the battery is connected between the S and M terminals of the magnetic switch,

Caution

● Do not connect the battery for more than ten seconds.

(b) Holding test

Connect the battery between the S terminal of the magnetic switch and the body and pull out the pinion fully by hand. The pinion must not return when it is released from the hand.

Caution

● Do not connect the battery for more than ten seconds.

(c) Return test

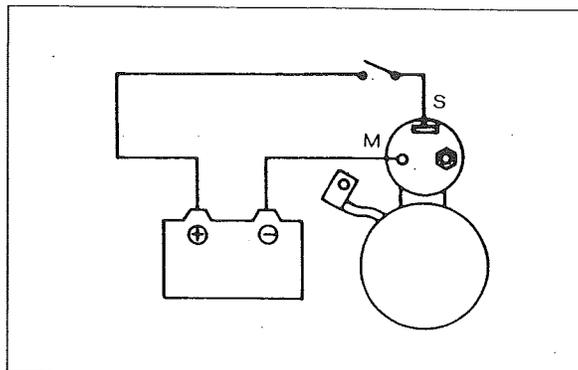
Connect the battery between the M terminal of the magnetic switch and the body and pull out the pinion fully by hand. The pinion must return immediately when it is released from the hand.

Caution

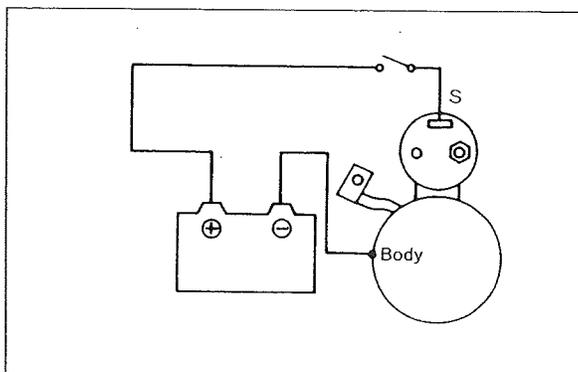
● Do not connect the battery for more than ten seconds.

■ Disassembly

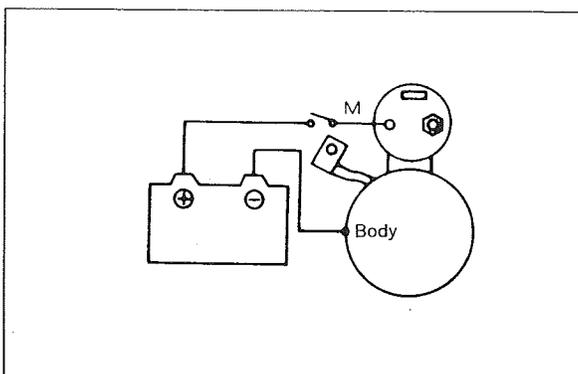
- (1) Loosen the nut on the M terminal and remove the connector.
- (2) Remove the two screws attaching the magnetic switch. Remove the switch assembly.
- (3) Remove the two through bolts, and two screws attaching the brush holder. Remove the rear bracket.



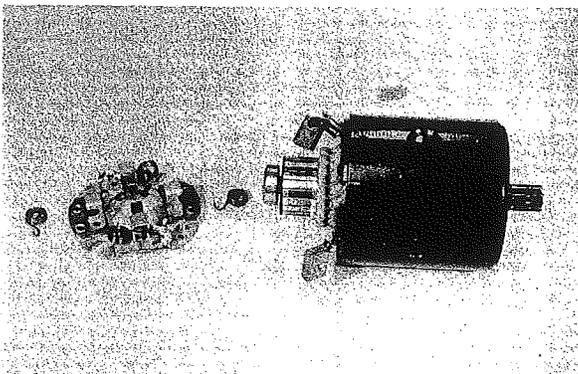
Attraction Test



Holding Test



Return Test



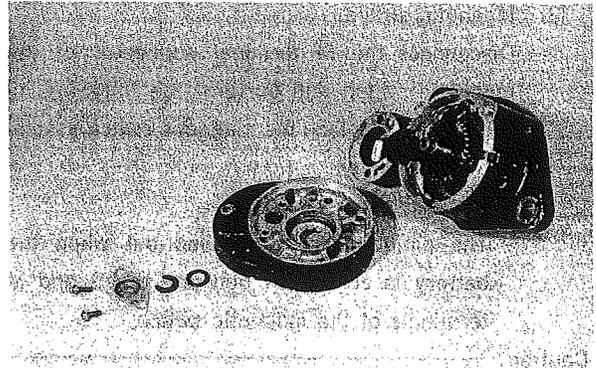
Removing Brush Holder Assembly



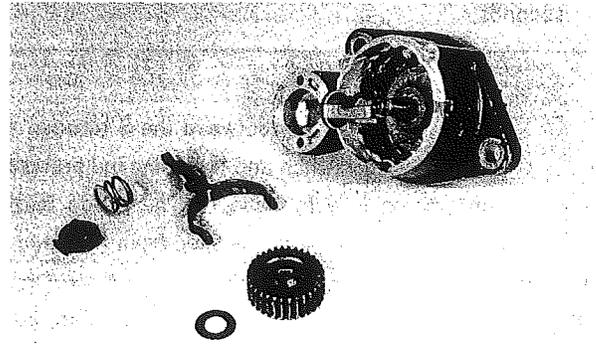
Group
No.

7-02 STARTER

- (4) Remove the yoke and brush holder assembly while releasing the two brushes. Remove the armature.
- (5) Remove the cover, snap ring and washer.
- (6) Remove the bolts and center bracket. Adjust the pinion shaft end play. Remove the snap ring to remove the end play adjusting washer.
- (7) Remove the reduction gear lever and the lever spring from the front bracket.
- (8) Remove the snap ring from the pinion end. Remove the pinion and shaft.
- (9) Remove the bearings from both ends of the armature using a bearing puller. The bearing pressed in the front bracket can not be replaced. Replace the front bracket assembly if the bearing is worn or damaged.



Removing Center Bracket

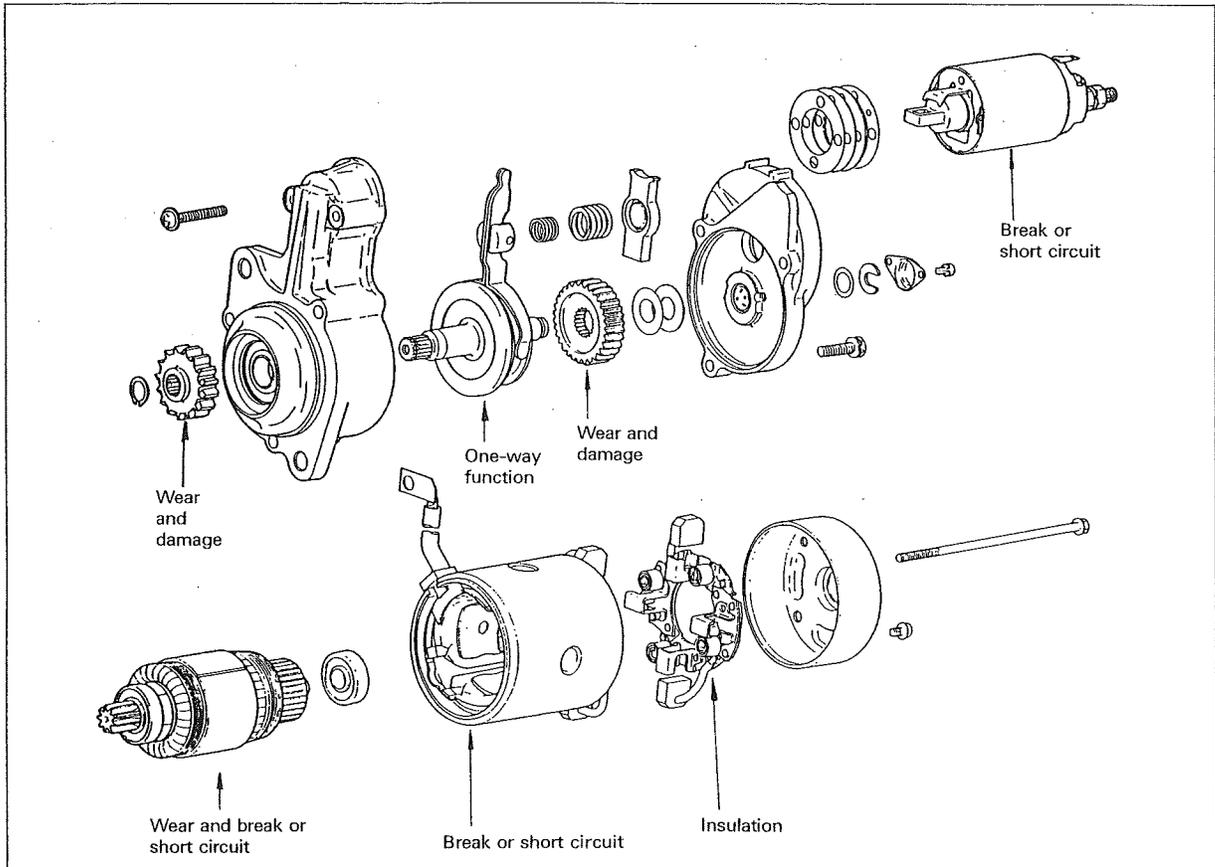


Removing Reduction Gear



■ Inspection after Disassembly

Check the disassembled starter for faulty conditions.

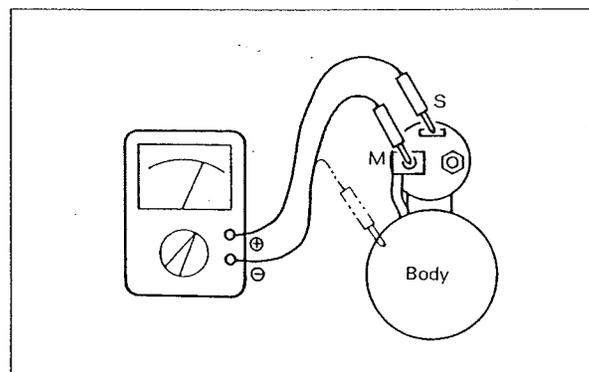


Armature		
Description	Standard value	Service limit
Undercut depth	0.5 mm	0.2 mm
O. D. of commutator	32 mm	-1.0 mm

Brush		
Description	Standard value	Service limit
Brush length	17 mm	6 mm
Spring force	3 kg	

(1) Magnetic switch inspection

Check for continuity between the S and M terminals, and the S terminal and body, respectively. If resistance is zero, it indicates short circuit and the magnetic switch should be replaced.



Magnetic Switch Inspection

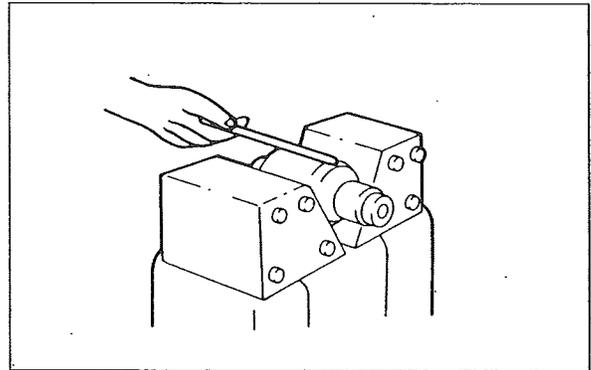


Group
No.

7-02 STARTER

(2) Armature inspection

- (a) Check the armature using a growler tester. Replace the armature if there is short circuit. Check for continuity between the commutator and the shaft. Replace if there is continuity.
- (b) Measure the O. D. of the commutator and depth of undercut. Repair or replace if they exceed the service limit. If the commutator surface is roughened, polish with a fine sand paper.



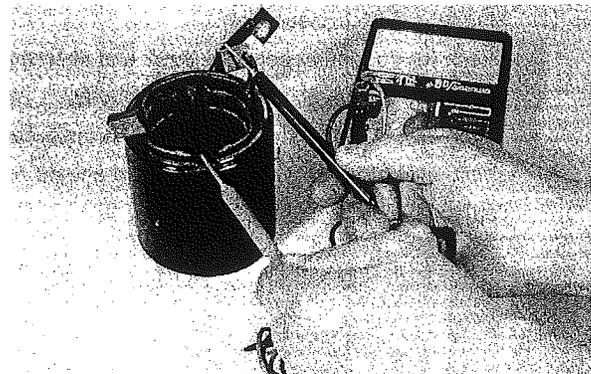
Short-Circuit Test of Armature Coil

(3) Brush holder

- (a) Check the brushes for wear. If they are worn to the wear limit line, replace with new ones.
- (b) Check the brush spring tension. Replace the brush holder assembly if the tension is not correct.
- (c) Check for continuity between the positive (+) side brush holder and the brush holder base. Replace the holder assembly if there is continuity. Also check the brush holder staked area for looseness.

(4) Field coil inspection

- (a) Check for continuity between the coil end (brush) and the yoke. There must be no continuity.
- (b) Check for continuity between the coil ends (brushes). There must be continuity.
- (c) Check the pole piece and coil for looseness.



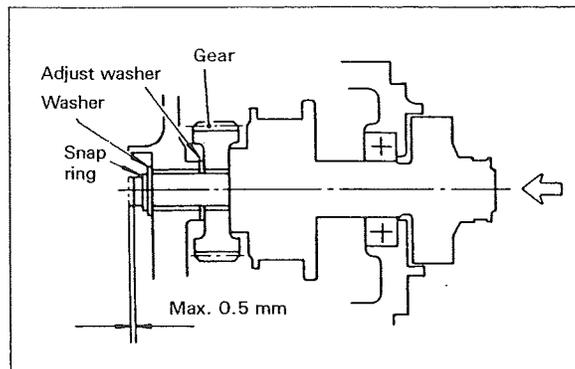
Field Coil Inspection



■ **Assembly and Adjustment**

Assemble the starter in the reverse order of disassembly while noting the following items.

- (1) Pinion shaft end play adjustment
Adjust the end play (thrust gap) to less than 0.5 mm by inserting the adjusting washer between the center bracket and the reduction gear.
 - (a) Install the pinion shaft, reduction gear washer and snap ring to the center bracket.
 - (b) Measure the end play by moving the pinion shaft in the axial direction. Adjust by adding the adjusting washer if the end play exceeds 0.5 mm.



Adjusting Thrust Gap

- (2) Lubrication
Apply grease to the following friction surfaces, gears and bearings when the starter is overhauled.

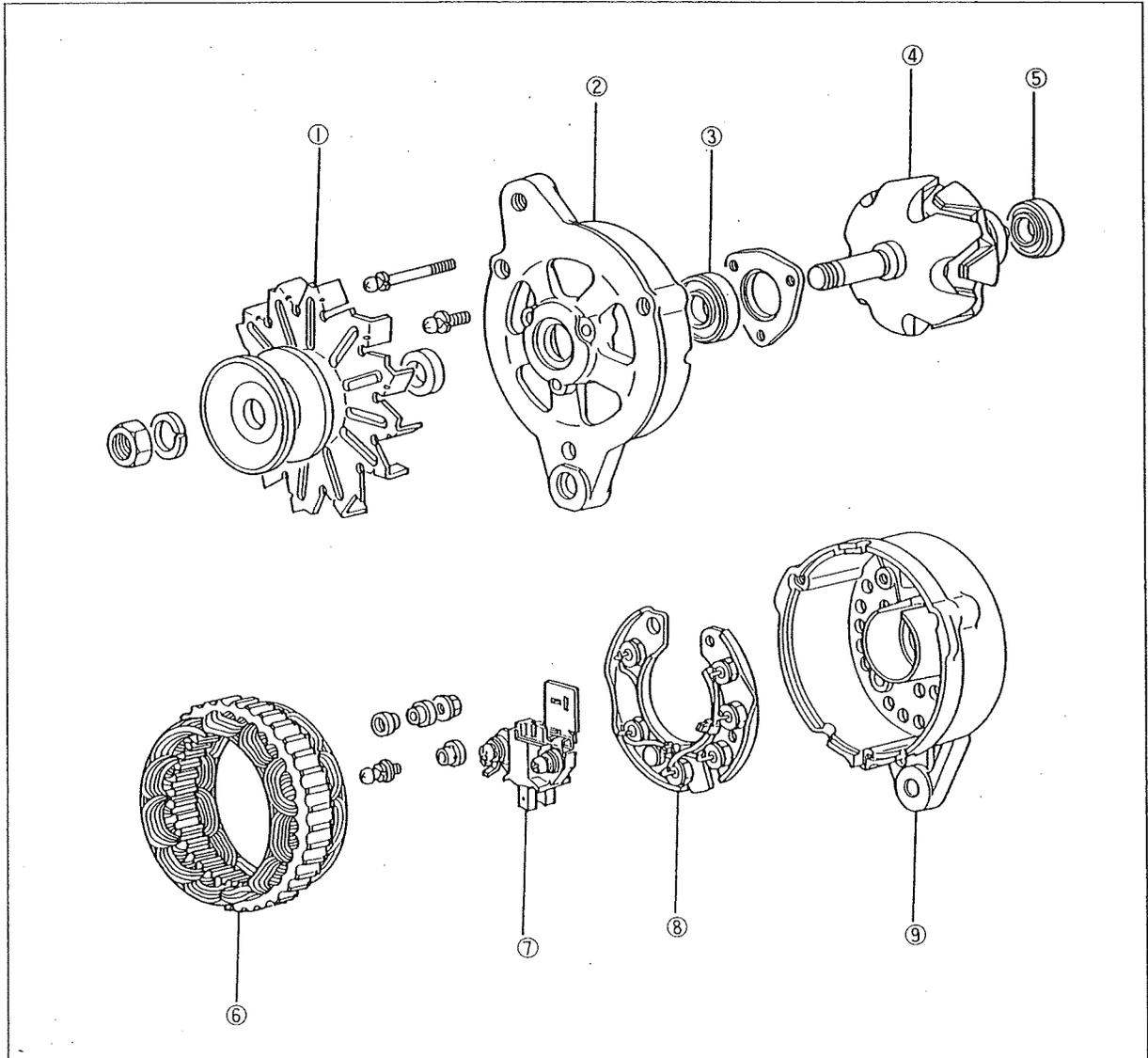
- Armature shaft gear and reduction gear
- All bearings
- Washer and snap ring of the pinion shaft
- Bearing sleeve
- Pinion
- Friction surfaces of the lever



Group
No.

7-03 ALTERNATOR

■ Components (Separate regulator type)



① Pulley

② Front bracket

③ Front bearing

④ Rotor assembly

⑤ Rear bearing

⑥ Stator

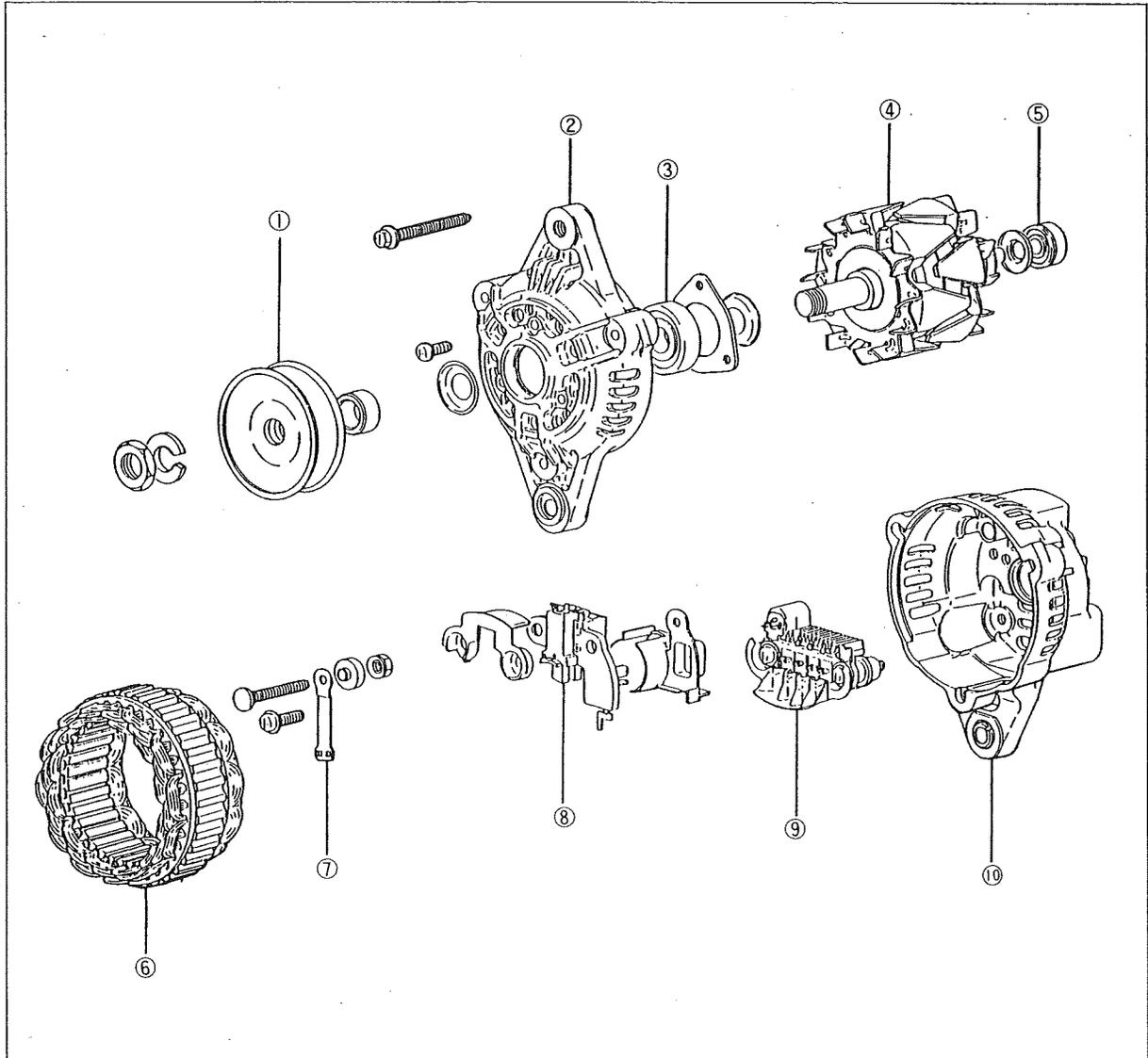
⑦ Brush holder assembly

⑧ Rectifier assembly

⑨ Rear bracket



■ Components (Built-in IC regulator type)



- | | | |
|------------------|-----------------------------------|----------------------|
| ① Pulley | ⑤ Rear bearing | ⑨ Rectifier assembly |
| ② Front bracket | ⑥ Stator | ⑩ Rear bracket |
| ③ Front bearing | ⑦ Terminal set | |
| ④ Rotor assembly | ⑧ Regulator brush holder assembly | |



Group No.

7-03 ALTERNATOR

■ Inspection on Engine

1. Precautions for Inspection

Note the following precautions to prevent the alternator from damage or trouble.

- (a) Do not connect the battery in reverse polarity. The negative (−) terminal should be connected to ground.
- (b) Do not use a high voltage tester such as a megger.
- (c) Disconnect the cables from the battery when recharging the battery.
- (d) Do not disconnect the lead wire from the alternator B terminal when the engine is running.
- (e) Do not ground the alternator B terminal because battery voltage is always applied to it.
- (f) Take care not to short or ground the L terminal. (Built-in IC regulator type)
- (g) When using a steam cleaner, take care not to apply steam directly to the alternator and other electrical parts.

2. Inspection

With the charging system parts left installed, check for faulty conditions such as shown in the table at right. Remove the questionable parts only when dismantling is necessary for inspection or repair.

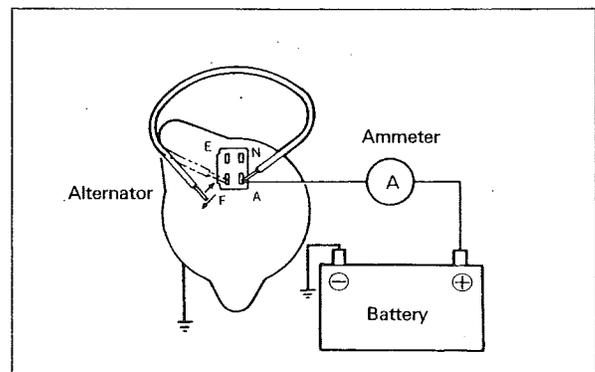
Over charge	Too high voltage relay set value
	Loose ground connection
	Faulty wiring
	Broken resistance or coil in series circuit
Discharge	Too low voltage relay set value
	Poor output of alternator
	Too much electric power consumption
	Use of improper load

(1) Inspection of alternator separate from regulator

(a) Diagnosis

Check to see whether the trouble is in the alternator or in the regulator by the following manner.

Connect an ammeter between the alternator A terminal and the battery positive (+) terminal. Run the engine at approximately 2000 rpm and observe the charging current.



Charging Performance Inspection

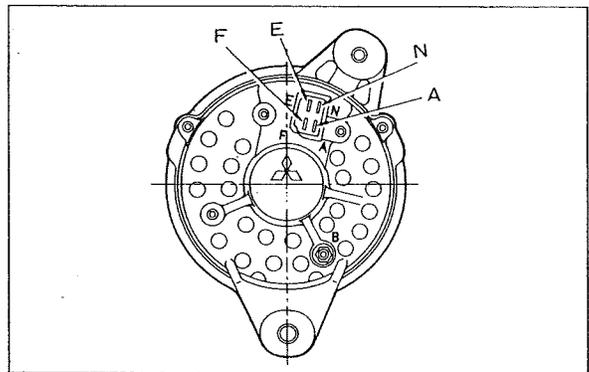


Disconnect the connector between the alternator and regulator. Connect the alternator A and F terminals to each other for several seconds with a jumper wire.

If the charging current remains unvaried, the alternator is suspected to be defective. If the charging current increases, the regulator is suspected to be defective.

(b) Diode inspection

- 1) Check for continuity between the alternator terminals A and N, and E and N, respectively, with an ohmmeter. Reverse the ohmmeter polarity and recheck for continuity.
 - The ohmmeter will indicate a large resistance in one direction and a small one in reverse direction.
 - If resistance is small in both directions, a short circuit is suspected. If resistance is large in both directions, an open circuit suspected. Replace the rectifier assembly in both cases.
- 2) Perform the same inspection for the E and N terminals.
- 3) This testing method is not suited to check the diodes individually. Disassemble the alternator to check each diode.



Alternator Terminals

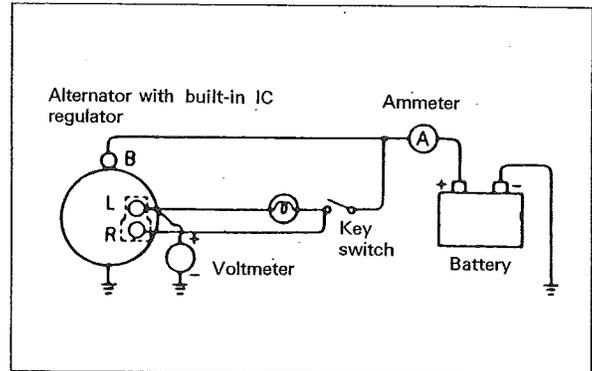


Group No.

7-03 ALTERNATOR

(2) Regulating voltage inspection (Alternator with built-in regulator)

- Disconnect the battery cable from the positive (+) terminal and connect an ammeter between the cable and the terminal.
- Connect a voltmeter between the alternator L terminal and ground.
- The voltmeter must indicate zero when the starter switch is OFF and indicate a value somewhat below the battery voltage when the starter switch is ON (without engine running).
- Short-circuit the ammeter and start the engine.
- Measure regulating voltage (with the ammeter reading below 5A, engine speed at 1800 and 2500 rpm, and all lamp switches OFF). The regulating voltage varies with alternator temperature and has a tendency to indicate lower voltage as temperature increases.



Regulating Voltage Inspection

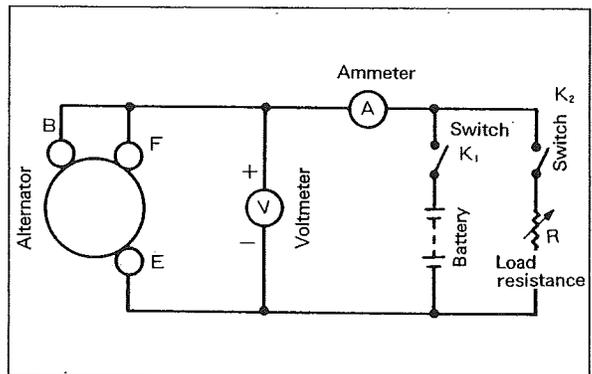
Description	Standard value
Regulating voltage (at 20°C)	14.7 ± 0.3V

(3) Output inspection - I (Alternator separate from regulator)

Remove the alternator from the engine, connect the alternator as shown in the figure, and drive it with a motor.

Close switch K1 to flow field current from the battery. Under this condition, increase the alternator speed gradually until current flow to the field coil stops, i. e. the ammeter indicates zero. Then, open switch K1 to start self-exciting. Increase the speed gradually until the voltmeter indicates 14V and read the alternator rpm. This reading must satisfy the standard speed without load (1300 rpm max.)

Adjust the load resistance R to the maximum to minimize the load current flow and close switches K1 and K2. While adjusting the terminal voltage to constant 14V, increase the alternator speed to 2500 rpm and read the indication of the ammeter. This reading must satisfy the standard speed with load.



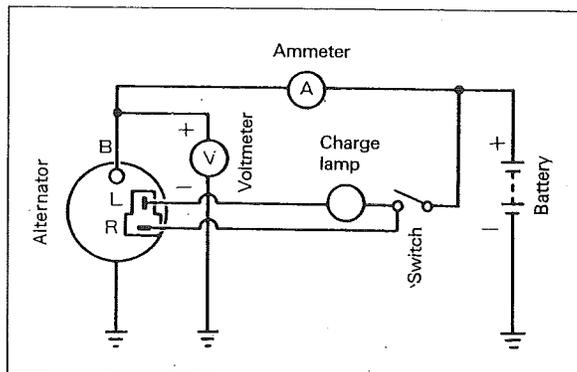
Output Test Connection (Separate regulator type)

Output (Normal temperature)

Description	Model	Standard value	
		Terminal voltage/current	Speed
No-load output (at cold)	AR2115Z2	14V/0A	1300 rpm max.
	AH2035M4	14V/0A	1300 rpm max.
Loaded output (at cold)	AR2115Z2	14V/15A min.	2500 rpm max.
	AH2035M4	14V/30A min.	2500 rpm max.



- (4) Output inspection — 2 (Alternator with built-in IC regulator)
- Disconnect the battery ground cable.
 - Connect the ammeter between the alternator B terminal and battery. Connect the voltmeter between the B terminal and ground.
 - Connect the battery ground cable.
 - Start the engine.
 - Turn all light switches ON.
 - Increase the engine speed and read the ammeter at 13.5V of output voltage and specified alternator rpm. Ammeter reading must satisfy the standard value.



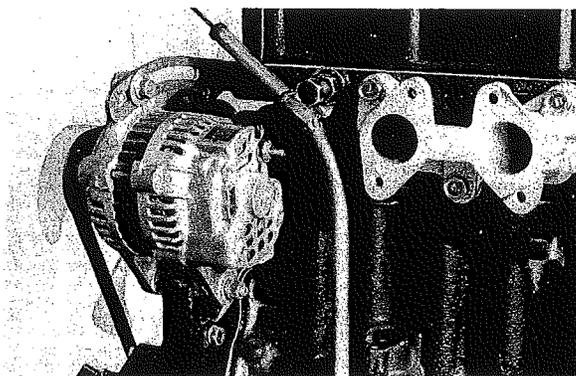
Output Test Connection (Built-in regulator type)

Output (normal temperature)

Description	Type	Standard value	
		Terminal voltage/current	Speed
Output (at hot)	A0T2517I	13.5V/21A	2500 rpm max.
	A0T2527I	13.5V/37A	5000 rpm max.

■ Removal

- Disconnect the battery cable.
- Disconnect the lead wire from the B terminal at the rear of the alternator.
- Disconnect the alternator connector.
- Loosen the alternator brace and support bolts and remove the fan belt by moving the alternator to the engine side.
- Remove the alternator.



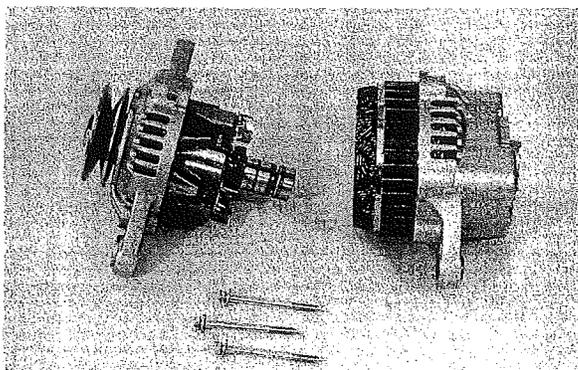
Removing Alternator

■ Disassembly

- Remove the three through bolts.
- Heat the rear bracket at the rear bearing to 50 ~ 60 °C with a soldering iron, etc. and separate the stator coil from the front bracket.

Caution

- Pry the clearance between the stator core and the front bracket using the tip of a screwdriver.
- Do not insert the screwdriver excessively.



Disassembling Stator



Group
No.

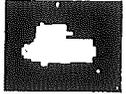
7-03 ALTERNATOR

- (3) Hold the rotor in a vise and remove the pulley nut, pulley, fan and spacer in that order.
- (4) Remove the rotor assembly from the front brakcet.
- (5) Disconnect the soldered wire lead of the stator coil using a soldering iron and remove the stator assembly.

Caution

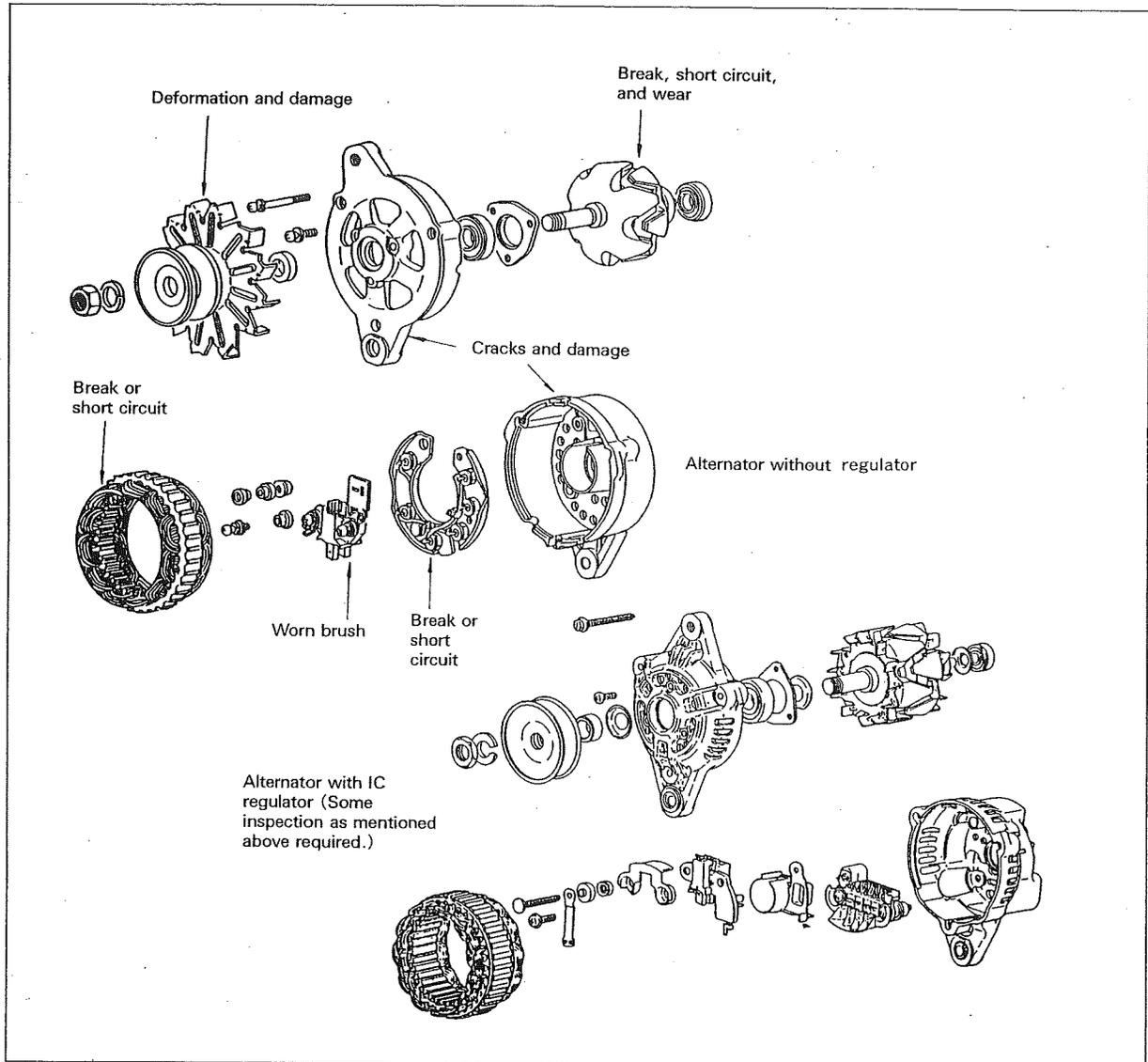
- When disconnecting the lead wire, never heat the solder unnecessarily long to prevent the diodes from being damage by excessive heat.
-

- (6) Remove the capacitor from the B terminal.
- (7) Remove the rectifier by removing the attaching screws.



■ Inspection after Disassembly

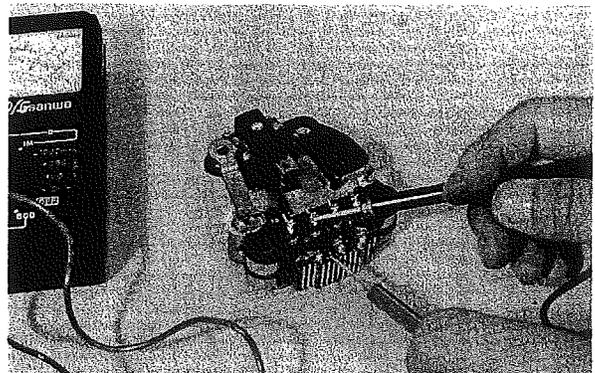
Replace the parts if necessary.



(I) Diode inspection

Check individual diodes assembled in the rectifier for continuity :

- (a) Check for continuity between the lead wire from each diode and the diode case. Resistance must be large in one direction and small in reverse direction.
- (b) If equal resistances are in both directions, replace the rectifier assembly.
- (c) Check all diodes for continuity.



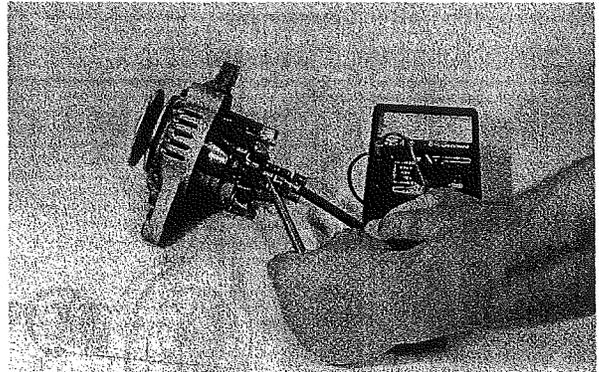
Diode Inspection



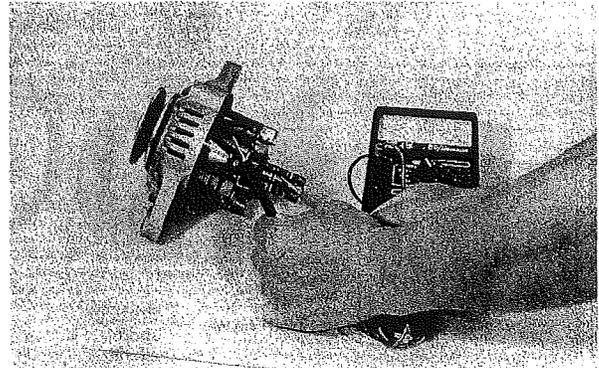
Group
No.

7-03 ALTERNATOR

- (2) Field coil inspection.
- (a) Check for continuity between the slip rings. If there is no continuity, the field coil is open and it should be replaced with a new one.
 - (b) Check for continuity between the slip ring and the shaft or the core. If there is continuity, the field coil is grounded and it should be replaced with a new one.

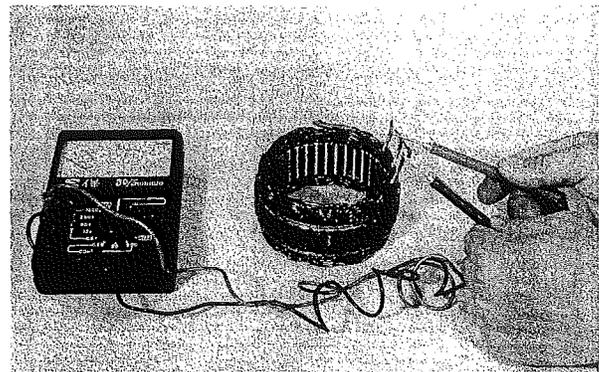


Continuity Test of Field Coil

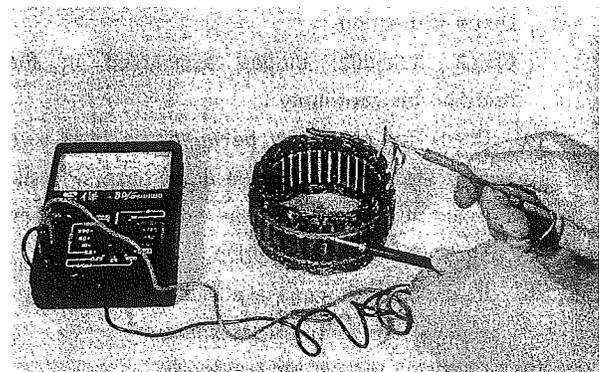


Insulation Test of Field Coil

- (3) Stator coil inspection
- (a) Check the stator coil for continuity between each lead wire. If there is no continuity, the stator coil is open and it should be replaced with a new one.
 - (b) Check for continuity between each lead wire of the stator coil and the stator core. If there is continuity, the stator coil is grounded and it should be replaced with a new one.



Continuity Test of Stator Coil



Insulation Test of Stator Coil



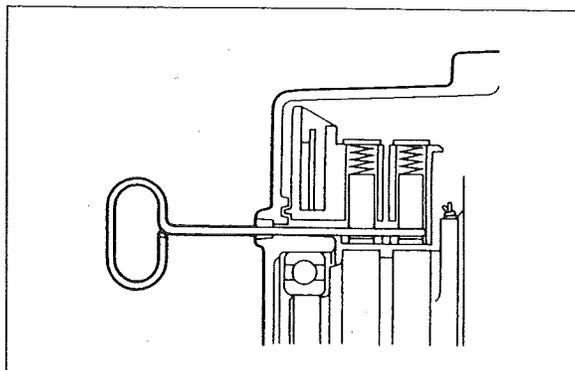
■ Alternator Assembly

Assemble the alternator in the reverse order of disassembly with care of the following :

- (1) Align the projection of the snap ring with the deepest portion of the eccentric groove in the rear bearing.
- (2) When replacing the rear bearing, press-fit a new bearing so that its groove faces the slip ring.
- (3) Heat the rear bracket when pressing the rear bearing into the rear bracket.

Caution

- When fitting the rotor into the rear bracket, lift the brushes by inserting a wire through the small hole in the rear bracket.



Lifting of Brushes

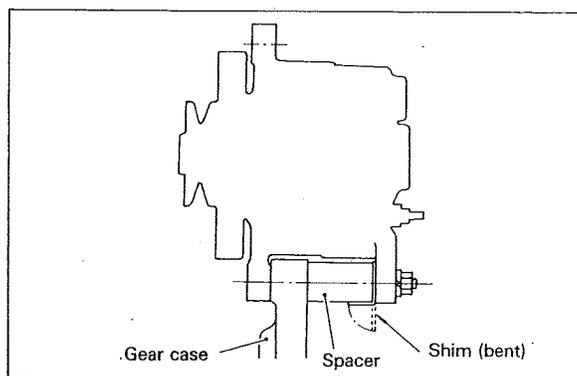
■ Installation

Install the alternator in the reverse order of removal.

(1) Spacer adjustment

When installing the support bolt, insert the spacer as follows :

- (a) Insert the support bolt to the specified position. (Do not install the nut yet.)
- (b) Install the alternator and insert the spacer between the alternator rear bracket and the gear case bracket.
- (c) Adjust the clearance between the rear bracket and the spacer to 0.2 mm or less by inserting the shims (0.198 mm thick each). Install the support bolt nut.
- (d) Adjust the fan belt tension.



Inserting Spacer

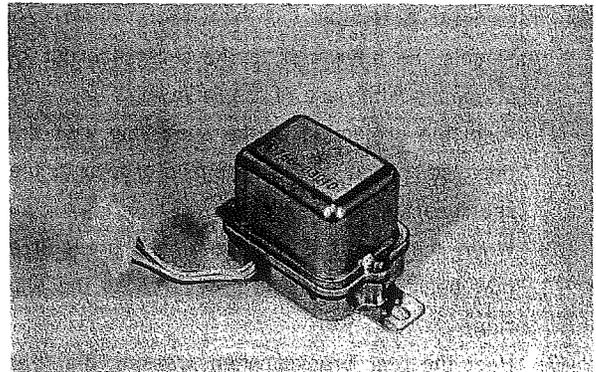


Group
No.

7-04 REGULATOR (Separate from Alternator)

Specifications

Description	Specification
Type	Tirill type
Model	RQB2220D4
Regulating voltage	14.8V ± 0.3V
Pilot lamp ON voltage	4.2 ~ 5.2V
Pilot lamp OFF voltage	0.5 ~ 3.0V
Installation direction	Lead wire outlet side bottom



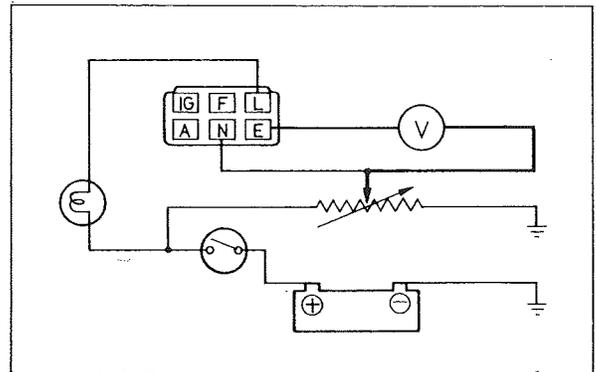
Regulator

Adjustment and Inspection

Caution

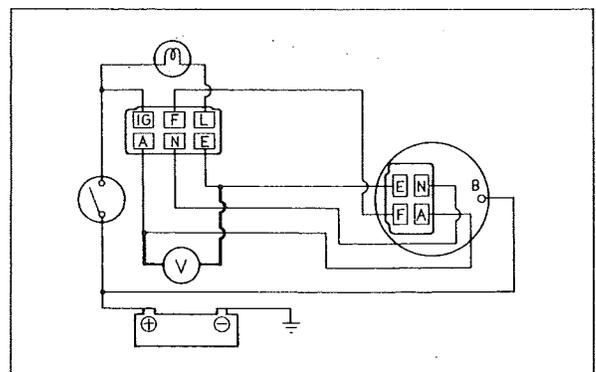
- The regulator is sealed. Breaking the seal makes the regulator no more warranted.
- Do not operate the engine with the regulator coupler disconnected.
- Do not connect a capacitor to the F terminal of the regulator.
- The standard regulator (RQB2220D2) should be installed sideways so that its lead wire outlet faces downward.

- (1) No-load regulating voltage inspection
 - (a) Connect a voltmeter between the regulator A and E terminals.
 - (b) Start the engine and let it be idle. Disconnect the lead wire from the alternator B terminal to unload the alternator.
 - (c) The regulating voltage must be within specification when the alternator speed increases to 4000 rpm.



Regulator Inspection

- (2) Pilot lamp voltage inspection
 - (a) Connect a voltmeter and variable resistor.
 - (b) With the pilot lamp lit, gradually increase voltage and read the voltage at which the lamp goes off.
 - (c) Decrease voltage gradually and read the voltage at which the lamp comes on again.



Pilot Lamp Voltage Inspection

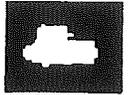


Group
No.

7-05 GLOW PLUG

Group
No.

7-05



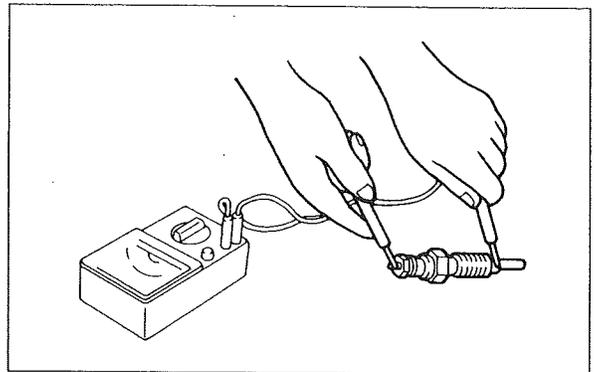
■ Removal/Installation

Glow plug tightening torque : 1.5 ~ 2.0 kgm

■ Inspection

Check the glow plug for continuity between the terminal and the body as shown. If there is no continuity or resistance is excessively high, replace the glow plug with a new one.

Description	Specification
Type	Y-142T
Rated voltage/current	10.5V/9.7A
Resistance	0.16Ω



Glow Plug Inspection



Group No.

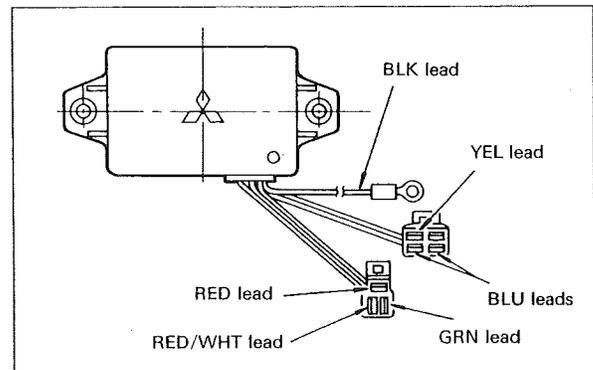
7-06 KEY-OFF STOP SYSTEM

■ General

This system stops the engine when the starter key is turned OFF, like the system used for ordinary automobile engines. Also, it incorporates with an oil pressure switch and a coolant temperature switch (if so specified) so that the engine is stopped urgently by the control-timer actuated solenoid valve in case of abnormal oil pressure drop or coolant temperature increase.

■ Control Timer Specification

Description	Specification
Model	YM-1
Input voltage range	DC9 ~ 15V
Load	Solenoid (Coil resistance : 1, 7Ω min.)



Control Timer

■ Wire Identification Color

Code	Wire color	Connection
①	Blue	Solenoid
②	Blue	Solenoid
③	Red	Battery (key switch B)
④	Green	Key switch ON
⑤	Red, white	Starter (key switch, starter)
⑥	Yellow	Oil pressure switch
⑦	Black	Ground

■ Solenoid for Key-Off Stop

Description	Specification
Type	Pushing out type
Voltage	10 ~ 15V DC
Coil resistance	1, 8Ω ± 10% (20 °C)
Stroke	13, 5 ± 0, 5



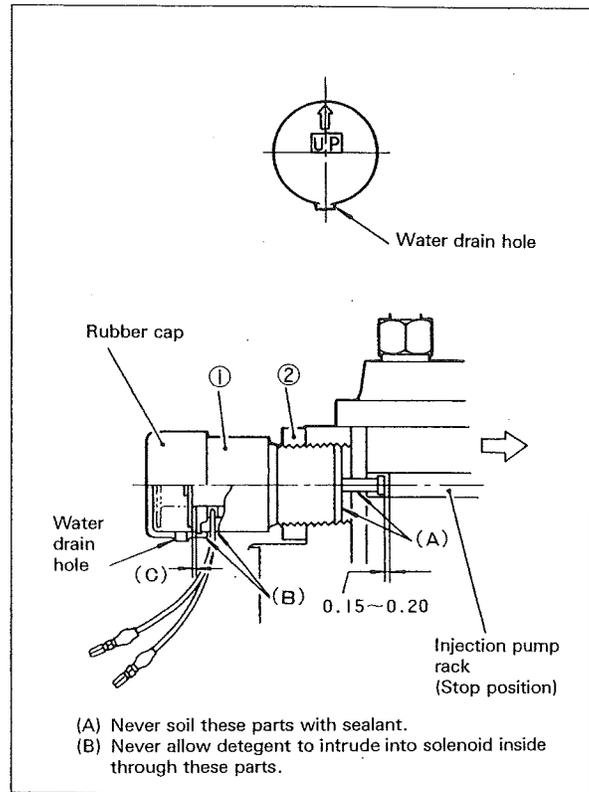
■ Solenoid Installation

- (1) Temporarily install the solenoid ① and nut ② on the crankcase. (Apply THREE-BOND 1212 or 1211 to the effective threads of the solenoid.)
- (2) Screw in the solenoid until clearance C is zero when the injection pump rack is at 0 position.
- (3) From this position, turn back the solenoid by 30° to 45° (rack-to-shaft clearance is 0.15 ~ 0.2 mm in this condition) and tighten the locknut to 5.0 kgm.
- (4) Start the engine and make sure that the engine stops when the solenoid shaft is fully pushed in.
- (5) Install the rubber cap with its arrow pointing up (water drain hole pointing down) as shown.

Caution

- Take care not to allow the cleaning agent to enter the solenoid terminal and solenoid (at the lead wire and shaft) when cleaning the engine.

- (6) Precaution after engine assembly
 - (a) The wiring of the key-OFF stop system should follow the wiring diagram shown in this manual.
 - (b) Start the engine and make sure that the engine is stopped by means of the solenoid when the key is turned OFF.
 - (c) Start the engine and make sure that the engine stops when the oil pressure switch terminal is connected to the switch body with a jumper wire.



Installing Solenoid



Group
No.

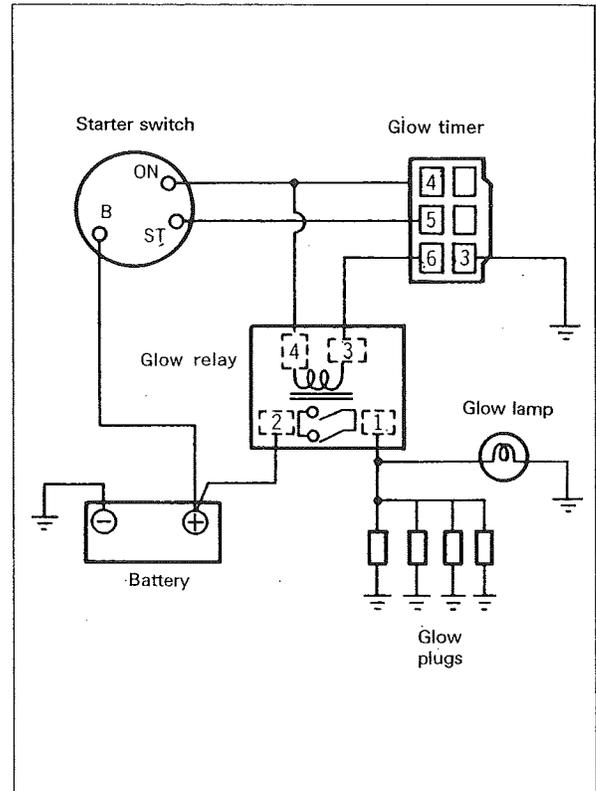
7-07 AUTO—GLOW TIMER SYSTEM

General

The glow plugs preheat the combustion chambers to facilitate the engine starting during cold weather. For the standard specification model, the starter key must be held in the glow position by hand for 20 ~ 30 seconds for preheating. The glow timer system eliminates this holding operation and shorten the glow time (approximately by 6 seconds) to make the glow operation simple. Take the utmost care not to allow the wiring to be made short because this system applies battery voltage to the glow plugs directly unlike the conventional system.

Note : After-glow specification

The after-glow specification provides the pre-heating function which is maintained for fixed time (4.5 sec) after the starter starts cranking the engine, in addition to the same pre-glow finction as provided by the ordinary glow timer specification.

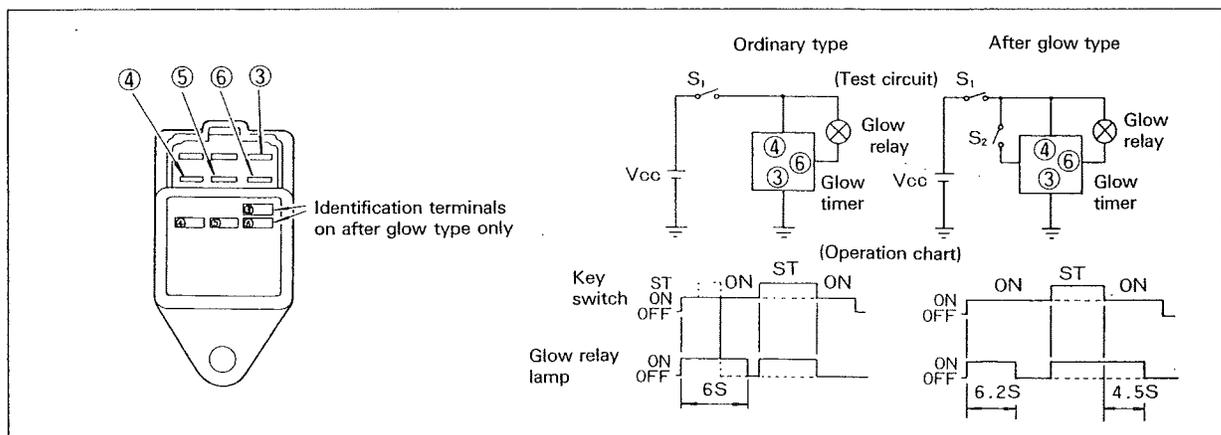


Auto-Glow Timer System Wiring

Note : * I Time passed until the glow relay is tripped to ON after switch S1 is turned ON in the test circuit.

Glow Timer Specifications

Description	Specification
Model	S81NJ
Rated voltage	DC12V
Temperature range	-40 °C ~ 85 °C
Initial characteristic (Normal temperature and humidity, Vcc=12V)	6±0.7 sec. * I

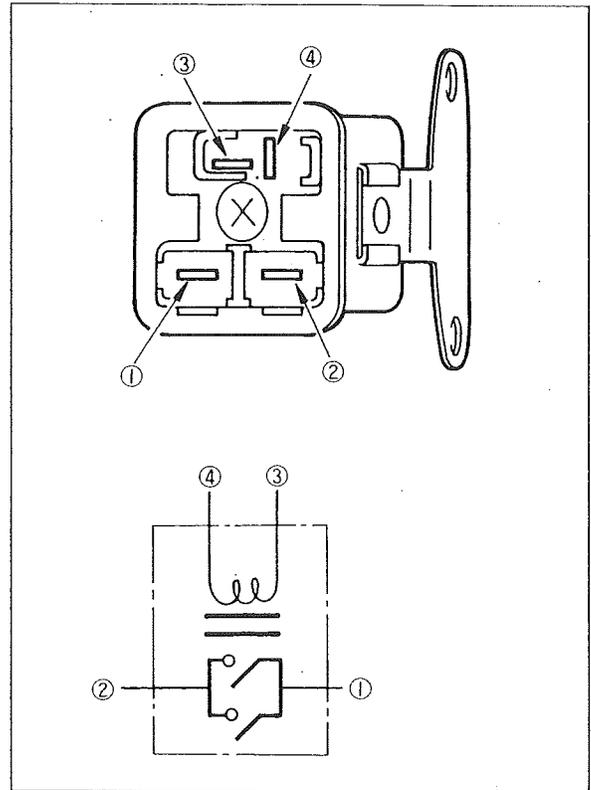


Glow Timer

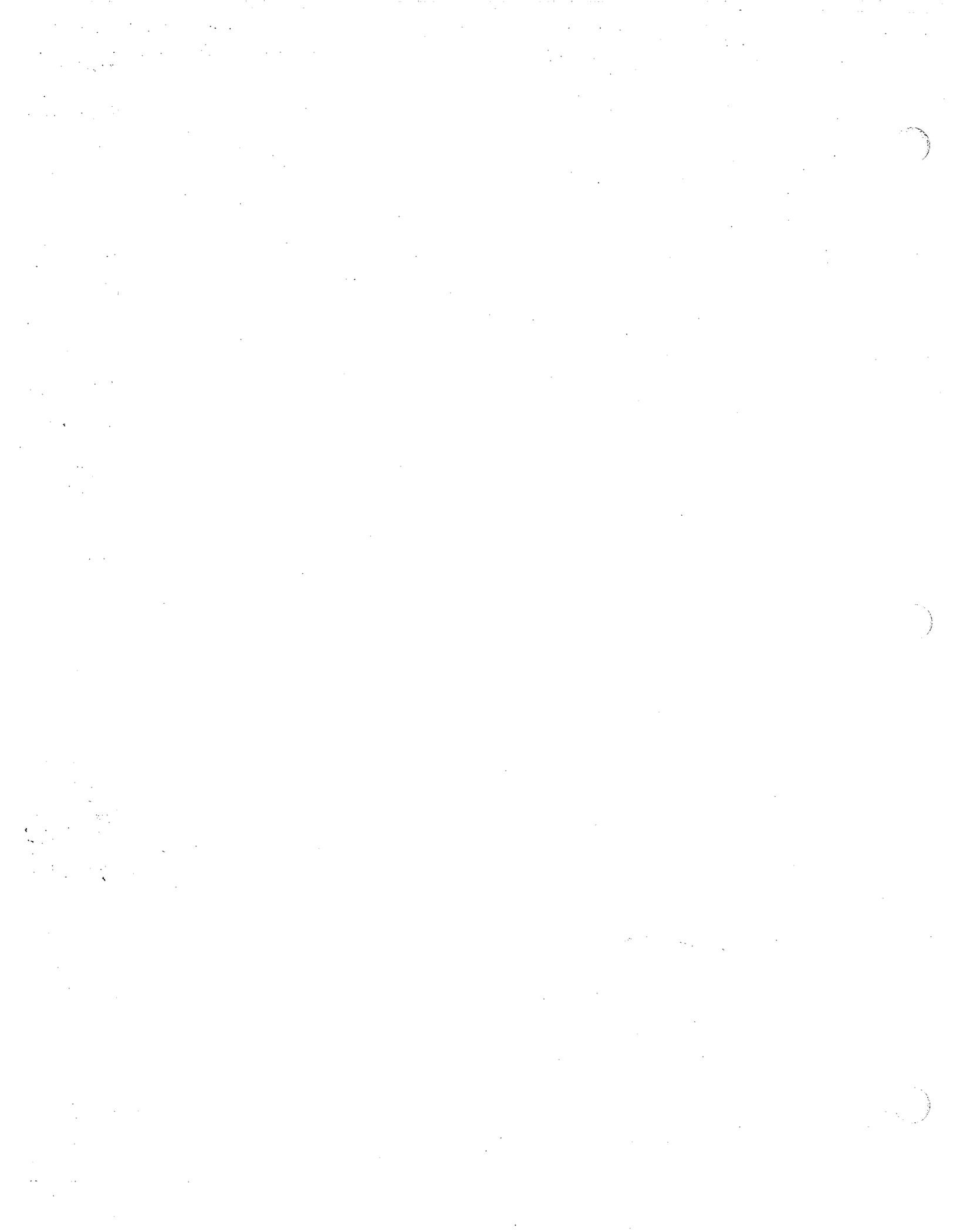


■ Glow Relay Specifications

Description	Specification
Model	G71SP
Rated voltage	DC12V
Continuous rating	1 minute
Coil resistance	13Ω
Inductance	24 mH (at 1 Hz)
Temperature range	-40 °C ~ 100 °C



Glow Relay



Group 8	MAINTENANCE	
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01	Periodic Service Chart	138
02	Specifications and Service Standard	139
03	Tightening Torque and Sealant	149
04	Special Tools	152



Group
No.

8-01 PERIODIC SERVICE CHART

○...Check, adjust or replenish □...Clean ●...Replace △...Drain

Service item		Service interval						Remarks
		Before operation	After first 50hours	Every 100hours	Every 400hours	Every 800hours	Long-period storage	
Engine	Loose, damaged and leaky points	○						
	Exhaust fume, noise, and vibration	○						
	Re-tightening engine parts		○			○		
	Valve clearance		○		○			
	Engine idle speed		○	○				
	Engine compression pressure						○	
Lubrication system	Engine oil	○	●	●				
	Oil filter (cartridge type)		●	●				
	Oil filter (disassemblable type)			□, ○	●			● : Replace element.
Fuel system	Fuel	○					△	
	Fuel tank				□		□	
	Fuel filter			□	●			For cock type, replace element only.
	Fuel pump		□	□				Filter (plunger type pump)
	Injection pump					○		Adjust fuel injection rate.
	Nozzle				○			
Intake system	Air cleaner (paper-element type)			□	●			
	Air cleaner (oil bath type)	○		□●				● : Replace oil.
Cooling system	Coolant	○	●			●	△	Unless antifreeze is used, drain after daily operation.
	Fan belt	○			○			
Electrical system	Gauges (incl. pilot lamps)	○						
	Starter motor, alternator, regulator				○	○*		* : Adjust voltage and current.
	Glow plug				○			
	Solenoid switch (key-OFF stop system)	○						Inspect switch operation.

Group
No.

8-02 SPECIFICATIONS AND SERVICE STANDARD

Group
No.

8-02



■ Engine

Unit : mm

Item	Standard value	Repair limit	Service limit
Compression pressure	29kg/cm ² at 280 rpm)	26 kg/cm ²	Approximately 22kg/cm ²
Pressure difference between cylinders (max,)	2; 5 kg/cm ²		
Injection order K3	1-3-2		
Injection timing (B. T. D. C.)			
K3, For agricultural use	19° (at SS starting)	19° ± 1.5°	
K3, For industrial use and export standard	20° (at SS starting) See page 156	20° ± 1.5°	
Cylinder head			
Bottom surface warpage	0.05 max.	0.1	
Valve seat width(intake and exhaust)	1.3~1.8	2.5	
Valve seat sinkage			-1
Valve clearances(intake and exhaust)	0.25 (at cold)		
Valves			
Stem O. D. × dia. × length (intake) :	6.6 × 32.2 × 114.5		
(exhaust) :	6.6 × 27.2 × 114.5		
Stem-to-guide clearance			
(intake)			0.10
(exhaust)			0.15
Seat angle	45°		
Valve head thickness(margin width)	1.0		0.5
Valve spring			
Free length	43		-1
Installation load/length	14 ± 0.7/36		-15%
(kg/mm)	29.8 ± 2/28		-15%

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No.

8-02 SPECIFICATIONS AND SERVICE STANDARD

Item	Standard value	Repair limit	Service limit
Squareness Upper identification color	2° Red		3°
Rocker arms Rocker arm-to-shaft clearance			-0.2
Cylinder block Cylinder bore	82	+0.2	+0.95
Oversize finishing } tolerances Taper of cylinders	0~0.03 for all oversizes		
Piston O. D. (skirt end) :	82 Less 0.30MM		
Piston-to-cylinder clearance	0.25, 0.50, 0.75		0.3
Piston pins Piston pin-to-piston clearance Piston pin-to-connecting rod clearance	Full-floating		0.08 Within standard 0.1

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Item	Standard value	Repair limit	Service limit
Piston rings Number of rings Compression ring Oil ring Side clearance Compression No. 1 Compression No. 2 and oil Ring gap Oversizes	0, 25, 0, 50, 0, 75		0, 3 0, 2 1, 5
Connecting rods Bend and twist Big end thrust clearance Small end bush I. D. Big end bearing Oil clearance Undersizes	0, 1~0, 35 23 0, 25, 0, 50, 0, 75		0, 15max. 0, 5 0, 15
Crankshaft Bend End play Journal O. D. Crankpin O. D. Undersizes (Pin and journal)	0, 05~0, 175 52 42 0, 25, 0, 50, 0, 75	-0, 15 -0, 15 -0, 15 -0, 15	0, 05 -0, 95 -0, 95 -0, 95 -0, 95
Main bearings (with flange for No. 3) Oil clearance Undersizes	0, 25, 0, 50, 0, 75		0, 10
Camshaft Journal-to-cylinder block or bush clearance Cam height (intake and exhaust)	35, 72		0, 15 -1, 0

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8-02 SPECIFICATIONS AND SERVICE STANDARD

Item	Standard value	Repair limit	Service limit
Pump camshaft			
Cam height	44		-1.0
Tappets			
Tappet-to-cylinder block hole clearance			0.15
Push rod			
Bend	0.3 max.		

■ Lubrication System

Unit : mm

Item	Standard value	Repair limit	Service limit
Oil pump (trochoid type)			
Check valve opening pressure	4 kg/cm ²		
Outer rotor-to-body clearance	0.15~0.2	0.3	
Outer rotor-to-inner rotor clearance	0.05~0.12	0.25	
Oil pressure switch			
Contact closing pressure	0.5 ± 0.1 kg/cm ²		

■ Fuel System

Unit : mm

Item	Standard value	Repair limit	Service limit
Fuel injection pump			
K3 : ND-PER3M			
Fuel injection rate			
Difference from reference cylinder	Refer to Group 9. 2 mm ² /rev., cylinder max.		
Nozzle (hole type)			
DLLA155			
Injection starting pressure	220 ⁺¹⁰ ₋₀ kg/cm ²	220 ⁺¹⁰ ₋₁₀ kg/cm ²	
Fuel filter			
Cartridge type fuel filter			
Model (Part No.)	3X05010 (MM435190)		
Filtration area	280 cm ²		
Passing particles	Max. 15μ		
Air bleeding	Air bleeder plug (2 places)		



■ Fuel System

Unit : mm

Item	Standard value	Repair limit	Service limit
Fuel filter width cock			
Model (Part No.)	MK ₃₄ 100 (MM434476)		
Filtration area	129cm ²		
Passing particles	Max. 30μ		
Air bleeding	Air bleeder plug (2 places)		
Model (Part No.)	MK ₄₁ 100 (MM435265)		
Filtration area	900cm ²		
Passing particles	Max. 30μ		
Air bleeding	Air bleeder plug (1 place)		
Model (Part No.)	MBK ₁₇ 100A (MM435250)		
Filtration area	129cm ²		
Passing particles	Max. 30μ		
Air bleeding	Automatic type (with nipple)		
Model (Part No.)	MK ₃₃ 100 (MM434448)		
Filtration area	260cm ²		
Passing particles	Max. 15μ		
Air bleeding	Automatic type (with nipple)		
Model (Part No.)	MK ₂₈ 100 (MM434705)		
Filtration area	900cm ²		
Passing particles	Max. 30μ		
Air bleeding	Automatic type (with nipple)		
Fuel pump			
Electromagnetic diaphragm type pump			
Model (Part No.)	UC-S6 (MB052904)		
Power source	12V, DC (negative ground)		
Pump delivery	370cc/mm min. (at terminal voltage 12V, DC)		
Max. suction head (at dry)	150mmHg min.		
Closing delivery pressure	0.13~0.18kg/cm ²		
Installation direction	Cover side down		

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Group
No.

8-02 SPECIFICATIONS AND SERVICE STANDARD

Item	Standard value	Repair limit	Service limit
Electromagnetic plunger type pump			
Model (Part No.)	378-02200 (MD025280)		
Power source	12V, DC (negative ground)		
Pump delivery	900cc/min. (at full pressure 0.18kg/cm ²)		
Dry suction pressure	-30mmHg max.		
Full pressure at closing	0.35-0.07kg/cm ²		
Installation direction	Filter side down		
Hand type fuel pump			
Model (Part No.)	MK ₃ 100C (MM409571)		
Pump delivery	4.5cc/stroke (16mm)		
Load at pushing in the push button	5.9kg		
Inlet and outlet nipple O. D.	φ5.2		

■ Cooling System

Unit : mm

Item	Standard value	Repair limit	Service limit
Cooling fan			
Fan O. D. (Part No.)			
(Unequal 5-blade, suction)	φ320 (MD009015) φ340 (MD009014)		
(Equal 6-blade, suction)	φ290 (MM409350) φ310 (MM409351)		
(Equal 7-blade, suction)	φ360 (MM435279)		
(Equal 6-blade, pusher)	φ360 (MM435867) φ390 (MM405431)		
Fan belt (HM, LL type)			
Periphery	932 ℓ (MD007528) 940 ℓ (MM409305) 964 ℓ (MD025523) 980 ℓ (MD088955)		
Water pump (centrifugal impeller type)			
Thermostat (wax type)			
82°C type	(MD001370)		
Valve opening temperature	82 ± 1.5°C		
Fully open temperature at approx. 8mm valve lift	95°C		



Item	Standard value	Repair limit	Service limit
76.5°C type Valve opening temperature Fully open temperature at approx. 8mm valve lift	(K6516441) 76.5 ± 1.5°C 90°C		
Thermostat (thermistor) Model Indicating specification (°C/Ω) Installation thread dia. Model Indicating specification (°C/Ω) Installation thread dia.	A20-WEu (MD001380) 70/104 ± 13.5, 115/23.8 ± 2.5 M16 V495240 (MM409383) 50/350 ± 20, 90/81 ± 5, 120/36.2 PT3/8		
Thermo-switch (bimetal type) Model Contact closing temperature Resistance between terminals Installation thread dia. Model Contact closing temperature Resistance between terminals Installation thread dia.	071400-1190 (MM409381) 111 ± 3°C 1.0 ± 0.4Ω PT3/8 071400-1180 (MM409380) 108 ± 3°C 1.0 ± 0.4Ω PT3/8		

■ Electrical System

Unit : mm

Item	Standard value	Repair limit	Service limit
Starter (electromagnetic push-in type) Model Nominal output No load characteristic (20°C) Terminal voltage/current Speed Pinion gap Thrust gap Rotating direction Model Nominal output (V/kW) No load characteristic (20°C)	M2T50381 (MM409410) 12V-1.6kW 11.5V/100A max. 3000rpm min. 0.5~2.0 0.5 max. Clockwise viewed from pinion side M2T56271 (MM409412) 12V-2.0kW		



Group
No.

8-02 SPECIFICATIONS AND SERVICE STANDARD

Item	Standard value	Repair limit	Service limit
Terminal voltage/current	11V/130A max.		
Speed	3850rpm min.		
Pinion gap	0.5~2.0		
Thrust gap	0.5 max.		
Rotating direction	Clockwise viewed from pinion side		
Model	M2T56272 (MM409413)		
Nominal output	12V-2.0kW		
No load characteristic (20°C)			
Terminal voltage/current	11V/130A max.		
Speed	3850rpm min.		
Pinion gap	0.5~2.0		
Thrust gap	0.5 max.		
Rotating direction	Clockwise viewed from pinion side		
Alternator (separate from regulator, AC generator)			
Model	AH2035M (MD017645)		
Nominal output	12V-35A		
No-load characteristic (20°C, at cold)			
Terminal voltage/current	14V/0A		
Speed	1300rpm max.		
Load characteristic (20°C, at cold)			
Terminal voltage/current	14V/30A		
Speed	2500rpm		
Model	AR2115Z ₂ (MM407671)		
Nominal output	12V/15A		
No-load characteristic (20°C, at cold)			
Terminal voltage/current	14V/0A		
Speed	1300rpm max.		
Load characteristic (20°C, at cold)			
Terminal voltage/current	14V/15A min.		
Speed	2500		
Alternator (with built-in IC regulator)			
Model	A0T25171 (MM432804)		



Item	Standard value	Repair limit	Service limit
Nominal output Load characteristic (20°C, at hot) Terminal voltage/current Speed Terminal voltage/current Speed Regulating voltage Capacitor capacity Model Specifications and performance are same as above.	12V/40A 13.5V/21A 2500rpm 13.5V/37A 5000rpm 14.7±0.3V 0.5 A0T25271 (MM435081)		
Regulator (separate from alternator) Model Type Regulating voltage Pilot lamp : Lamp on voltage Lamp off voltage	RQB2220D4 (MD001821) Tirrill type 2-element 14.8V 4.2~5.2V 0.5~3.0V		
Glow plugs (sheathed, immediately heating type) Model Rated voltage/current Resistance	Y-142T (MM431439) 10.5V/9.7A 0.16Ω		
Glow plug indicator Model Type Rated current Voltage between terminals Model Type Rated current Voltage between terminals	DH-139V-29 (MM409515) Red heat type (immediately heating, for 3-cylinder engines) 29A 1.7±0.2V DH-136V-39 Red heat type (immediately heating, for 4-cylinder engines) 39A 1.2±0.1V		
Glow timer Model Rated voltage Initial characteristic (normal temperature and humidity, Vcc : 12V)	S81NJ (MM431762) 12V, DC 6 seconds		



Group
No.

8-02 SPECIFICATIONS AND SERVICE STANDARD

Item	Standard value	Repair limit	Service limit
Temperature range	-40°C ~ 85°C		
Glow timer (with after glow) Model Rated voltage Initial characteristics (normal temp., normal humidity, Vcc = 12V) Pre-glow timer After-glow timer	S83AD DC12V 6.2 ± 0.7 seconds 4.5 ± 0.7 seconds		
Glow relay Model Rated voltage Continuous rating Coil resistance Temperature range	G71SP 12VDC 1 minute 13Ω -40°C ~ 100°C		
Control timer unit Model Input voltage range Load Temperature range	YM-1B (MM435745) 9 ~ 15VDC Solenoid (coil resistance : 1.7Ω min.) -30°C ~ 80°C		
Solenoid (push type) Model Coil resistance Stroke Voltage Attraction force (20°C) Temperature range	YMS-1 (MM431975) 1.8Ω ± 10% (20°C) 13.5 ± 0.5mm 10 ~ 15VDC 4.2kgf min. / 9V (at 1mm stroke) YMS-1 (MM431975)		



■ Tightening Torque

Description	Tightening torque (kgm)
Cylinder head bolts	11.5 ~ 12.5 (Wet)
{ M12 main bolts -----	
{ M10 sub bolts -----	6.5 ~ 8.0 (Wet)
Rocker cover bolts (M8) standard -----	1.0 ~ 1.3
Rocker stay bolts (M10) standard -----	3.0 ~ 4.2
Thermo-switch (PT3/8) at cylinder head -----	2.0 ~ 3.0
Blind plug for gear case governor shaft hole (PT1/2), for both FC and A & Ø Crankshaft pulley nut	4.0 ~ 5.0
(M18) -----	15 ~ 20
Main bearing cap bolts -----	5 ~ 5.5
Connecting rod cap nuts -----	3.2 ~ 3.5
Flywheel mounting bolts -----	13 ~ 14
Oil pan drain plug (M18) -----	5 ~ 6
Oil relief plug (M18) -----	4.0 ~ 5.0
Oil filter -----	1.1 ~ 1.3
Fuel injection pipe nuts (M12) -----	2.5 ~ 3.5
Fuel injection pump	
Delivery valve holders -----	4 ~ 5
Nozzle holder	
Holder tightening bolts (M8) -----	2.0 ~ 2.5
Holder body retaining nuts -----	3 ~ 4
Glow plugs (M10) -----	1.5 ~ 2.0
Glow plug lead wire nuts (M4) -----	0.1 ~ 0.15
Key-OFF stop solenoid nuts (M30) -----	4.0 ~ 5.0

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Group
No.

8-03 TIGHTENING TORQUE AND SEALANT

Standard screws tightening torque

Thread dia.	Head mark		
	4	7	
M6	0.3 ~ 0.5	0.8 ~ 1.0	
M8	1.0 ~ 1.3	1.5 ~ 2.2	
M10	1.8 ~ 2.5	3.0 ~ 4.2	
M12	3.0 ~ 4.2	5.5 ~ 7.5	
M14	5.0 ~ 7.0	8.0 ~ 11.0	

Taper screws tightening torque

Size	To aluminum	To cast iron
NPTF 1/16	0.5 ~ 0.8	0.8 ~ 1.2
PT 1/8	0.8 ~ 1.2	1.5 ~ 2.2
PT 1/8, NPTF 1/4	2.0 ~ 3.0	3.5 ~ 4.5
PT 3/8	—	5.5 ~ 7.5

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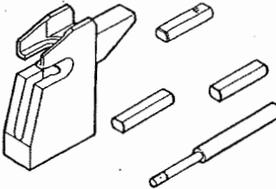
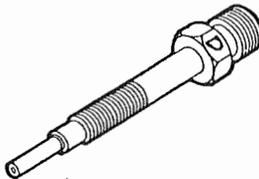
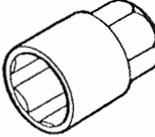
■ Sealant

	Applied parts	Applied surface (location)	Sealant name
Thread parts	Taper screws 1/2"	Threads (gear case)	Hermeseal H1 or ThreeBond 1104
	Taper screws 1/4"	Threads (right side of cylinder block, pump cover)	
	Taper screws 1/8"	Threads (rear surface of cylinder head)	
	Water drain plugs	Threads (right side and rear middle of cylinder block)	
	Oil pressure switch	Threads (right side surface of cylinder block)	
	Thermo-switch and thermo-senser	Threads (side surface of cylinder head or water outlet fitting)	
	Joint gauge unit	Threads (side surface of cylinder head)	
	Key-OFF solenoid	Threads	
Press-fit parts	Sealing caps	Press-fitting surface (cylinder head and block)	Hermeseal 52B
	Expansion plugs	Press-fitting surface (cylinder head and block)	
	Oil level gauge guide or guide retainer	Press-fitting surface (cylinder block)	
	Air breather hose nipples	Press-fitting surface (rocker cover and inlet manifold)	
Others	Side seals	Outer surface (main bearing cap No. 1 and No. 4)	ThreeBond 1212 or 1211 ThreeBond 1212
	Bearing cap front	Contact surface to cylinder block	
	Bearing cap rear	Contact surface to cylinder block	



Group
No.

8-04 SPECIAL TOOLS

Tool No.	Tool name	Figure	Use
ST332301	Piston pin setting tool		Piston pin removal/installation Guide D (92, 5 l) : for K3A Guide E (91 l) : for K3B, C Guide F (89 l) : for K3D For K3D and smaller
ST332340	Camshaft bush installer		Camshaft front bush removal/installation
ST333060	Compression gauge adaptor		Compression measure- ment (for direct injection)
MD998054	Oil pressure switch socket wrench (26)		Oil pressure switch remov- ing/installing

In addition to the above, commercially available bearing pullers, valve seat cutter, valve guide installer, oil filter wrench, etc. are required.

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Group 9	REFERENCE	
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01	Comparison Between Swirl Chamber Type and Direct Injection Type	154
02	Speed Adjusting Table	155
03	Fuel Injection Timing Table	156
04	Fuel Injection Rate Table	157

Note :

Specifications given in this Group are as of April, 1988 and they are subject to change without notice.

In the maintenance of your engines, therefore, the existing parts should be checked carefully for conformity to this manual. For new parts which this manual does not cover, refer to Service Bulletins applicable to the parts involved.





Group
No.

COMPARISON BETWEEN SWIRL CHAMBER TYPE 9-01 AND DIRECT INJECTION

Item \ Type	Swirl chamber type	Direct injection type
Fuel consumption	Fuel consumption is bad as compared with the direct injection type due to following reasons, (1) Cooling loss is excessive because the combustion chamber (sub-chamber) is covered by the coolant. (2) Restriction loss is excessive because there is a restriction between the main and sub chambers. (3) Friction loss is excessive due to high compression ratio.	Opposition of the swirl chamber type
Exhaust fume	Good exhaust fume can be obtained in all range because forming of fuel-air mixture depends on strong swirl flow from the main chamber to sub-chamber.	Forming of fuel-air mixture depends on the swirl generated by the intake port. It is generally difficult to obtain good fume in all range because the swirl varies according to the engine speed. On the K series, however, exhaust fume equal to the swirl chamber type can be obtained as a result of thorough investigation of the best swirl and improvement of the combustion and injection systems.
Noise and vibration	It is generally quiet as compared with the direct injection type because its pressure increases slowly.	It is disadvantageous at noise and vibration because its pressure increases rapidly due to rapid combustion. On the K series, mild noise rather than the swirl chamber type can be obtained (at no load) as a result of lowered noise pressure level at high-frequency wave range by means of combustion and piston profile improvements.
Starting ability At hot At cold	Ignitability is not good as compared with the direct injection. Combustion after ignition is good and start of revolution is rapidly raised because the combustion pressure is high and cold air does not enter the sub-chamber directly.	Ignitability is good. Determination of the optimum swirl is important to obtain smooth starting of revolution because the combustion tends to be disturbed due to cold air being sucked into the combustion chamber directly.
Blue and white exhaust fume		Blue or white exhaust fume or smell due to unburned fuel tends to generate immediately after starting the engine because the compression ratio is generally low. However, on the K series, blue or white fume, or smell is scarcely generated by complete combustion from immediately after starting the engine by means of thorough investigation of intake, combustion and injection systems.
Others		Less LOC and oil deterioration
Precautions		1. Always use the filtered diesel fuel. 2. Thoroughly clean all disassembled parts when overhauling the fuel system. Take care not to allow foreign matter or dust to enter the system, especially the nozzle injection holes because they are very precision.