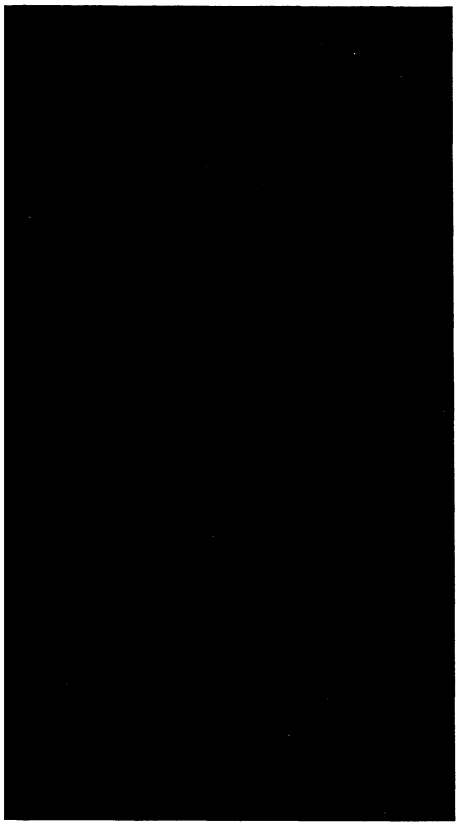
SERVICE MANUAL



MITSUBISHI DIESEL ENGINE

L-SERIES

L2A, L2C, L2E
L3A, L3C, L3E

APRIL 2001

MITSUBISHI HEAVY INDUSTRIES, LTD.

FOREWARD

This Service Manual, prepared for the benefit of service mechanics, describes the construction and service procedures of the Mitsubishi diesel engine models L series (L2A, L2C, L2E, L3A, L3C and L3E).

We hope that this manual will be helpful for you to make proper and fast service operations, ensuring that the engines are able to keep top performance over an extended period of time.

This manual has been prepared on the basis of the latest engines in May 1997 and, therefore, does not contain possible changes in specification to which those engines are subject thereafter.

Pub. No. 99619−15180

MITSUBISHI DIESEL ENGINE
L MODELS

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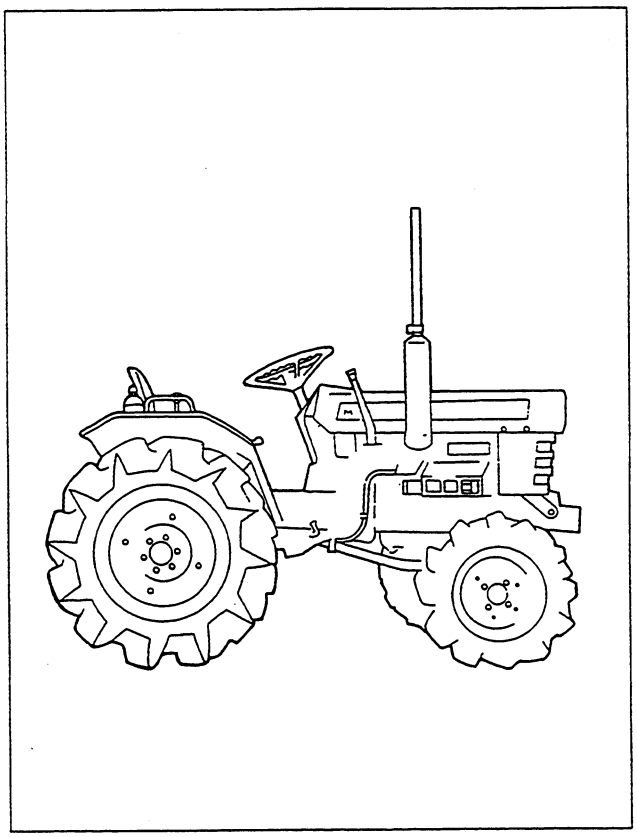
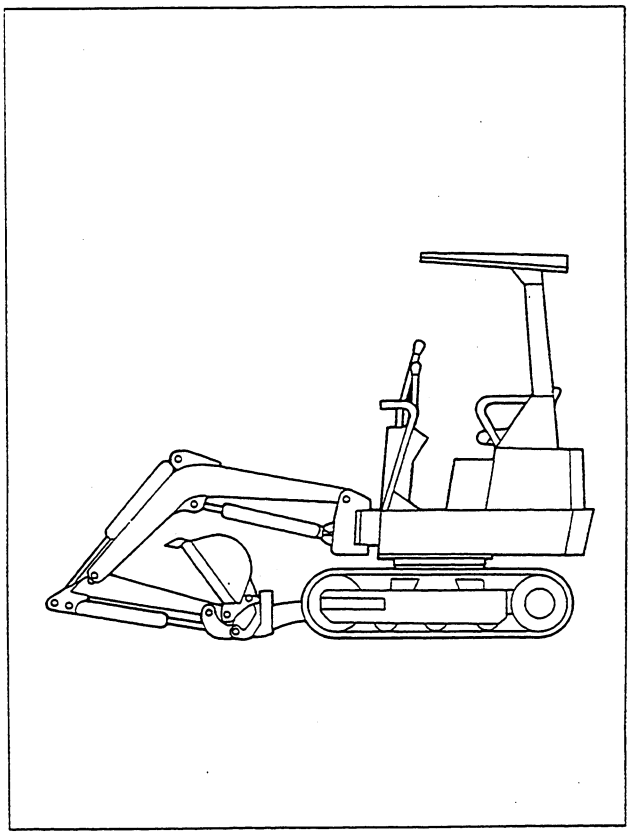
Group 0	GENERAL	

Tractor Application



Excavator Application



Group No.

0-01 ENGINE MODEL AND ENGINE NUMBER

■Engine Model and Engine Number

0. 1 Model, Classification, and Use

(1) Engine model and

Model	Application	Use
L2A L2C	11, 12～	For For Agricultural
L2E L3A	31, 32～	For Industrial
L3C L3E	61, 62～	For Export only

(2) The engine model number may be broken down as follows :

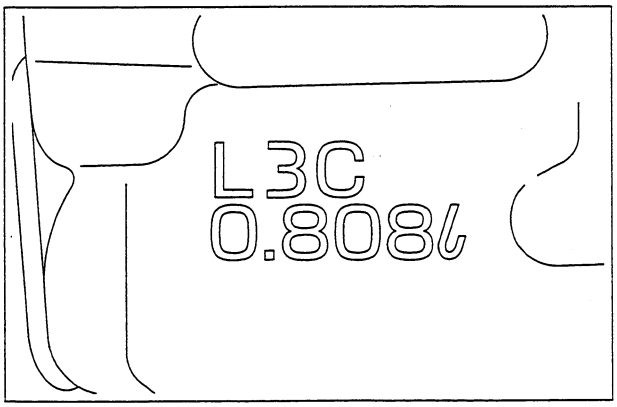
L 3 C – 11 A

- A — Subdivision of specification
- 11 — Application (11 : Agricultural, 31 : Industrial, 61 : For export only)
- C — Cylinder bore (A : φ65, C : φ70, E : φ76)
- 3 — Number of cyls. (2 : Two, 3 : Three)
- L — Name of series (L : Lightweight engine)

0. 2 Engine model embossment and engine number stamp

(1) Embossment of engine model and cylinder volume

The engine model and cylinder volume are embossed on the side of injection pump mounting portion of the cylinder block.



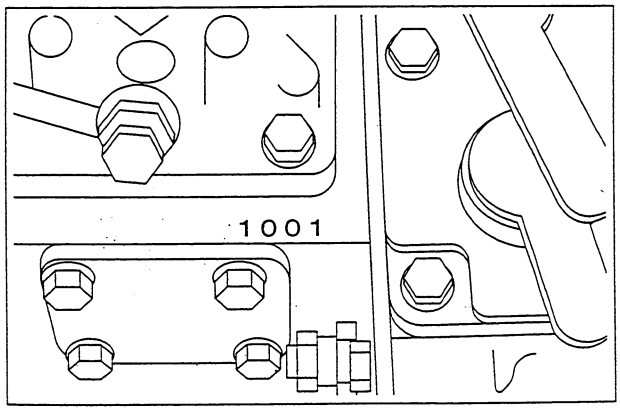
Engine Model and Cylinder Volume

(2) Engine number stamp

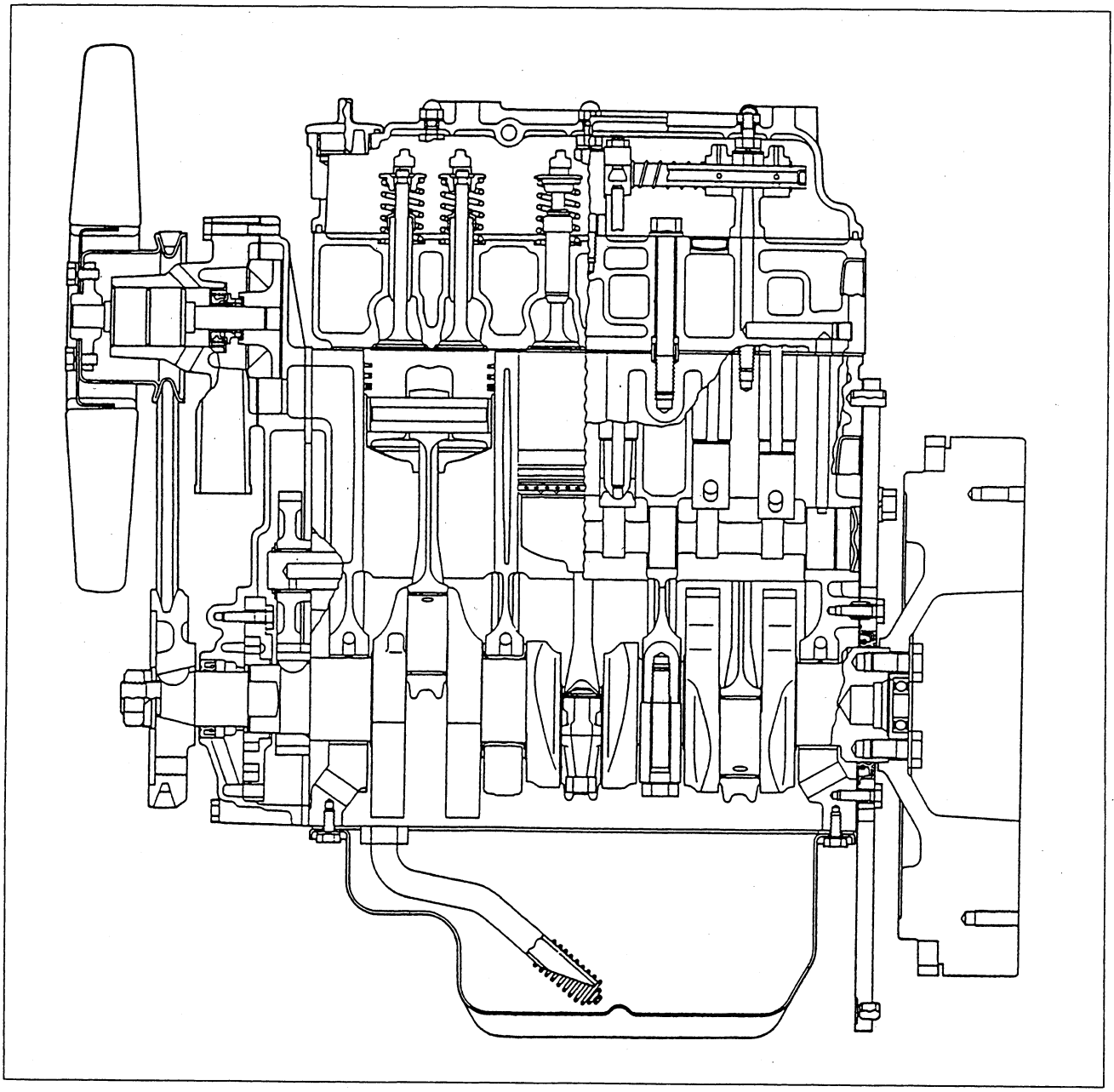
The engine number is stamped on the injection pump mounting portion of the cylinder block (on the upper side of the tie rod cover).

It is a serial number beginning with 1001 as shown below.

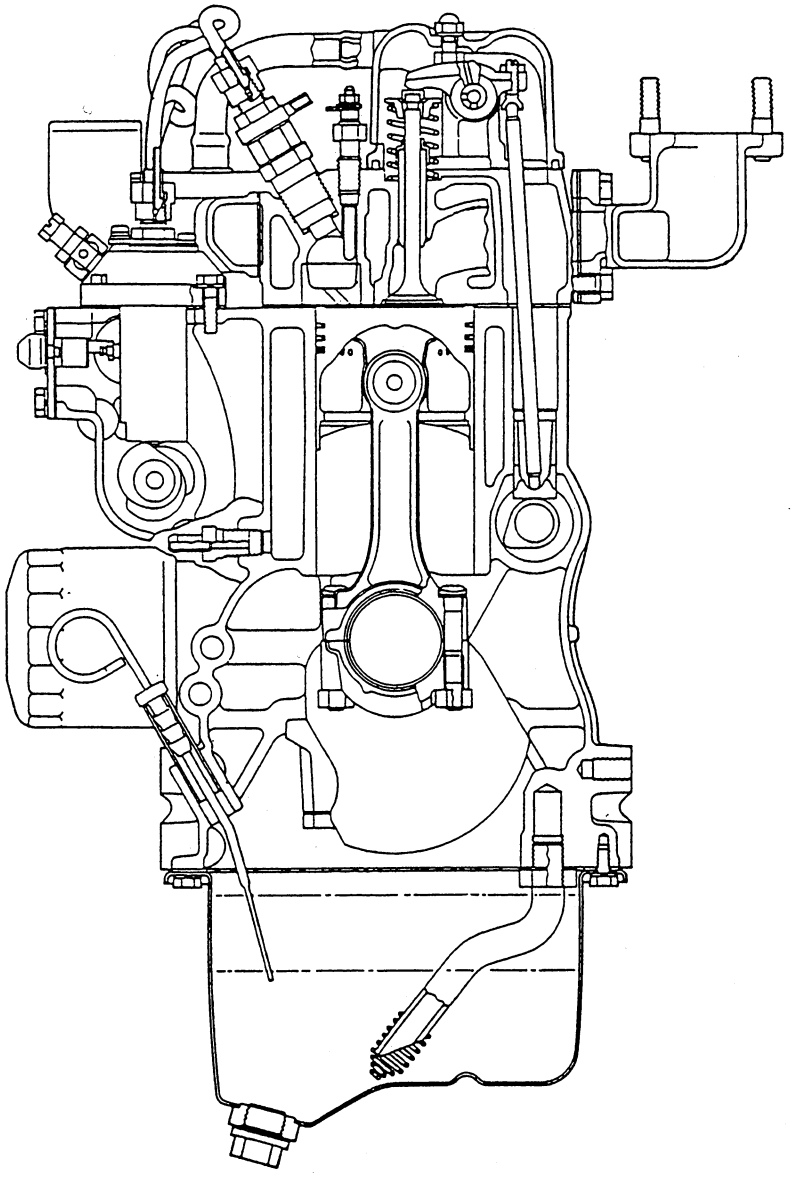
Number	Engine model
1001～	(ALL models)



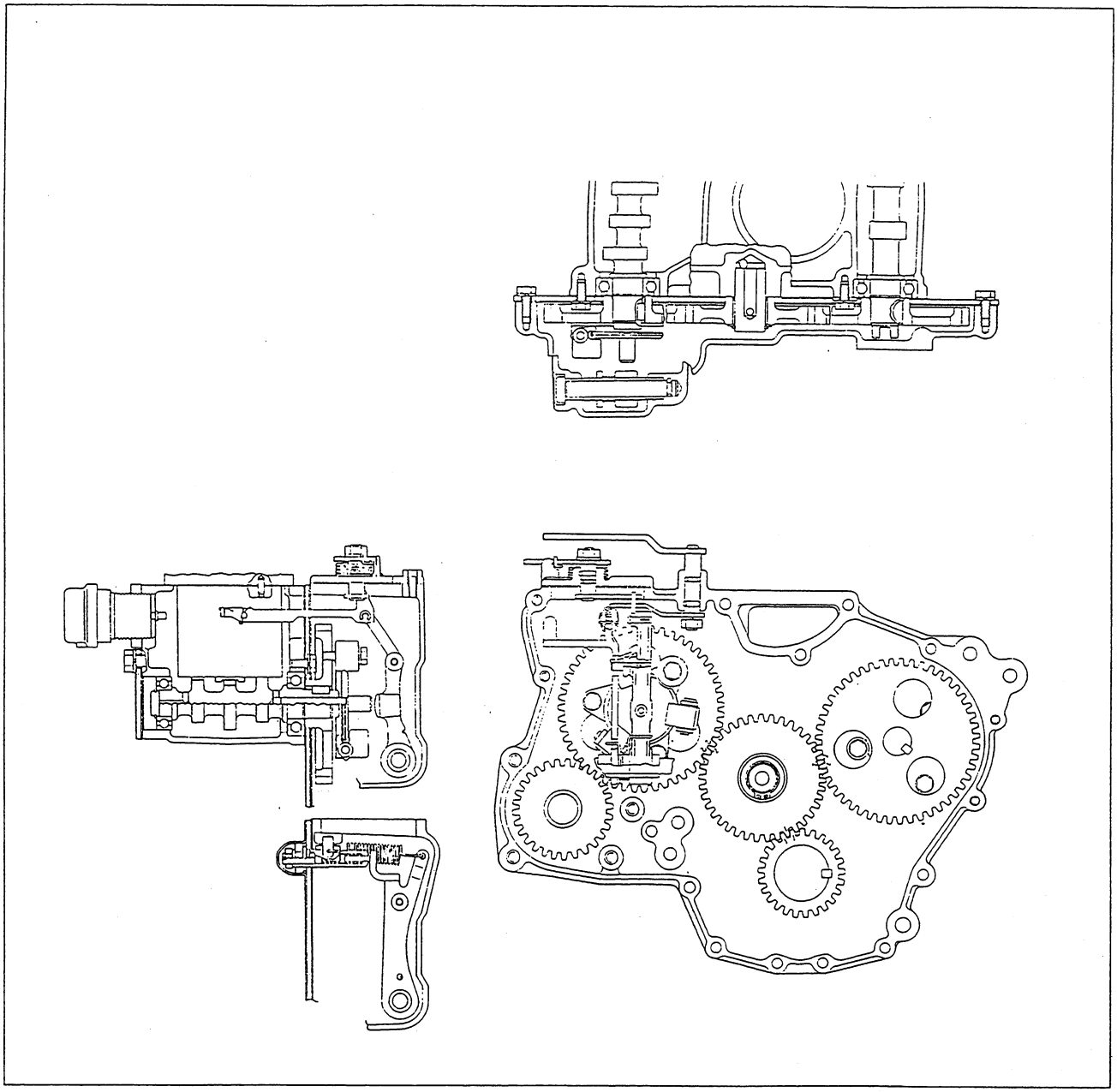
Engine Number



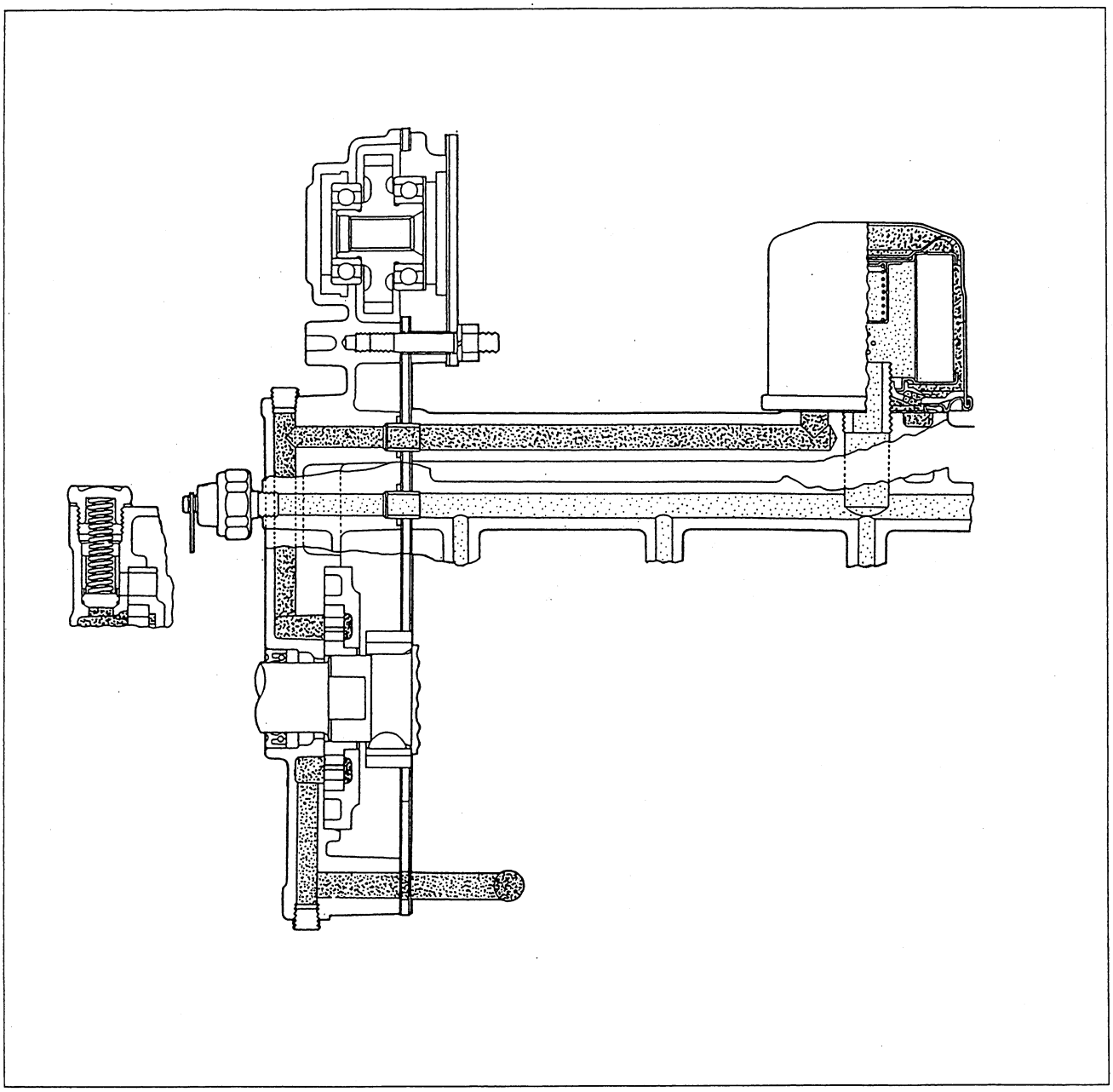
Longitudinal Section (L3C)



Cross Section (L3C)



Sectional Views of Governor (L3C)



Oil Pump and Oil Filter

1. Aim of development

The L series aim at the through going compact, lightweight engines which are suitable for superseding gasoline engines to power lawn mowers, vehicles, etc. The high-speed (3600 rpm continuous) specification engines are also available to apply them to the generators, welders, and marine use. The L series are the smallest and lightest water-cooled diesel engines in the world.

2. Features of the new series

(1) Small and lightweight engine

The new L series are 10 to 20% smaller in weight and 15 to 20% smaller in contour volume than the same class of engines of competitors.

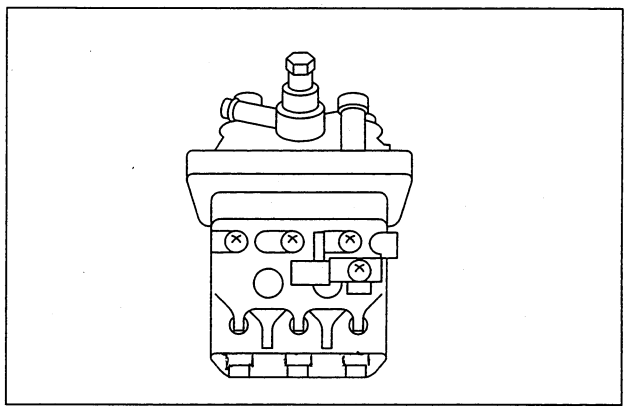
(2) Low noise and economical fuel consumption

Low noise and economical fuel consumption are attained by the well designed cylinder block construction (having curved side faces), the rearranged combustion chambers, and the small-sized fuel injection system.

(3) Easy starting

The engine can be started instantly only by keeping the starting switch key in the ON position for about 6 seconds to allow automatic feeding of current to the glow plugs, eliminating the necessity of setting the key to the HEAT position. (For engines with the automatic glow plug system.)

The new governor mechanism also contributes to easy engine start, because it increases fuel injection and delays injection timing for easy engine start without necessity of moving the throttle lever to the " full throttle" position.

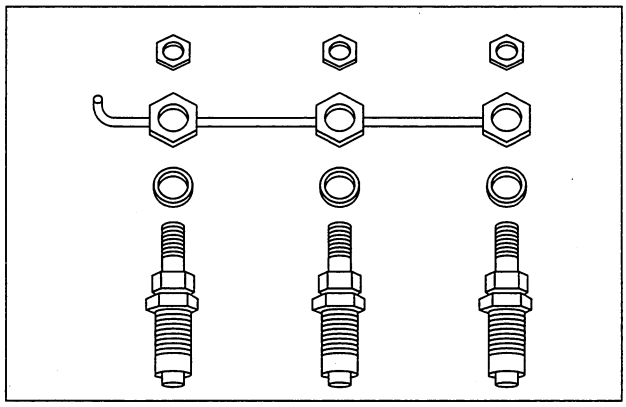


Injection Pump

(4) Multipurpose engine

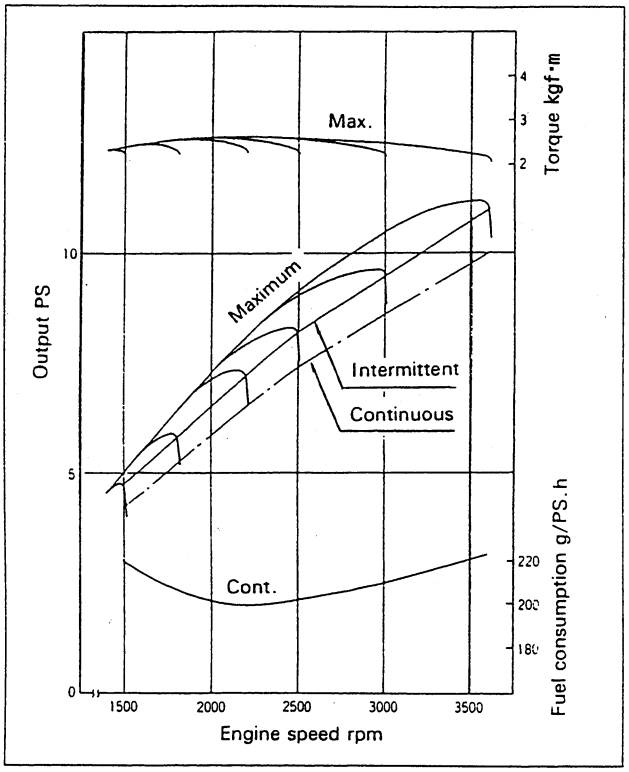
The L series engine can be equipped with various kinds of optional devices.

Ex. ◎Key-OFF stop system (Fuel cutoff valve)
◎Torque spring
◎Manual stop lever

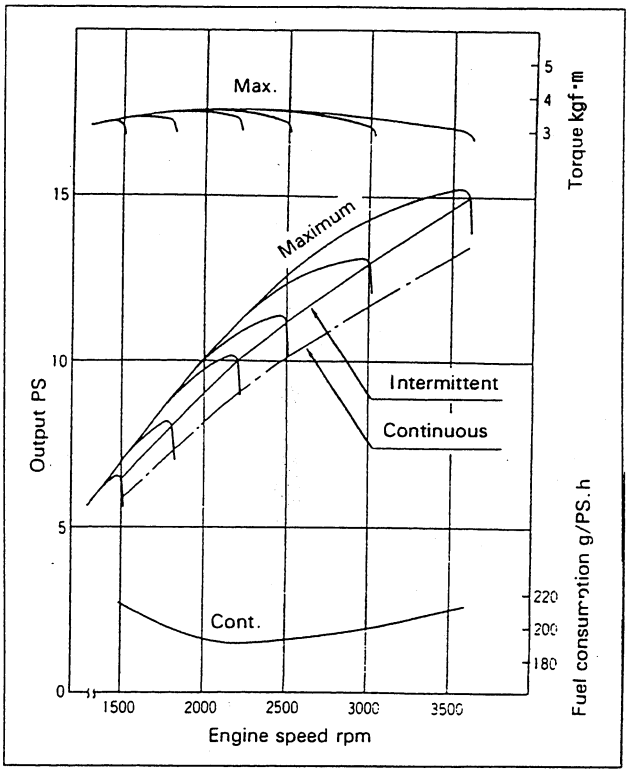


Nozzle Holders and Return Pipe

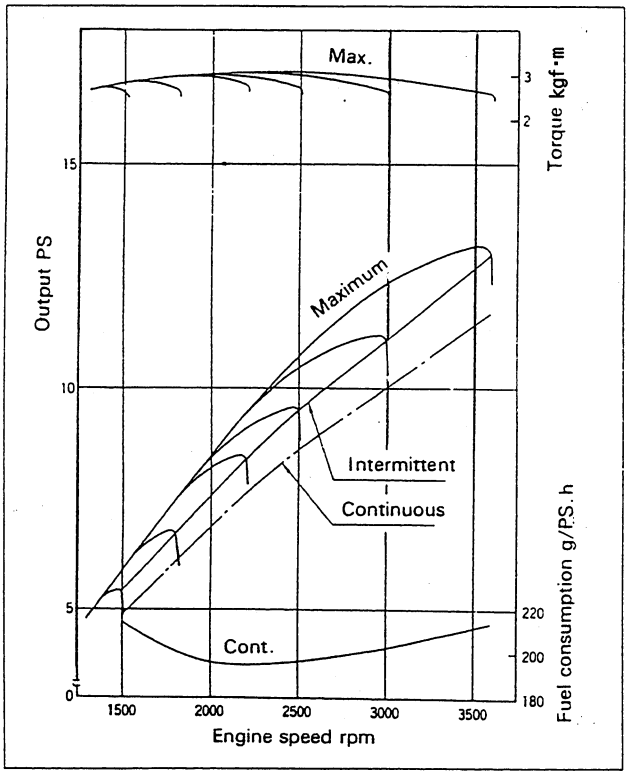
■L2 Series Performance Curves



L2A



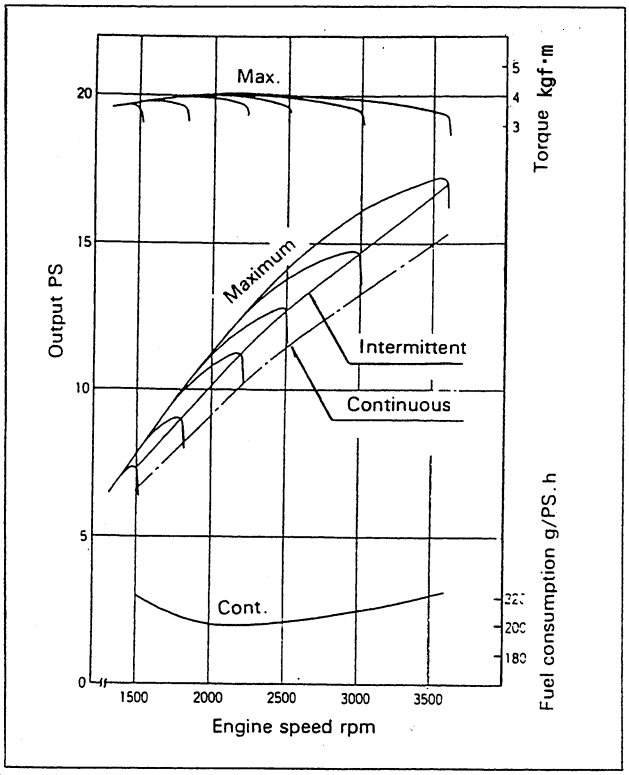
L2E



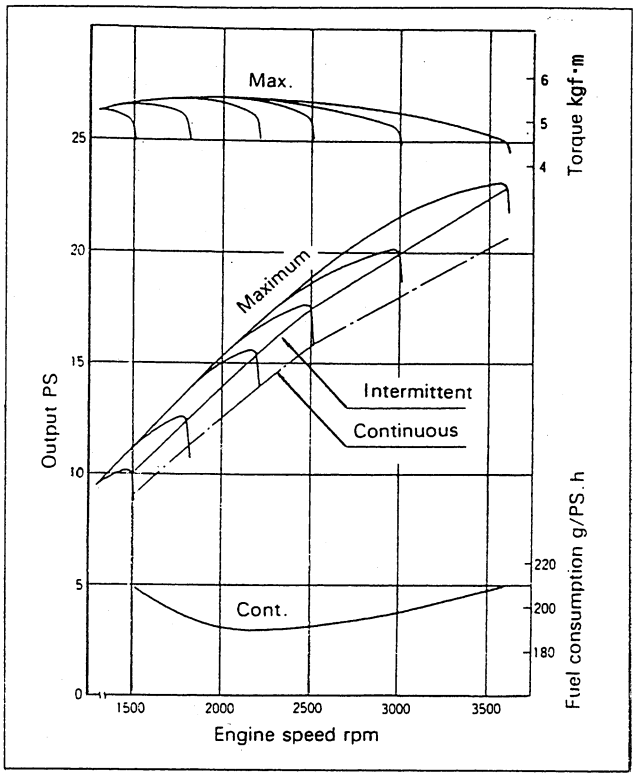
L2C

DIN 6270	: NET
Barometric pressure	: 736mmHg
Ambient temperature	: 20°C
Vapor pressure	: 10.5mmHg

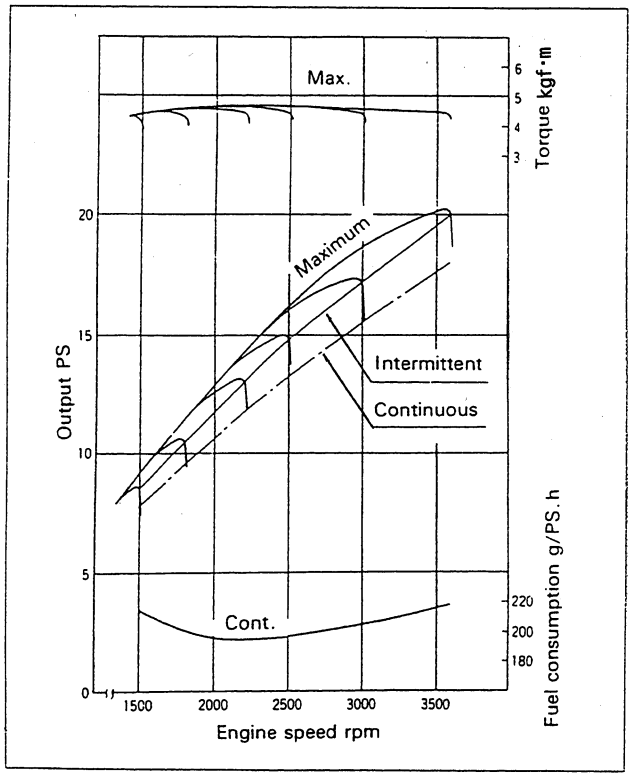
■L3 Series Performance Curves



L3A



L3C



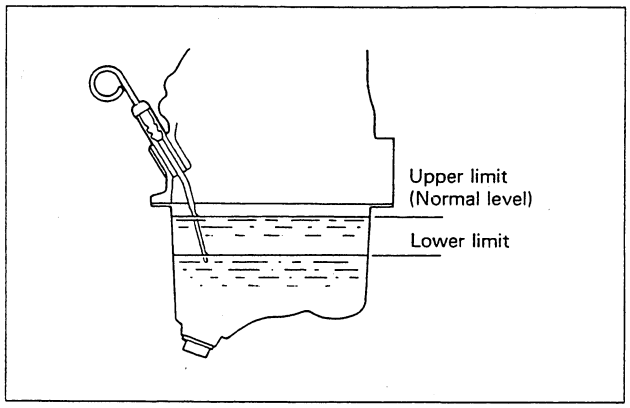
L3C

DIN 6270	: NET
Barometric pressure	: 736mmHg
Ambient temperature	: 20°C
Vapor pressure	: 10.5mmHg

Item / Model		L2A	L2C	L2E	L3A	L3C	L3E
General	Engine type	4-cycle, water-cooled, vertical, diesel					
	Firing order	1-2			1-3-2		
	Compression ratio	23					
	Combustion chamber	Swirl chamber					
	Dry weight	61			75		
Cylinders	Number of cylinders	2			3		
	Bore x Stroke (mm)	65 x 70	70 x 70	76 x 70	65 x 70	70 x 70	76 x 70
	Total displacement (ℓ)	0.464	0.538	0.635	0.696	0.808	0.952
Performance	Maximum power Maximum torque Specific fuel consumption	See the engine performance curves.					
List ability	In every direction (to lower limit of oil level)	25° continuous			30°in a short time(within 30 min.)		
Fuel system	Injection pump	Bosch NC type					
	Nozzle	Throttle type					
	Fuel	JIS No. 2 or No. 3 diesel fuel					
Lubrication system	Lubricating method	Forced lubrication					
	Oil filtration	Paper-element filter (Full-flow type)					
	Oil capacity (ℓ) Upper limit/Lower limit [Excluding 0.5 ℓ for oilfilter]	2.4/1.4			3.0/1.5, 3.6/1.8 or 4.8/3.0		
Cooling system	Cooling method	Forced water circulation with pressurized radiator					
	Coolant capacity (ℓ) (except, radiator and hose)	1.2			1.8		
Accessories	Alternator (V/A)	12/15 or 12/40					
	Starting motor (V/kW)	12/1.2 or 12/1.6					
	Battery (Ah)	45 or more			60 or more		

■Engine oil and oil filter

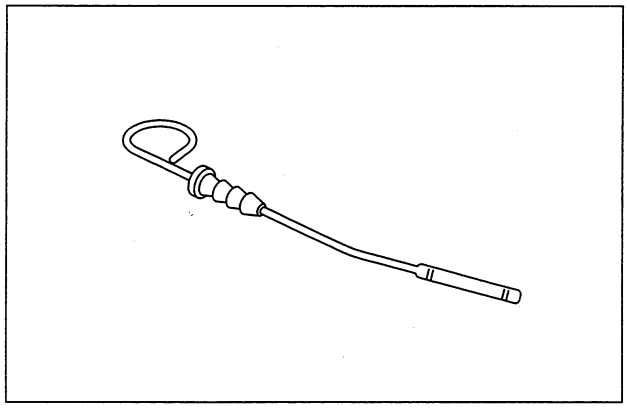
1. Checking and correcting the engine oil level.
   (1) Place the engine horizontally.
   (2) Check the oil level with the oil level gauge. If the oil level has fallen to the lower limit, add oil up to the upper limit.
   (3) Check the oil level before (everyday) operation of the engine.



Checking Oil Level

Caution

- **Whenever oil is added, check the oil level again after waiting for about 1 minute.**
- **When adding oil, use only the same engine oil as used in the engine.**
- **When checking the oil level in an engine which has been long out of use, run the engine for several minutes, stop the engine, and check the oil level after a while.**

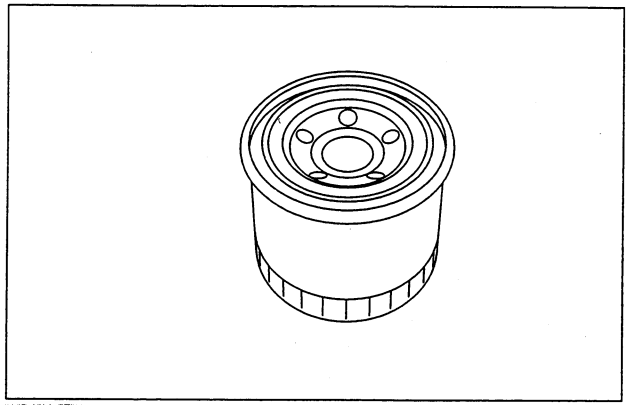

Oil Level Gauge

2. Oil change intervals
   Change the oil after initial 50-hour operation of a new engine and, thereafter, every 100 hours of operation.
   Replace the oil filter after initial 50-hour operation of a new engine and, thereafter, every 200 hours of operation.

3. Engine oil to be used
   Engine oil must conform to the API classification and viscosity number specified in the table at right.

API classification	Atm. temperature	Viscosity
Class CC or better	Above 20°C	SAE30
	5°-20°C	SAE20
	Below 5°C	SAE10W-30
(Class CD for 3000 or higher speed specification engine)	All seasons	↑

4. When replacing the oil filter, use only the genuine replacement filter.



Oil Filter

5. Changing the oil

To change oil, first warm up the engine and remove the drain plug to let oil drain completely. Put back the drain plug and refill the oil pan with fresh engine oil through the oil filler.

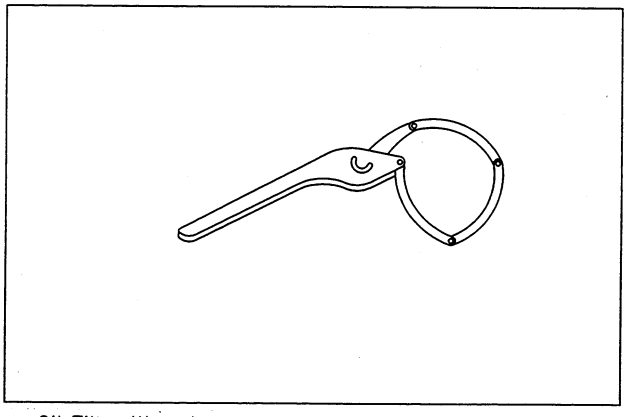
- Oil pan drain plug tightening torque :
  5.0 — 6.0 kgf·m [49 — 59 N·m]
- Oil capacity (Upper limit/Lower limit)
  L2 : 2.4 ℓ/1.4 ℓ
  L3 : Ordinary type 3.0 ℓ/1.5 ℓ
  Deep type 3.6 ℓ/1.8 ℓ or 4.8 ℓ/3.0 ℓ
  (excluding 0.5 ℓ of oil filter capacity)

6. Replacing the oil filter

(1) Remove the oil filter with a filter wrench or the like.

(2) Thoroughly clean the filter mounting surface of the filter bracket. Install the new filter with the O-ring coated with engine oil and tighten securely by hand.

- Tightening torque :
  1.0 — 1.3 kgf·m [9.8 — 12.7 N·m]



Oil Filter Wrench

Caution

Be careful not to twist the O-ring.

(3) Run the engine for several minutes and make sure that no oil leaks.

(4) After stopping the engine, check the oil level. If necessary, add oil.

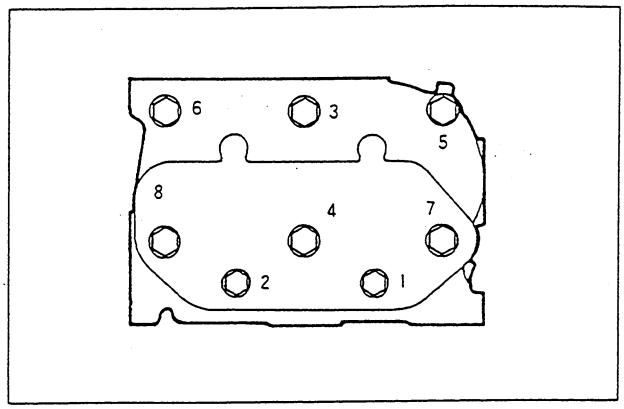
■Retightening the cylinder head bolts

When retightening the cylinder head bolts, draw out coolant, loosen the bolts slightly, and then retighten the bolts to the specified torque in the numerical order illustrated at right.

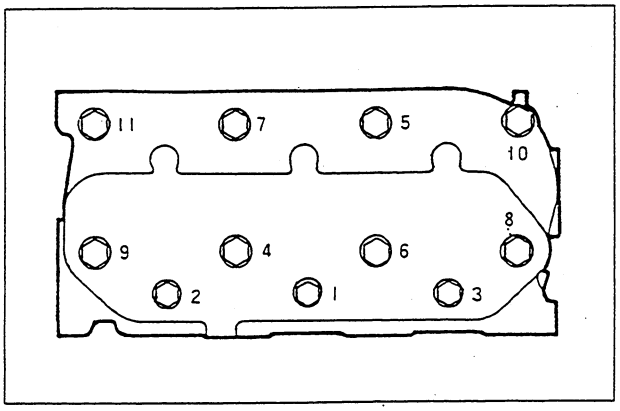
- Tightening torque : M10 bolt 7.5 — 8.5 kgf·m [73.5 — 83.4 N·m]
  M8 bolt 2.0 — 3.0 kgf·m [19.6 — 29.4 N·m]

The rocker assembly (the rocker arms, shaft, and stays) is to be kept removed when the cylinder head bolts are retightened.

- Rocker stay tightening torque : M8 bolt 1.5 — 2.2 kgf·m [14.7 — 21.6 N·m]



Cylinder Head Bolt Tightening Sequence (L2)



Cylinder Head Bolt Tightening Sequence (L3)

■Adjusting the valve clearance

Caution

Be sure to retighten the cylinder head bolts before adjusting the valve clearance.

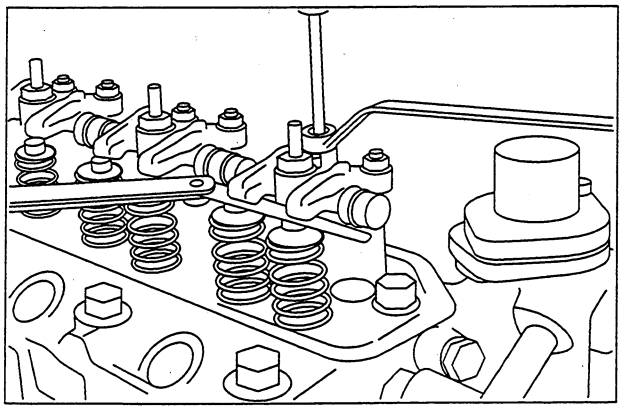
(1) Set the cylinder to be adjusted to the top dead center of compression stroke.

- Valve clearance : 0.25 mm (cold) for both intake and exhaust valves

(2) The top dead center of compression stroke can be obtained by aligning the T.D.C. (Top Dead Center) mark (notch) on the crankshaft pulley with the mark on the gear case.

(3) First align the T.D.C. mark for the No. 1 cylinder.
Confirm that the valves do not move up and down when the crankshaft is turned about 20 in normal direction of rotation and in reverse direction.

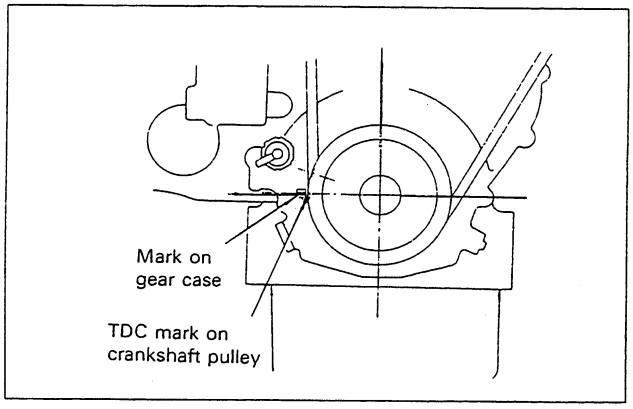
(4) When setting the top dead center for the No. 2 cylinder and that for the No. 3 cylinder, perform as follows :



Adjusting Valve Clearance

a) L2 (Two-cylinder engine)
From T. D. C. (Top Dead Center) for the No. I cylinder, turn the crankshaft 180° clockwise, and the No. 2 cylinder is set to T. D. C.

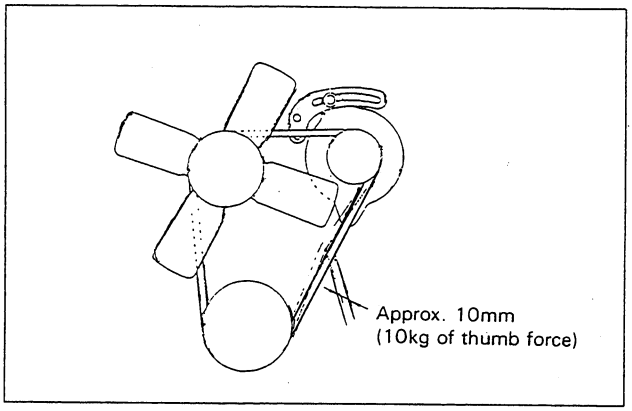
b) L3 (Three-cylinder engine)
From T. D. C. for the No. I cylinder, turn the crankshaft 240° clockwise to set the No. 3 cylinder T. D. C. Further, turn the crankshaft 240° clockwise, and the No. 2 cylinder is set to T. D. C..



Timing mark

■Adjusting the fan belt tension

Move the alternator so that the belt may deflect about 10 mm deep when depressed by thumb force (about 10 kg) at a point mid- way between the alternator pulley and crankshaft pulley.



Adjusting Fan Belt Tension

■Bleeding air from the fuel system

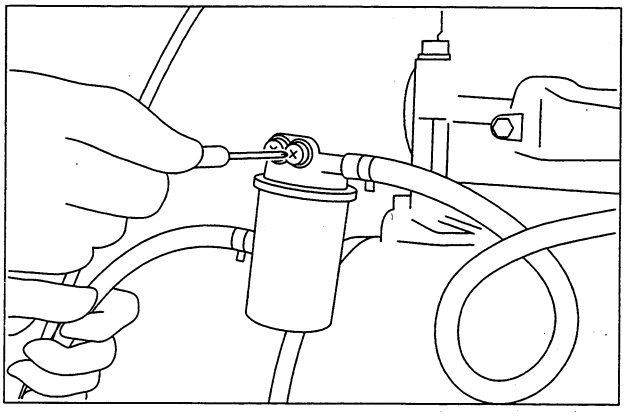
(1) Loosen the air vent screw on the fuel filter.

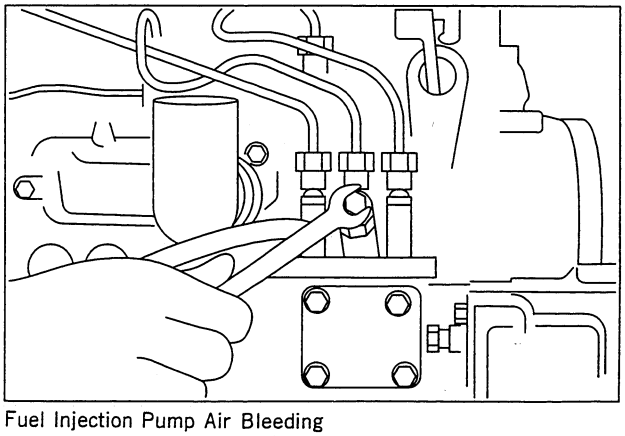
(2) For the engine without fuel pump, in which fuel drops spontaneously and enters the fuel filter, wait for fuel to overflow the fuel filter. Then, tighten the air vent screw.

(3) For the engine with the electromagnetic fuel pump, turn the starting switch key to the ON position to feed fuel to the fuel filter. Loosen the air vent screw on the filter and, after air escapes, tighten the air vent screw.

(4) Loosen the air vent screw on the fuel injection pump to let air escape from the fuel pipe and fuel injection pump.

(5) Air in the injection pipes and nozzles is driven out automatically by cranking up of the engine.

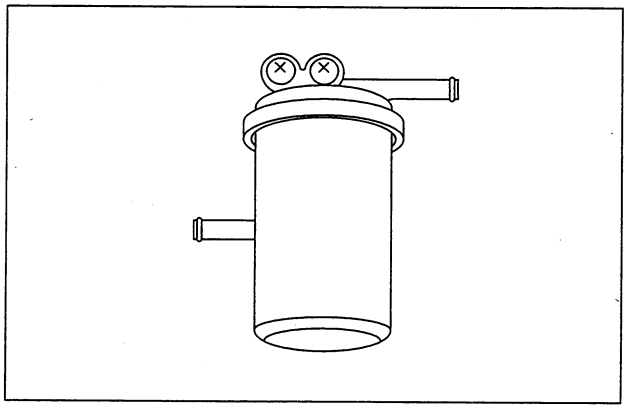

Fuel Filter Air Bleeding


Fuel Injection Pump Air Bleeding

■Replacing the fuel filter

(1) Cartridge type

Replace the cartridge type filter as an assembly if accumulation of dust or water in its element is evident. Regular replacement interval is every 400 hours of engine operation. Check the filter every 100 hours and, if necessary, replace early.



Cartridge Type Filter

(2) Separate type filter with cock

Close the filter cock, remove the ring nut, and take out the element from the inside of filter. Clean or replace the element.

(3) Fuel pump

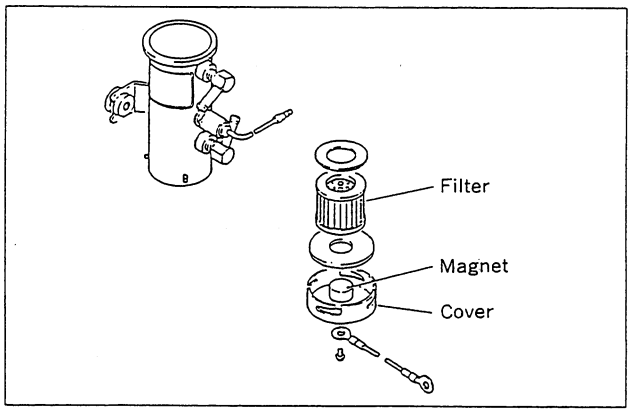
The foolowing three types of fuel pumps are available. Which type of pump is to be used for an engine depends upon engine specification.

(a) Plunger type electromagnetic pump

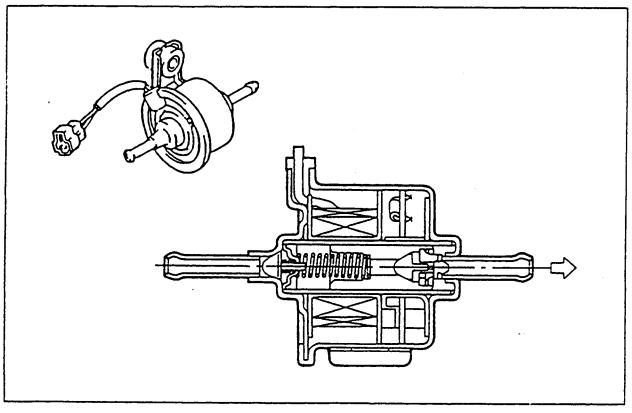
The plunger-type pumps are classified as the common, large-sized pump having a filter element or as the compact, light-weight, low-priced pump without filter element. Regardless of classification, check the plunger-type pump for normal function and make sure that it does not leak fuel. Only on the pump with filter element, remove the cover and clean orrepalce the filter element.

(b) Diaphragm type electromagnetic pump

The diaphragm type electromagnetic pump should not be disassembled. Like the compact plunger-type pump mentioned above, check that the pump funcitons normally and does not leak fuel.



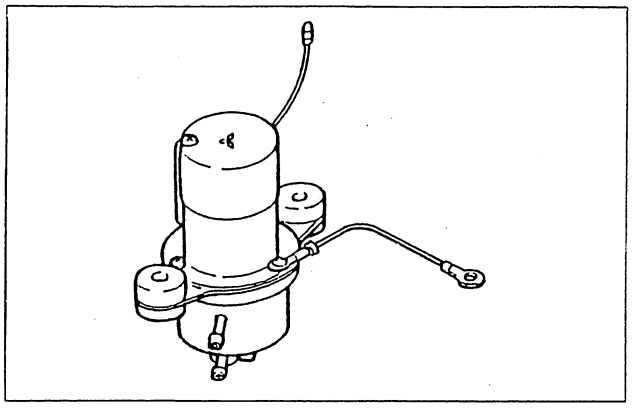
Plunger type (Common) Fuel Pump



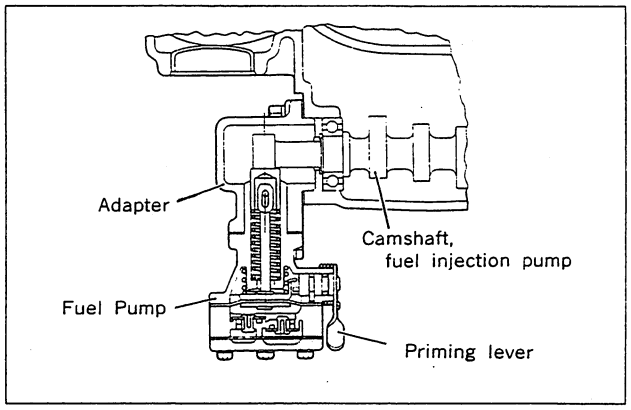
Plunger type (Compact) Fuel pump

(c) Mechanical type fuel pump

This type of fuel pump is installed with an adapter on the rear-end side of the fuel injection pump camshaft. As the camshaft rotates, the fuel pump cam pushes the tappet to actuate the diaphragm of the fuel pump. This type of fuel pump is provided with a priming lever to allow manual feed of fuel. Check the fuel pump for normal function and make sure that it does not leak fuel or make abnormal sound.



Diaphragm type Fuel Pump



Mechanical type Fuel Pump

Pump type	Delivery flow	Shut-off pressure
Plunger type (Common)	0.9 ℓ/min or more	0.35kgf/cm² [0.03 MPa]
Plunger type (Compact)	0.4 ℓ/min or more	0.35kgf/cm² [0.03 MPa] or more
Diaphragm type	0.37 ℓ/min or more	0.15kgf/cm² [0.01 MPa]
Mechanical type	0.225 ℓ/min or more	0.2kgf/cm² [0.02 MPa]

At 12V (electromagnetic pumps only) and at 20°C

(4) Draining water from the water sedimenter

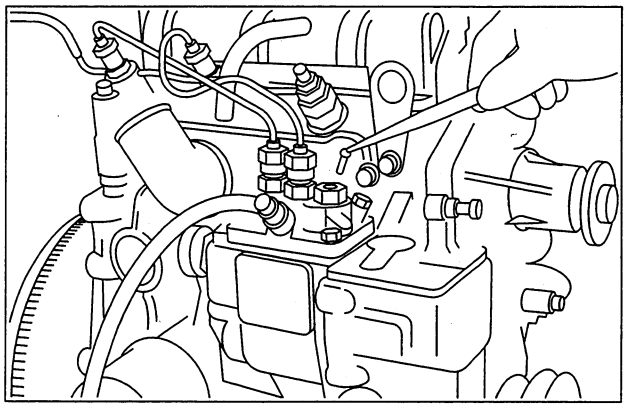
For the engine provided with a water sedimenter, remove the filter ring nut involved and take out the cup. Wipe off water and dust accumulated in the cup.

■Checking and adjusting injection timing

To check and adjust injection timing, use the following procedure :

(1) Disconnect the No. I injection pipe.

(2) Remove the No. I delivery valve from the injection pump. Put back the valve holder only.



Removing Deliverry Valve

Caution

Be sure to shut off the fuel feed pipe before removing the delivery valve.

(3) Remove the tie-rod cover and disconnect the tie rod from the control rack.

(4) Set the control rack to a midway position in the working range.

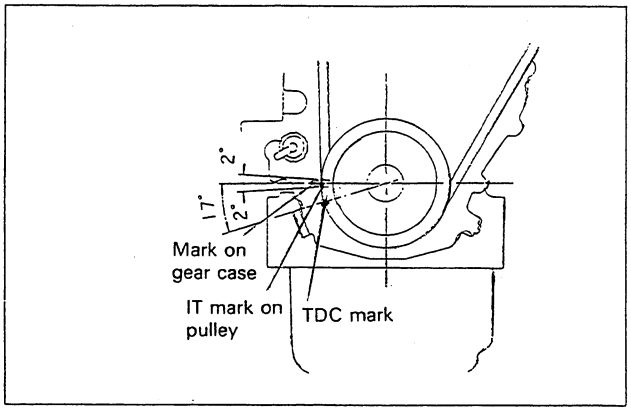
(5) Open the fuel feed pipe and make sure that fuel flows from the delivery valve holder.

(6) Turn the crankshaft in the direction of normal rotation (clockwise) and find an instant that fuel stops flowing from the delivery valve holder. This instant is the real injection timing.

Caution

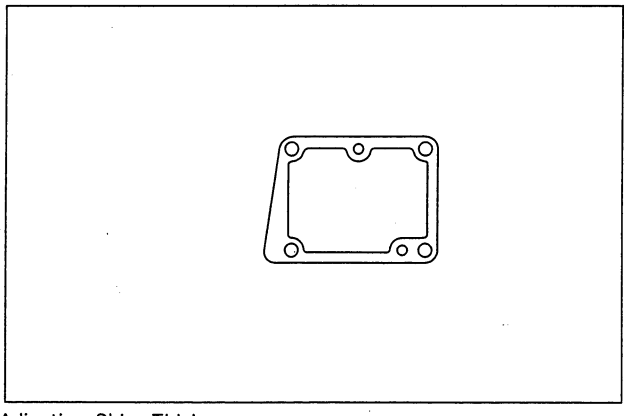
The standard injection timing differs with engine specification and engine speed.

Check to see whether the real injection timing coincides with the standard injection timing (whether the IT mark on the crankshaft pulley is in alignment with the mark on the gear case).



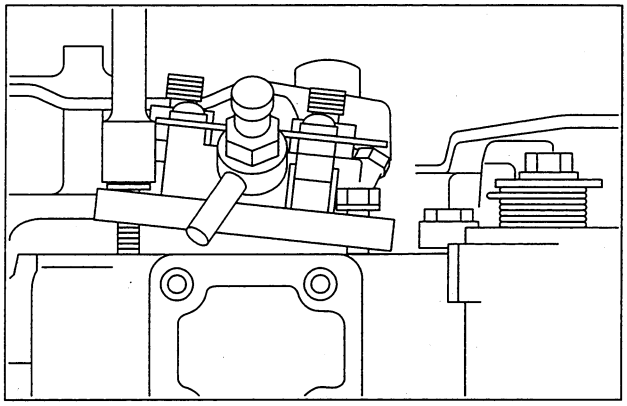
Injection Timing Mark

(7) If they do not coincide with each other, adjust thickness of the injection pump mounting shim. Increasing or decreasing thim thickness by 0. I mm causes the real injection timing to vary about I°.



Adjusting Shim Thickness

(8) To remove the injection pump, first disconnect the injection pipes and fuel feed pipe from the injection pump. Then, remove the tie-rod cover and tie rod. Dismount the pump assembly. Installation of the pump is the reversal of removal.



Removing Injection Pump

(9) In the dusty place or when the engine is dirty, removal of a delivery valve may cause intrusion of dust into the injection pump. Under such circumstances leave the delivery valve installed and check injection timing using the following procedure :

(a) Remove the tie-rod cover and disconnect the tie rod from the control rack.

(b) Set the control rack to a midway position in the working range. Disconnect the injection pipe from the No. I nozzle. Turn the crankshaft gradually in the direction of rotation until swelling of fuel is found at the open end of the injection pipe. This instant is the real injection timing, which will come approx. I° late than the standard injection timing.

Standard Injection Timing

model / rpm	L2	L3
Up to 2000	BTDC 15°	←
Over 2000~ Under 3800	BTDC 17°	←
Over 3800	BTDC 19°	←

■Adjusting the engine speeds

To adjust engine speed, remove the cooling fan and install the safety cover over the fan to prevent getting hurt. For speed adjustment specification, see 8-05.

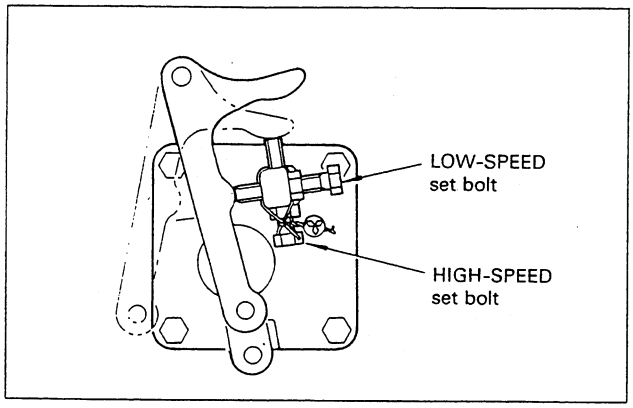
(I) The upper limit of engine speed can be adjusted with the HIGH-SPEED stopper bolt.
This stopper bolt has been set properly and sealed in the factory before shipping of the engine. Never tamper with the seal unless it is necessary.

(2) The lower limit of engine speed can be adjusted with the LOW-SPEED stopper bolt.

(3) Never remove the sealing cap unnecessarily to adjust the torque spring set. For the proper disassembling procedure, see 4-02.

Caution

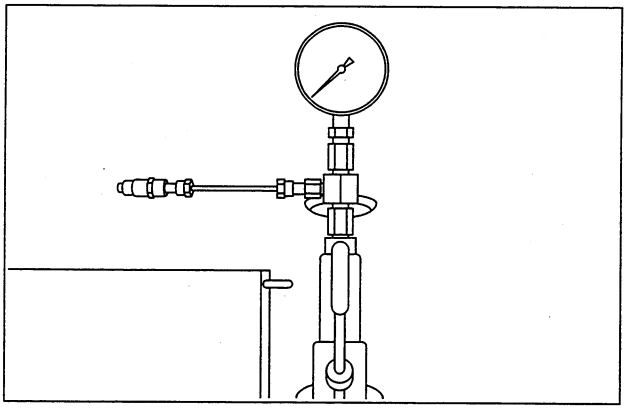
Warm up the engine (until coolant temperature rises up to 60°C or above) before adjusting engine speeds.



HIGH-SPEED and LOW-SPEED Set Bolts

(4) During running of the engine for speed adjustment, check the engine for gas leak, water leak, oil leak, and fuel leak.

(5) After adjustment, perform engine acceleration and deceleration test to confirm that the engine is free from hunting and smoking.



Testing Injection Start Pressure

■Checking and adjustment of nozzles

To check and adjust the injection nozzles, use the following procedure :

I. Injection start pressure

(1) Remove the nozzle assembly to be tested from the cylinder head and set the nozzle on the nozzle tester.
Perform air bleeding by moving the tester handle up and down.

(2) Operate the handle at a speed of 60 rpm or more and read the gauge pressure of fuel injected from the nozzle.

- Injection start pressure : 140^{+10}_{-0} kgf/cm² [$13.7^{+1.0}_{-0}$ MPa]

(3) If reading of gauge pressure is not within the specified range, disassemble the nozzle and vary thickness of the adjusting shim.
Increasing or decreasing shim thickness by 0.1 mm will cause injection pressure to vary about 10 kgf/cm² [0.98 MPa]

(4) When installing the nozzle, use the following values of tightening torque :

- Nozzle tightening (to cylinder head) torque : 5.0 — 6.0 kgf·m [49 — 59 N·m]
- Nozzle retaining nut tightening torque : 3.5 — 4.0 kgf·m [34 — 39 N·m]
- Nozzle union collar tightening torque : 2.5 — 3.0 kgf·m [25 — 29 N·m].

2. Chattering test

Operate the tester handle at a speed of about I stroke per second.

(I) Needle valve oscillation

It is consedered normal if the nozzle injects fuel mist, making intermittent sounds, and oscillations of the needle valve are transmitted to the handle.

(2) State of fuel mist injection

The nozzle should inject fuel mist straight in the direction of its axis. A nozzle is defective if it does not inject steadily or it injects fuel in several separate stripes.

A nozzle is defective if it spills fuel accumulated on the bottom of the nozzle after chattering test. However, a very small drop of fuel remaining on the tip of nozzle after chattering test may be regarded as normal.

3. Injection test

Operate the tester handle at a speed of 4 to 6 strokes per second.

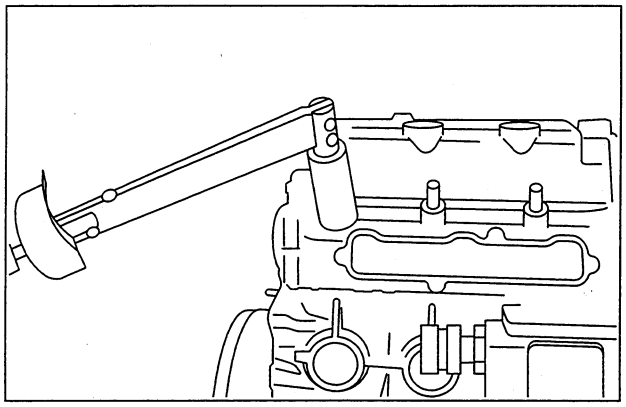
- A nozzle should inject fuel mist uniformly in the shape of a cone.

4. Checking the compression pressure

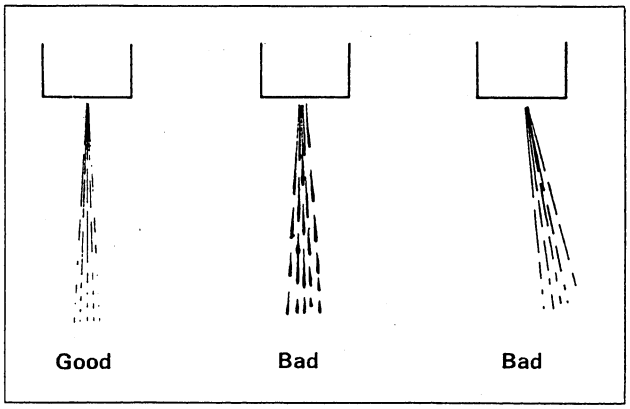
(I) Make sure of the following :

(a)All of the engine oil level, air cleaner, starting motor, and battery are well-conditioned.

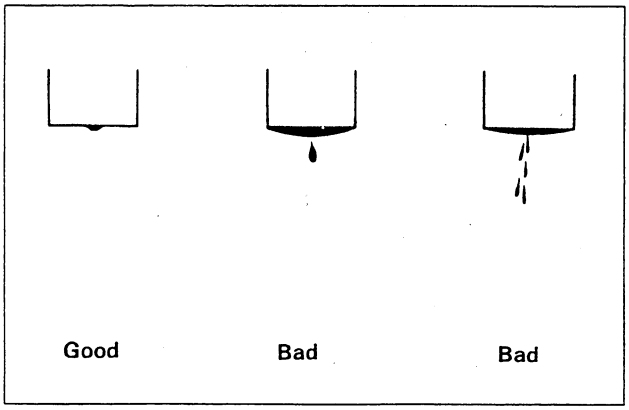
(b)The engine is preferably warmed up (to a coolant temperature of 50°C or more).



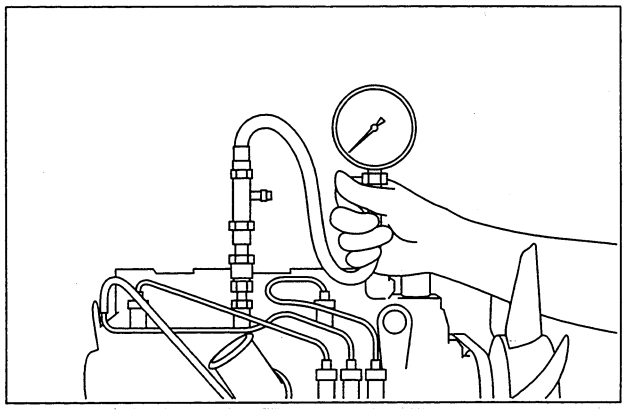
Installing Nozzle Assembly



Charttering Test



After-spilling



Testing Compression Pressure

(2) Measure the compression pressure using the following procedure :

(a)Pull the stop lever to the " non-injection" position.

(b)Remove the glow plug from the cylinder to be tested. Set the compression gauge adapter to that cylinder and install the gauge.

(c)Crank the engine with the starting motor until a stable reading of the compression gauge is obtained.

(d)After reading the gauge, remove the compression gauge and adapter. Put back the glow plug.

(e)Check all cylinders using the procedure described above.

Engine speed	: 250 — 280 rpm
Compression pressure	: 29 — 32 kg/cm
Pressure difference between cylinders	: Within 3 kg/cm

Hints on using the trouble-diagnosis chart

As for diesel engines, trouble symptoms and causes are often so complicated that it will be difficult to locate the root cause by judging from a trouble symptom. For example, trouble symptoms caused by the faulty injection pump, faulty injection nozzles, and improper cylinder compression, respectively, will be much the same. To pass judgment on such a case, very close examination of the existing trouble symptom is necessary.

The trouble-diagnosis charts on the succeeding pages are prepared in such a way of beginning with the most possible or easiest-to-inspect item and then proceeding stepwise to less possible or more complicated items.

Before troubleshooting you should have a right understanding of the following features about the construction and fuel combustion in the diesel engines.

- Normal engine operation is accompanied by combustion noise (diesel knocking sounds).
- A heavy-loaded engine exhausts some black smoke.
- When operated singly an engine may vibrate because of high cylinder compression and large output torque.
- When an engine is accelerated or decelerated quickly, some hunting may occur.

CAUTION

- **Do not attempt to readjust or disassemble the injection pump for the purpose of troubleshooting, without use of a pump tester which is indispensable to measure injection quantity for each cylinder.**
- **To check whether state of combustion in a desired cylinder is normal or not, loosen the injection pipe to cut fuel feed to that cylinder, and find the resulting slowdown of the engine. Compare the degree of slowdown by that cylinder with that by another cylinder.**

■Hard starting

1. Matters to be checked before diagnosis
   - ● Clogging of air cleaner
   - ● Coagulation of engine oil
   - ● Use of poor-guality fuel
   - ● Lowering of cranking speed

2. Diagnosis

Does preheating stem operate ›rmally ?
No ⇨ Does current flow in glow plug circuit as soon as key switch is turned to " H" (ON).
No ⇨ Inspect key switch, wiring, and glow indicator.

⇩ yes

yes ⇨ Inspect glow plug.

Is electric wiring normal ? { Does fuel pump, if provided, operate when key switch is turned to ON ?
No ⇨ Inspect fuel pump and/or wiring

⇩ yes

Does fuel flow in fuel line ?
No ⇨ Does fuel get out when fuel injection pump air vent screw is loosened ?
No ⇨ Inspect fuel filter, fuel pipe, and fuel tank.

⇩ yes

Is engine put in order ? { Injection timing and valve timing
No ⇨ Adjust engine properly.

⇩ yes

Do injection nozzles operate normally ? { State of fuel mist injection and injection start pressure
No ⇨ Inspect injection nozzles.

⇩ yes

Is cylinder compression normal ?
No ⇨ Inspect valves, pistons, piston rings, and cylinder head gasket.

⇩

Inspect injection pump.

■Knocking

Diesel engines are usually accompanied by fuel combustion noise (diesel knocking sounds) because of structural feature.

A trouble should be suspected only when the engine makes abnormally large sounds.

1. Matters to be checked before diagnosis
   - ● Clogging of the air cleaner
   - ● Use of poor-quality fuel (Small cetane number fuel such as used for burning)

2. Diagnosis

Is injection timing normal ?
(Check for premature injection.)
→ No ⇨ Adjust injection timing.

⇩ yes

Do injection nozzles operate normally ?
(Check for lowering of injection start pressure and improper state of fuel mist injection.)
→ No ⇩ Inspect injection nozzles.

⇩ yes

Is cylinder compression normal ?
→ No ⇨ Inspect valves, pistons, piston rings, and cylinder head gasket.

⇩ yes

Does injection pump operate normally ?
(Check for uniformity of injection quantity.)

⇩ yes

Mechanical noise (Worn or damaged main moving parts)

■Overheating

1. Matters to be checked before diagnosis
   - ● Shortage of coolant and leakage
   - ● Loosening of fan belt
   - ● Clogging of radiator fins
   - ● Too rich antifreeze solution
   - ● Clogging of muffler
   - ● Shortage of engine oil and deterioration
   - ● Stagnation of cooling air
   - ● Defective thermostat

2. Diagnosis

Is engine operating condition moderate ?
(Check for overload continuous running.)
⇨ Find the cause of overload.

⇩ yes

Is cooling system in good order ? (Check cylinder head gasket for blowing through, water pump, water hose, and radiator fins for clogging, and thermostat for malfunctioning.)
No ⇨ Repair cooling system.

⇩ yes

Is injection timing is normal ?
No ⇨ Adjust injection timing.

NOTE :

Overheating is mostly caused by mis-matching load of the engine. If overheating arises only when the engine drives a load, measure coolant temperature under the working load condition (full open thermostat) to see whether the measurement exceeds a point 60° C higher than atmospheric temperature. If so, it is advised to check for mis-matching of load, too.

■Black-smoky exhaust

1. Matters to be checked before diagnosis
   - ● Clogging of air cleaner element
   - ● Use of poor-quality fuel
   - ● Overload
2. Diagnosis

Is smoke set of injection pump is normal ?
No ⇨ Adjust smoke set.

⇩yes

Is engine put in order ?
(Check for excessive valve clearance and improper injection timing.)
No ⇨ Adjust engine.

⇩yes

Do injection nozzles operate normally ?
(Check for improper state of fuel mist injection and for excessively large injection start pressure.)
No ⇨ Inspect injection nozzles.

⇩yes

Is cylinder compression normal ?
No ⇨ Inspect valves, cylinder head gasket, pistons, and piston rings.

⇩yes

Inspect injection pump.

■Unsteady idling

1. Matters to be checked before diagnosis
   - ● Faulty engine control system
   - ● Too high engine oil viscosity
   - ● Use of poor-quality fuel

2. Diagnosis

Is engine adjusted properly ? (Check for idling speed, valve clearance, and injection timing.)	No ⇨	Adjust engine.

⇩ yes

Do injection nozzles operate normally ? (Check for state of fuel mist injection and injection start pressure.)	No ⇨	Inspect injection nozzles.

⇩ yes

Is cylinder compression normal ? (Check equality between cylinders.)	No ⇨	Inspect valves, pistons, and piston rings.

⇩ yes

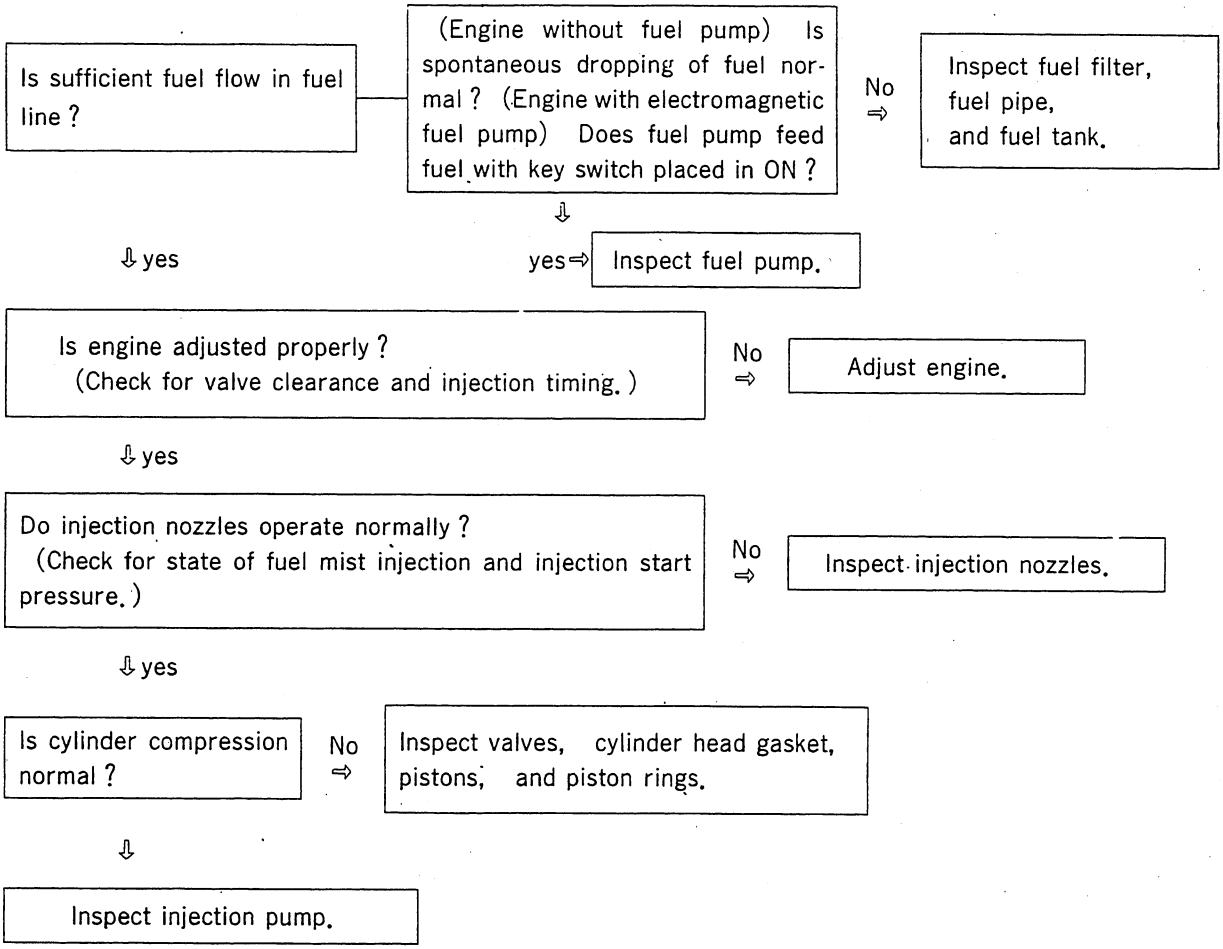
Inspect injection pump and governor system.

■Low output

1. Matters to be checked before diagnosis

- ● Seizing of engine moving parts.
- ● Too viscous engine oil
- ● Use of poor-quality fuel
- ● Clogging of air cleaner element
- ● Clogging of muffler
- ● Malfunctioning of drive system

2. Diagnosis



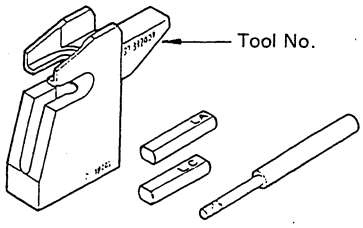
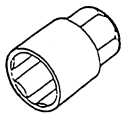
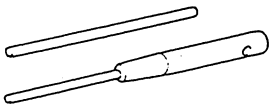
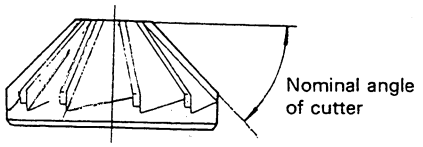
Group 1	ENGINE	

■Specifications

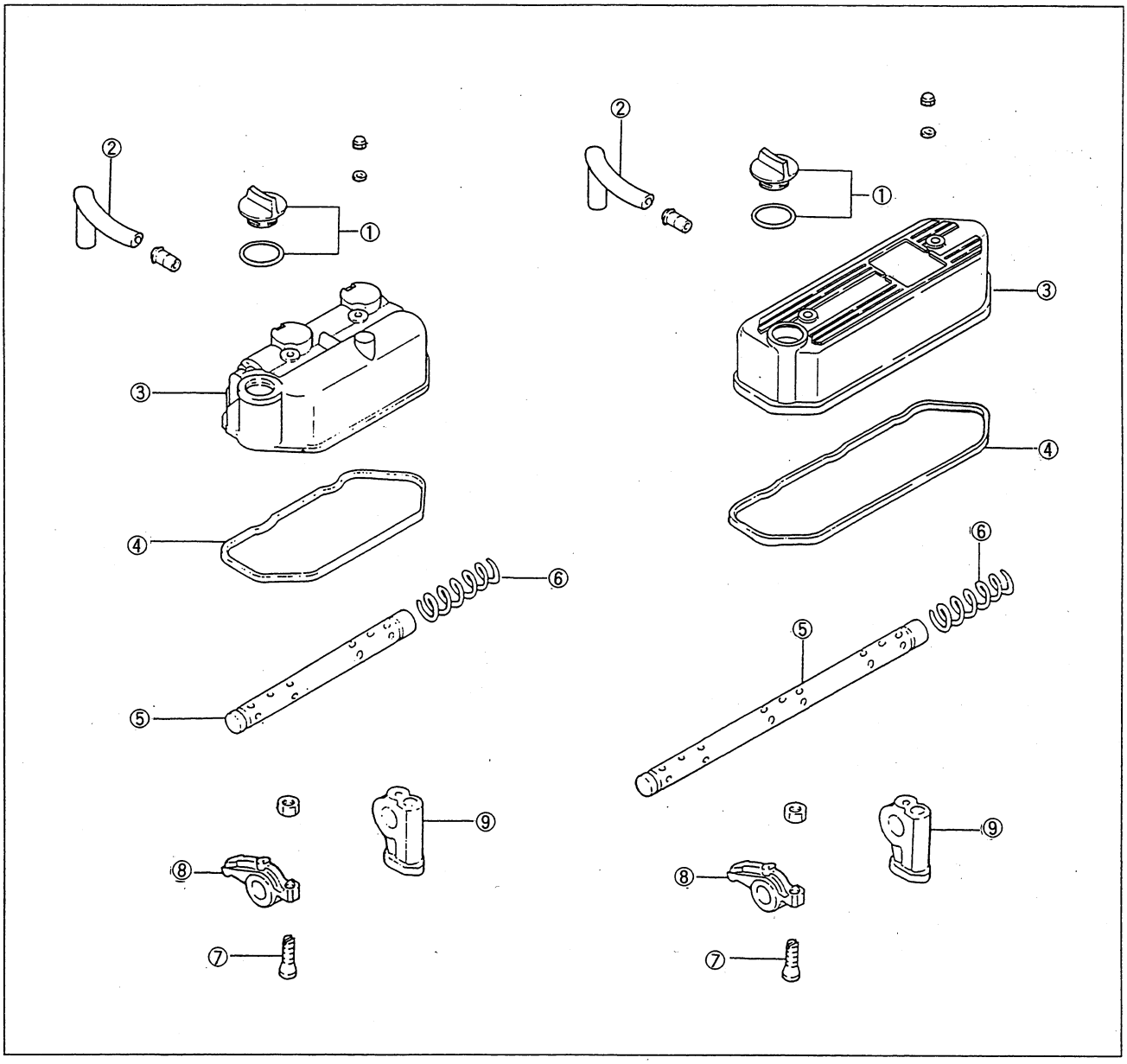
Item \ Model			L2	L3
Cylinder head	Material		Special cast iron	
	Combustion chamber type		Swirl chamber	
	Material of chamber		Heat-resisting steel (press-fitted in cylinder head)	
	Type of intake and exhaust ports		Cross-flow type	
Valve seats	Material		Heat-resisting steel (3600 rpm specification engines)	
			Special cast iron (3000 rpm or less engines)	
Valves	Face angle		45°	
	Identification mark	Intake	IN	
		Exhaust	EX	
Valve springs	Type		Uniformly pitched, single	
	Identification mark		White paint at top (common to intake and exhaust valves)	
Cylinder head gasket	Material		Carbon sheet (Graphoil)	
Cylinder head bolts	Material		Special steel	
	Size x Number of bolts		M10 x 6	M10 x 8
			M8 x 2	M8 x 3
Camshaft	Material	Valve cam	Carbon steel	
		Pump cam		
	Arrangement — Drive		Side — Gear driven	
Cylinder block	Cylinder bore		L2A: 65 / L2C: 70 / L2E: 76 / L3A: 65 / L3C: 70 / L3E: 76	
	Cylinder liner type		Monoblock type	
	Water jacket type		A, C : Full jacket, E : " Siamese" type	
Crankshaft	Material		Carbon steel	
	Surface treatment		Hardening (Induction)	
	Main journal dia. x Crankpin dia.		43 x 40	
piston	Type		" Autothermic"	
	Joint to connecting rod		Semi-floating	
	Cooling		Oil jet	

Item \ Model		L2	L3
Piston rings	No. 1	Semi-keystone type	
	No. 2	Plain type	
	Oil ring	With coil expander	
Oil pump	Type	Gear type	
	Drive	Direct drive by crankshaft	
Timing gears	Crankshaft gear	Number of teeth : 26	
	Idle gear	// : 40	
	Injection pump camshaft gear	// : 52	
	Valve camshaft gear	// : 52	

■Special Tools

Use	Tool name	Sketch	Referential page
Removal and installation of piston pin	Piston pin setting tool ST332400		56 ~ 58
Measurement of cylinder compression	Compression gauge adapter ST332270		20
Removal and installation of oil pressure switch	Oil pressure switch socket wrench (26) MD998054		68
Repair of valve seat	Valve seat cutter pilot Valve seat cutter, 45° Valve seat cutter, 60° Valve seat cutter, 30°	 	37 ~ 38

■Construction



Rocker System component Parts

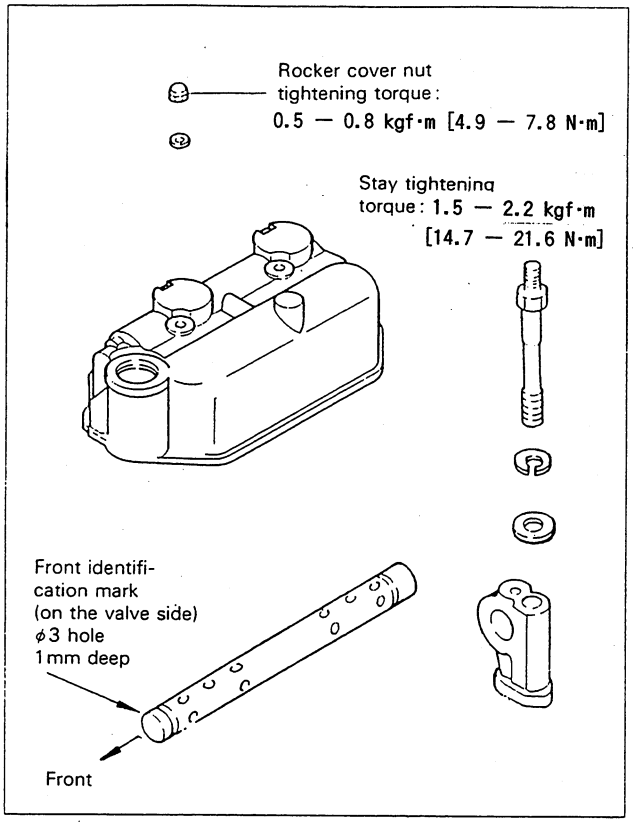
① Oil filler cap	④ Rocker cover gasket	⑦ Adjust screw
② Breather hose	⑤ Rocker shaft	⑧ Rocker arm
③ Rocker cover	⑥ Rocker spring	⑨ Rocker stay

1-02 ROCKER ARMS AND ROCKER SHAFT

■Removal and Installation

Caution

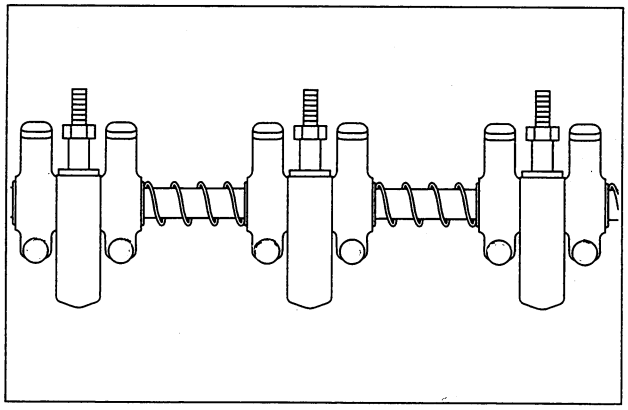
1. Be careful not to confuse proper direction of installation of the rocker shaft.
2. After installing the rocker shaft, adjust valve clearance.



Installing Rocker Shaft and Rocker Cover

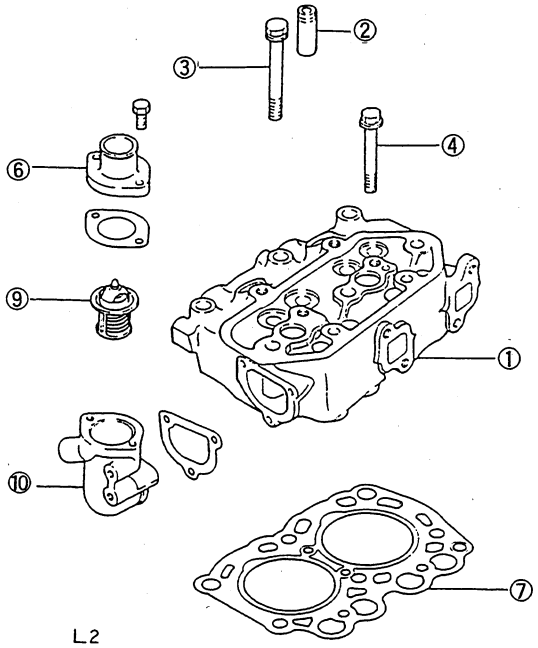
■Inspection

If any parts are found defective, replace them.

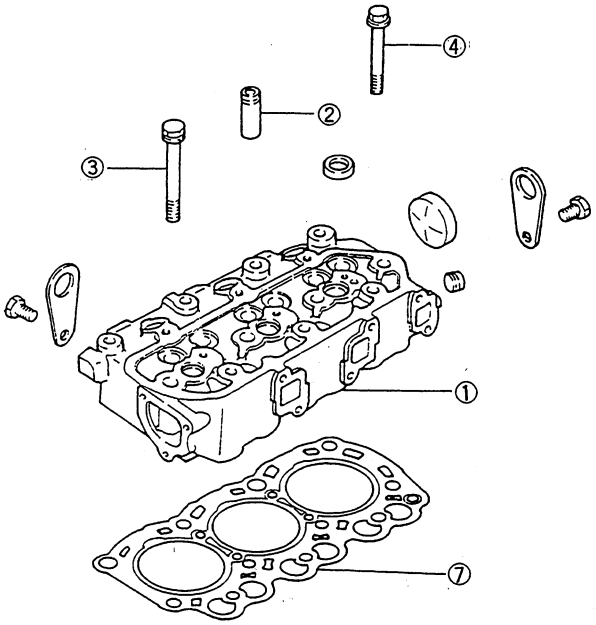


Inspecting Rocker Shaft and Rocker Arms

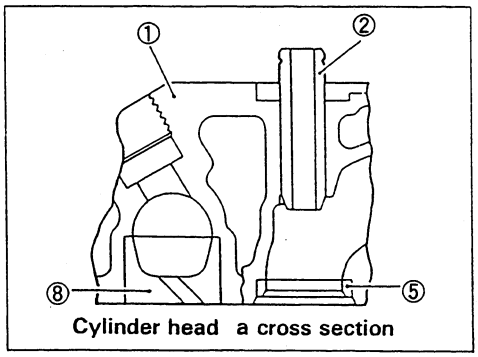
■Construction



L2



L3



Cylinder head a cross section

Cylinder Head Component Parts

① Cylinder head
② Valve guide
③ Cylinder head bolt (Main bolt)
④ Cylinder head bolt (Sub-bolt)
⑤ Seat ring (3600 rpm specification engine)
⑥ Water outlet fitting
⑦ Cylinder head gasket
⑧ Mouth piece
⑨ Thermostat
⑩ Thermostat fitting

■Removal

(1) Remove the injection pipe assembly.

Caution

- **When disconnecting each injection pipe from the injection pump side delivery valve holder, grasp the holder with a wrench to prevent it from loosening.**
- **After removing the pipe assembly, plug the nozzle holders and delivery valve holders to prevent intrusion of dust.**

(2) Disconnect the glow plug lead wire.

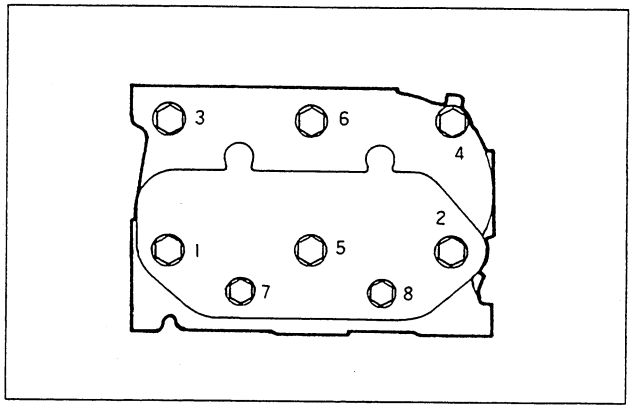
(3) Loosen the alternator bracket bolts and dismount the alternator.

(4) Disconnect the air breather hose.

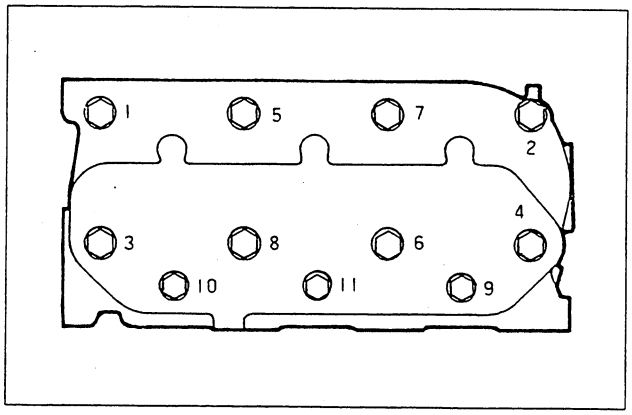
(5) Remove the rocker cover.

(6) Remove the rocker shaft assembly.

(7) Loosen the cylinder head mounting bolts in the numerical order illustrated at right and remove the cylinder head assembly (including the intake and exhaust manifold).



Sequence for Loosening Cylinder Head Bolts (L2)



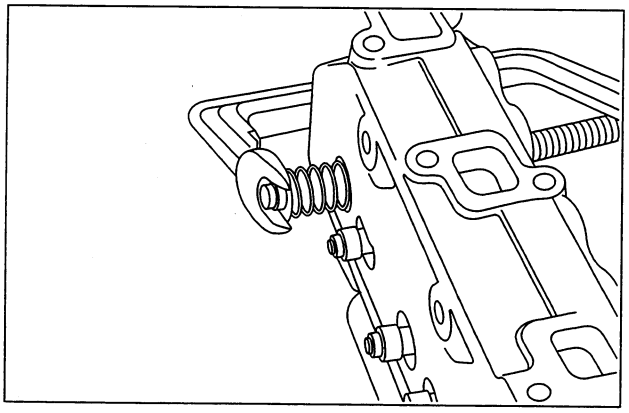
Sequence for Loosening Cylinder Head Bolts (L3)

(8) Remove the cylinder head gasket.
Clean the cylinder head and the cylinder block surface from which the gasket has been removed.

(9) Remove the nozzle holder assemblies and glow plugs from the cylinder head.

(10) Remove the intake manifold and exhaust manifold from the cylinder head.

(11) Remove the valve retainers, valve springs, and valves from the cylinder head.



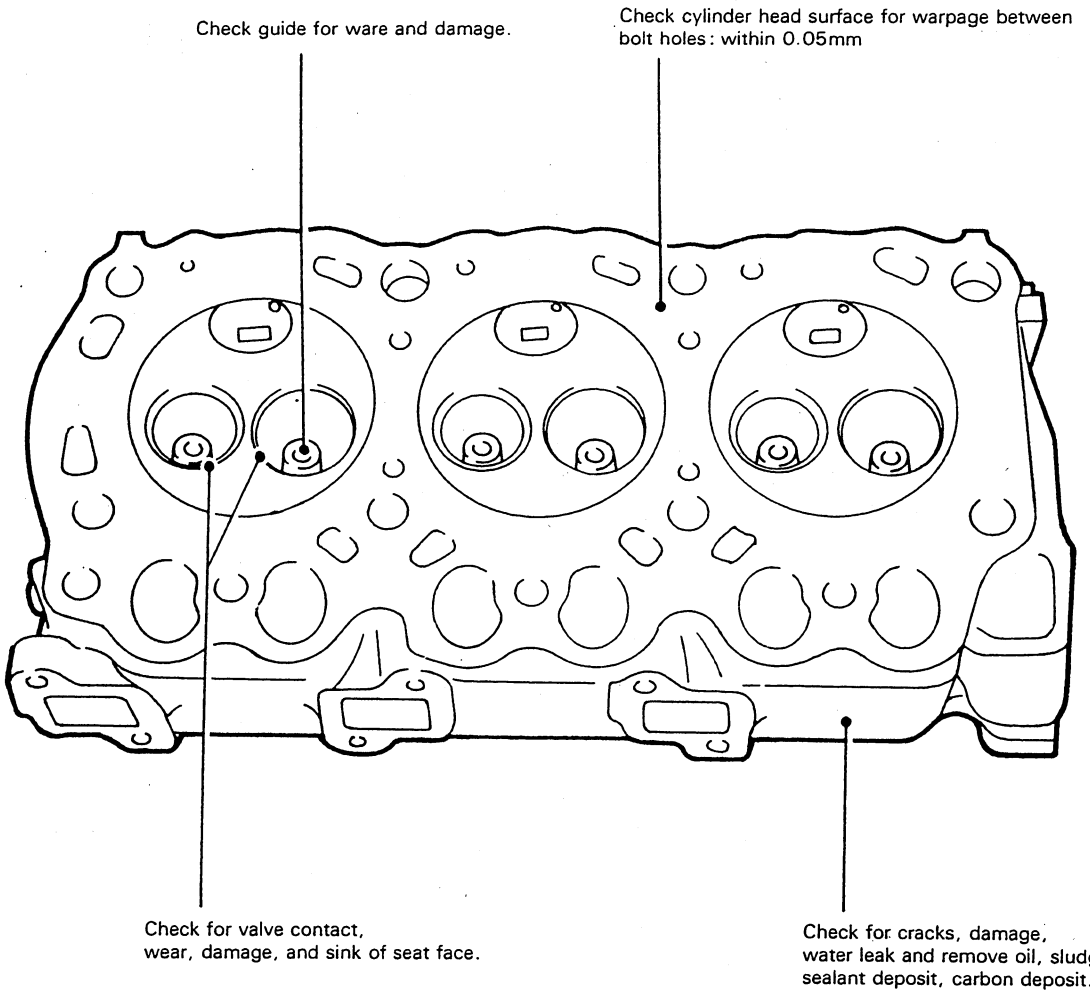
Removing Valves

Caution

- **When removing each valve retainer, depress the retainer against the valve spring and remove the retainer lock.**
  Identify each valve by putting a mark indicating the number of cylinder from which the valve is removed.

(12) Remove the valve stem seals.

■Inspection and Repair

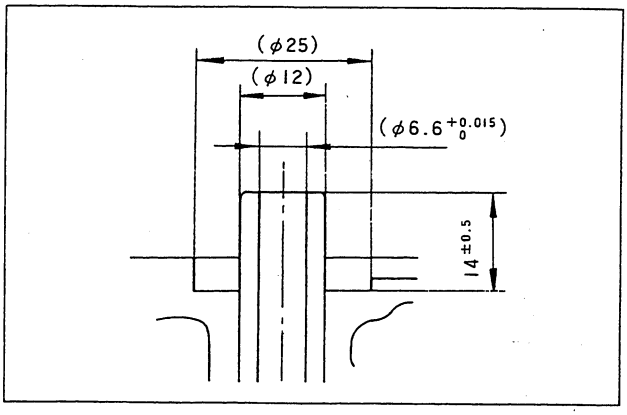


Inspection of Cylinder Head

■Replacement of Valve Guide

If a valve guide is found defective, replace it.

1. Removal
   Press the guide at its upper end and pull it out to the valve seat side.
2. Installation (Press-fitting)
   Press-fit the guide from the upper side of the cylinder head to a height of 14 ± 0.5 mm from the valve spring seat face.

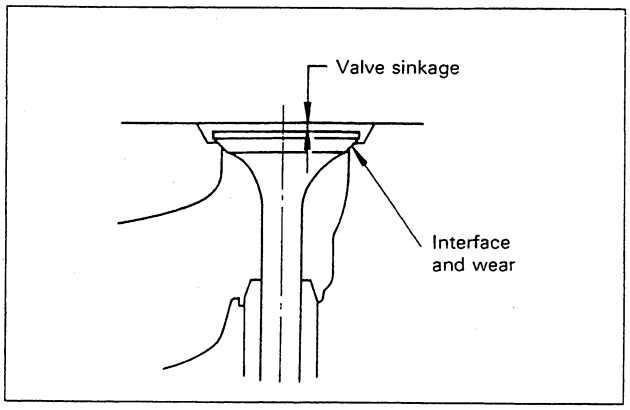


Press-fitting Valve Guide

■Repair of Valve Seat

If a valve seat is found defective, reface it or replace the cylinder head.

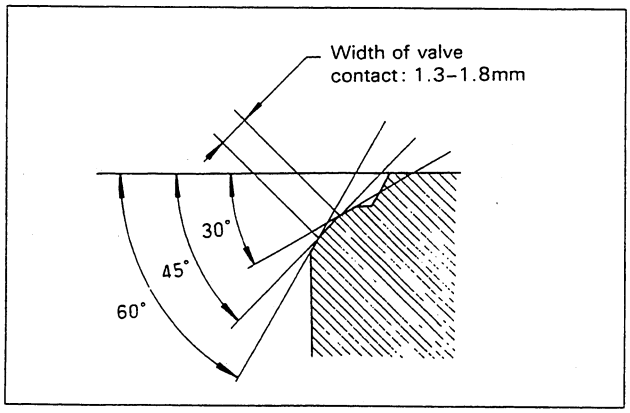
Sinkage of valve	
Standard	Service limit
0.5 mm	1.5 mm



Checking Valve Sinkage

Caution

- **When checking valve sinkage, the valve guide must be in the normal condition.**
- **Resurface the valve seat so that it contacts the mid-portion of the valve face.**



Resurfacing Valve Seat (Common to intake and exhaust valves)

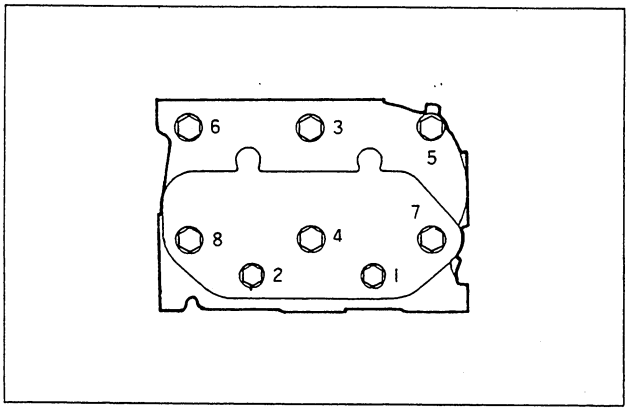
■Installation

Installation of the cylinder head is in the reverse order of removal. Pay attention to the following :

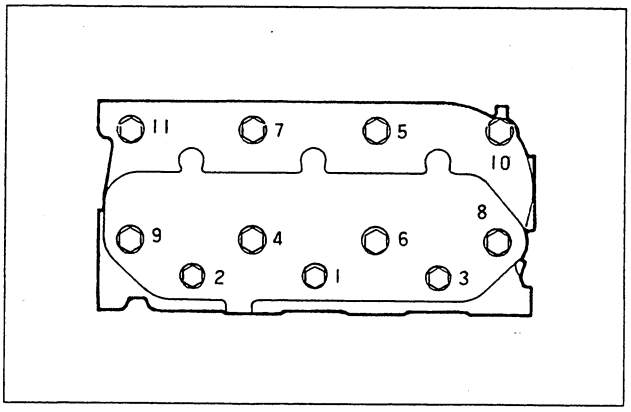
(1) Renew the cylinder head gasket. No application of sealant is necessary. On the upper front of the gasket is engine model to which that gasket is applicable. Be careful not to confuse with a gasket for other engine model.

(2) tighten the cylinder head bolts in the numerical order shown in the figure at right, going through that order two or three times. Tighten each bolt a little at a time until all are tightened to the specified torque.

(3) When connecting the injection pipe assembly, loosen the pipe clamp.
When tightening the nut at each end of pipe, grip the nozzle holder or delivery valve holder with a wrench to prevent it from being turned together with the nut.
Also, take care not to allow dust to enter the fuel line.

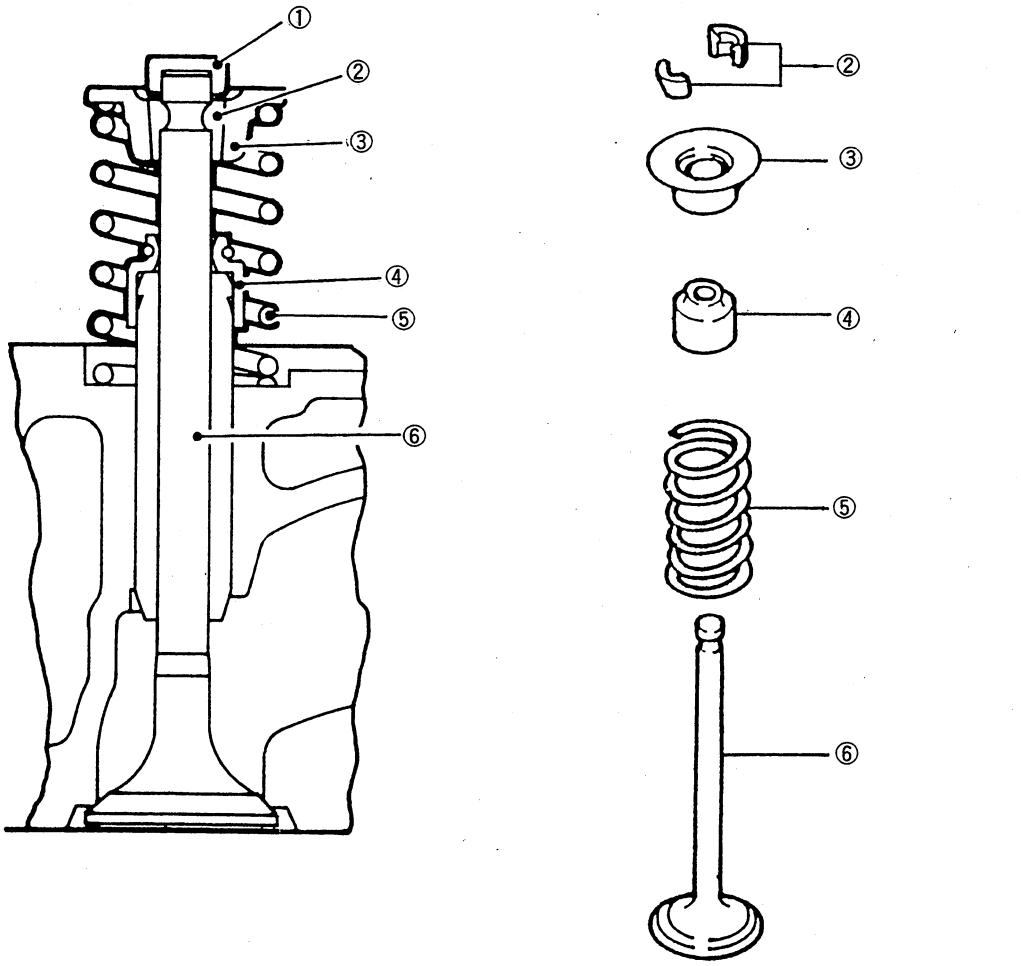


Sequence for Tightening Cylinder Head Bolts (L2)



Sequence for Tightening Cylinder Head Bolts (L3)

■Construction



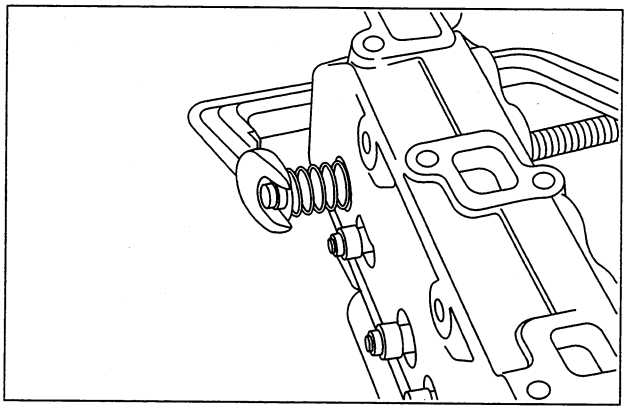
Valve System Component Parts

① Valve stem cap
② Retainer lock
③ Valve spring retainer
④ Valve stem seal
⑤ Valve spring
⑥ Valve

1-04 VALVES AND VALVE SPRINGS

■Removal

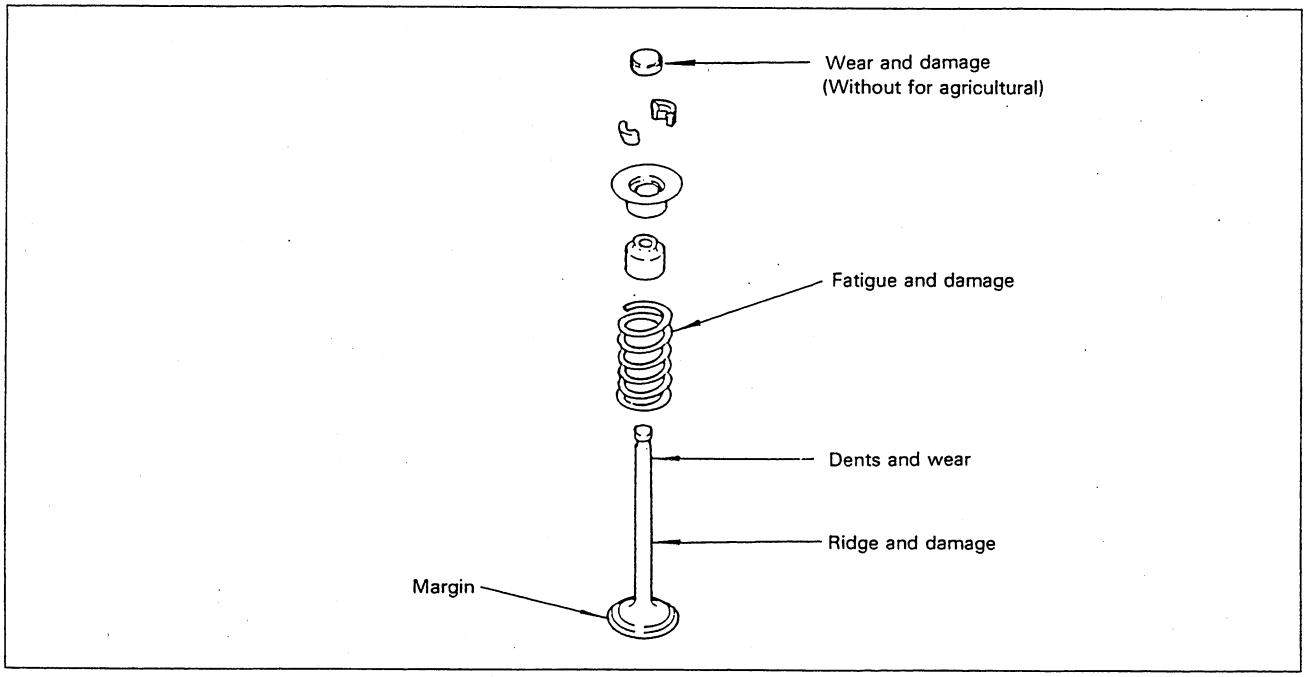
(1) Dismount the cylinder head assembly.
(2) Depress the valve retainer (to compress the valve spring) and remove the retainer lock.
(3) Remove the valve.



Removing Valve and Valve Spring

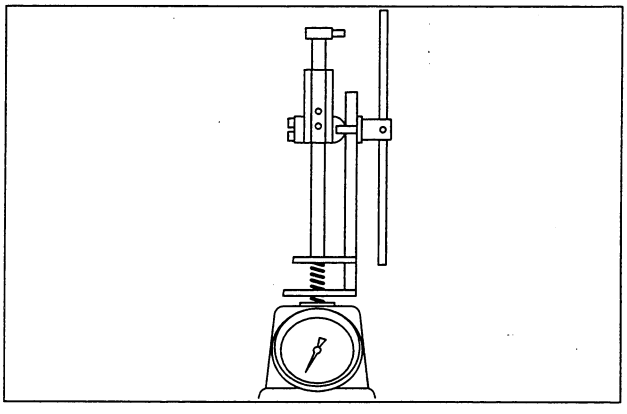
■Inspection and Repair

If any parts are found defective, repair or replace them.



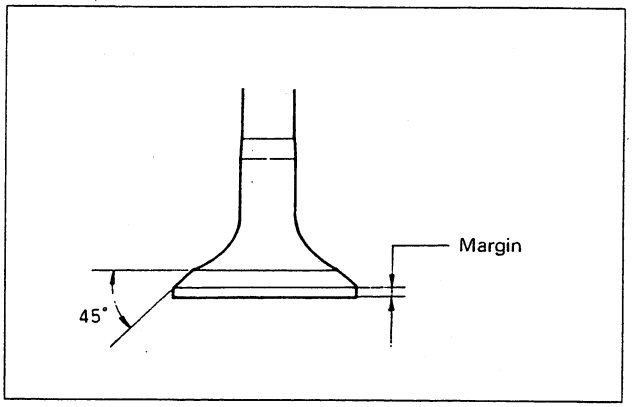
Inspection of Valve and Valve Spring

Valve fatigue and damage		
Inspection item	Standard	Service limit
Free length (mm)	40.5	−1
Load (kg/mm)	5.94/35.5	−15%
Squareness	2°	3°
Margin (mm)	1.0	0.5



Valve Spring Tester

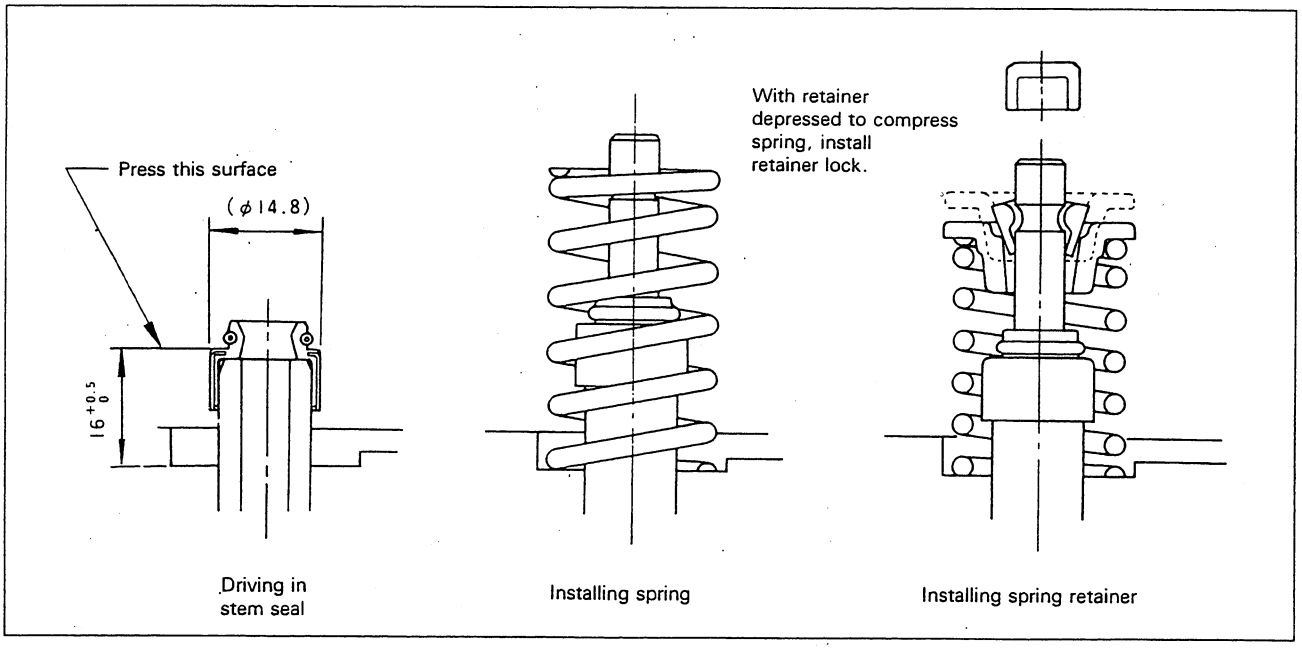
1. Repair of valve face
   If the valve face is found worn down, resurface with a valve refacer. If margin of the resurfaced valve exceeds service limit, replace the valve.
2. Repair of valve stem end
   If the valve stem end has been indented by wear, flatten with an oil stone.



Inspecting Valve

■Installation

(1) Install the valves and valve springs, referring to notes shown in the figure below.
(2) Mount the cylinder head assembly.
(3) Adjust the valve clearances.



Installation of Valve Spring

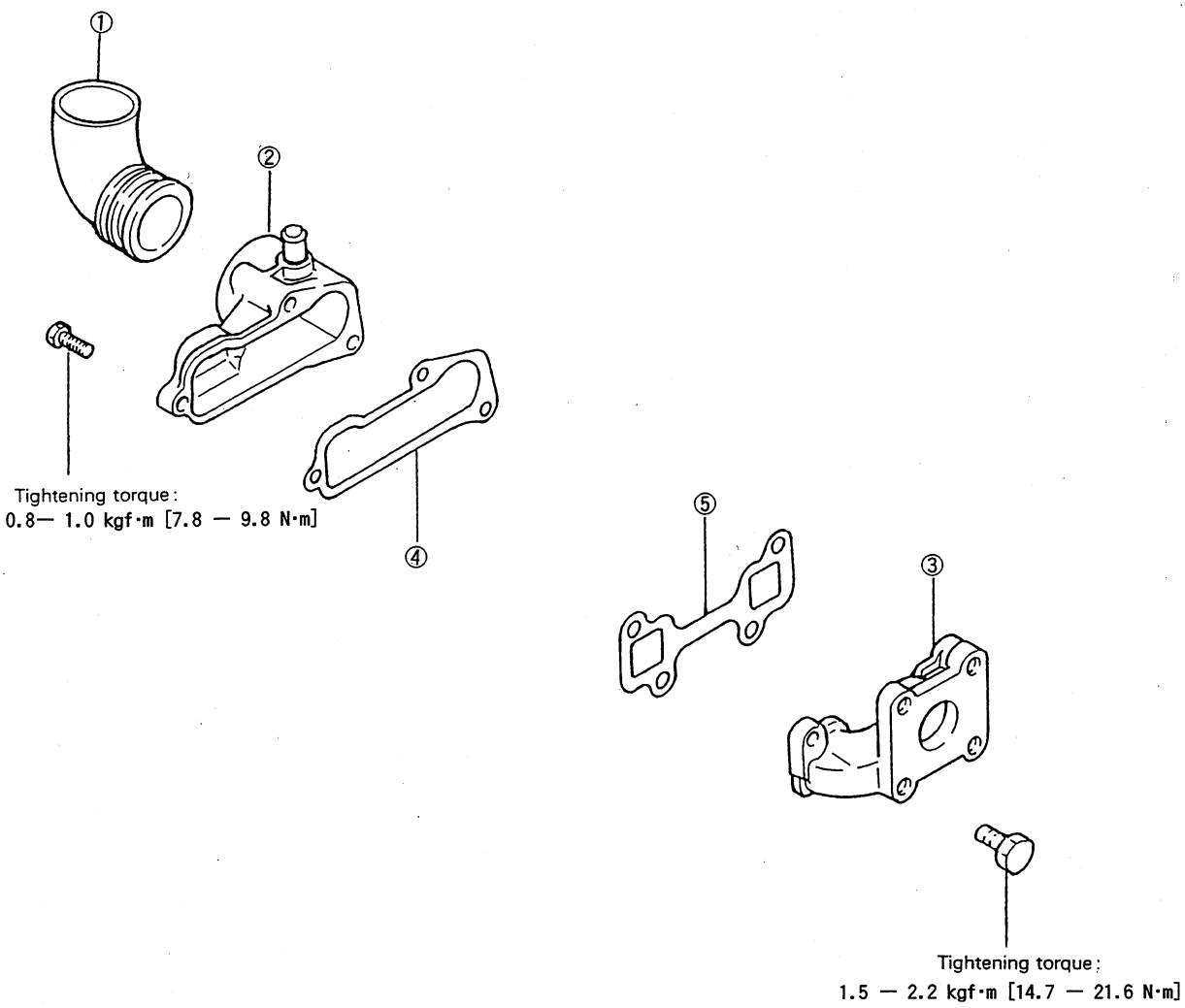
Caution

Be careful not to damage the spring and stem seal by excessively compressing the spring when installing the valve spring.

Group No.

1-05 INTAKE MANIFOLD AND EXHAUST MANIFOLD

■Construction



Manifold Component Parts

① Intake pipe
② Intake cover
③ Exhaust manifold
④ Intake manifold gasket
⑤ Exhaust manifold gasket

■Inspection

Check the following matters. If any defect is found, repair or replace the manifold.

(1) Check the mounting surfaces to the cylinder head for flatness. The surfaces must be flat within 0.15 mm.

(2) Check the manifolds for corrosion, damage and cracks.

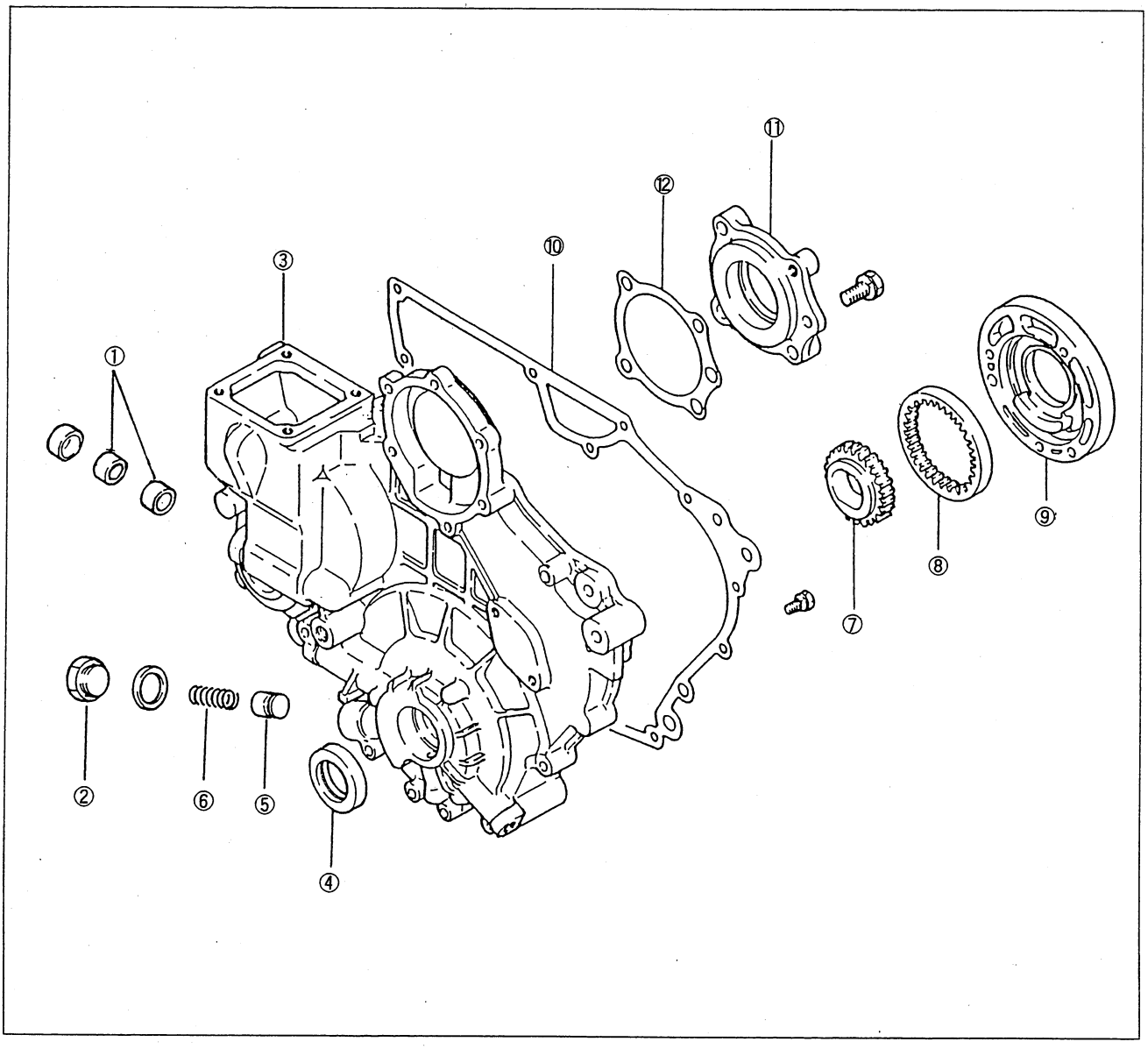
Caution

Check the interior of the intake manifold for dust and dirt. If any dust is found, check the joints to the air cleaner and intake pipe for sealed condition.

1-06 GEAR CASE AND OIL PUMP

■Construction

Common to L2 and L3



Gear Case Component Parts

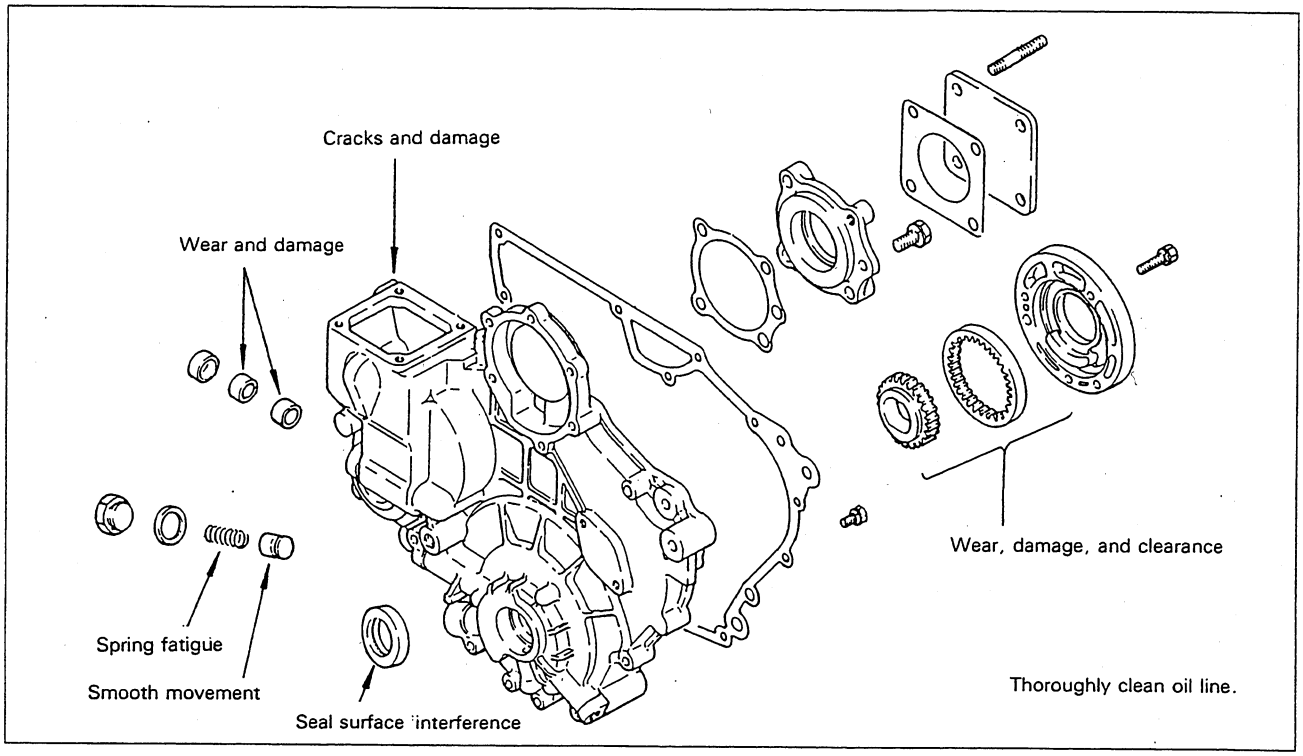
① Bushings	⑤ Relief plunger	⑨ Oil pump housing
② Plug	⑥ Relief spring	⑩ Gear case gasket
③ Gear case	⑦ Oil pump inner gear	⑪ High-pressure pump gear housing
④ Front oil seal	⑧ Oil pump outer gear	⑫ Housing gasket

■Removal

(1) Remove the crankshaft pulley.
(2) Remove the fan and fan belt.
(3) Remove the tie-rod cover from the side face of the injection pump.
(4) Remove the tie rod and tie rod and tie-rod spring. Be careful not to let the spring fall into the case.
(5) Remove the governor cover assembly.
(6) Remove the water pump assembly.
(7) Remove the alternator.
(8) Remove the pump housing.
(9) Remove the gear case assembly.

■Inspection

Check the removed parts. If any parts are found defective, repair or replace them.



Inspection of Gear Case and Oil Pump

Oil Pump Performance

Description \ Speed, rpm		1000	2000
Discharge	Pressure, kgf/cm²[MPa]	1.5 [0.15]	2.0 [0.20]
	Flow rate, ℓ/min	3 or more	17 or more
Relief valve	Cracking pressure kgf/cm²[MPa]	3.0 [0.29]	—
	Closing pressure kgf/cm²[MPa]	—	5 [0.49] or below

*Oil used : SAE30, 100℃±5℃

■Replacement of Front Oil Seal

(1) Remove the front oil seal.

(2) Press-fit the new front oil seal.

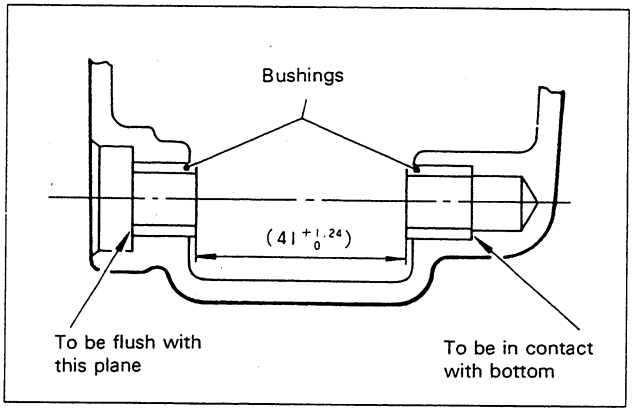
Caution

- **Apply thin coat of engine oil to the circumference and lip of the oil seal.**

■Replacement of Governor Shaft Bushings

(1) Remove the expansion plug and draw the bushings out.

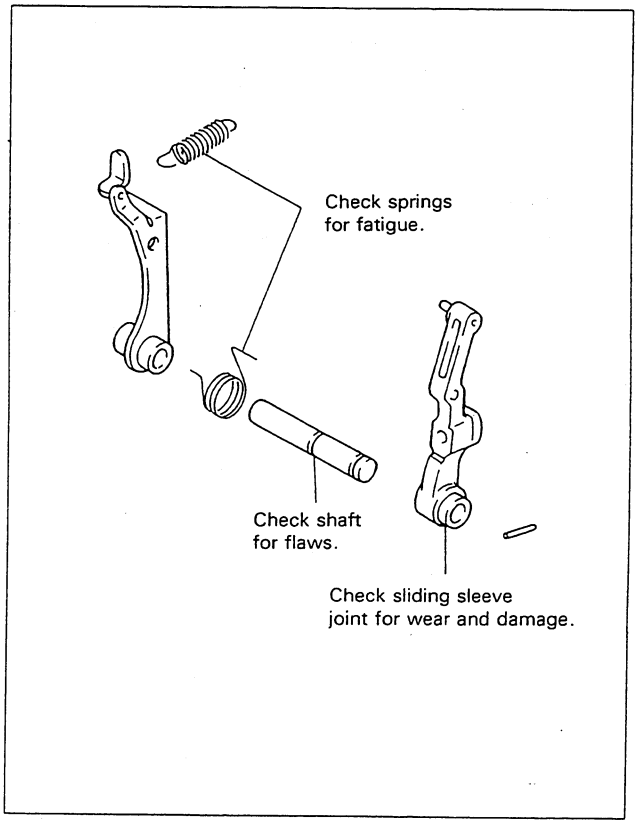
(2) Press-fit the new bushings into positions shown in the figure at right.



Press-fitting Governor Shaft Bushing

■Inspection of Governor System

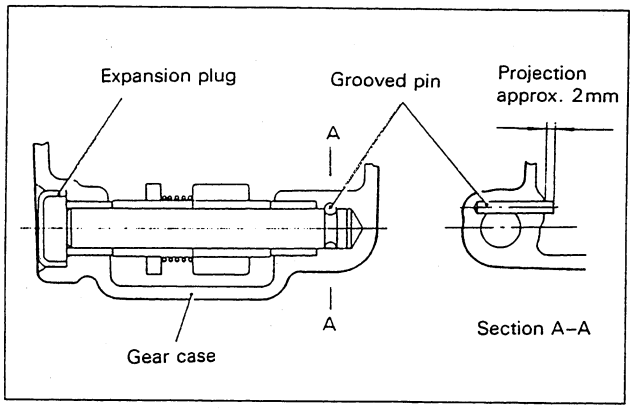
Check the governor system parts. If any parts are found defective, repair or replace them.



Check weight for wear and damage.

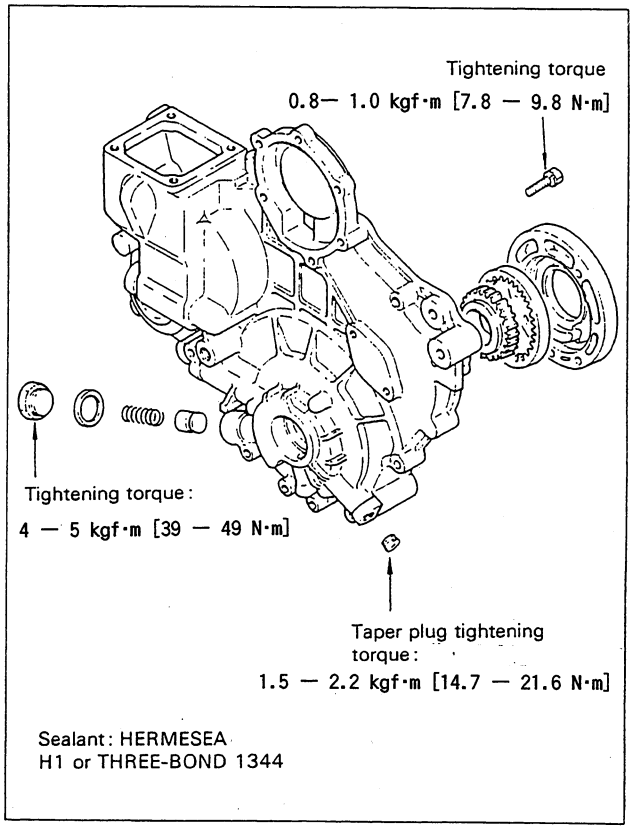
■Disassembly and Reassembly of Governor Levers

1. Removal of shaft
   (1) Remove the expansion plug, taking care not to scratch the gear case.
   (2) Pull out the grooved pin.
2. Installation of shaft
   (1) Install the shaft in the reverse order of removal.
   (2) After installing the shaft, press-fit the expansion plug into the shaft hole in the gear case.

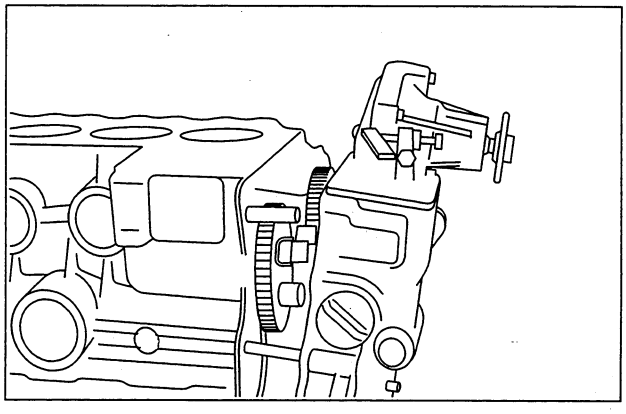


Installing Governor Shaft

■Installation of Gear Case Assembly

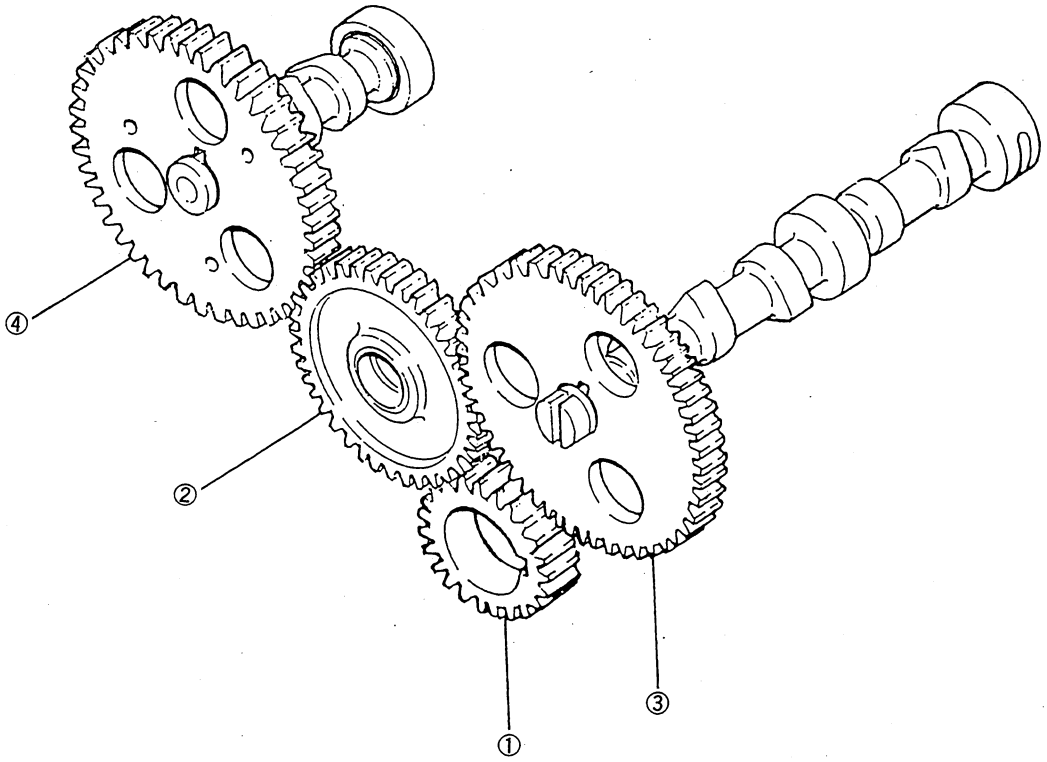


Gear Case Assembly



Installing Gear Case Assembly

■Construction

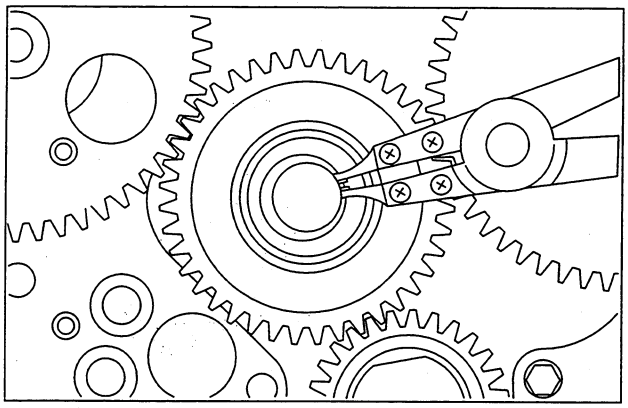


Timing Gear Component Parts

① Crankshaft gear
③ Idle gear
③ Camshaft gear
④ Injection pump camshaft gear

■Removal

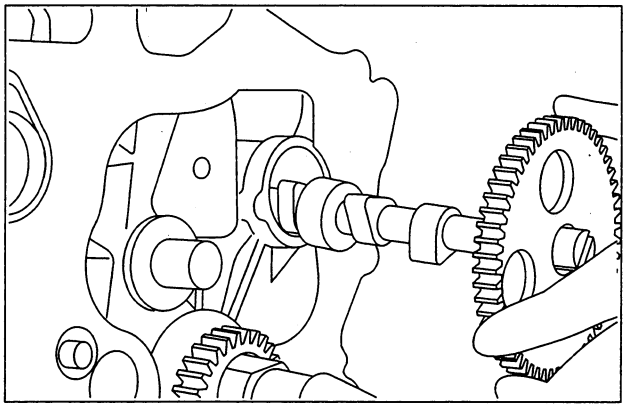
(1) Pry the snap ring out and remove the idle gear.



Removing Idle Gear

(2) Remove the valve camshaft and injection pump camshaft on which the respective gears are press-fitted. Remove the gears from the shafts.

(3) Remove the crankshaft. Remove the gear from the crankshaft.



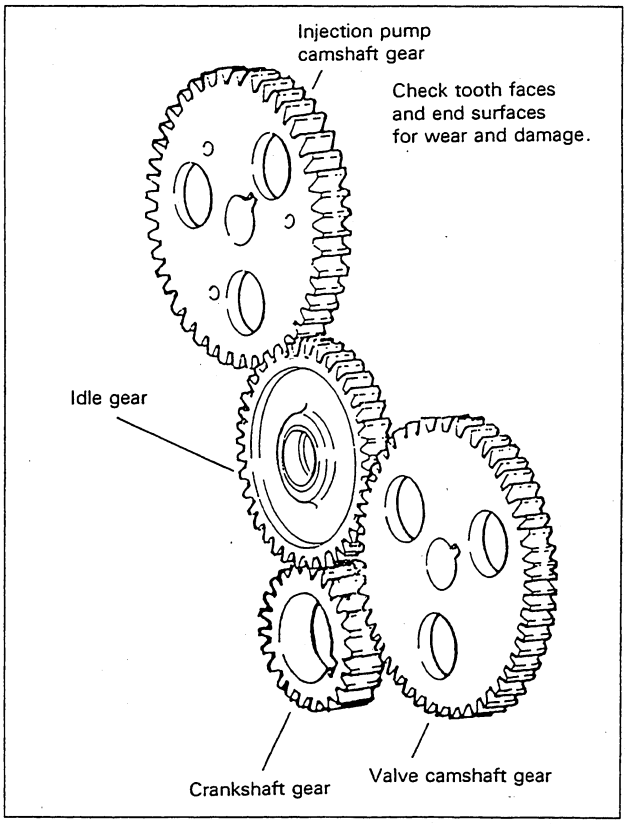
Removing Camshaft Gear

■Inspection

Check the removed gears. If any gear is found defective, replace it.

Idle gear bushing		
Description	Standard value	Service limit
Clearance between bushing and shaft	0.03 – 0.07	0.2

Backlash between gears in mesh		
Description	Standard value	Service limit
Crankshaft-Idle	0.01 – 0.14	0.3
Idle-Camshaft		
Idle-Fuel pump Gear		



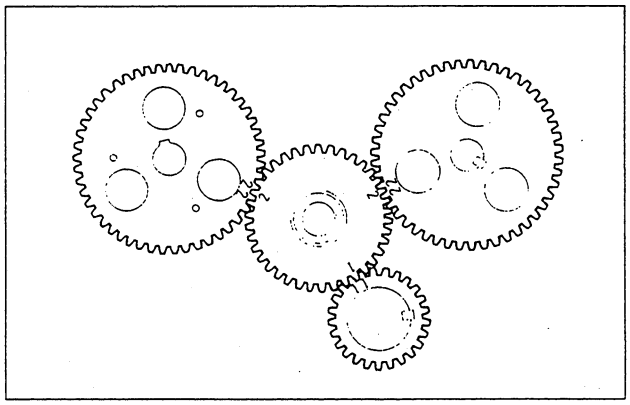
Inspecting Timing Gears

■Installation of Timing Gears

(1) Press-fit the crankshaft gear onto the shaft.

(2) Press-fit the valve camshaft gear and injection pump camshaft gear onto the respective shafts.

(3) Install the gears in the following sequence



Timing Gears in Alignment with Each Other

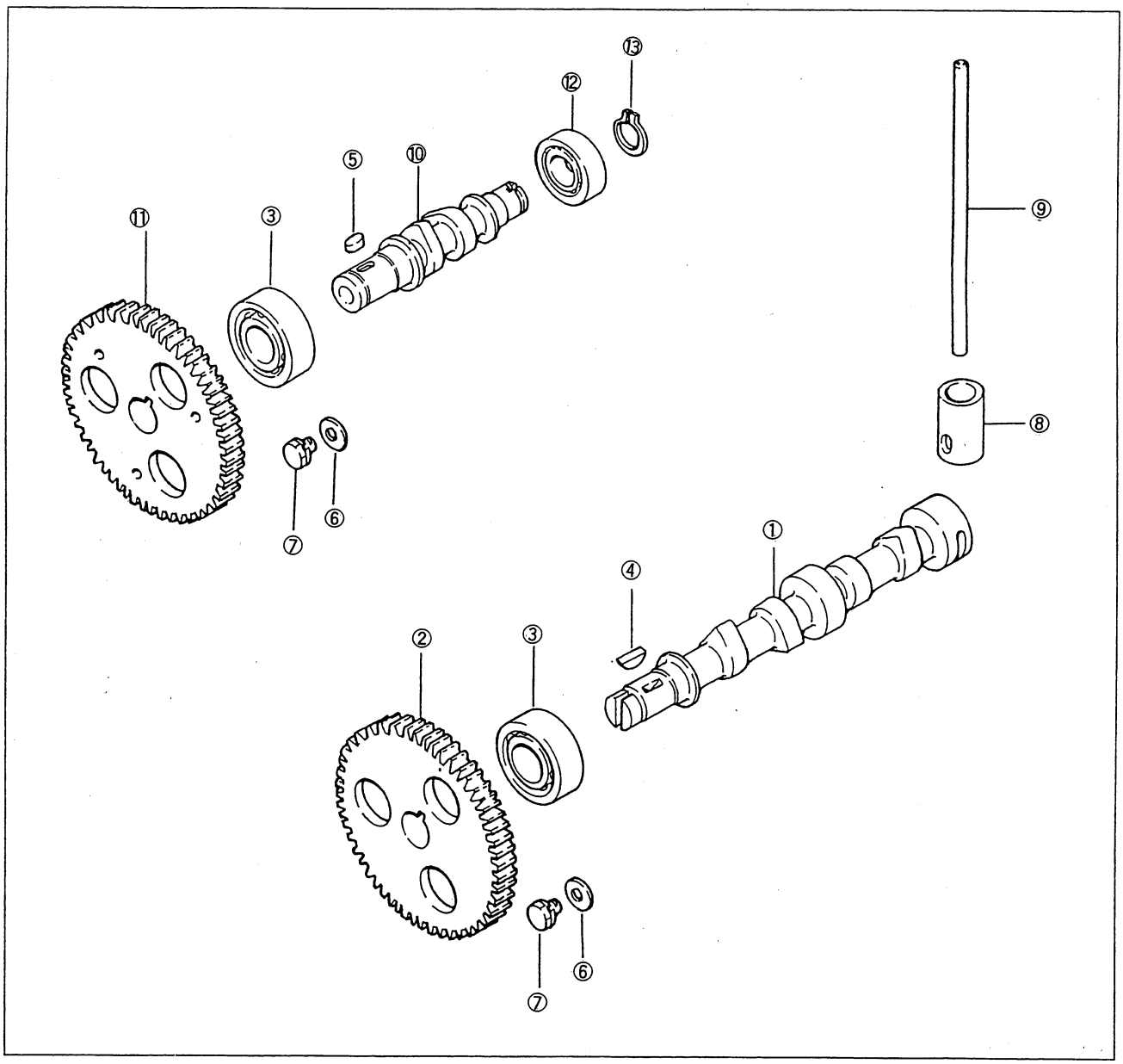
(a) Turn the crankshaft to set the No. I cylinder to top dead center on compression stroke.

(b) Install the valve camshaft and injection pump camshaft.

(c) Install the idle gear so that timing marks on it are in alignment with marks on other gears.

(d) Confirm that timing gears are in alignment with each other.

■Construction



Camshaft Component Parts

① Camshaft (Valve)
② Camshaft gear
③ Ball bearing
④ Woodruff key
⑤ Sunk key
⑥ Camshaft stopper
⑦ Bolt
⑧ Tappet
⑨ Push rod
⑩ Camshaft (Injection pump)
⑪ Camshaft gear
⑫ Ball bearing (Rear)
⑬ Snap ring

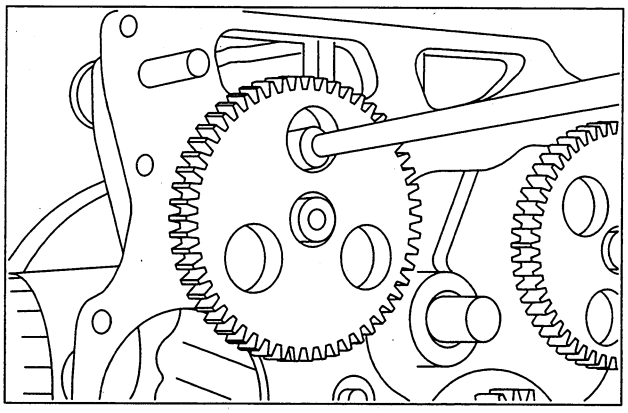
■Removal of Valve Camshaft

1. When it is necessary to remove only the valve camshaft, use the following procedure :

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

2. Removal of the injection pump camshaft

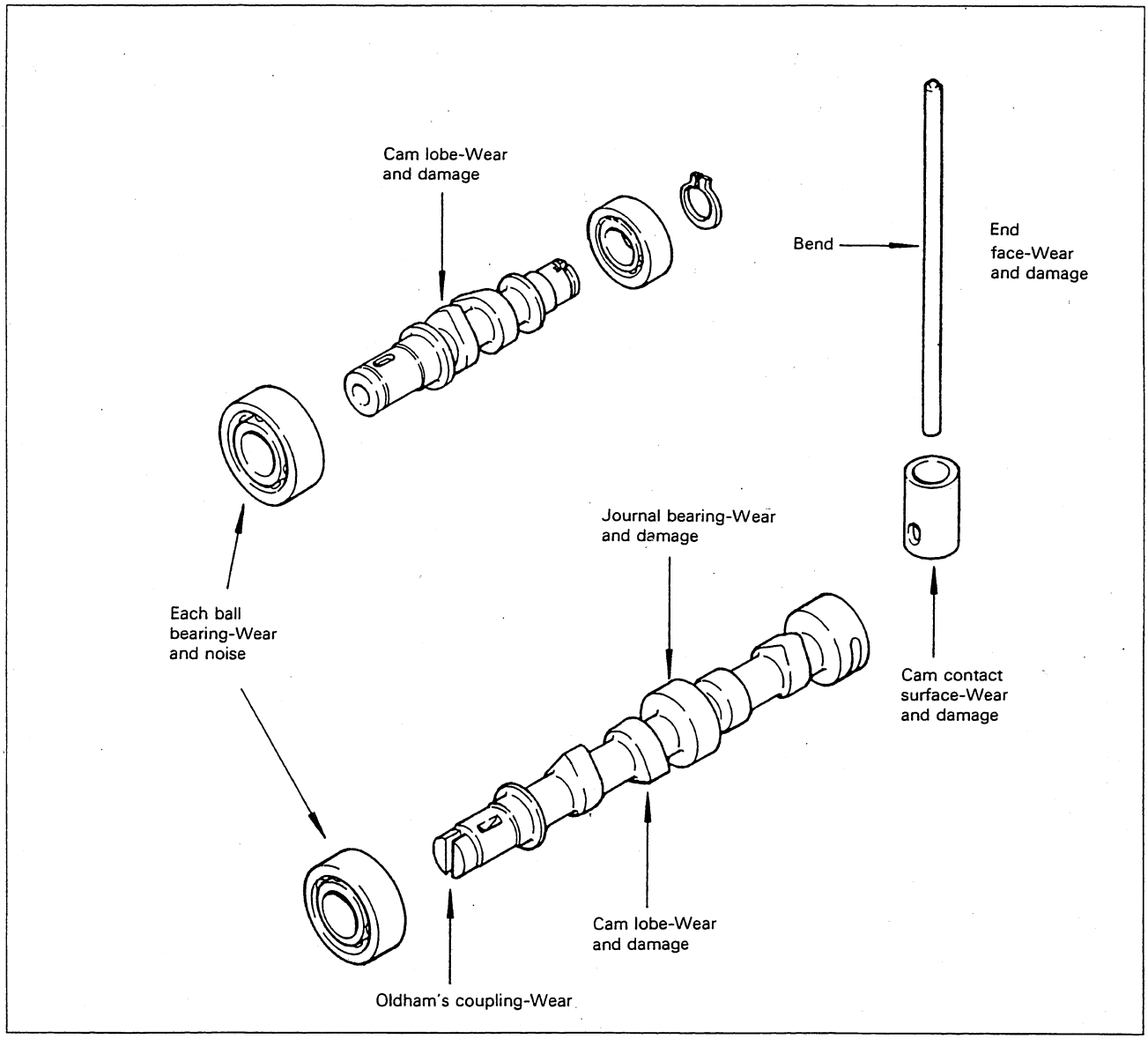
(1) Disconnect the injection pipes.
(2) Remove the injection pump assembly.
(3) Remove the gear case assembly.
(4) Remove the shaft rear cover.
(5) Remove the stopper bolt.
(6) Pull out the shaft to the front side.



Removing Injection Pump Camshaft

■Inspection

If any parts are found defective, repair or replace them.



Inspection of Camshafts

Major diameter of injection pump cam	
Standard value	30
Service limit	−0.7

Major diameter of valve cam	
Standard value	27.37
Service limit	−1.0

■Installation

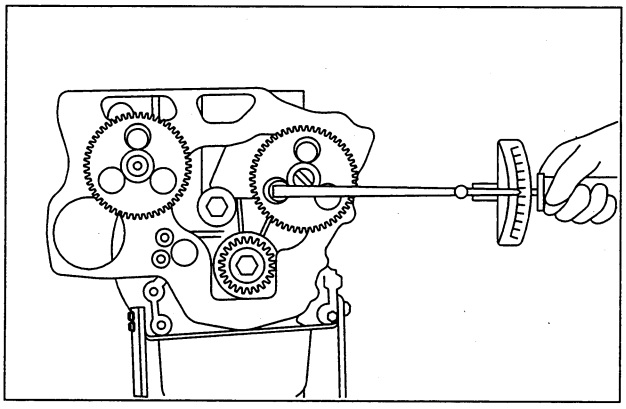
When installing the camshafts, give care to the following :

(1) Coat the bearings and cam lobes with oil.

(2) Install the camshafts in the reverse order of removal.

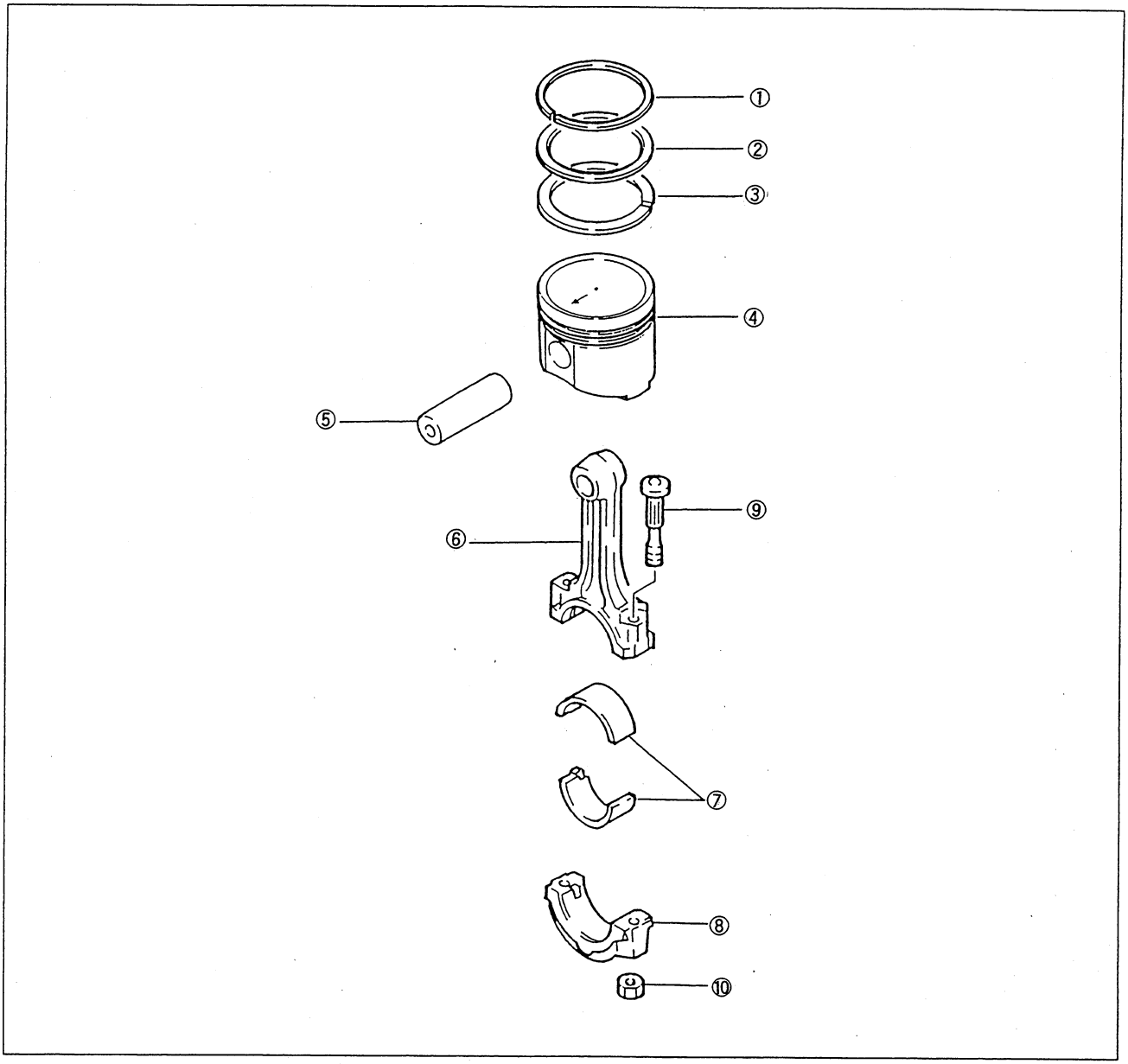
(3) Position the timing marks on the gears in alignment with the marks on the idler gear. Refer to 1-07 TIMING GEAR.

(4) After installation, check and adjust fuel injection timing and valve clearances.



Installing Valve Camshaft

■Construction



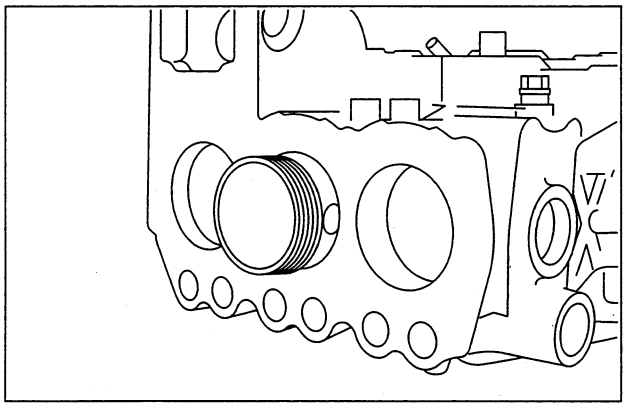
Piston and Connecting Rod Component parts

① Piston ring No. I	⑤ Piston pin	⑧ Connecting rod cap
② Piston ring No. 2	⑥ Connecting rod	⑨ Connecting rod bolt
③ Oil ring	⑦ Connecting rod bearing	⑩ Connecting rod nut
④ Piston		

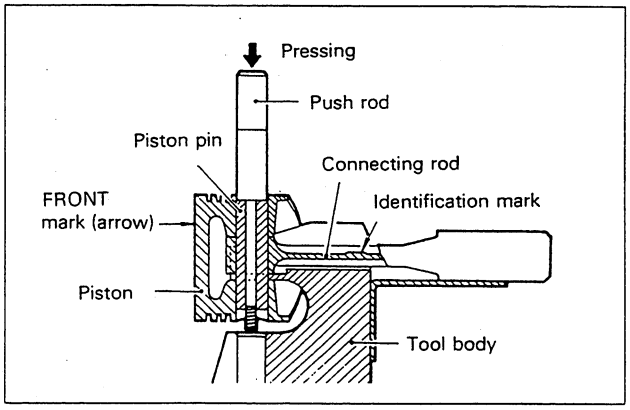
1-09 PISTON AND CONNECTING ROD

■Removal

(1) Remove the cylinder head assembly.
(2) Remove the oil pan.
(3) Remove the oil screen.
(4) Chalk the cylinder number on the side face of big end of each connecting rod to prevent confusion of connecting rods.
(5) Remove the connecting rod cap from each piston-and-rod assembly, and draw the assembly upward from the cylinder.
Take care not to allow the connecting rod to scratch the crankshaft pin and cylinder.
Keep the removed parts (connecting rod, rod cap, piston, etc.) classified by cylinders.
(6) Remove the rings from each piston with the piston ring pliers.
(7) Using the piston setting tool, pull out the piston pin from each piston.



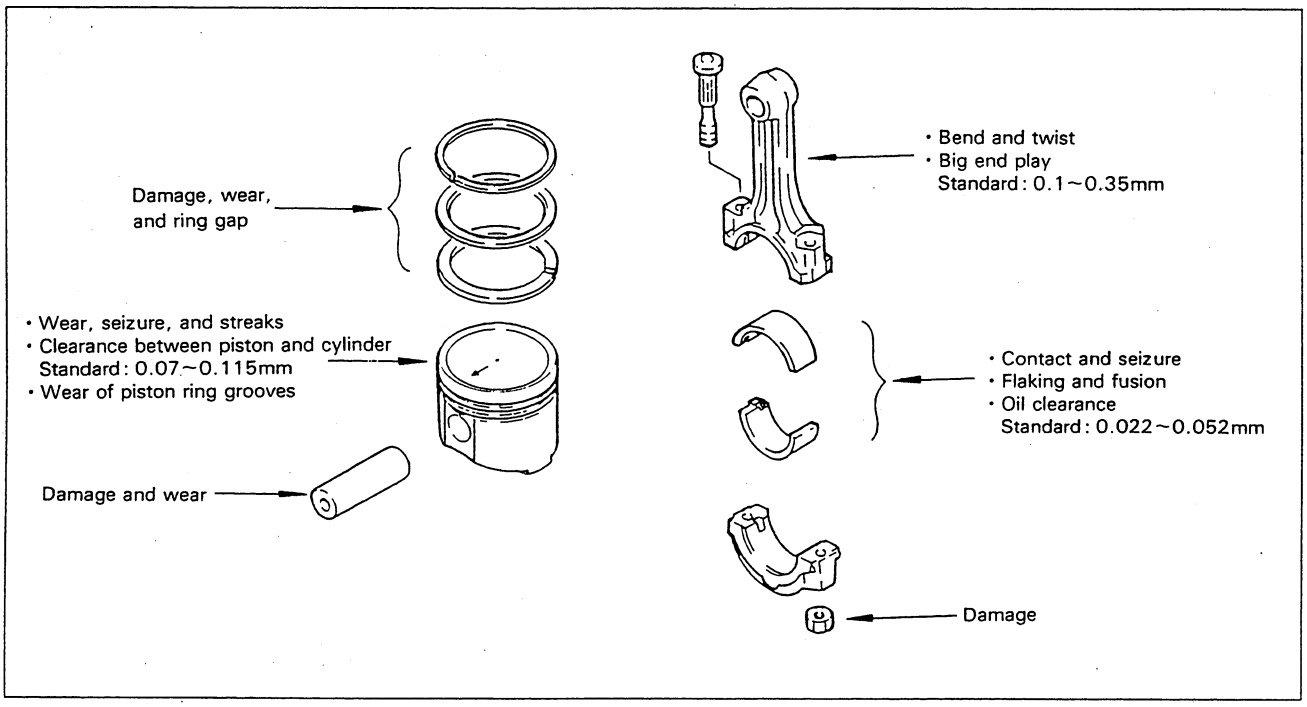
Removing Connecting Rod and Piston



Removing Piston Pin

■Inspection

Inspect the removed parts. If any parts are found defective, replace or repair them.



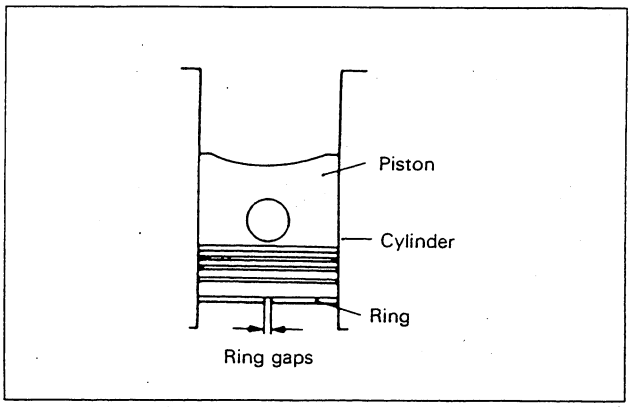
Inspection of Piston and Connecting Rod

1. Inspection of piston ring gaps

Put each piston ring into the cylinder bore and push the ring with piston to position the ring on square with the cylinder wall. Measure the ring gap with a feeler gauge. If the measurement exceeds service limit, replace that piston ring.

Caution

- **When only the replacement of rings is to be made, without reboring (honing) of the cylinder, position the ring to be measured at the least worn place of cylinder skirt.**
- **When replacing rings, install the new rings having the same size as the piston.**
- **Piston rings available for servicing are sized into three classes : STD, 0.25 OS, and 0.50 OS.**

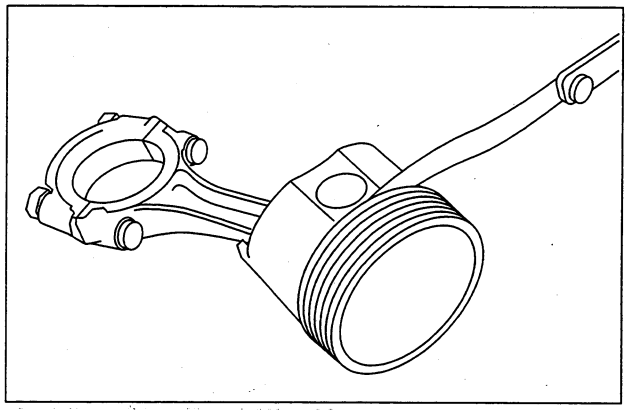


Measuring Ring Gap

Ring	Standard	Service limit
All rings	0.15~0.40	1.5

2. Inspection of ring groove in piston

Measure the side clearance for each piston ring set in the ring groove in the piston. If the service limit is exceeded, replace the ring with new one. If the clearance still exceeds the service limit, replace the piston with new one.



Measuring Ring Side Clearance

Ring	Standard	Service limit
No. 1	–	0.3
No. 2	0.05~0.09	0.2
Oil	0.03~0.07	0.2

Note : No. 1 ring is of the semi-key stone type.

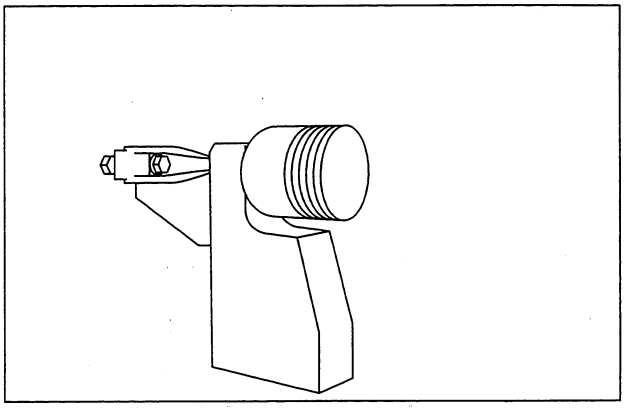
■Installation

When reassembling the piston and connecting rod and installing the piston-and-rod assemblies in the cylinder block, pay attention to the following :

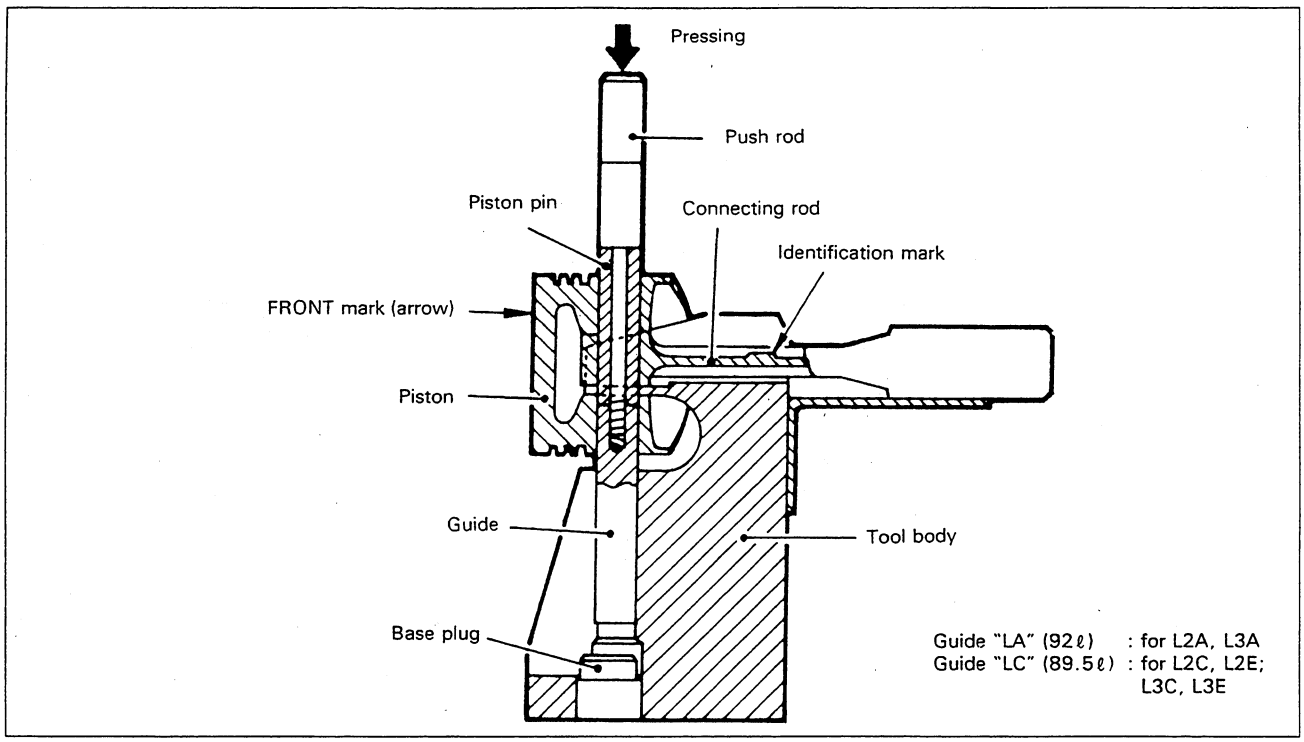
(1) Reassembling the piston and connecting rod

Using the Piston Pin Setting Tool, press the piston pin in to the set position.

Description	Standard
Pin press-fitting force (at a normal temperature)	1000±500kg

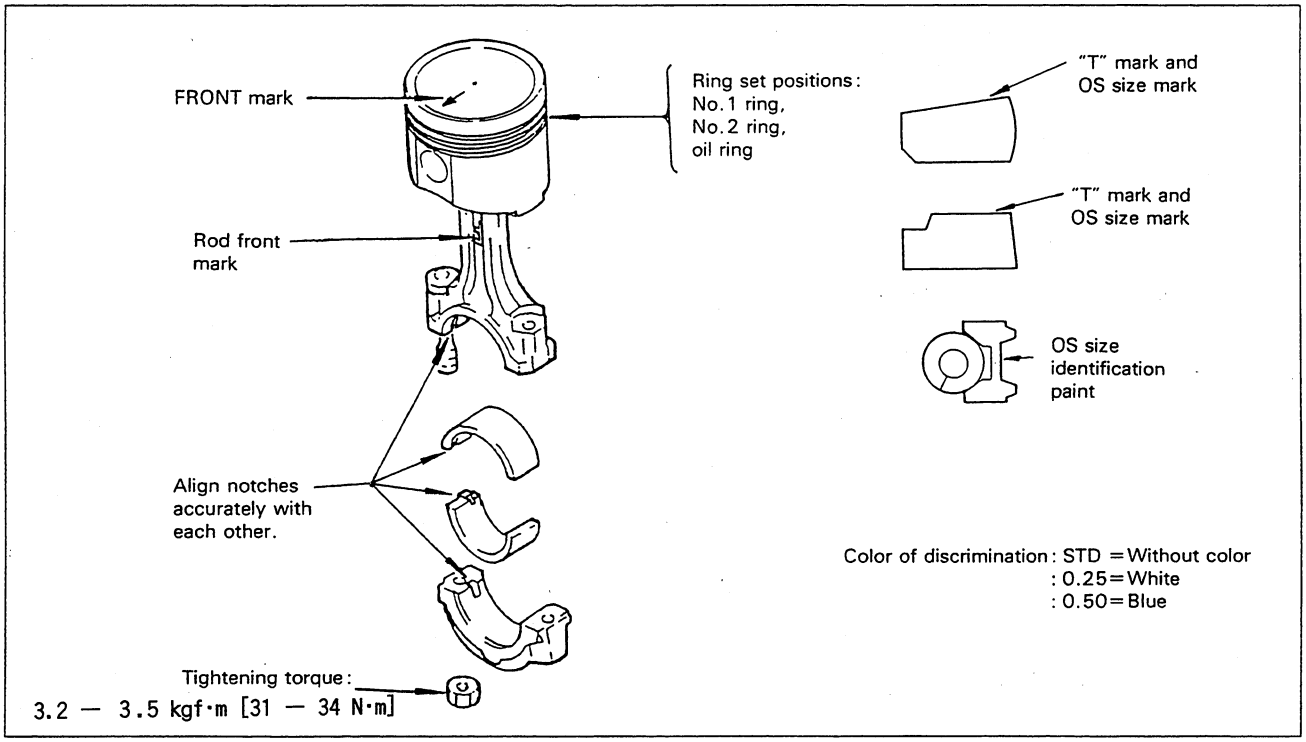


Installation of Piston and Connecting Rod



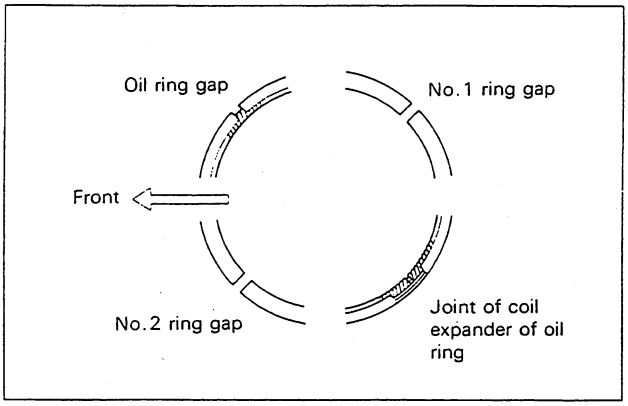
Pressing in Piston Pin

(2) Installation of piston rings



Installation of Piston Rings and Connecting Rod Cap

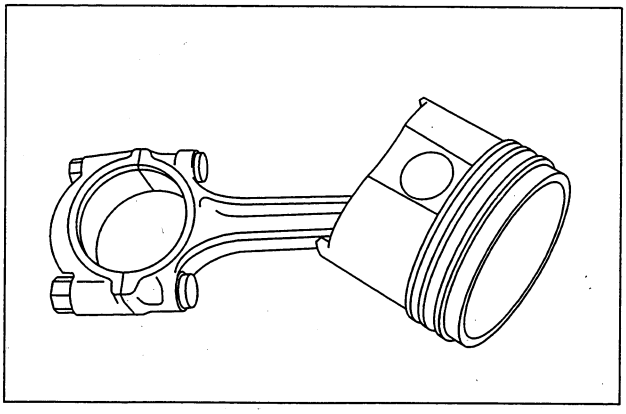
(3) Set the piston ring gaps to the proper positions as shown in the figure at right. Coat the rings and cylinder wall with oil.



Proper Arrangement of Ring Gaps

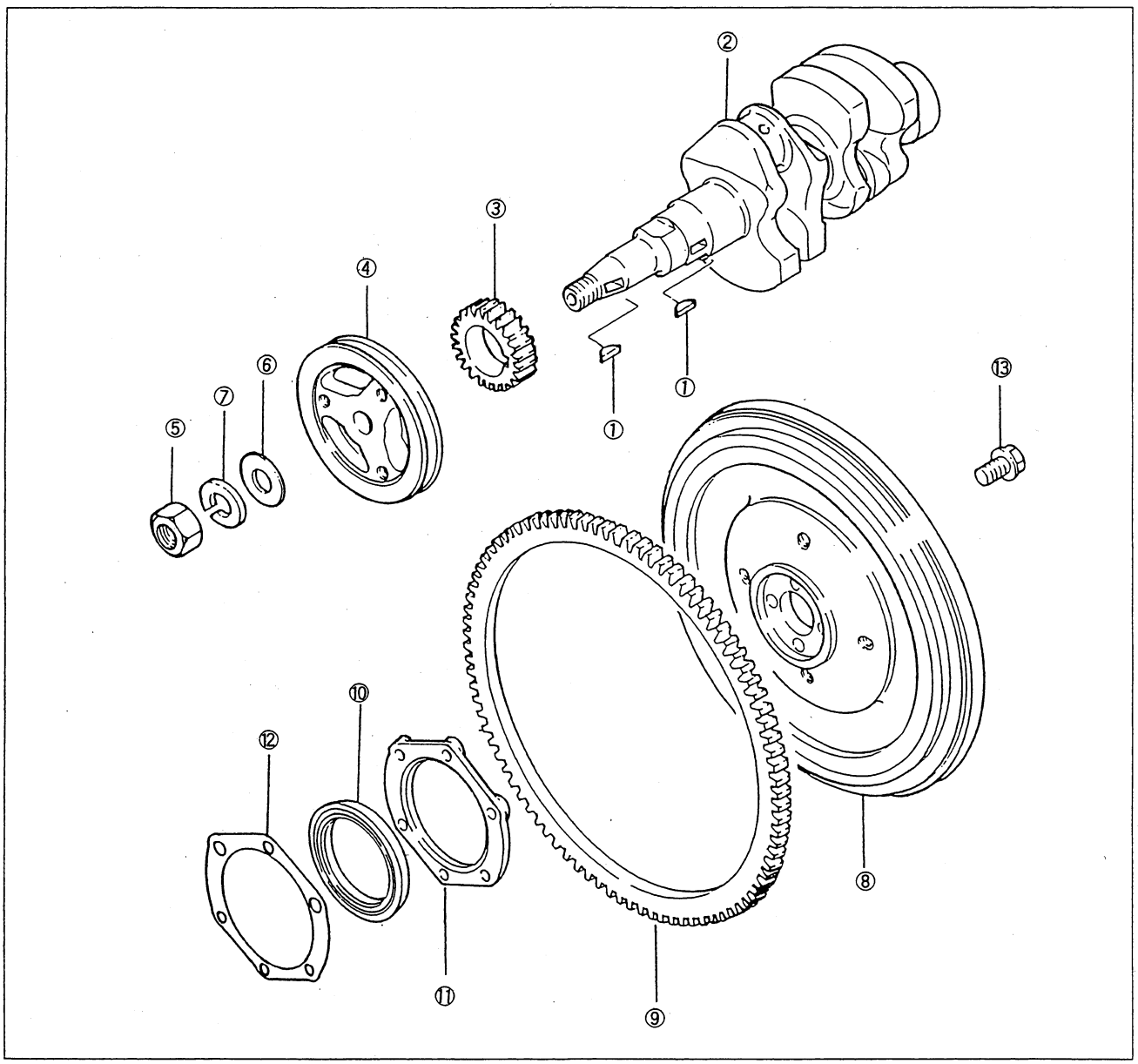
(4) Using a piston-ring compressor to compress the rings into the grooves, push the piston-and-rod assembly down into the cylinder. Be careful not to break the rings by excessively knocking the head of piston. Note that the front marks on the piston and connecting rod are toward the engine front.

(5) Coat the bearing surface of the connecting rod caps with engine oil. Fit each cap to the connecting rod using match marks put before removal as a guide. In the case of a new rod which does not such a match mark, position the notches (provided for preventing the bearing from rotating) on the same side.



Fitting Cap to Connecting Rod

■Construction

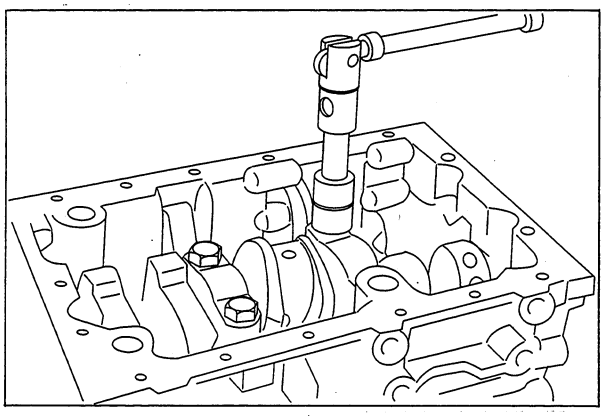


Crankshaft Component Parts

① Key
② Crankshaft
③ Crankshaft gear
④ Crankshaft pulley
⑤ Nut
⑥ Washer
⑦ Spring washer
⑧ Flywheel
⑨ Ring gear
⑩ Rear oil seal
⑪ Rear oil seal case
⑫ Gasket
⑬ Flywheel bolt

■Removal

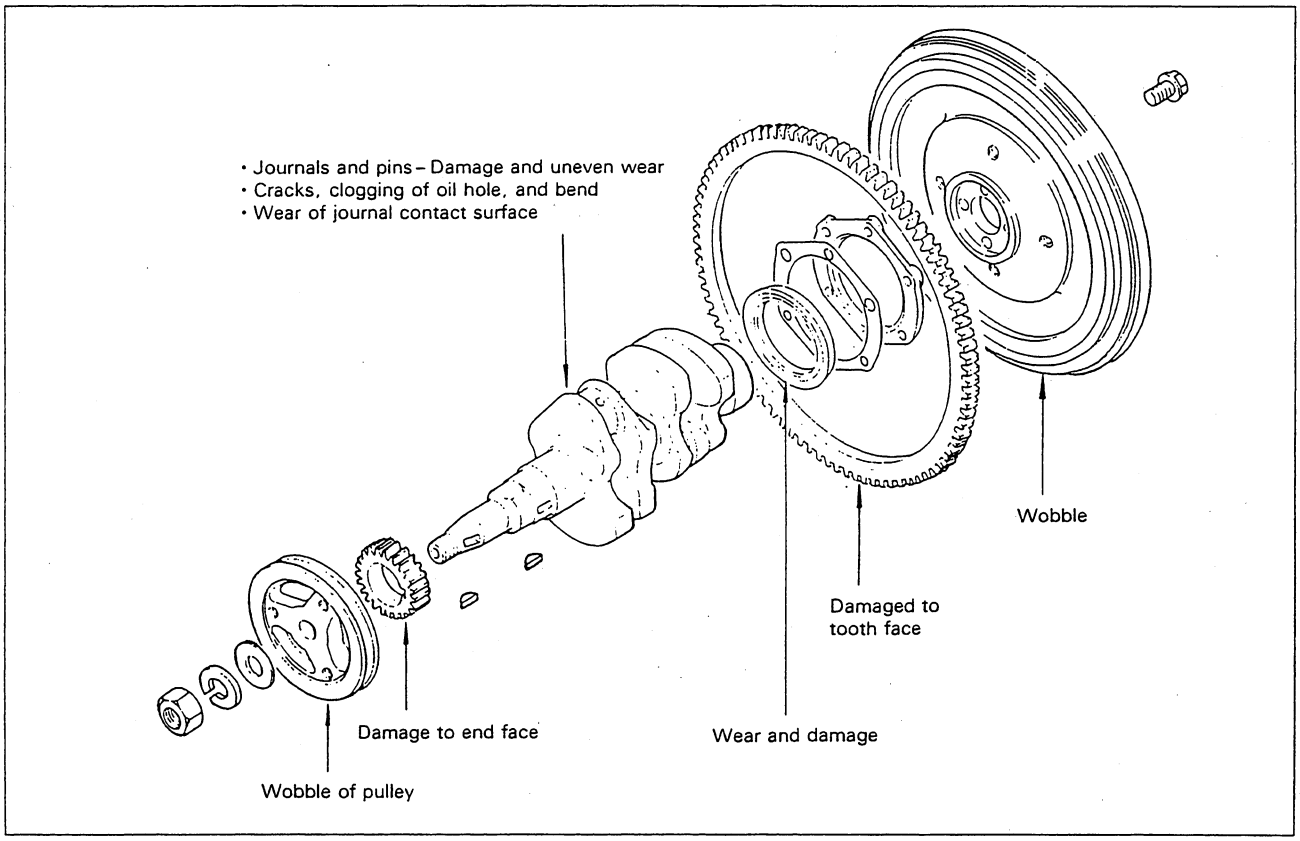
(1) Loosen the flywheel bolts and remove the flywheel.
(2) Loosen the crankshaft pulley nut and remove the pulley.
(3) Remove the rear oil seal case assembly.
(4) Remove the main bearing caps. Keep each set of bearings removed together with its bearing cap.
(5) Take out the crankshaft.



Removing Main Bearing Cap

■Inspection

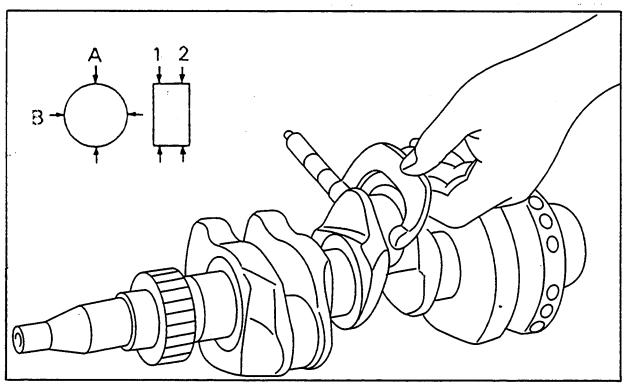
Inspect the removed parts. If any parts are found defective, repair or replace them.



Inspection of Crankshaft and Flywheel

I. Checking the crankshaft for wear

To check the crankpins and main journals for tapering wear and out-of-round wear, diameter of each crankpin or main journal should be measured at two places along the crankpin or main journal, in two directions " A" and " B" each place, as shown in the figure at right. If necessary, regrind the crankpins and main journals to the next under size. If any crankpin or main journal has been worn out beyond the service limit, replace the crankshaft.



Checking Crankshaft for Wear

Diameter of crankpin and main journal (mm)		
Description	Standard	Service limit
Main journal dia.	43	−0.70
Crankpin dia.	40	−0.70

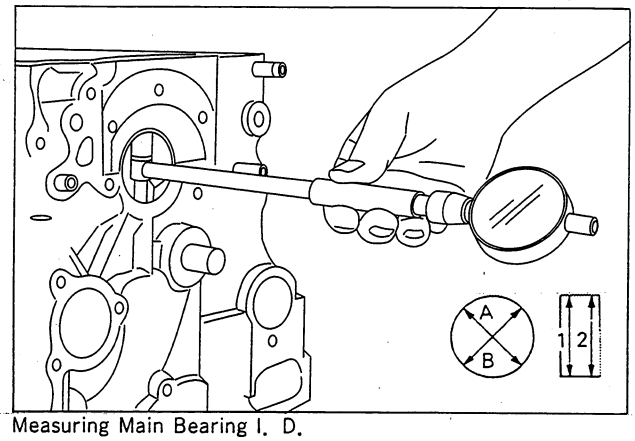
Under-size diameters (mm)		
Description	Main journal	Crankpin
0.25 US	42.715～42.730	39.715～39.730
0.50 US	42.465～42.480	39.465～39.480

2. Inspection of crankshaft oil clearance

Oil clearance is calculated by subtracting the diameter of main journal or crankpin from the inside diameter of main bearing or rod bearing.

To check the main bearings and rod bearings for tapering wear and out-of-round wear, inside diameter of each main bearing or rod bearing should be measured, after its bearing-cap is fastened to the specified torque, at two places along the bearing, in two directions " A" and " B" each place, as shown in the figure at right.

If necessary, replace the worn bearing with new one. If oil clearance still exceeds the service limit, regrind the crankshaft to the next under size and replace the bearing with one of the corresponding under size.



Measuring Main Bearing I. D.

Caution

- **A crankshaft which has been sized cannot be re-ground to any under size.**

Tightening torque kgf·m [N·m]	
Description	Standard
Main bearing cap bolt	5.0 – 5.5[49 – 54]
Rod bearing cap nut	3.2 – 3.5[31 – 34]

Oil clearance (mm)	
Description	Service limit
Main bearing	0.10
Rod bearing	0.15

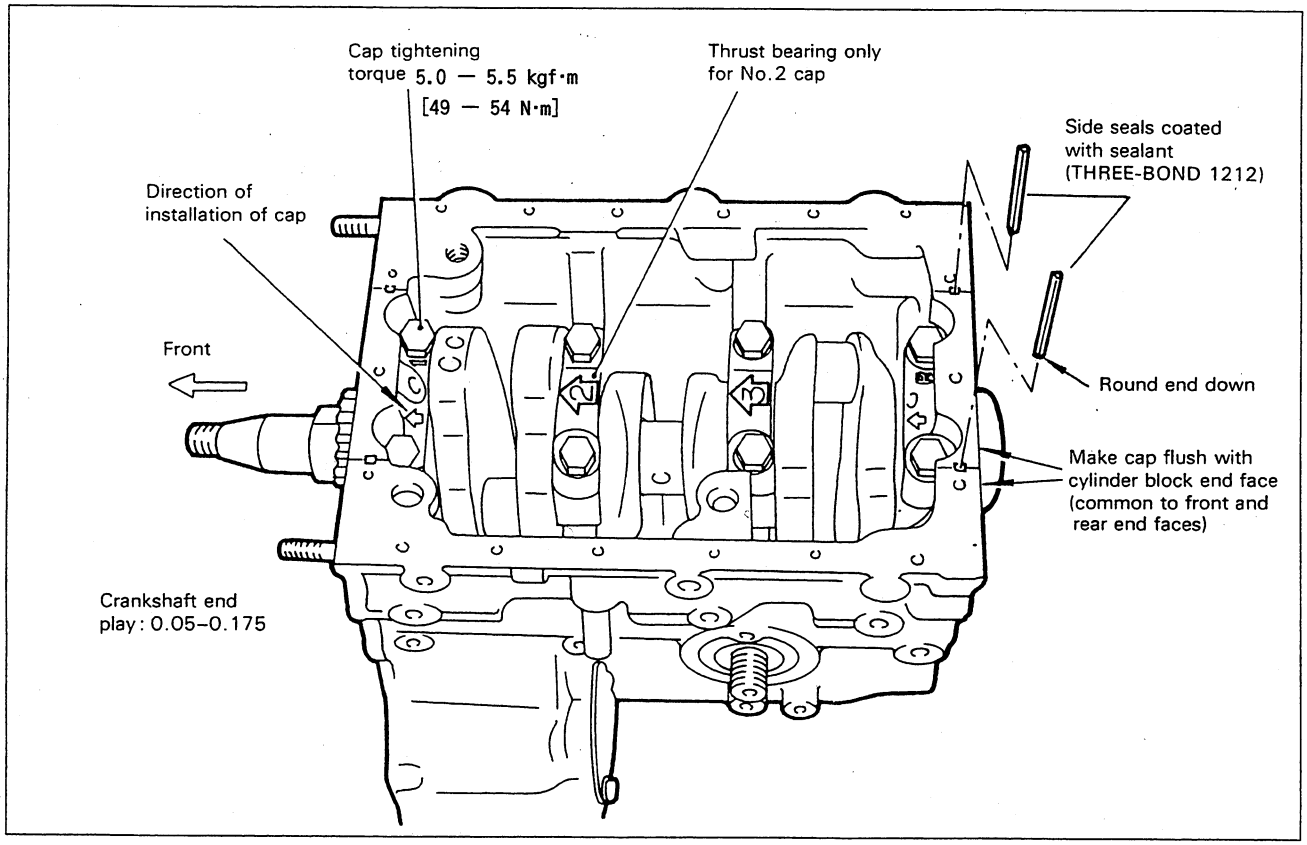
■Replacement of Crankshaft Rear Oil Seal

(1) Pry the oil seal out with a screwdriver.

(2) Drive in a new oil seal to the oil seal case.

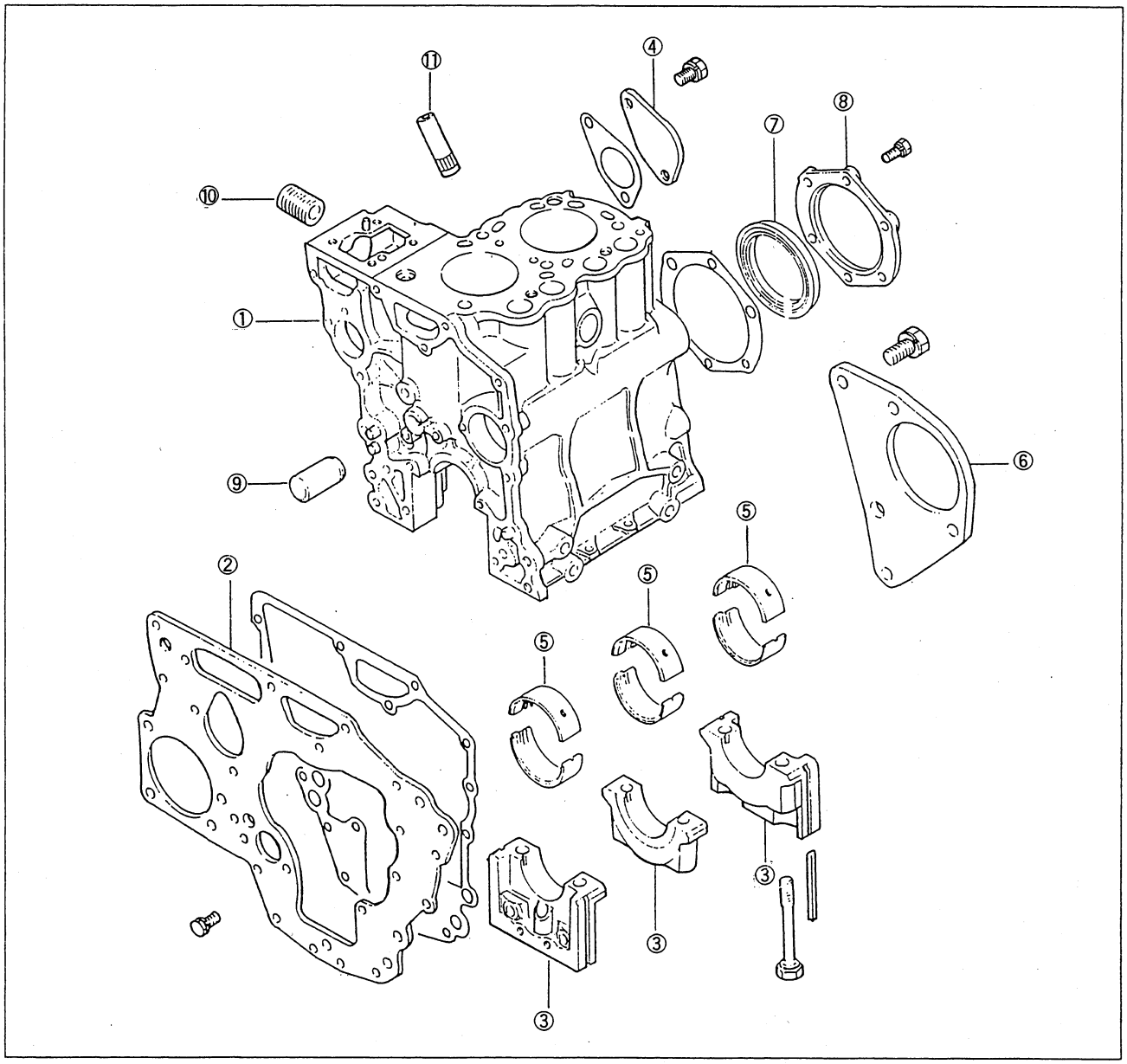
■Installation

When installing the crankshaft, pay attention to the notes given in the figure below.



Installation of Crankshaft

■Construction



Cylinder Block Component Parts

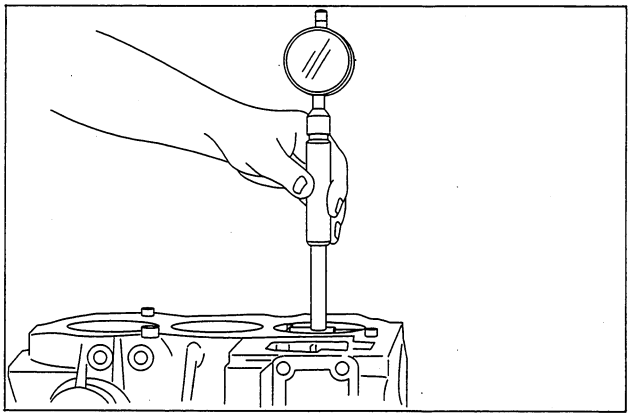
① Cylinder block
② Front plate
③ Bearing cap
④ Cover
⑤ Main bearing
⑥ Starter bracket
⑦ Rear oil seal
⑧ Oil seal case
⑨ Idler gear shaft
⑩ Oil filter shaft
⑪ Oil level gauge guide

1-11 CYLINDER BLOCK

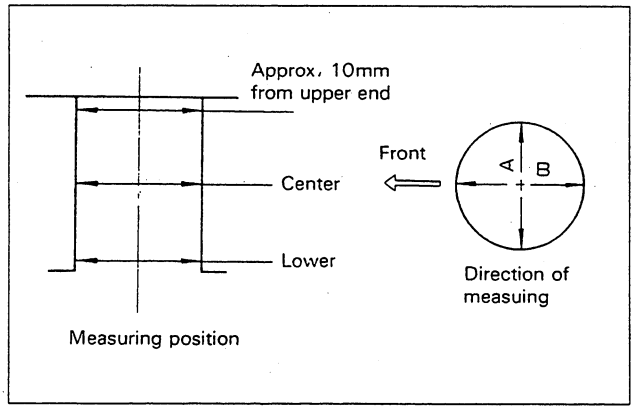
■Inspection

Inspect the cylinder block. If it is found defective, repair or replace the block.

Cylinder bore (mm)		
Model	Standard	Service limit
L2A, L3A	$65^{+0.03}_{0}$	+0.2
L2C, L3C	$70^{+0.03}_{0}$	+0.2
L2E, L3E	$76^{+0.03}_{0}$	+0.2



Measuring Cylinder Bore



Cylinder Bore Measuring Positions

■Reboring of Cylinder

When reboring a cylinder, use the following procedure :

(1) Selecting a piston
Piston service size
0.25 OS or 0.50 OS

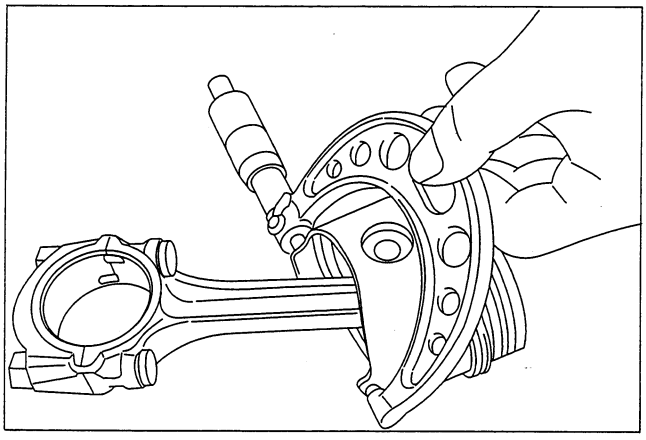
(2) Measuring the piston diameter

(3) Reboring finish dimension =
〔Piston OD〕 + 〔Clearance〕 − 〔Honing allowance (0.02 mm)〕

- Clearance (between piston and cylinder)
Standard : 0.071～0.084mm (A～D)

Caution

- **When it is necessary for a cylinder to be rebored to the next over size, the remainders must also be rebored to the same over size.**



Measuring Piston Diameter

Group 2	LUBRICATING SYSTEM	

■Specifications

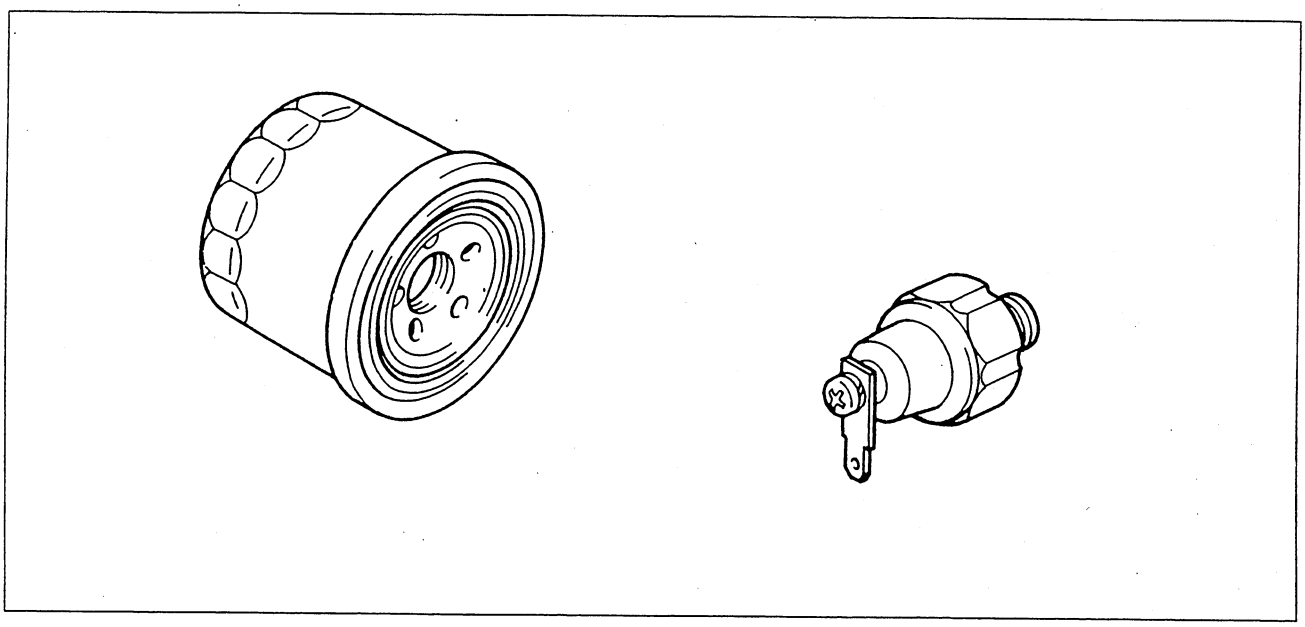
Description		Specification	
Lubricating system and filtering system		Pressure-feed lubricating, full-flow filtering	
Oil capacity (Upper limit/lower limit) : excluding 0.5 for oil filter		L2 : 2.4/1.4 ℓ	L3 : 3.0/1.5 ℓ or 3.6 ℓ/1.8 ℓ 4.8/3.0 ℓ
Oil pump	Type	Gear type (Inner and outer gears in mesh) enclosed in gear case	
	Driving method	Direct drive by crankshaft	
Relief valve opening pressure		3.0±0.3 kgf/cm² [0.3±0.03 MPa] / 1000 rpm	
Oil pressure switch closing pressure		0.5±0.1 kgf/cm² [0.05±0.01 MPa]	
Oil filter	Type	Paper-element cartridge type	
	Relief valve opening pressure	1.0±0.2 kgf/cm² [0.1±0.02 MPa]	

For the oil pump, which is enclosed in the gear case, see Group 1 ENGINE PROPER.

■Special Tools

Use	Tool name
Removal and installation of oil pressure switch	Oil pressure switch wrench MD998054

■Construction



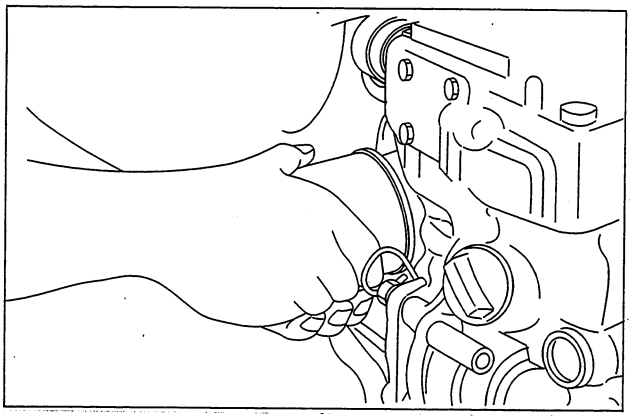
Oil Filter and Pressure Switch
① Oil filter
② Oil pressure switch

■Removal and Installation

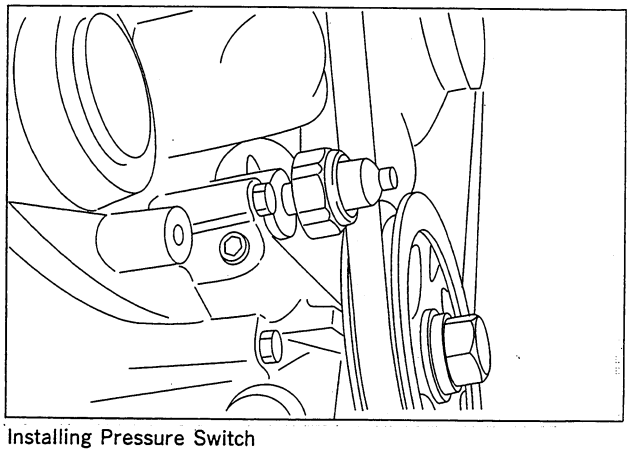
(1) Coat the O-rings witch engine oil.
Take care not to twist the O-rings.
(2) Coat the threads with sealant (HERMESEAL H1 or THREEBOND 1314).
(3) Tightening torque : 1.1 — 1.3 kgf·m
[10.8 — 12.7 N·m] (Do not use any wrench.)

Caution

- **After installation, check for oil leak while the engine is running.**



Installing Oil Filter



Installing Pressure Switch

2-02 OIL FILTER AND OIL PRESSURE SWITCH

■Inspection

Inspect the following :

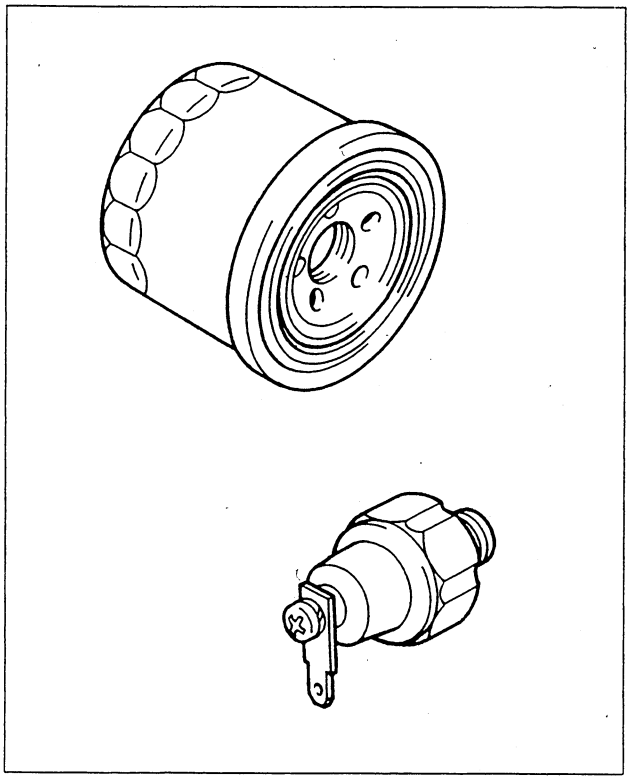
(1) Oil leak

Pressure switch ON pressure :

0.5±0.1 kgf/cm² [0.05±0.01 MPa]

Caution

- **Check the oil filter for dirtiness. If necessary, clean the engine interior with flushing oil.**



Inspecting Oil Filter and Switch

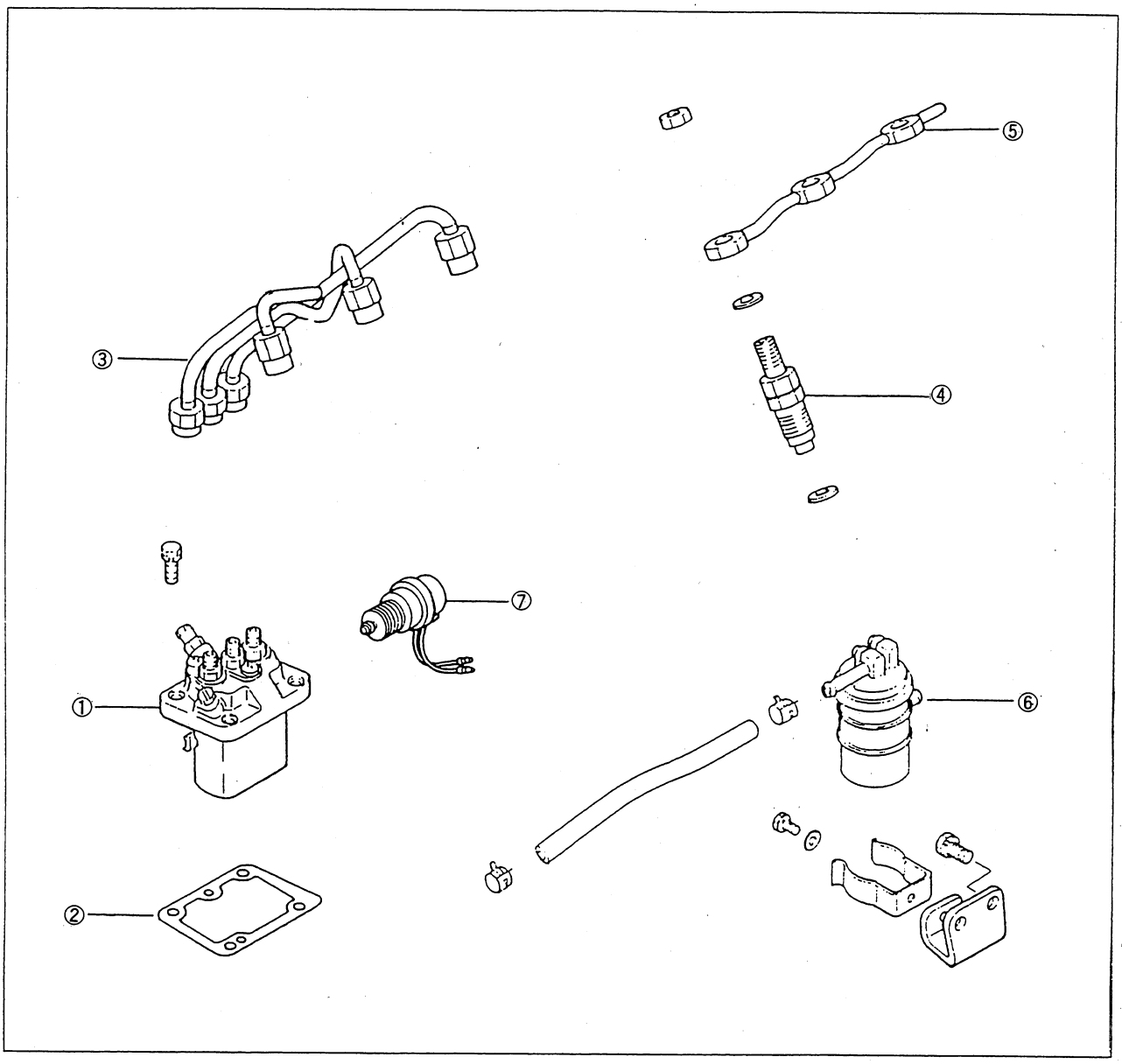
Group 3	FUEL SYSTEM	

■Specifications

Description			Specification	
			L2	L3
Injection pump	Type		In-line type (Bosch NC)	
	Direction of rotation		Clockwise (as viewed from driving side)	
	Injection order		1−2	1−3−2
	Injection timing		See page 141	
	Plunger diameter		6φ	
	Number of plungers		2	3
	MS retard		4° (for crank)	
	Delivery valve		Silt or Bosch	
Injection nozzle	Type		Thread type	
	Nozzle	Type	Throttle type	
		Number of jet	1	
	Injection pressure		140^{+10}_{-0} kgf/cm² [$13.7^{+1.0}_{-0}$ MPa]	
Fuel pump (optional)	Type		Electromagnetic diaphragm type	
	Delivery		0.37 ℓ/min (12 V, at 20°C)	
	Type		Electromagnetic plunger type	
	Delivery : Common type		0.9 ℓ/ (12 V, at 20°C)	
	: Compact type		0.4 ℓ/min (12 V, at 20°C)	
	Type		Mechanical drive type	
	Delively		0.225 ℓ/min	
※1 Fuel cutoff valve	Type		Solenoid pull hold type	
	Rated current pull		5.5 A	
		Hold	1.0 A	
	Working voltage		12 V, DC	
	Stroke		13.5 mm	
	Type		Solenoid, push out type	
	Coil resistance		1.6 Ω±10% (at 20°C)	
	stroke		10 mm	
Fuel filter			Paper-element type	

※1 : See 7-03

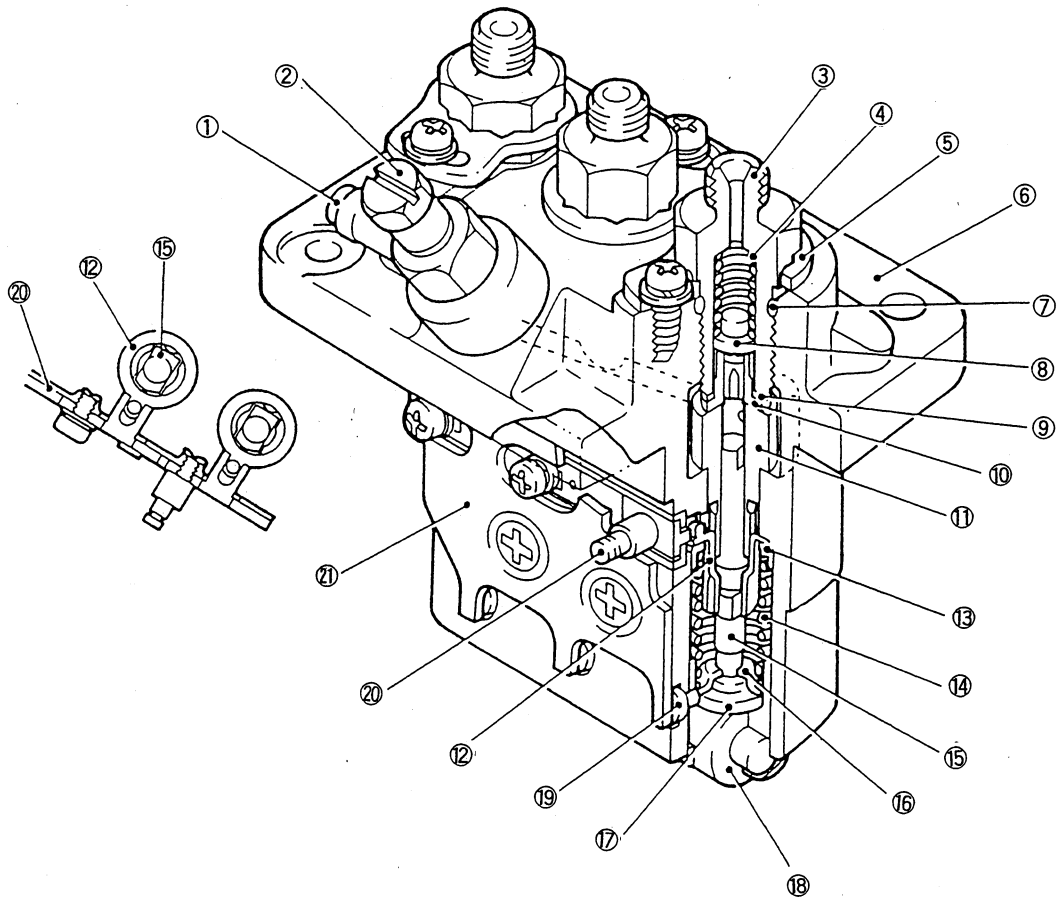
■Component parts



Fuel System Component Parts

① Injection pump
② Adjustment shim
③ Injection pipe
④ Injection nozzle
⑤ Return pipe
⑥ Fuel filter
⑦ Fuel cutoff solenoid

■Construction



Injection Pump Component Parts

① Union collar	⑧ Delivery valve	⑮ Plunger
② Air vent screw	⑨ Gasket	⑯ Lower seat
③ Delivery valve holder	⑩ Seat valve	⑰ Adjusting shim
④ Valve spring	⑪ Plunger barrel	⑱ Tappet roller
⑤ Holder stopper	⑫ Sleeve	⑲ Pin
⑥ Housing	⑬ Upper seat	⑳ Control rack
⑦ O-ring	⑭ Plunger spring	㉑ Stop wire bracket

■Inspecting the injection pump while it is mounted on the engine

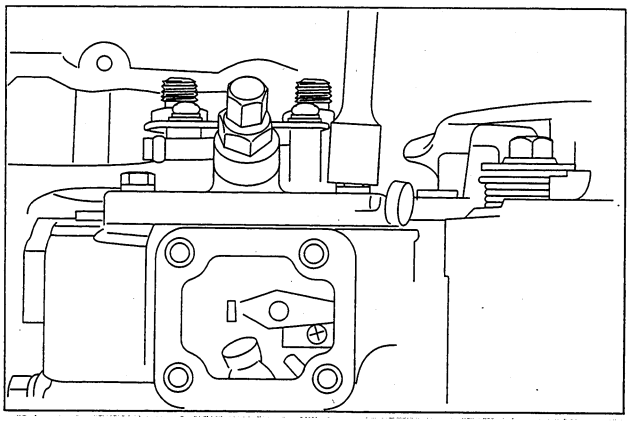
Never attempt to disassemble the pump unless it is necessary.

If the pump is assumed defective, it is recommended to replace the pump assembly.

Inspection	Inspection procedure	Criterial
Idling speed	Measure engine speed.	900^{+50}_{0}rpm
Exhaust smoke color	1) Quickly accelerate engine without load. 2) Apply load to engine	No remarkably black-smoke exhaust permitted.
Fuel cut-off solenoid	Turn ignition switch to OFF from ON.	A solenoid acting sound.

■Removal

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



Removing Injection Pump

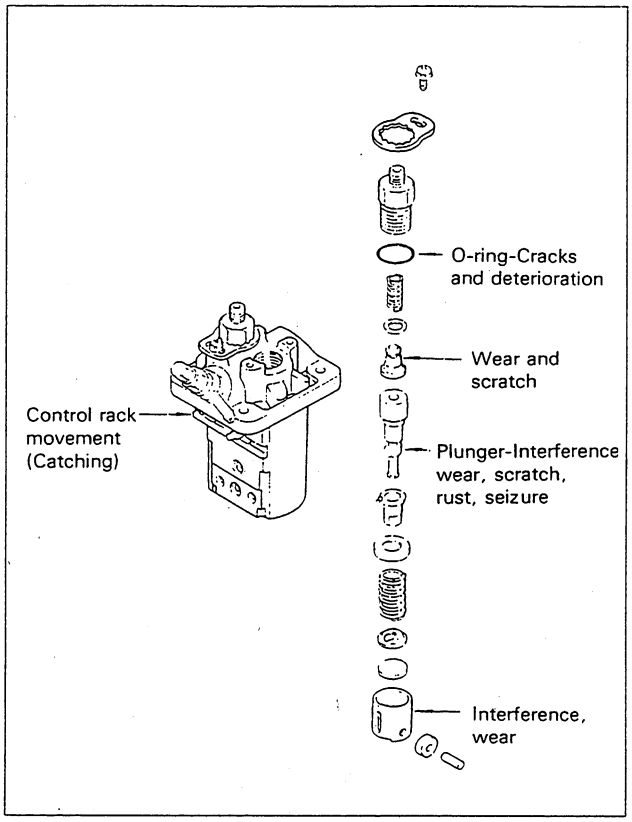
■Disassembly

(1) Remove the stopper plate.
(2) Unscrew the delivery holder. Take out the delivery valve and valve spring.
(3) Remove the tappet roller and stopper pin.
(4) Remove the tappet, plunger spring, etc.

Caution

1. **When replacing the plunger barrel, delivery valve, etc., do not loosen the adjusting screw and plate for each cylinder.**
2. **When those parts have been replaced, it is necessary to measure fuel injection quantity by using the pump tester and cam box.**
3. **All parts removed from the pump should be kept classified by cylinders and immersed in clean fuel.**

■Inspection



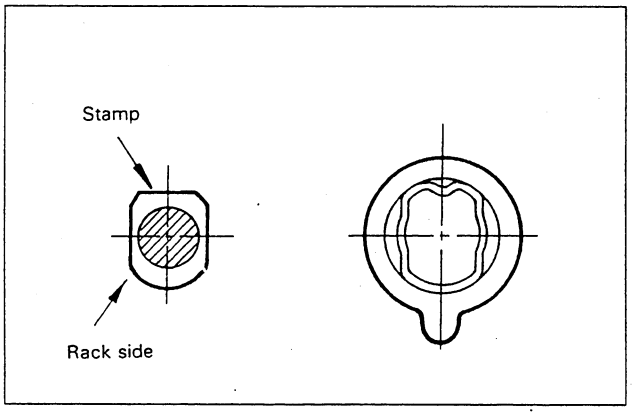
Inspection of Injection Pump

■Assembly

(1) Insert the plunger barrel into the housing.
(2) Install the delivery valve and valve spring. Temporarily tighten the holder.
(3) Insert the control rack.
(4) Insert the control pinion. Align the matchmark on the rack with that on the pinion.
(5) Install the spring upper seat.
(6) Insert the plunger spring.
(7) Fit the lower seat to the plunger. Insert the plunger into the barrel side.
(8) Depress the tappet roller assembly and install the stopper pin.
(9) Tighten the delivery holder.
tightening torque : 3.5 — 3.9 kgm

■Installation

Install the injection pump assembly in the reverse order of removal.

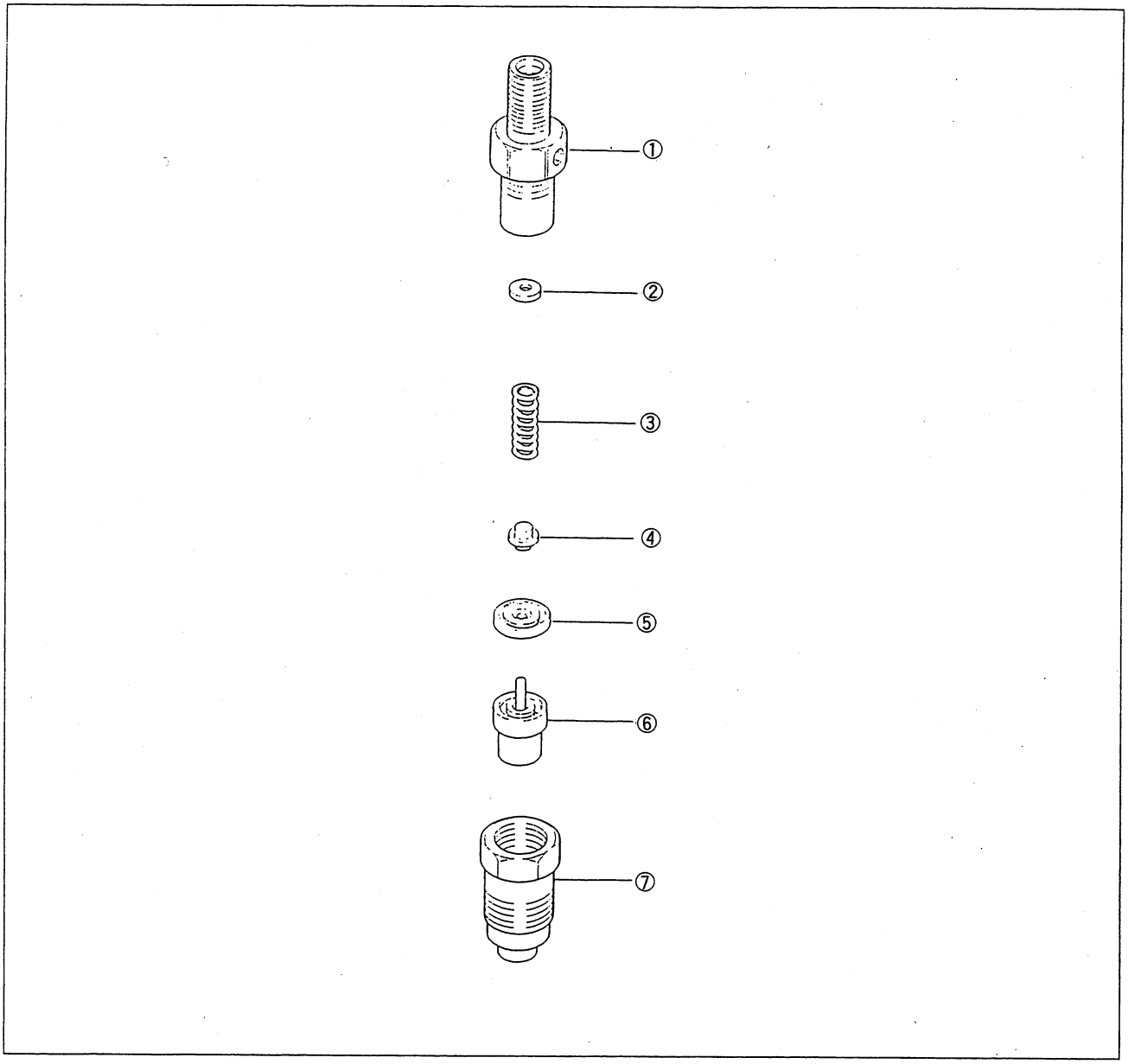


Direction of Installation of Plunger

Caution

- **When installing the plunger barrel, engage the dowel pin on the housing side with the groove in the barrel.**
- **Position the plunger so that the part-number stamp on its flange faces the direction opposite to the rack side. (Engage the feed hole with the plunger lead.)**
- **After installation, check for proper injection timing.**

■Construction



Nozzle Holder Ass'y Component Parts

① Body sub-assembly
② Shim washer
③ Pressure spring
④ Pin
⑤ Distance piece
⑥ Nozzle assembly
⑦ Retaining nut

3-03 INJECTION NOZZLE

■Removal

(1) Disconnect the injection pipe and fuel return pipe.

(2) Remove the injection nozzle assembly from the cylinder head.

Caution

- **Attach an identification-number tag to the removed injection nozzle.**
- **Plug the openings, from which the pipes are disconnected and the nozzle is removed, to prevent intrusion of dust, water, and other foreign particles into the pipes and combustion chamber.**

■Disassembly

If the removed nozzle assembly is assumed defective, disassemble the assembly and repair or replace the faulty parts.

(1) Grip the nozzle holder body in a vise. Loosen the retaining nut. Never vise the retaining nut to prevent deformation.

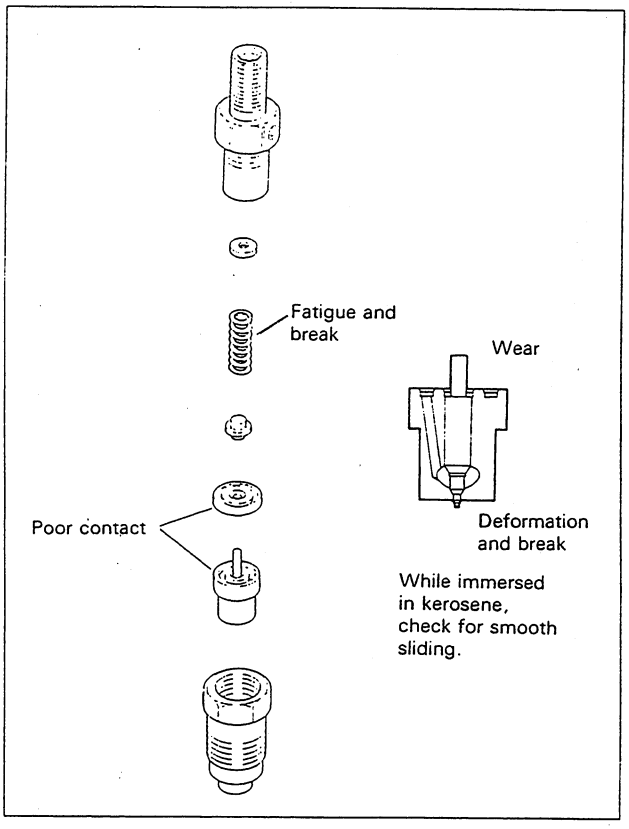
(2) Take out the shim washer, pressure spring, distance piece, and nozzle assembly.

Caution

- **Scrape off carbon deposite with a wooden spatula. Keep the removed parts immersed in washing oil (kerosene). Take special care not to scratch the needle valve in the nozzle assembly.**

■Inspection

Inspect the removed parts. If any part is found defective, replace it.



Inspecting Nozzle

■Assembly

(1) Insert the nozzle assembly into the retaining nut so that the nozzle is perfectly seated in the nut.
(2) Place the distance piece, retaining pin, pressure spring, and shim washer on the nozzle assembly.
(3) Tighten the nozzle holder body fully by hand.
(4) Grip the nozzle holder in a vise. Tighten the retaining nut to the specified torque.
(Tightening torque : 3.5 — 4.0 kgf·m [34 — 39 N·m]

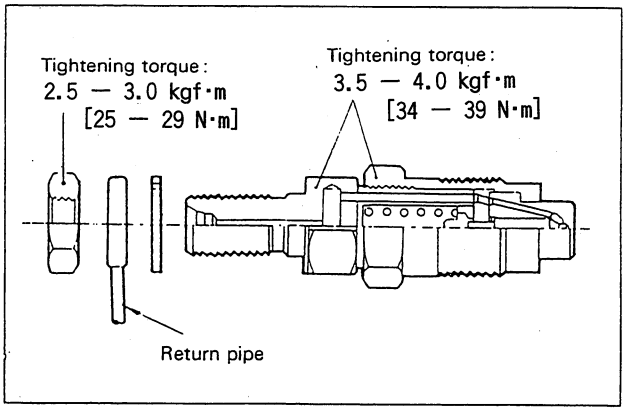
■Adjustment

Adjust injection start pressure by increasing or decreasing the thickness of shim washer to be inserted.

Varying shim thickness by 0.1 mm causes injection start pressure to change 10 kg/cm.

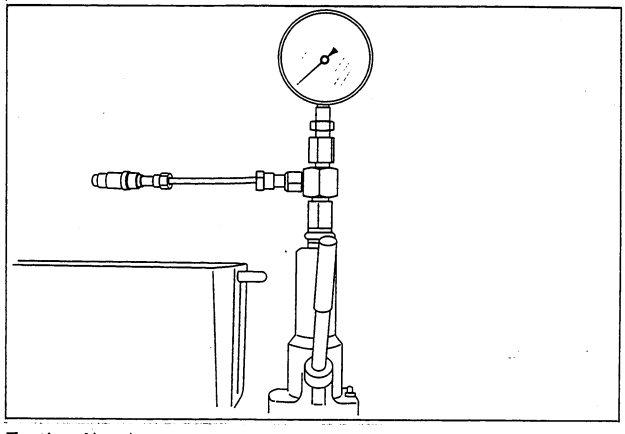
Available shims :

10 kinds of shims available from 1.25 mm to 1.7 mm in thickness, 0.05 mm step.



Assembling the Nozzle

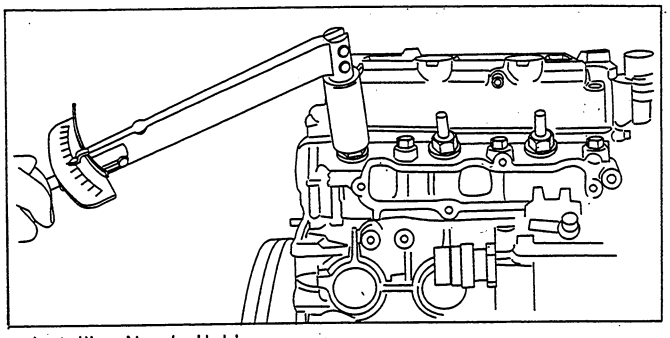
Injection start pressure	
Standard	140^{+1}_{0} kgf/cm² [$13.7^{+1.0}_{0}$ MPa]
Allowable limit	130 kgf/cm² [12.7 MPa] or less



Testing Nozzle

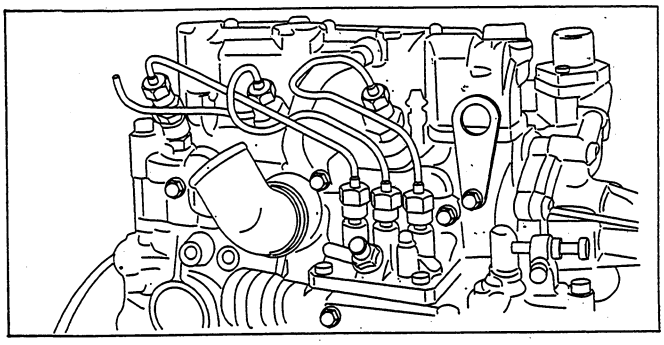
■Installation

(1) Clean the nozzle holder fitting surface of the cylinder head. Install the nozzle holder with a gasket interposed.
Tightening torque : 5.0 — 6.0 kgf·m [49 — 59 N·m]

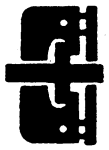


Installing Nozzle Holder

(2) Connect the fuel return pipe and injection pipe.
Tightening torque :
Injection pipe 2.5 — 3.5 kgf·m [25 — 34 N·m]
Fuel return pipe 2.5 — 3.0 kgf·m [25 — 29 N·m]



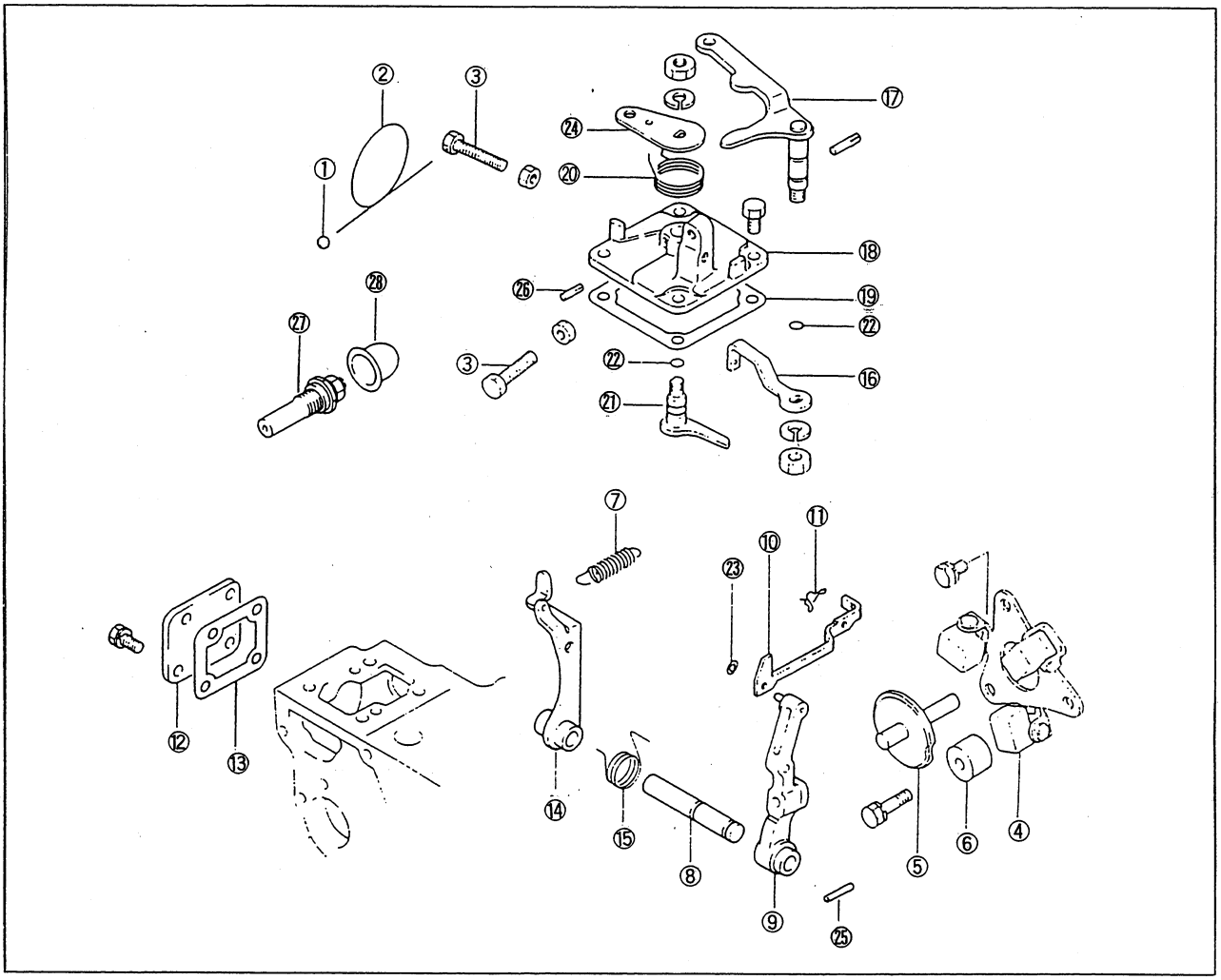
Installing Injection Pipe

Group 4	GOVERNOR SYSTEM	

■Specification

Governor type	Centrifugal flyweight type

■Construction



Governor System Component Parts

① Sealing metal
② Sealing wire
③ Low- and high-speed
④ Governor spring
⑤ Sliding shaft
⑥ Stopper
⑦ Governor spring
⑧ Governor shaft
⑨ Governor lever
⑩ Tie-rod
⑪ Tie-rod clip
⑫ Tie-rod cover
⑬ tie-rod cover gasket
⑭ Tension lever
⑮ Start spring
⑯ Governor spring lever
⑰ Speed control lever assembly
⑱ Cover assembly
⑲ Governor cover gasket
⑳ Return spring
㉑ Stop lever assembly
㉒ O-ring
㉓ Snap ring
㉔ Stop lever
㉕ Grooved pin (3 x 20)
㉖ Grooved pin (3 x 14)
㉗ Torque spring set
㉘ Sealing cap

■Installation of Torque Spring Set

Install and adjust the torque spring set using the following procedure :

(1) Set the speed control lever to the high-idling speed position by adjusting the high-speed set bolt.

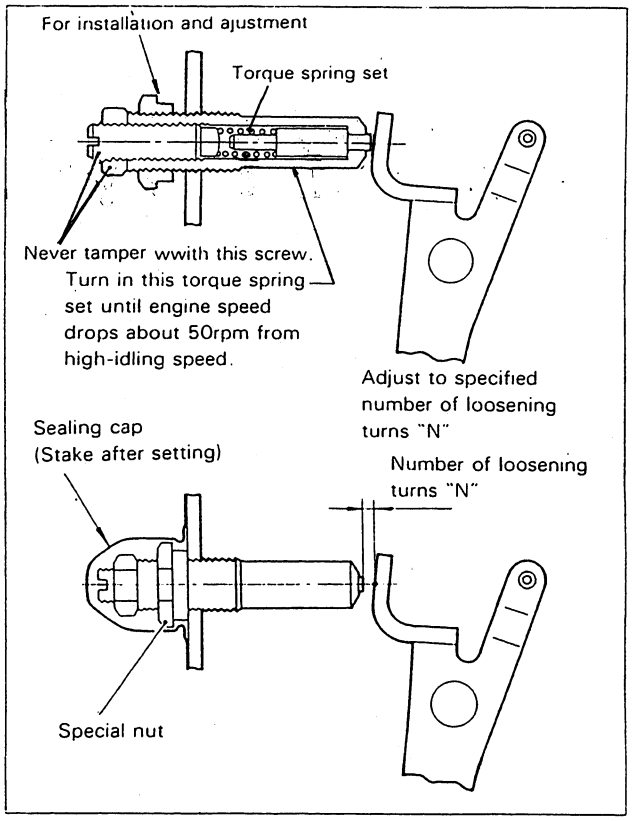
(2) Turn in the torque spring set until engine speed drops about 50 rpm from high-idling speed.

(3) From this position, turn back the torque spring set by the specified number of turns (N.) Lock the torque spring set at that position with the special nut.

(4) Install the torque spring set sealing cap and stake the cap to prevent loosening.

Cauthion

There are two types of torque spring set : The single spring type and the double-spling type. Since each torque spring set has been abjusted precisely during asembly, do not tamper with the abjust screw unless it is necessary.

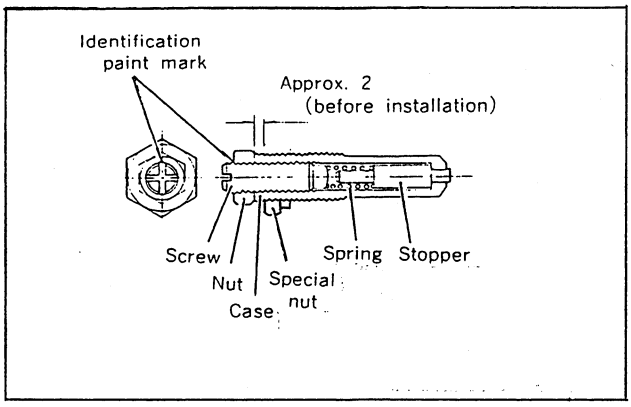


Torque spring set

Model	Number of loosening turns (N)
L2A-62A, L2A-62DA, L2A-61DM	2.1
L3C-63WM	2.2
L2E-61IR, L3C-61ES	2.3
L2A-61A, L2A-61RR, L2A-62SS, L2A-61SS, L2A-62SDG, L2A-61DA, L2C-62A, L2E-62WM, L3A-61A, L3A-62A, L3A-61RG, L3C-61A, L3C-62A, L3C-61DA	2.4
L2C-61A, L2C-61CV, L2E-61SC, L2E-61SDG, L2E-61GS, L2E-61SD, L3A-61TG, L3A-61ES, L3C-61TG, L3C-62DA, L3C2-62TG, L3E-61TG, L3E-61RG	2.5
L2E-61TM, L2E-62A, L2E-62DA, L2E-61ES, L2E-62PL, L2E-61DM, L3E-61A, L3E-61SS, L3E-61SA, L3E-61DS, L3E-61HMG, L3E-61SHS, L3E-61LS, L3E-61KG, L3E2-62TG	2.6
L2E-61WM, L2E-61DA, L3C-63WMA, L3E-61TM, L3E-62A, L3E-62DA, L3E-62WM, L3E-62SS, L3E-61SC	2.7
L2E-61HMG, L2E-61A, L2E-62SS, L2E-61SS, L2E-62SDG, L2E-61SA, L2E-62ES, L2E-61SHG, L2E-61SDH, L3E-61DA, L3E-61KL	2.8
L2E-61WH, L3A-61WM, L3E-61SDH, L3E2-63ESA	2.9
L3E-31NSA	3.8
L3E-61SD	3.3
L3E2-61ES, L3E2-62ES, L3E2-63ES	3.0

■Assembling the Torque Spring Set

When the torque spring set has been disassembled or its component parts have been replaced, reassemble and adjust the torque spring set using the following procedure :



Assembling torque spring set

Single spring type

When installing the single-spring type torque spring set, use the following steps.

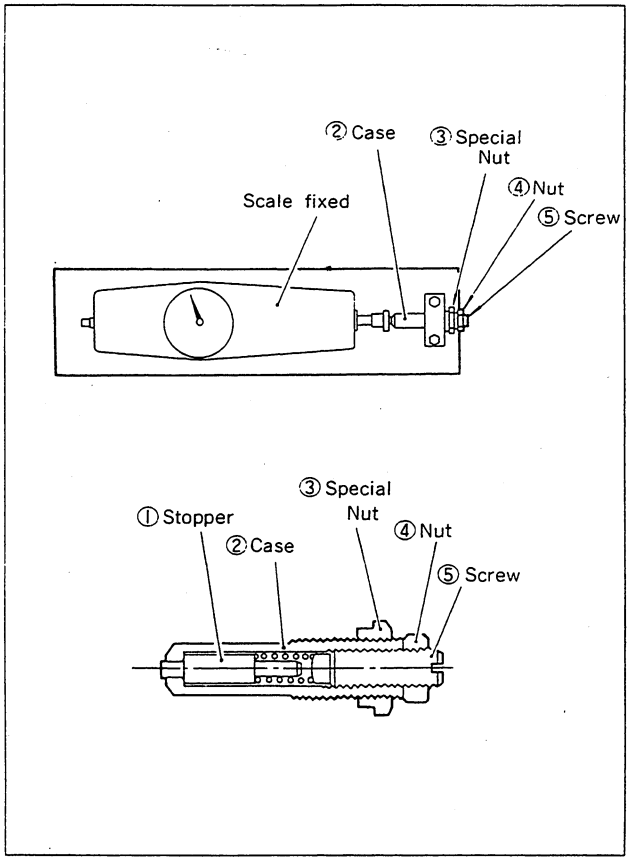
(1) Lightly turn in abjust screw ⑤ (with a screwdriver operated by fingertips) until a resistance to screw rotation is felt. Lightly lock the screw at that position with locknut ④.

(2) Set the scale to the zero-point. Turn in the spring case ② until the value of load "A" shown in table below can be attained. Lock the spring case at that position with special nut ③.

(3) Temporarily loosen abjust screw ⑤ until the value of load "A" is reduced by about 200 grams, and then retighten the screw until the value of "B" is tattained. Lock the screw at that position with locknut ④.

Adjust screw tightening torque : 0.8 to 1.2 kg.

(4) To inspect the torque spring set for ploperly abjusted spring load, use a testing arrangement such as shown in the figure at right. Gradually push the scale against the torque spring set until the stopper ① is moved (or the pointer of dial gauge deflects). Check that the load applied to the torque spring at that moment coincides with the value of load "C".



Setting of Torque Spring

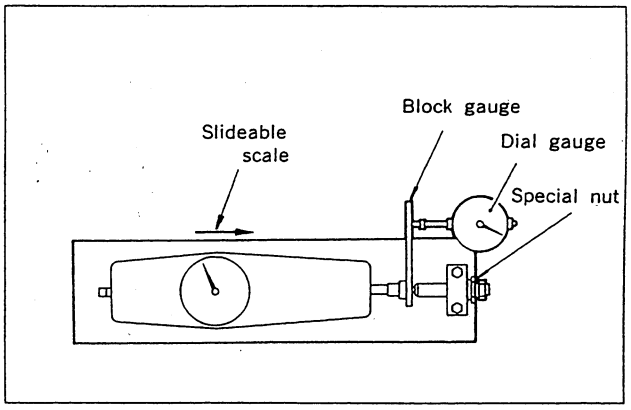
Model	A(g)	B(g)	C(g)	Identification color
L3A-61TG, L3A-61ES, L3C-61DA, L3C-61ES L3E-61DA, L3E-31NSA, L3E2-61ES, L3E2-62ES, L3E2-63ES, L2E-61GS, L3E2-63ESA, L2A-61DA, L2E-61ES, L2E-61DA,	570^{+10}_{0}	570^{+10}_{0}	550^{+20}_{-30}	Green
L2E-62PL	1520^{+10}_{0}	1520^{0}_{-10}	1500^{+20}_{-30}	Red
L3E-61TG, L3A-61A, L3C-61A, L3C-61TG, L3E-61A, L3E-61SC, L3E-61SA, L3E-61DS, L3E-61SHS, L3E-61LS, L3E-61KL, L2A-61A, L2C-61A, L2C-61CV, L2E-61A, L2E-61SC, L2E-61SA, L2E-61WH, L2E-61HMG, L2E-61IR	970^{+10}_{0}	970^{0}_{-10}	950^{+20}_{-30}	Yellow
L3C2-62TG, L3E2-62TG, L3A-61RG, L3E-61RG	1270^{+10}_{0}	1270^{0}_{-10}	1250^{+20}_{-30}	Purple

■CHECKING

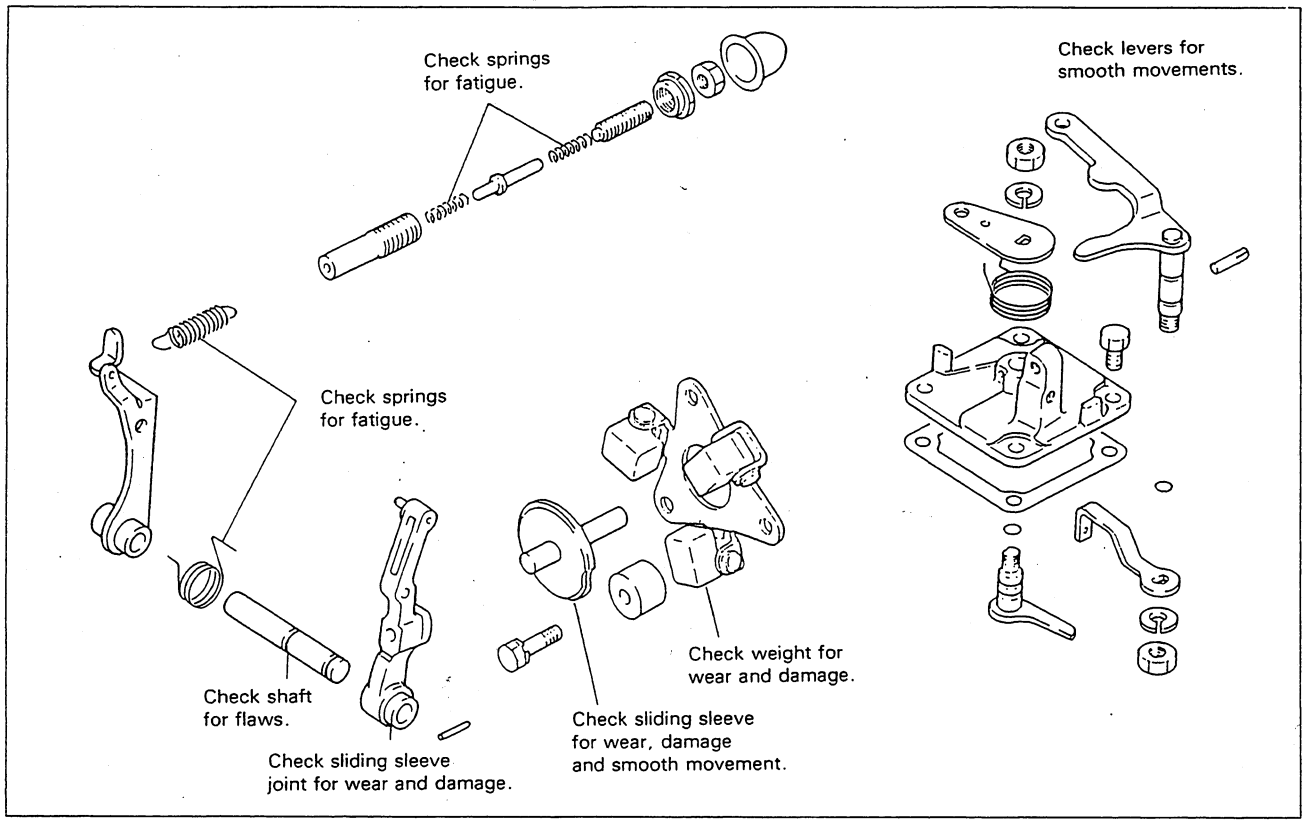
Replace the gear case and inspect the governor.
When removing the gear case, be sure to remove the tie-rod cover by the side of the fuel pump and disconnect the tie-rod from the rack.
If any parts are found defective, replace them.

Caution

When the governor is assumed to be malfunctioning, check the bearing on the gear case side, too.



Inspecting Torque Spring



Inspection Governor System Parts

■Removal and Installation

(Refer to I-06 GEAR CASE AND OIL PUMP.)

Removal

(1) Removing the levers

(a) to remove the levers, pull out the grooved pins which have been driven into the governor lever, stop lever, and speed control lever.

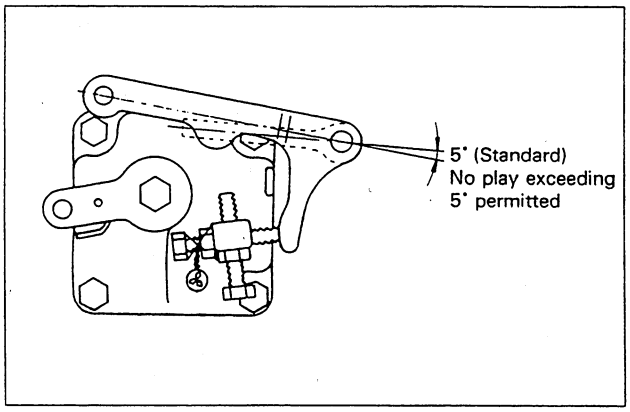
(b) Loosen bolts fastening the levers and shafts.

(2) Installation

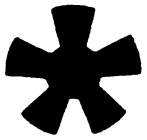
Install the levers and shafts, one after another, checking for proper function of them.

Caution

1. **After press-fitting each grooved pin, check the shaft for smooth rotation.**
2. **Coat the O-rings with oil before installing them.**
3. **No deflection exceeding 20 mm is permitted for the governor spring installed.**
4. **Install the governor spring lever and speed control lever so that play of angle between levers (standard : 5°) is minimized.**



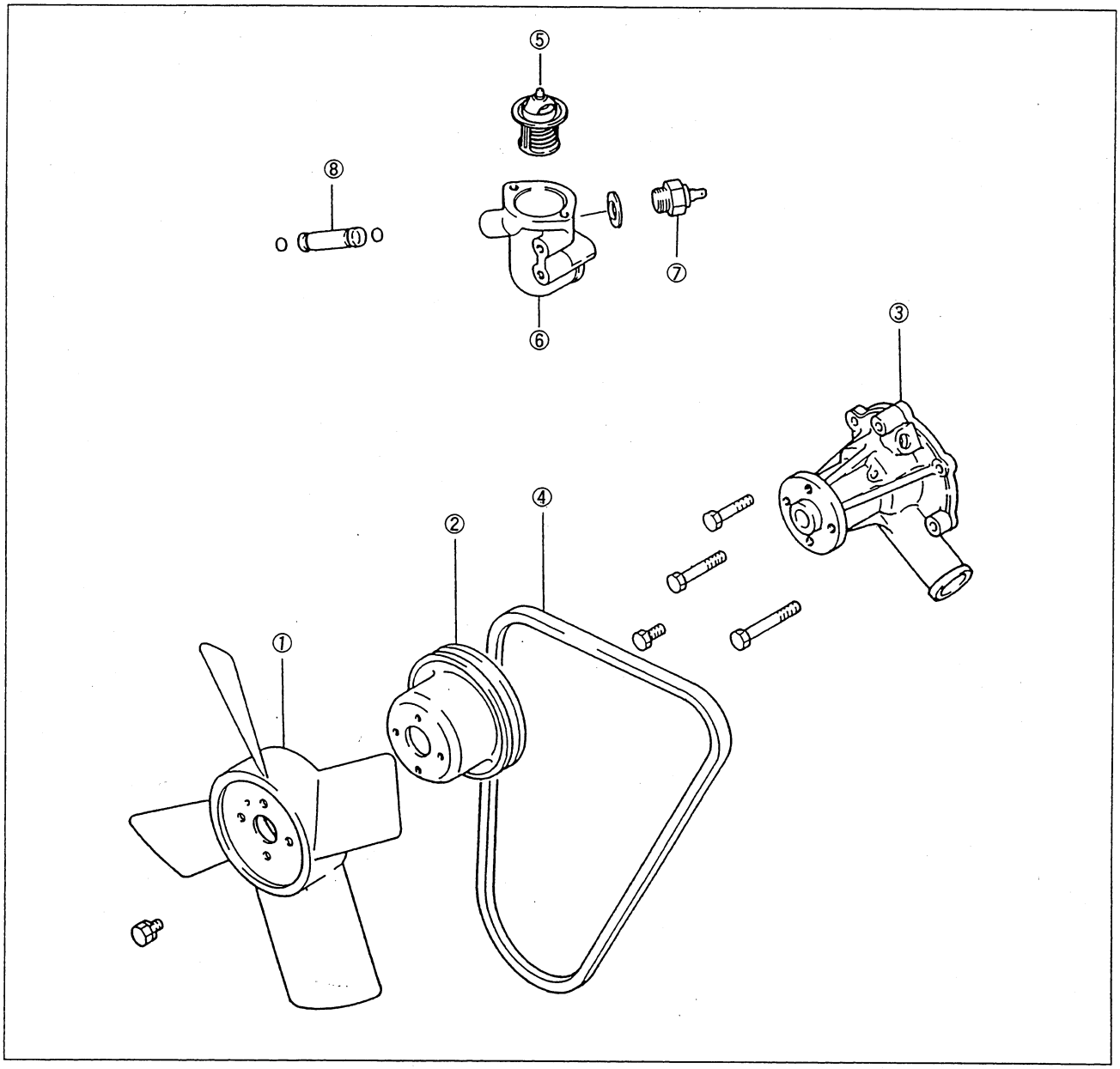
Instaling Speed Control Lever

Group 5	COOLING SYSTEM	

■Specifications

Description		Specification
Fan belt	Standard type for industrial application	L2, 3 : LL HM type, length 905
Cooling fan	L2 : Standard type for industrial application L3 : Standard type for industrial application	4-blade, unequal pitch, suction type, 260ϕ 4-blade, unequal pitch, suction type, 290ϕ
Water pump	Type	Centrifugal impeller
Thermostat	Type Standard type Valve cracking temperature Full-opening temperature	Wax type 76.5°C ± 1.5°C 90°C (Valve lift 8 mm)
Thermoswitch	Standard type Switch-ON temperature	 111°C ±3°C
Temperature gauge unit	Gauge specification	70°C / 104 ± 13.5Ω 115°C / 23.8 ± 2.5Ω (See page 129)
	Voltage used	12 volt DC

■Construction

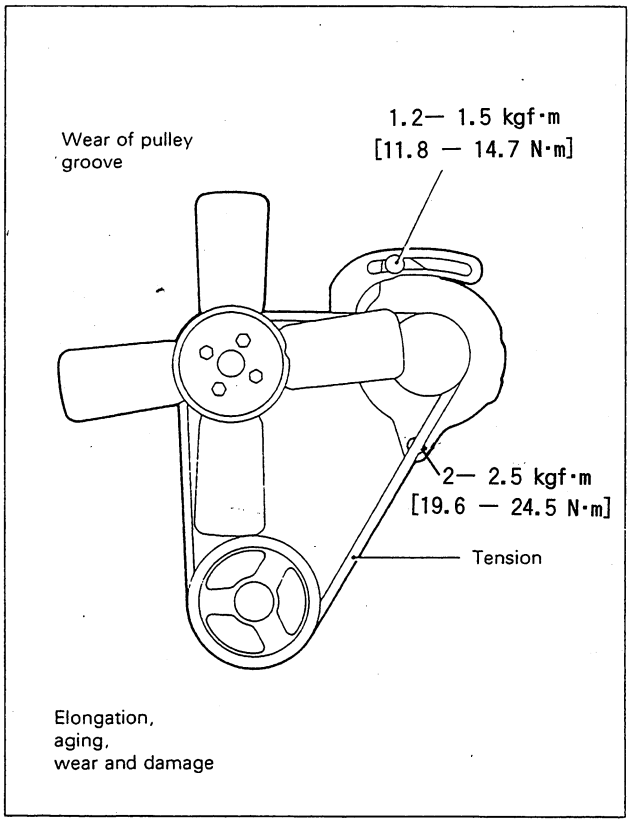


Cooling System Component Parts

① Cooling fan
② Water pump pulley
③ Water pump assembly
④ V-belt
⑤ Thermostat
⑥ Thermostat fitting
⑦ Thermoswitch
⑧ Bypass pipe

■Fan Belt Inspection

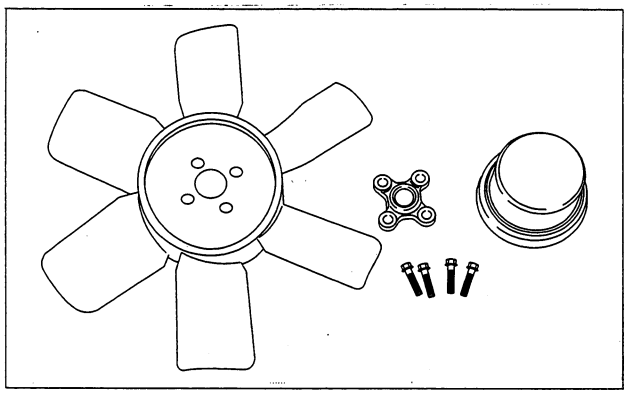
For fan belt tension, see 0-06 MAINTENANCE.



Inspecting Fan Belt

■Fan Inspection

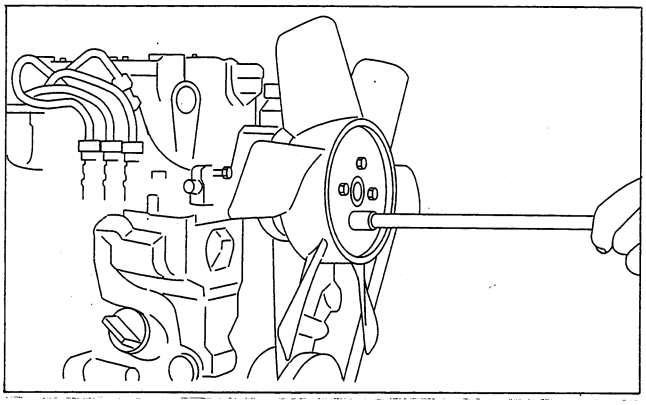
Check the fan for cracks, damaged and deformation.
If any, replace the fan.



Inspecting Fan

■Removal and Installation

(1) Remove the fan and fan belt.
(2) Remove the water pump.
(3) When installing the water pump, reverse the above-mentioned order of removal.



Removing Water Pump

■Inspection

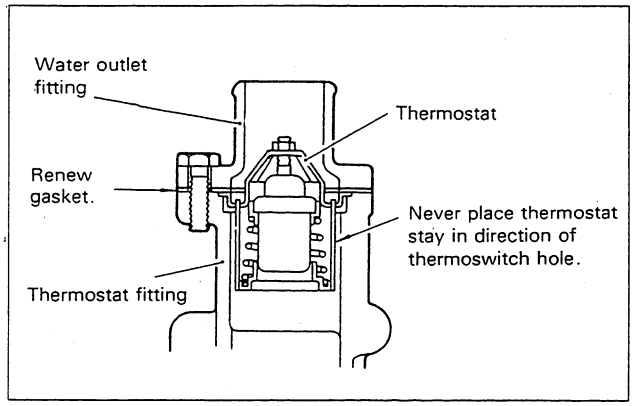
Check the water pump for water leak, rough rotation, and cracks. If any, replace the water pump assembly.

■Removal and Installation

Pay attention to the following :

(1) Never allow the flange to protrude from the faucet joint.

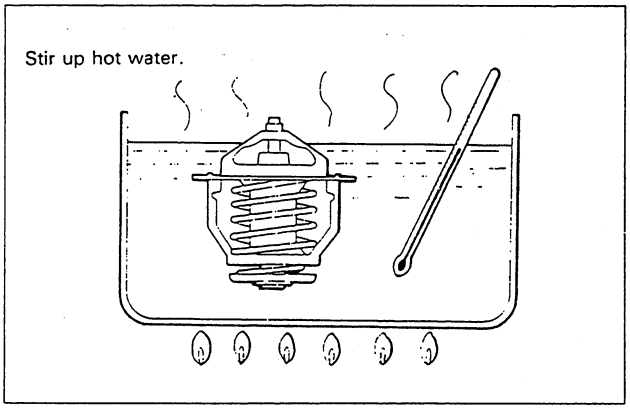
(2) Renew the gasket.



Installing Thermostat

■Inspection

If the thermostat does not operate properly, replace it.



Inspecting Thermostat

Item	Specification	
	76.5	71
Valve cracking temperature	76.5°±1.5°C	71°C
Full-open temperature (Lift 8 mm)	90°±1.5°C	95°C

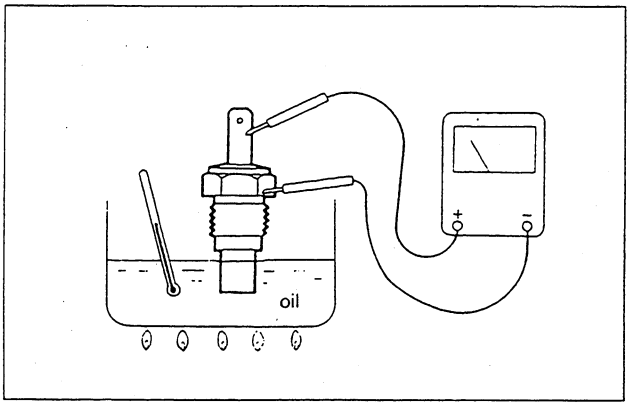
■Inspection of Water Temperature Gauge Unit

If the gauge does not function properly, replace it.

Gauge Unit Part No.	specification
MD001380	70°C／104±13.5Ω, 115°C／23.8±2.5Ω
MM435133	80°C／118±6Ω, 115°C／42±2.5Ω
0452510100	80°C／29.5±2.5Ω, 106°C／14.3±0.5Ω

Caution

Handle hot oil with special care not to cause a scald or a fire.



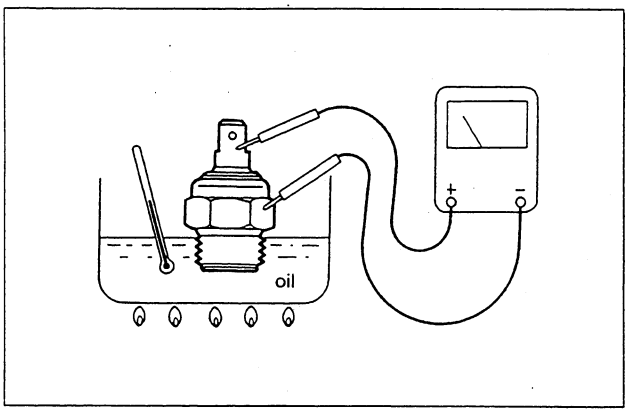
Inspecting Temperature Gauge Unit

■Inspection of Thermoswitch

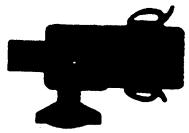
Switch-ON temperature : 111°C ±3°C

Caution

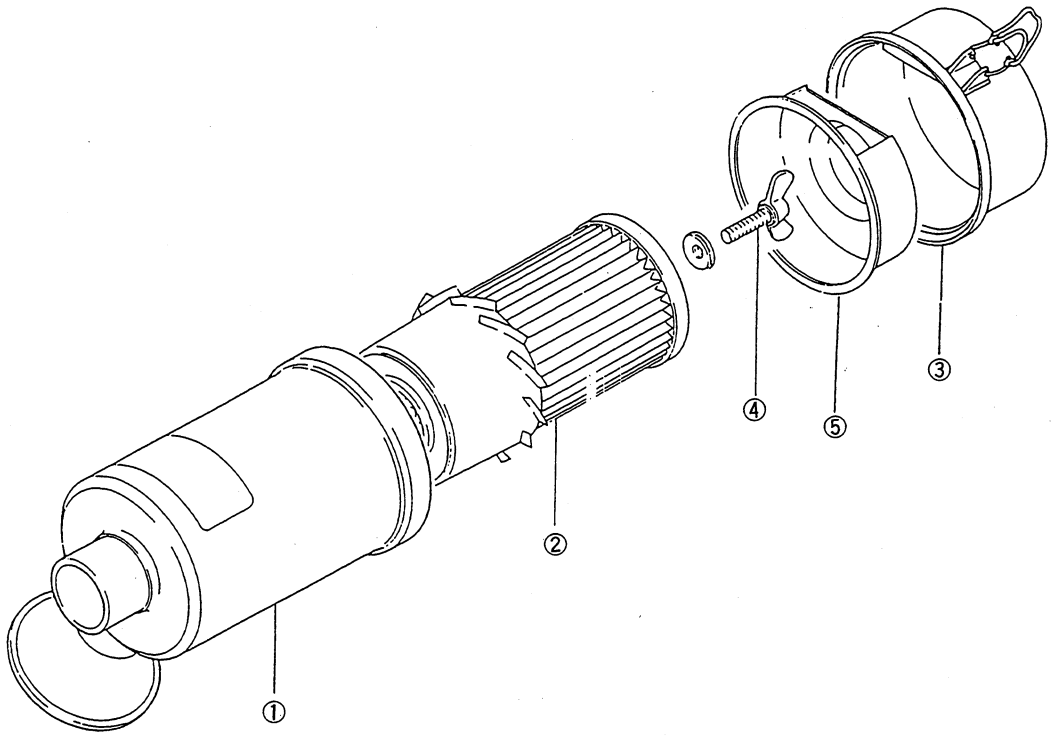
Handle hot oil with special care not to cause a scald or a fire.



Inspecting Thermoswitch

Group 6	AIR CLEANER	

■Construction



Air Cleaner Component Parts

① Body assembly
② Element assembly
③ Dust pan assembly
④ bolt
⑤ Partition plate

■Inspection

(1) Check the air cleaner body and cover for deformation, corrosion, and damage. If any defect is found, repair or replace.

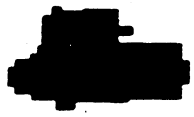
(2) If the body and cover (element) are not airtight, dust would intrude into the engine, causing the cylinders and pistons to wear down early. Check the interior of the body for evidences of intrusion of dust. If any, repair the air-leak part.

(3) Check the element and packing for damage and air leak. If any defect is found, replace.

(4) Check the element for dirtiness, clogging, and damage. If necessary, clean or replace the element.

(5) Check the intake hose for damage and cracks. If necessary, replace the hose.

(6) When installing the air cleaner, properly position it so that the air inlet opening faces sideward or downward. Also, install the dust pan with the arrow mark " TOP" indicating top.

Group 7	ELECTRICAL SYSTEM	

■Specifications

Description		L3 (-11) for agricultural application, etc.	L2, 3 for general application	L2 (-11) for combine application
Starter	Model	M002T52381	M002T53681	
	Type	Solenoid shift type		
	Nominal output	12V-1.2kW		
	No-load characteristic	11.5 V/100A or more/3000rpm maximum		
	Load characteristic	7.7V/300A/0.93kgm or more/850rpm minimum		

		L 2		L 3	
Alternator	Model	A	B	A	B
		A000T25371	A007TA0171 (NEW TYPE)	A000T25371	A007TA0171 (NEW TYPE)
	Type	Alternator with built-in IC regulator			
	Nominal output	12V-40A	12V-40A	12V-40A	12V-40A
	Output performance (Hot)	21A/2500rpm	←	21A/2500rpm	←
		37A/5000rpm	←	37A/5000rpm	←

Glow plug	Model	Y-145T
	Type	Sheath type, quick-heating
	Rated voltage	10.5V DC
	Current	9.7A±1.0A (when rated voltage is applied for 30 seconds)
	Resistance at normal temperatures	0.16 Ω

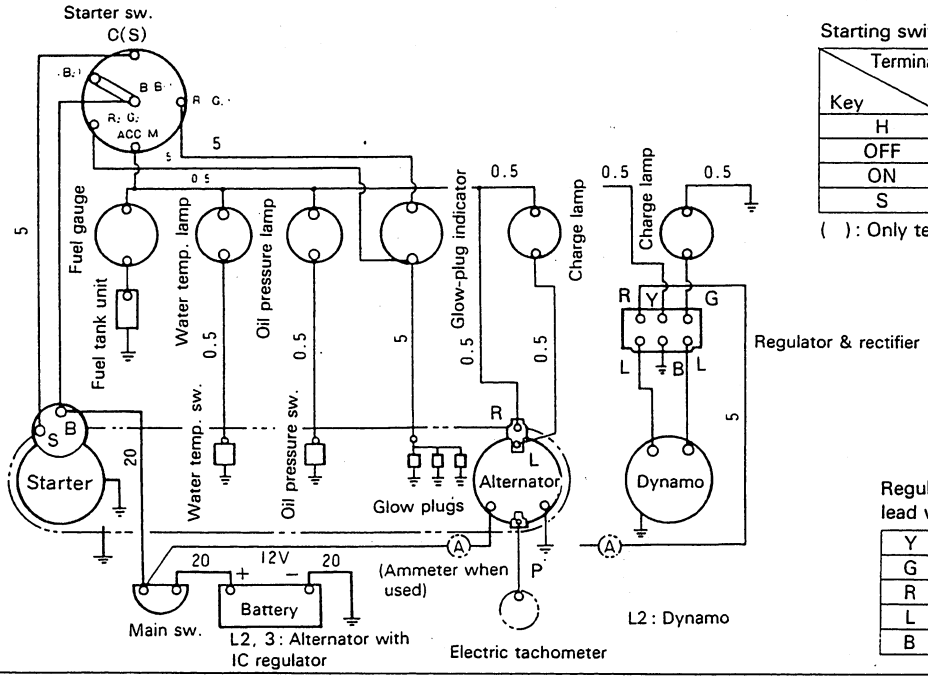
		L 2	L 3
Glow lump	Model	DH-139V-19	DH-139V-29
	Type	Red-hot type (Quick-heat type)	
	Rated current	19A	29A
	Voltage between terminal	1.5V ± 0.2V	1.7V ± 0.2V

■General

■Wiring Diagrams

Numeral on each wire is a "nominal size" according to JIS. C-3406 Low-voltage Electrical Wiring for Automobiles.

(1) For standard type engines with alternator (with built-in IC regulator) or AC dynamo



Starting switch connection

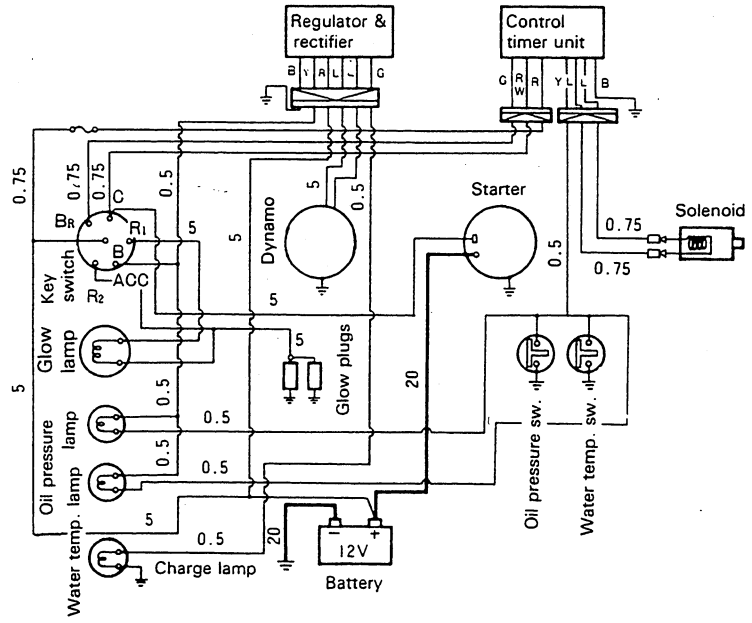
Terminal / Key	B	R	R_2	C	ACC
	B_1 / B_2	G_1	G_2	S	M
H	○	○			
OFF	○				
ON	○				○
S	○		○	○	(○)

( ) : Only terminal "M"

Regulator & rectifier lead wire Cord color

Y	YEL
G	GRN
R	RED
L	BLU
B	BLK

(2) For L2 engines of " Key-OFF stop" specification (With AC dynamo)



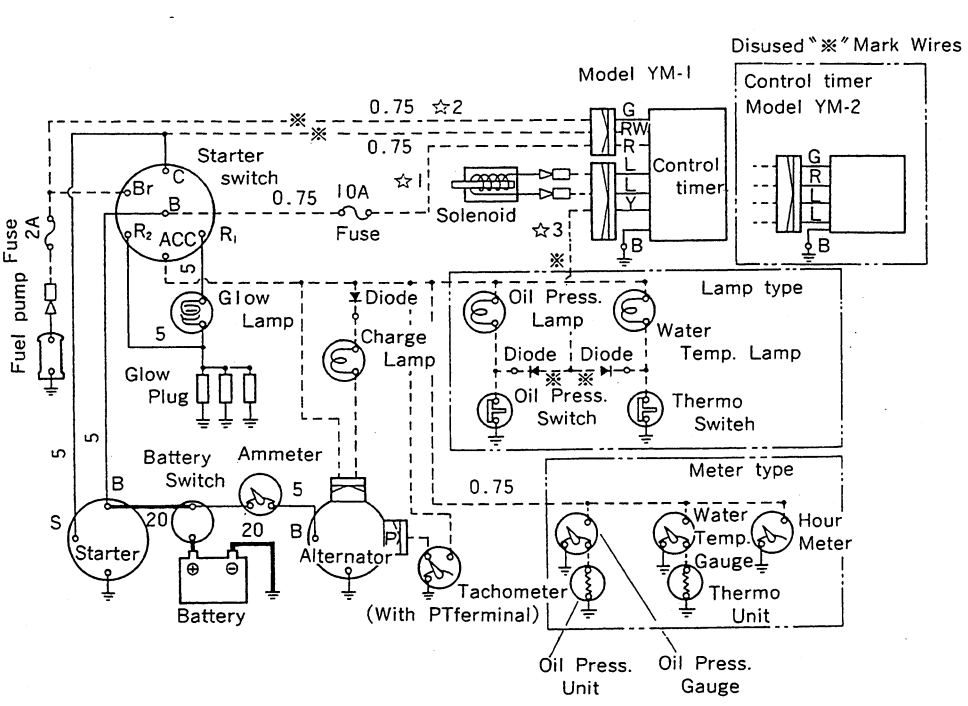
Key switch connection

Position	Connection
GLOW	B−R_1−B_R
OFF	B
ON	B−ACC−B_R
START	B−R_2−C−B_R

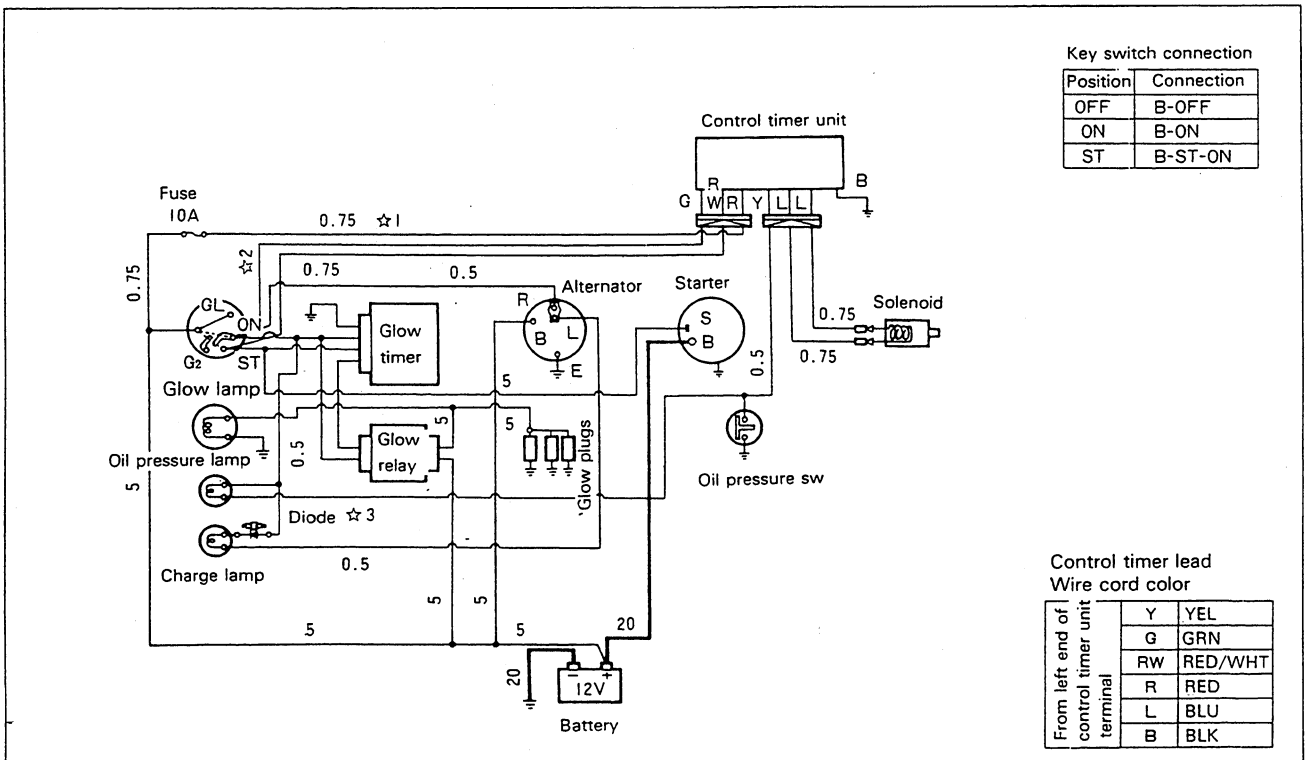
Regulator and Timer lead wire Cord color

Y	YEL
G	GRN
RW	RED/WHT
R	RED
L	BLU
B	BLK

(3) For standard engines of " Key-OFF stop" specification



(4) For L2, L3 engines with glow timer, key-OFF stop specification



(5) Three kinds of wiring diagrams for the engines with the " Key-OFF stop" system are shown above. Machines equipped with those engines may be in need of wiring modification to match with those key-OFF stop system circuits. In such a case, careful attention should be paid to the matters mentioned in the below.

Caution

1. **Wires G and R (☆1 and ☆2) for the control timer unit are to be minimized in wire resistance, with the necessary consideration to prevent those wires from being influenced by electric noises (caused by voltage variations, etc.) from other electrical devices.**
2. **Be careful not to confuse the polarity of the diode (☆3) interposed between the key switch and alternator terminal " L." (If that diode is connected in reverse, it will make the "Key-OFF stop" system ineffective.)**

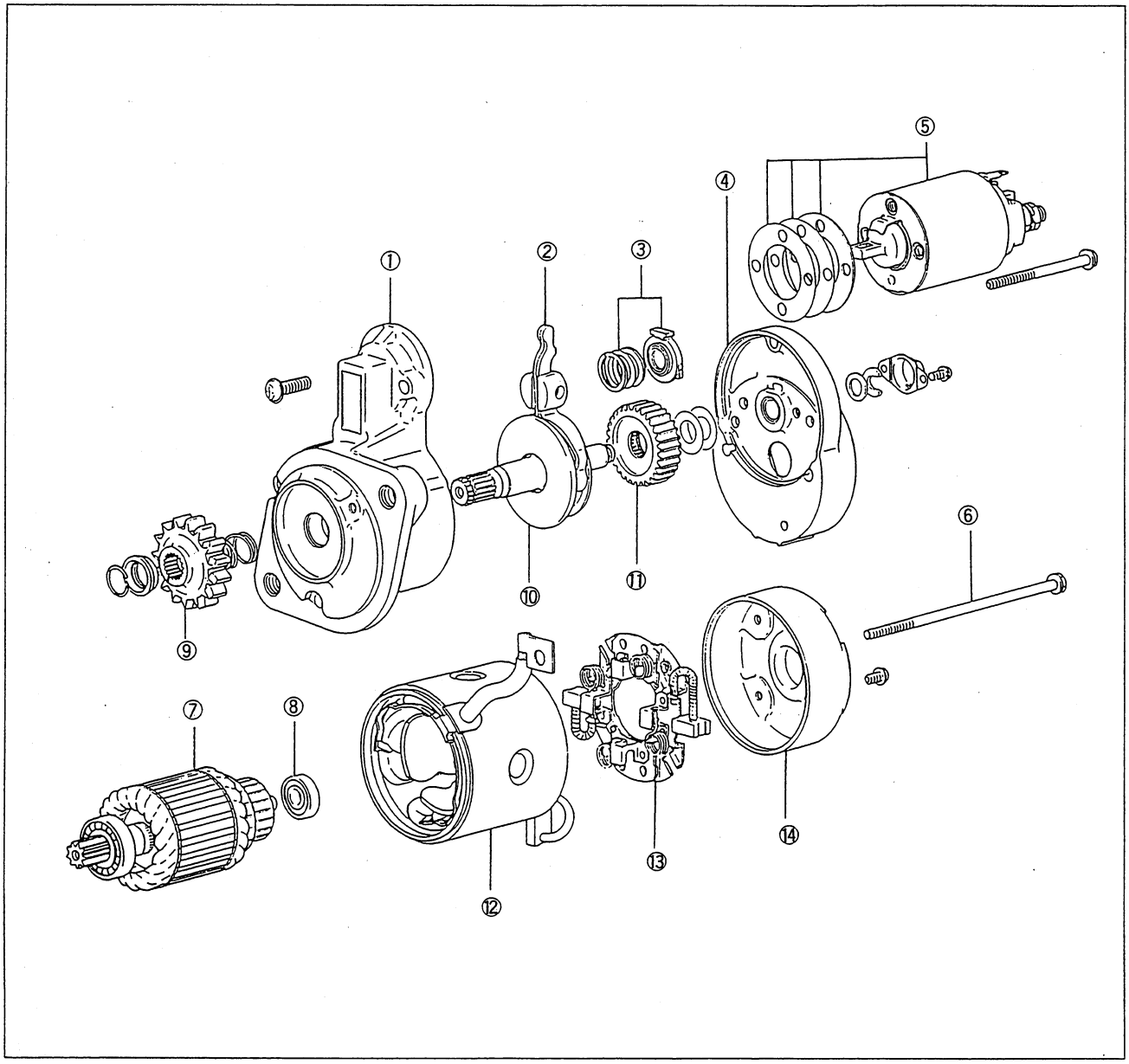
(6) Combination of operations of components in " Key-OFF stop" (fuel cutoff solenoid) system circuit

State of engine	Key switch	Oil-pressure switch	Fuel outoff solenoid	Injection pump control rack position	Function
At start	ON	ON	ON	STOP	
	START	OFF	OFF	MS	Cranking up
On the run	ON	OFF	OFF	(SS)	Normal running
	ON	ON	ON	STOP	Emergency stop by an act of oil pressure switch
	OFF	OFF	ON	STOP	Key-OFF stop

(7) Key switch connection for automatic glow system operations

Key switch position	Connection	Remarks
OFF	B-OFF	
ON	B-ON	Current flows in the glow-plug circuit (the glow-lamp is lit) for a fixed period of time (about 6 seconds).
ST	B-ST-ON	Current flows in the glow-plug circuit (the glow-lamp is lit) as long as the key is in the ST position.

■Construction



Starter Component Parts

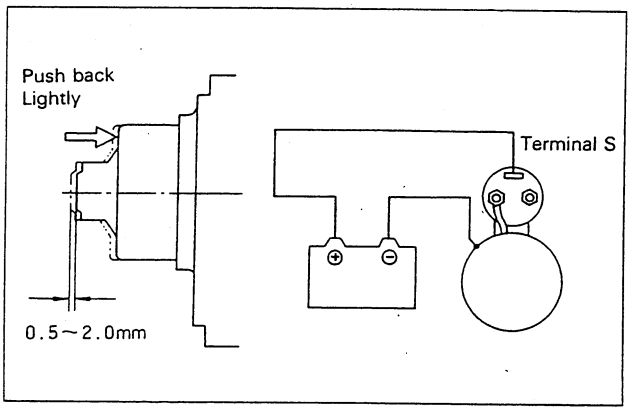
① Front bracket assembly	⑥ Through bolt	⑪ Gear
② Lever assembly	⑦ Armature	⑫ Yoke assembly
③ Spring set	⑧ Rear bearing	⑬ Brush holder assembly
④ Center bracket assembly	⑨ Pinion	⑭ Rear bracket
⑤ Switch assembly	⑩ Pinionshaft assembly	

■Inspection (Assembly)

If any abnormality is assumed by the following tests, adjust the starter or disassemble and repair it.

(1) Pinion gap inspection

(a) Interpose a battery (12 V) between starter terminal " S" and starter body, and the pinion will protrude and stop.



Inspecting Pinion Gap

Caution

Never apply battery voltage for over 10 seconds continuously.

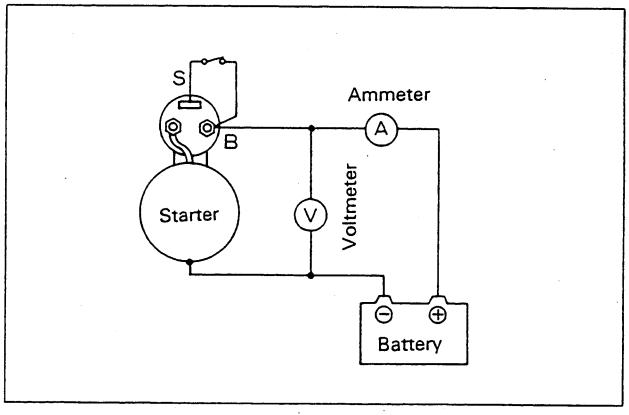
(b) Lightly push the pinion back and measure the return stroke (called pinion gap).

(c) If the pinion gap is not within the standard range (0.5 to 2.0 mm), adjust it by increasing or decreasing the number of packings on the magnetic switch. The gap is decreased as the number of packings increases.

(2) No-load test

(a) Connect the ammeter, voltmeter and battery to the starter as illustrated.

(b) When the switch is closed, the pinion must protrude and the starter must run smoothly (at 3000 rpm or more). If the current or starter speed is out of specification, disassemble the starter and repair it.



No-load Test

Caution

- **Use the thick wires as far as possible for wiring and tighten every terminal securely.**
- **This is a solenoid shift type starter which makes a rotating sound larger than that of a direct-drive type starter.**
- **When detecting starter rotation at the pinion tip, take care of protrusion of the pinion.**

(3) Magnetic switch

Perform the following tests. If any test is not satisfied, replace the magnetic switch assembly.

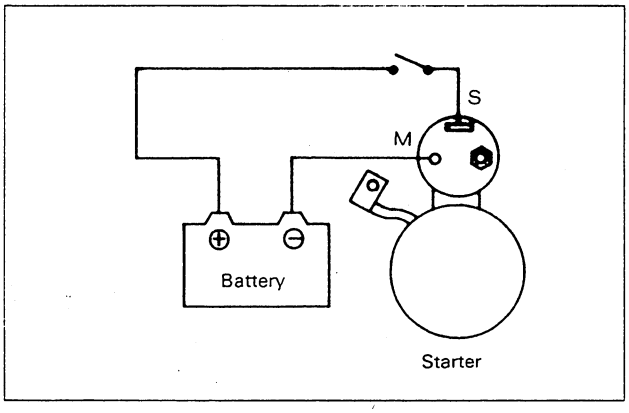
(a) Disconnect wire from terminal " M. "

(b) Attraction test

Connect a battery to the magnetic switch terminals S and M. The pinion must protrude.

Caution

Do not apply battery current for more than 10 seconds.



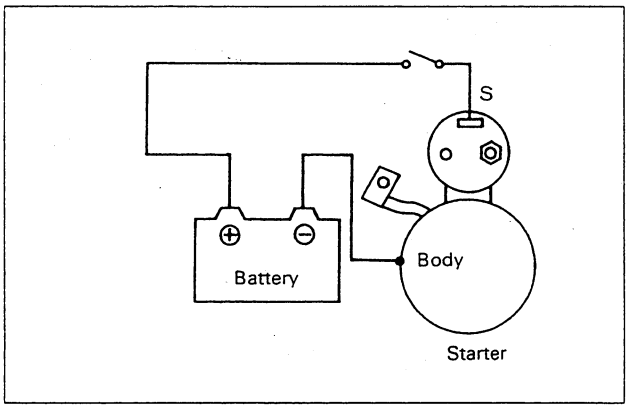
Attraction Test

(c) Holding test

With a battery connected to the magnetic switch terminal "S" and to the starter body, manually pull out the pinion fully. The pinion must remain at that position even when released from holding by hand.

Caution

Do not apply battery current for more than 10 seconds.



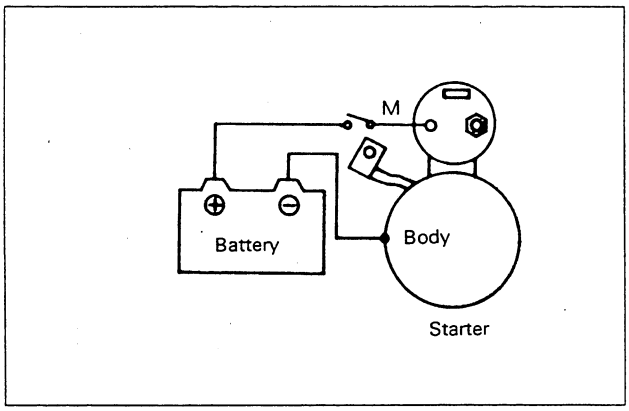
Holding Test

(d) Return test

With a battery connected to the magnetic switch terminal "M" and to the starter body, manually pull out the pinion fully. The pinion must return to its original position when released from holding by hand.

Caution

Do not apply battery current for more than 10 seconds.



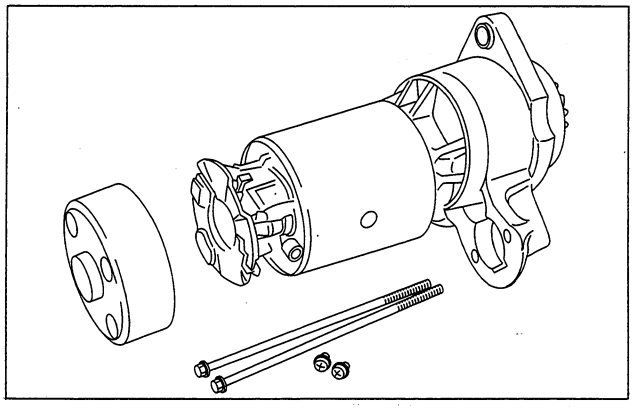
Return Test

■Disassembly

(1) Disconnect wire from the magnetic switch terminal " M. "

(2) Loosen two screws fastening the magnetic switch. Remove the magnetic switch assembly.

(3) Remove two through bolts and two screws fastening the brush holder. Remove the rear bracket.



Removing Brush Holder Assembly

(4) With two brushes brought in floating state, remove the yoke-and-brush-holder assembly. Then, pull the armature out.

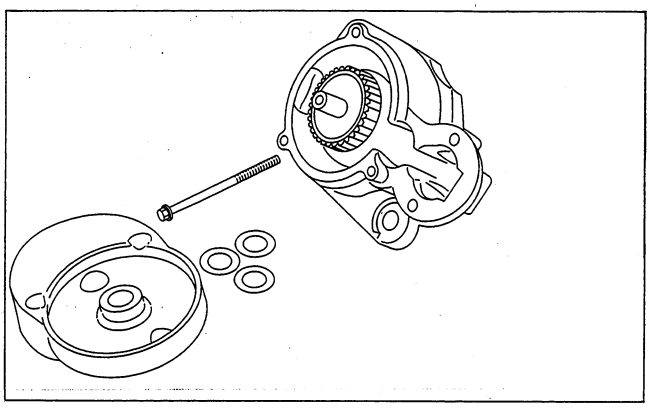
(5) Remove the cover, pry the snap ring out, and remove the washer.

(6) Unscrew the bolts and remove the center bracket. At the same time, washers for pinion shaft end play adjustment will come off.

(7) Pull out the reduction gear lever and lever spring from the front bracket.

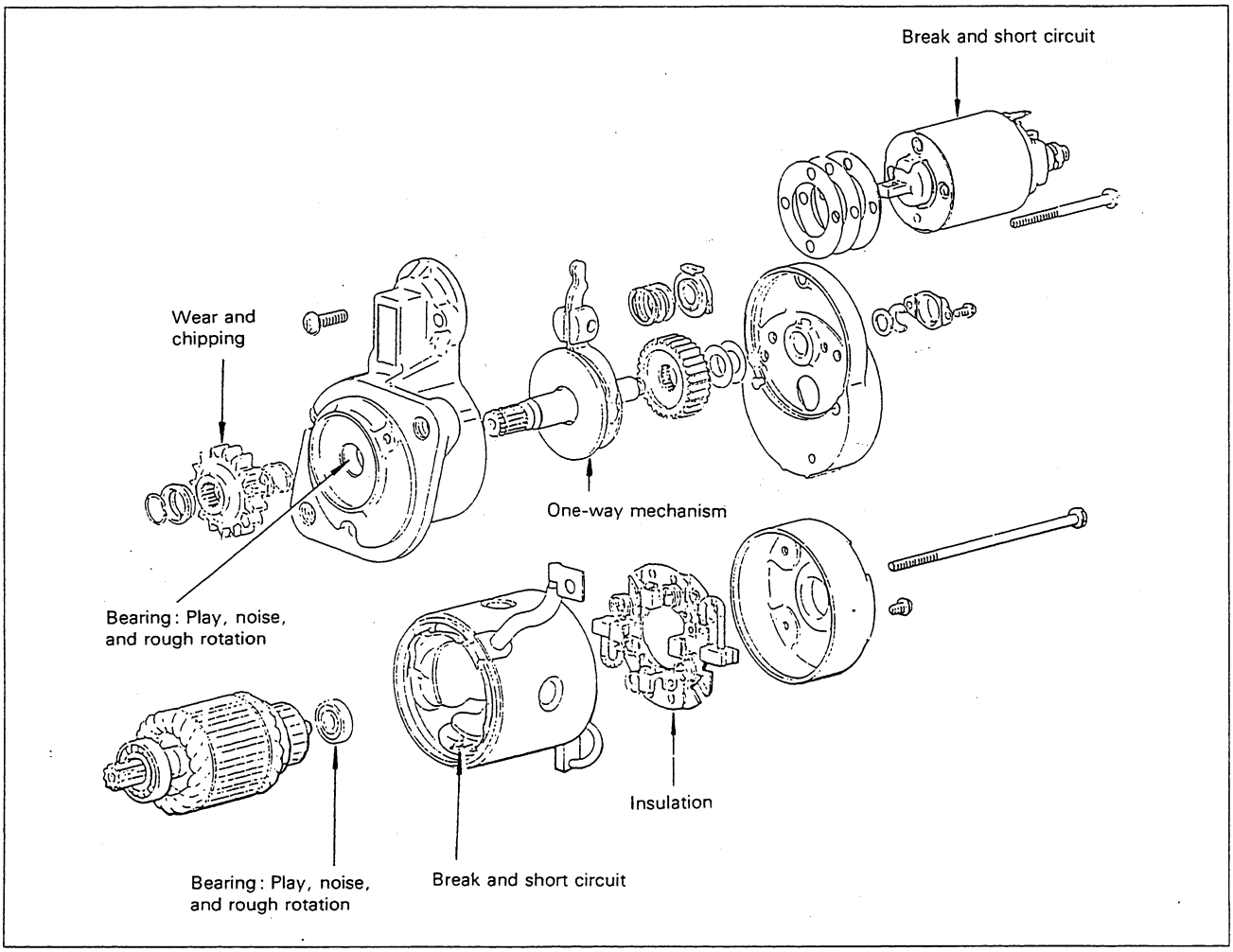
(8) On the pinion side, pry the snap ring out, and pull out the pinion and pinion shaft.

(9) At each end of the armature, remove the ball bearing with a bearing puller.
It is impossible to replace the ball bearing press-fitted in the front bracket. If that bearing has worn off, replace the front bracket assembly.



Removing Reduction Gear

■Inspection



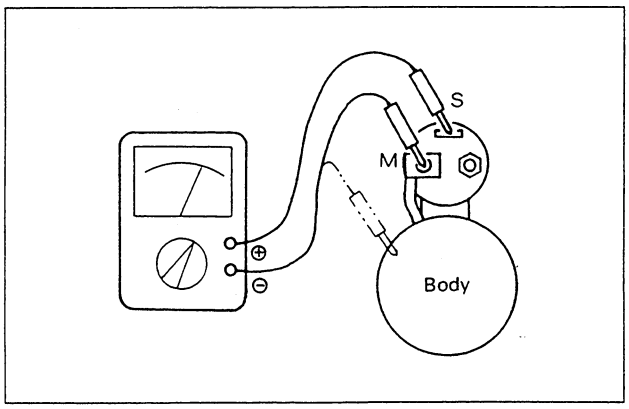
Inspect about the following :

Description	Standard	Service limit
Depth of under cut	0.5 mm	0.2 mm
Commutator O. D.	38.7 mm	−1.0 mm

Description	Standard	Service limit
Height of brush	17 mm	6 mm
Spring pressure	3 kg	

(1) Inspecting the magnetic switch

Check the magnetic switch for conduction between terminals S and M and between terminals S and body. If zero-ohm is indicated (as an evidence of short circuit), replace the magnetic switch.



Checking Magnetic Switch

(2) Inspection the armature

(a) Check the armature with a growler tester. If short-circuited, replace the armature. Also, check for insulation between the commutator and its shaft. If poorly insulated, replace the armature.

(b) Measure the commutator O. D. and the depth of undercut. Repair or replace if the service limit is exceeded. Also, check the commutator outside surface for dirtiness and roughness. If rough, polish the commutator with fine-grain sandpaper.

(3) Brush holder inspection

(a) Check the brushes. If worn out beyond the service limit, replace the brushes.

(b) Check the brush spring tension. If decreased beyond the service limit, replace springs.

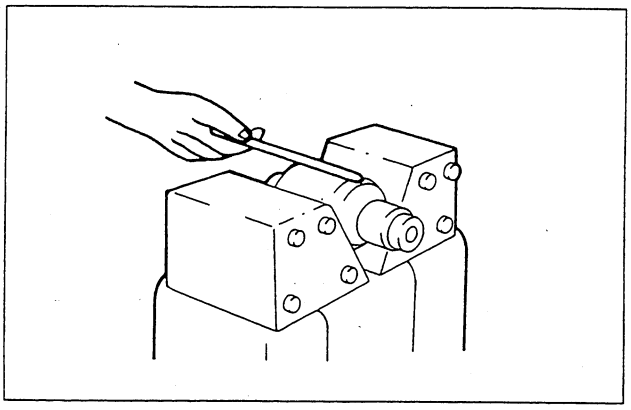
(c) Check for insulation between the positive brush holder and holder base. If poorly insulated, replace the holder assembly. Also, check the brush holders for proper staking.

(4) Field coil inspection

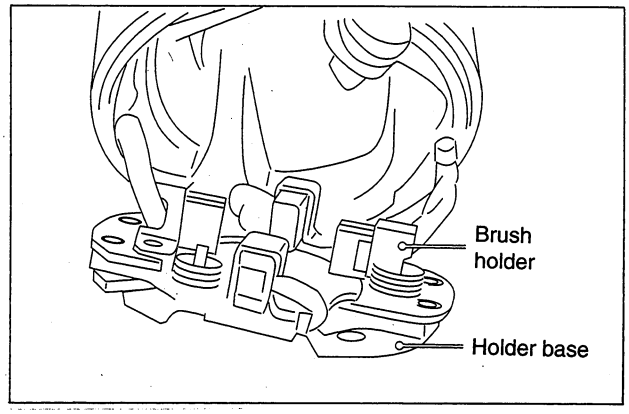
(a) Check for insulation between one end (brush) of coil and yoke.

(b) Check for conduction between both ends (brushes) of coil.

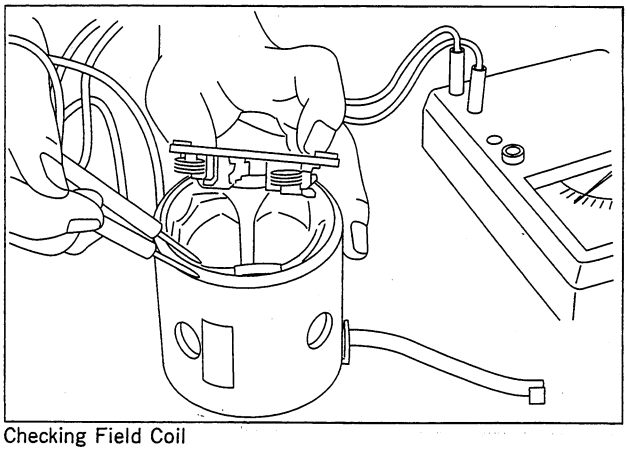
(c) Check the poles and coil for tightness.



Checking Armature Coil



Checking Brush Holders



Checking Field Coil

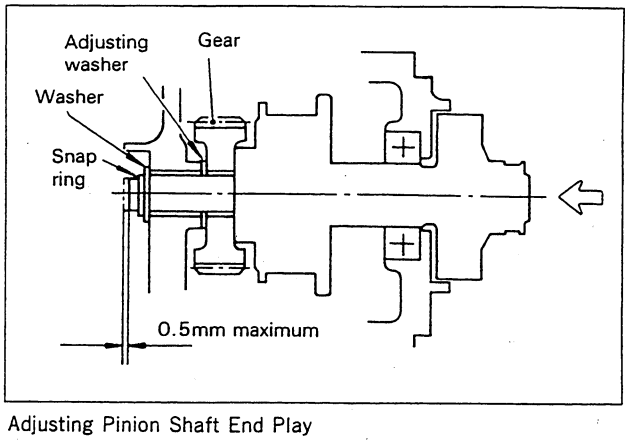
■Assembly and Adjustment

Reassemble the starter assembly in the reverse order of disassembly, giving care to the following :

(1) Pinion shaft end play adjustment

Set the end play (thrust gap) to 0.5 mm or less by inserting an adjusting washer between the center bracket and reduction gear.

(a) Fit the pinion shaft, reduction gear washer and snap ring to the center bracket.



Adjusting Pinion Shaft End Play

(b) Measure end play by moving the pinion shaft in the axial direction. If end play exceeds 0.5 mm, increase the number of adjusting washers inserted.

(2) Greasing

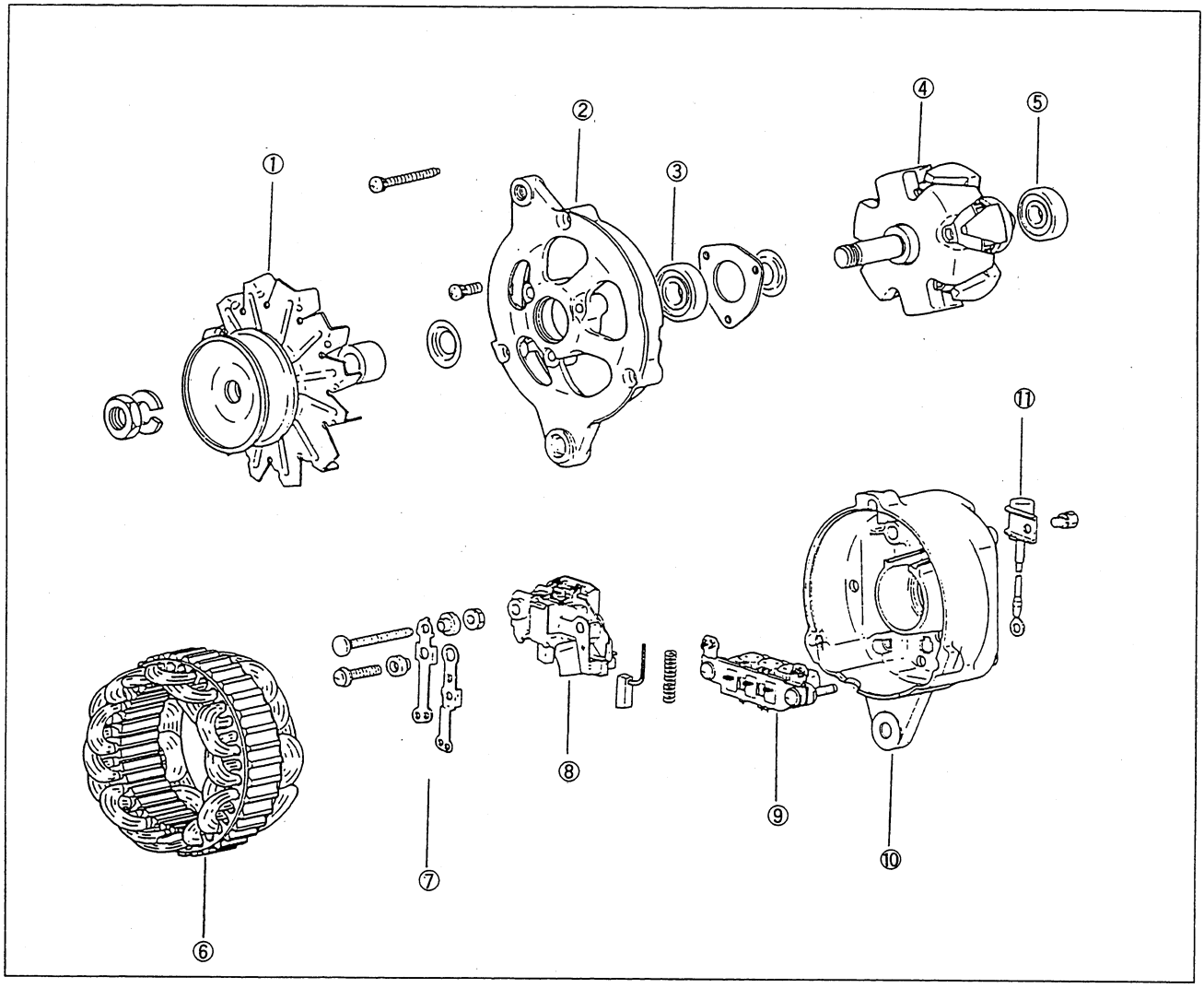
Whenever the starter has been overhauled, apply grease to the following parts :

- Armature shaft gear and reduction gear
- All bearings
- Bearing shaft washers and snap rings
- Bearing sleeves
- Pinion
- Sliding portion of lever

Caution

Never smear the starter fitting surface, terminals, brushes, and commutator with grease.

■Construction

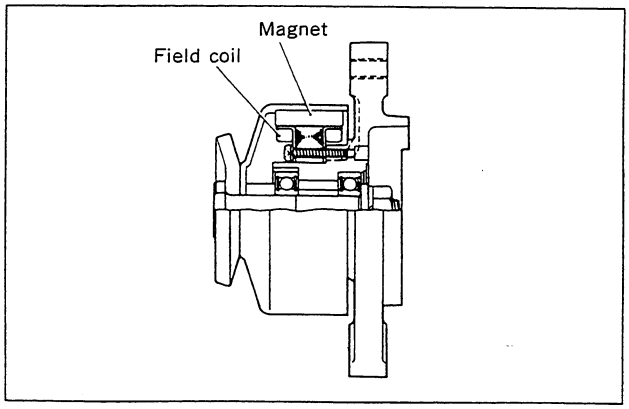


Alternator Component Parts

① Pulley
② Front bracket assembly
③ Front bearing
④ Rotor assembly
⑤ Rear bearing
⑥ Stator
⑦ Terminal set
⑧ Regulator assembly
⑨ Rectifier assembly
⑩ Rear bracket assembly
⑪ Condenser assembly

■Dynamo

The dynamo is used for so-specified engines. This maintenancefree dynamo is the permanent magnet type, light-weight, compact, single-phase AC generator. Alternating current generated by the dynamo is rectified through the separate regulator-and-rectifir unit. For dynamo inspection items, see the end of this section.



Dynamo

On-the engine Inspection

(1) Precautions for handling

Erroneous handling possibly causes damage to the charging circuit and other troubles.

(a) Never connect the battery in reverse.

(b) Do not use a megger and other high-voltage testers.

(c) When recharging the battery, disconnect the battery cable from the alternator.

(d) Never disconnect the lead wire from the alternator terminal B during running of the engine.

(e) Never ground the alternator terminal B to which battery voltage is always applied.

(f) Never short-circuit or ground terminal L.

(g) When using a steam cleaner, be careful not to direct steam directly to the alternator.

(2) Checking for regulated voltage

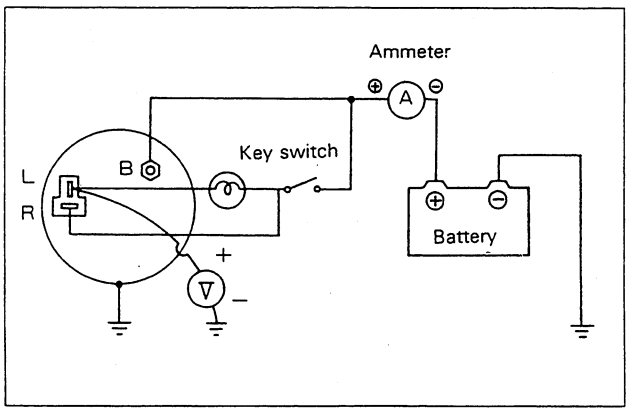
(a) Interpose an ammeter between positive terminal of battery and terminal B of alternator.

(b) Ground the alternator terminal " L" through a voltmeter.

(c) Note that the voltmeter indicates zero volt when the key switch is in the OFF position. The voltmeter will indicate a voltage considerably lower than battery voltage when the key switch is in the ON position (while the engine is at a stop).

(d) Short-circuit the ammeter and start the engine.

(e) Read the voltmeter indication (regulated voltage) under the following test conditions : Ammeter indication is below 5 A ; engine speed is at 1800 rpm and 2500 rpm ; and lamps are switched off. Regulated voltage shows a tendency to decrease as alternator temperature increases.



Checking for Regulated Voltage

(3) Output inspection

(a) Disconnect the grounding cable from the battery.

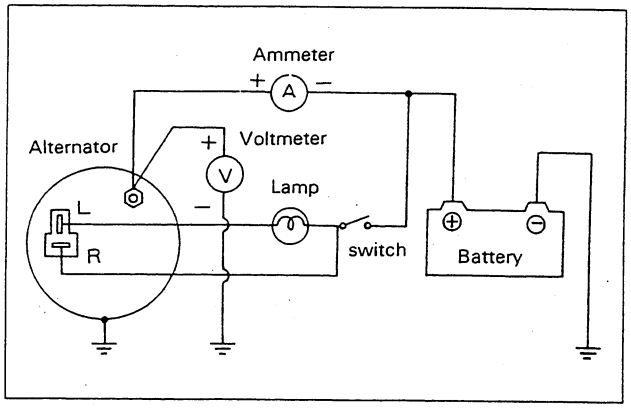
(b) Interpose an ammeter between the battery and alternator terminal " B." Ground the terminal " B" through a voltmeter.

(c) Connect the battery grounding cable.

(d) Start the engine.

(e) Apply all load including the lamps.

(f) Increase engine speed until normal alternator speed is attained. Read the maximum indication of the ammeter at 13.5 V of voltmeter indication. Output current must conform to the specification.



Checking for Output

Description		12V×35A	12V×40A
Alternator output at 13.5 V	Cold	7 A/1300 rpm	
		30 A/2500 rpm	
	Hot	3 A/1300 rpm	——
		23 A/2500 rpm	21 A/2500 rpm
		(36A)/5000rpm	37 A/5000 rpm

■Removal

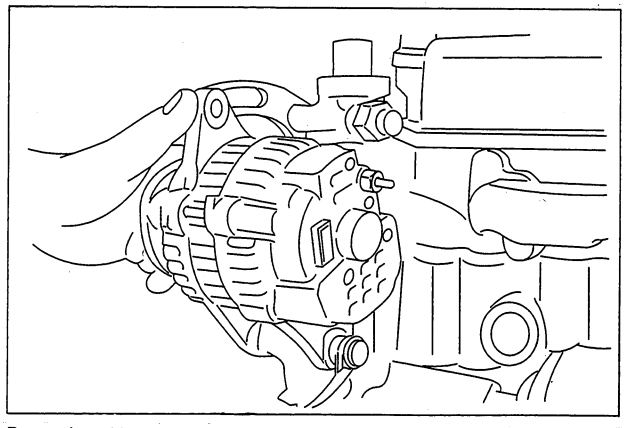
(1) Disconnect the battery cable.

(2) Disconnect lead wire from terminal " B" on the back of alternator.

(3) Disconnect the alternator connector.

(4) Loosen the alternator brace bolt and support bolt. Push the alternator toward the engine and remove the fan belt.

(5) Dismount the alternator.



Removing Alternator

■Disassembly of Alternator

(1) Remove three through bolts.

(2) Heat the rear bracket around the rear bearing up to 50 to 60 °C (with a solder iron) and separate the bracket from the stator coil.

Caution

1. **Pry open the alternator with a screwdriver blade inserted into the clearance between the stator core and front bracket.**
2. **Be careful not to insert the blade deeply.**

(3) Grip the rotor in a vise, remove the pulley nut, and pull out the pulley, fan and spacer.

(4) Pull out the rotor assembly from the front bracket.

(5) Unsolder the stator coil lead wires. Remove the stator assembly.

Caution

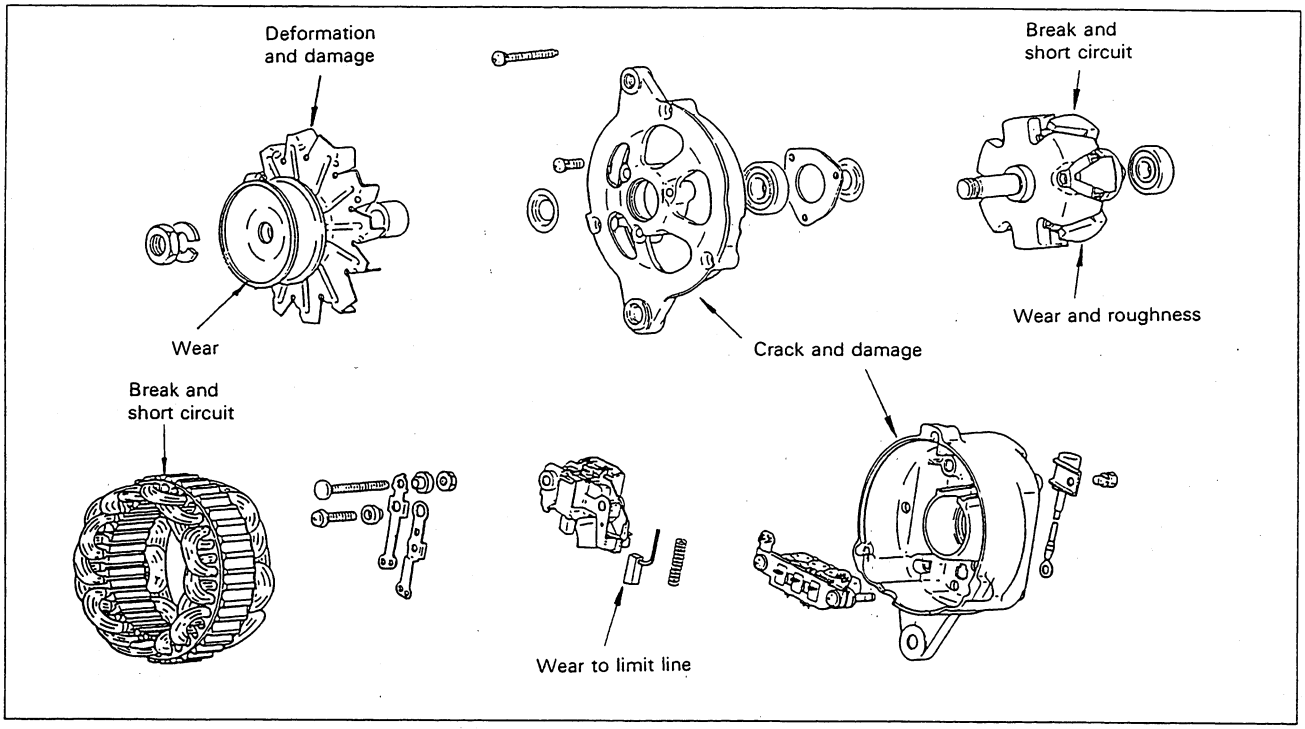
- **Never heat the lead wires long to prevent damage to diodes.**

(6) Disconnect the capacitor from terminal " B. "

(7) Loosen the screws fixing the rectifier and remove the rectifier.

■Inspection

Inspect the disassembled parts. If any part is found defective, replace.



Inspection of Alternator

(1) Inspecting the diodes

Check each built-in diode in the rectifier for conduction as follows :

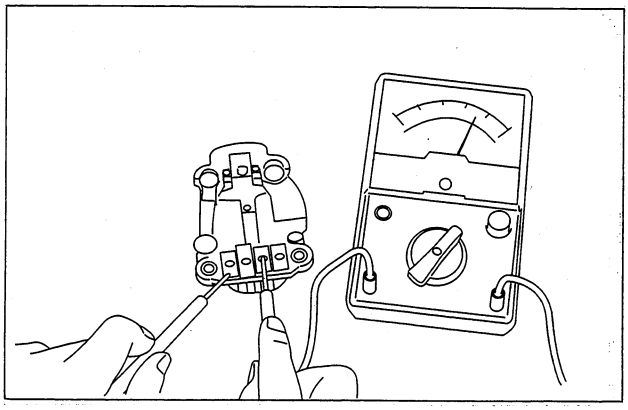
(a) Connect a circuit tester (ohm meter) across the lead wire and case of the diode to be tested. The diode is considered normal if its resistance is large in either direction and small in the reverse direction.

(b) If there is equal resistance in both directions, the diode is suspected to be defective. Replace the rectifier assembly.

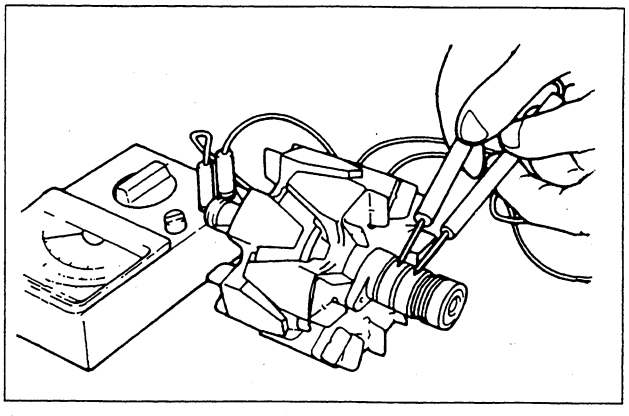
(c) Check every diode for conduction.

(2) Inspecting the field coil

(a) Check for conduction between slip rings. If there is no conduction, the field coil is suspected to be broken. Replace the field coil.

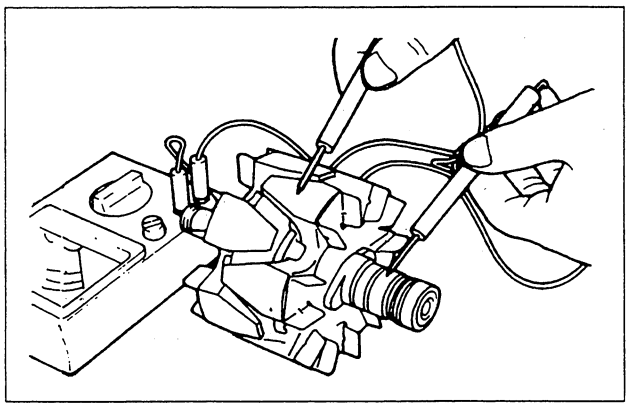


Checking Diodes



Checking Field Coil for Conduction

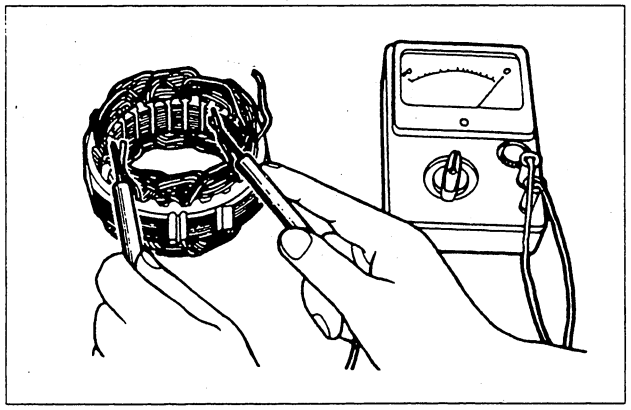
(b) Check for conduction between a slip ring and shaft (or core). If any conduction is found, the field coil is suspected to be poor in insulation. Replace the field coil.



Checking Field Coil for Insulation

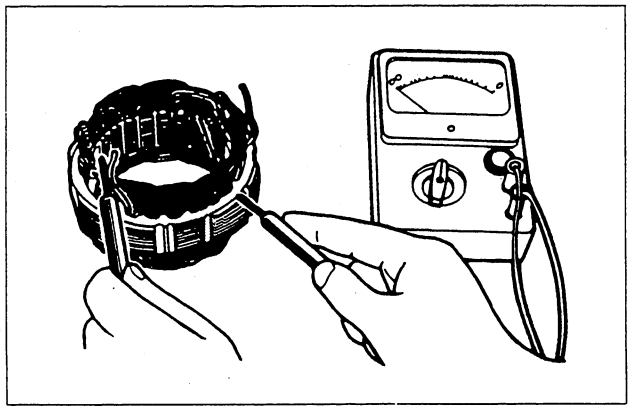
(3) Inspecting the stator coil

(a) Check for conduction between lead wires of the stator coil. If there is no conduction, the stator coil is suspected to be broken. Replace the stator coil.



Checking Stator Coil for Conduction

(b) Check for conduction between each lead wire and stator core. If any conduction is found, the stator coil is suspected to be poor in insulation. Replace the stator coil.



Checking Stator Coil for Insulation

■Assembly of Alternator

Reassemble the alternator assembly in the reverse order of disassembly, giving care to the following :

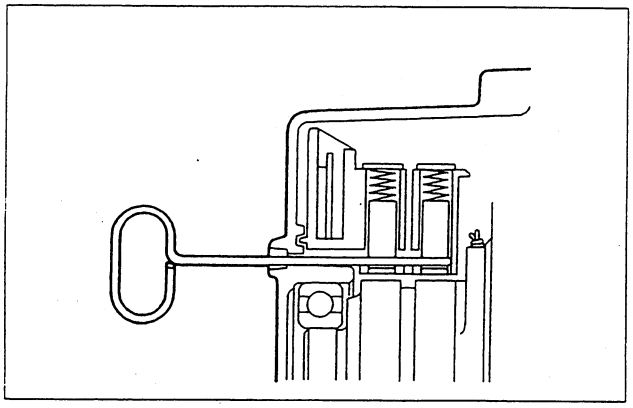
(1) The rear bearing has an eccentric groove. Install the snap ring so that its projection fits in with the deepest part of the groove.

(2) When installing a new rear bearing, press-fit the bearing with its groove facing the slip ring side.

(3) When press-fitting the rear bearing into the rear bracket, heat the bracket.

Caution

- **Pass a wire through the small hole in the rear bracket to lift the brushes before installing the rotor to the rear bracket. Remove the wire after the rotor is installed.**



Lifting Brushes

■Installation

Install the alternator in the reverse order of removal.

(1) Insertion of spacer

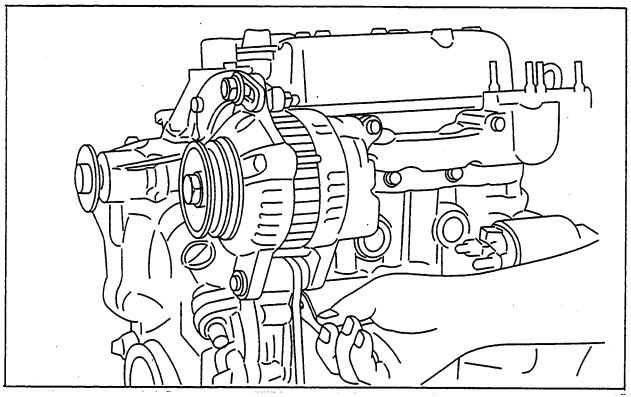
When installing the support bolts, insert the spacer in place using the following procedure :

(a) Push in the support bolts to the normal position. (Leave the nuts removed from the bolts.)

(b) Push the alternator backward. Measure the clearance between the alternator rear bracket and gear case bracket to determine the number of spacers to be inserted into the clearance (0.2 mm maximum).

(c) Reinstall the alternator with the necessary spacer inserted in place. tighten the support bolt nuts securely.

(d) Perform the belt tension adjustment.



Inserting Spacer

■Dynamo, Regulator and Rectifier

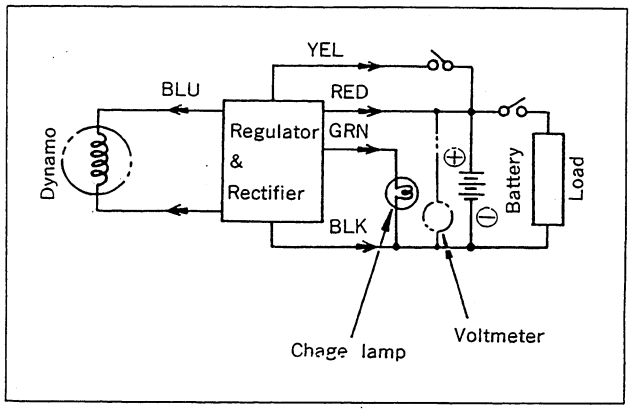
I. Specifications

For specifications, see 7-01.

II. Inspection

(1) Checking the unit in service

Measure battery voltage across terminals with a circuit tester. It is considered normal if no-load measurement is kept steady at about 15.0V at 5000rpm or more of alternator speed.



Measuring Voltage Across Battery Terminals

(2) Checking the regulator alone

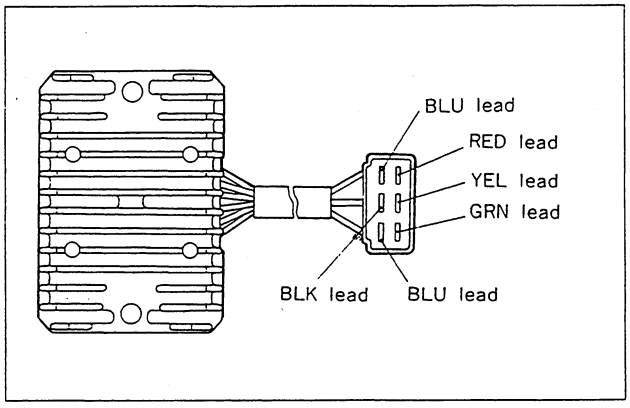
To judge whether the regulator itself is acceptable or not, check the regulator for normal conduction by connecting the circuit tester to the lead wires as follows.

Lead to be tested		Normal measurement	If abnormal-Possible cause of regulator trouble
Tester(+)	Tester(−)		
RED	BLU 1	Conduction	Broken diode
RED	BLU 2		
BLU 1	BLK		
BLU 2	BLK		
BLU 1	RED	Non-conduction	Shorted diode
BLU 2	RED		
BLK	BLU 1		Shorted diode or thyristor
BLK	BLU 2		

Note : For testing, use the circuit tester as an ohmmeter.

III. Installation

(1) Heat affects largely on the regulator and rectifier. Position them in a well-ventilated place. Install the regulator in proper direction so that the outlet of leads from the body faces downward.



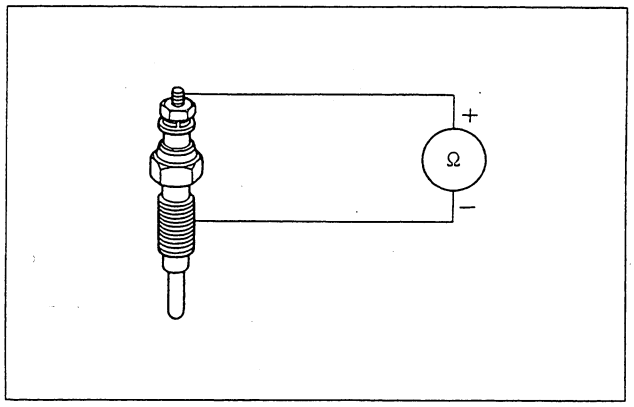
Lead Outlet Coupler

■Removal and Installation

Glow plug tightening torque : 1.5 – 2.0 kgm

■Inspection

Check for conduction between the glow plug terminal and body. If the plug is not conductive at all or shows a large resistance, replace the plug.



Checking Glow Plug

7-05 KEY-OFF STOP SYSTEM

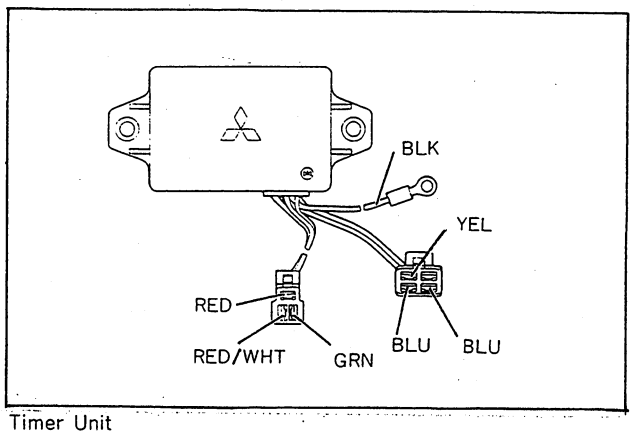
■General

The function of this system is to actuate the fuel cutoff solenoid when the starter key is placed in the OFF position. It also has the emergency engine stop function by actuating the control timer in case of abnormal lowering of oil pressure (and abnormal increase of coolant temperature for special-specification engines).

■Control Timer Unit

Description	Specification
Ir ut voltage	9V – 15V DC
Load	Solenoid (Coil resistance 1.7Ω or more)

No.	Cord color	Connect with
①	Blue	Solenoid
②	Blue	Solenoid
③	Red	Battery (Key switch " B")
④	Green	Key switch " ON"
⑤	Red/White	Starter (Key switch " ST")
⑥	Yellow	Oil pressure switch
⑦	Black	(Ground)

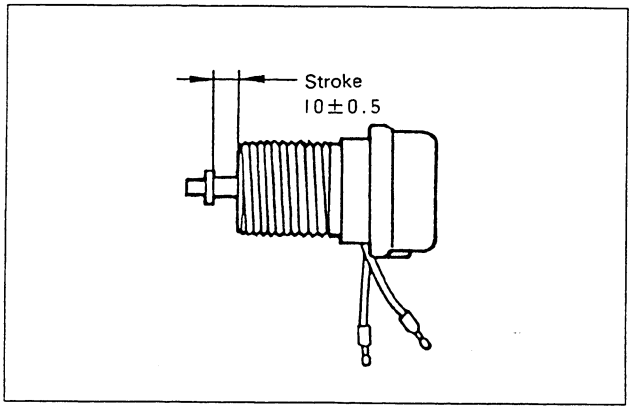


Timer Unit

■Fuel Cutoff Solenoid (Push type)

(1) Specification

Description	Specification
Type	ETS type (Solenoid push type)
Voltate	10V – 15V DC
Coil resistance	1.6Ω±10% (at 20°C)
Stroke	10 ± 0.5



Fuel Cutoff Solenoid (Push type)

(2) Solenoid installation procedure

(a) Temporarily fit the solenoid ① and nut ② to the crank case. (Coat the effective thread of solenoid with THREE-BOND 1212 and 1211.)

(b) Turn in the solenoid so that clearance " C" becomes zero at the injection pump rack position " 0 (stop position)."

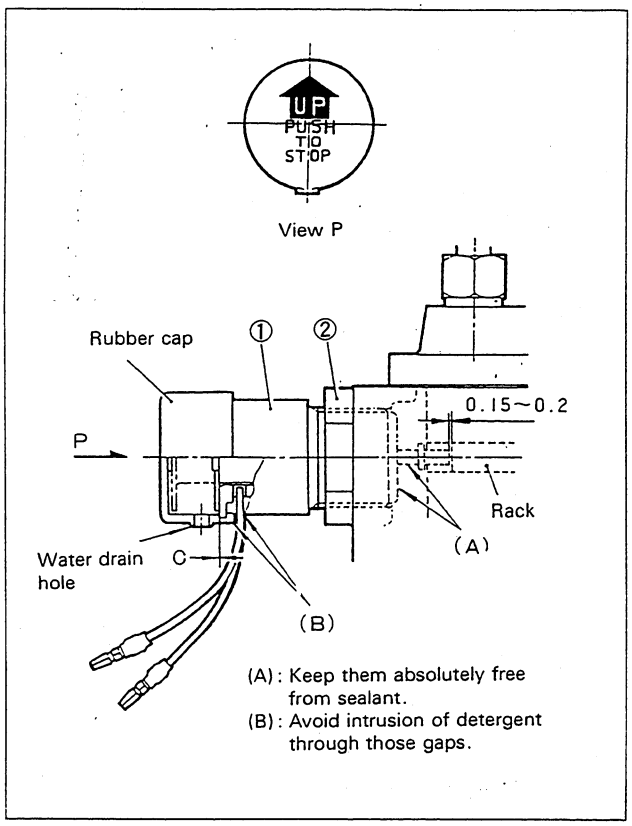
(c) Turn back the solenoid 30° to 45° (the clearance between the rack and shaft will be 0.15 to 0.20 mm) and tighten the locknut. (Nut tightening torque : approx. 5 kgm)

(d) Start the engine. Confirm that the engine is stopped without fail when the solenoid shaft is pushed in fully.

(e) Install the rubber cap arrow mark side top (water drain hole side down).

Caution

- **Be careful not to allow detergent to intrude into the solenoid terminal and solenoid interior (cords and shaft).**



Solenoid Installation

(f) Care after engine assembly

1) Make wiring properly for the " key-OFF stop" system, according to the foregoing wiring diagrams. (See 7-01 GENERAL.)

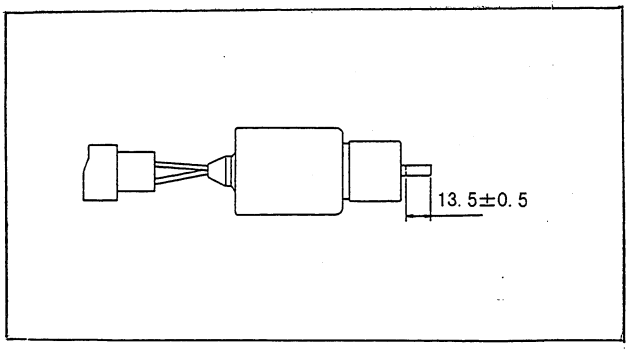
2) Start the engine and confirm that the solenoid comes into action to stop the engine when the key switch is placed in the OFF position.

3) Confirm that the engine comes to a stop when the oil pressure switch terminal is short-circuited to the switch body.

■Fuel Cutoff Solenoid (Pull type)

(1) Speccification

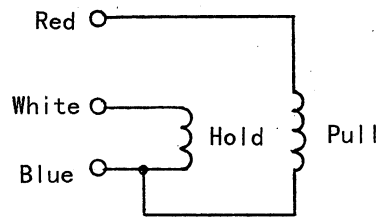
Type	ETR type (Solenoid pull type)	
Rated Voltate	12V DC	
Rated temperature	20°	
Coil resistance	pull Hold	0.25 Ω ±10% 13.5 Ω ±10%
Stroke	13.5±0.5mm	
Rated current	pull Hold	50A 1A



Fuel Cutoff Solenoid (Pull type)

(2) Solenoid installation

In this solenoid, the solenoid shaft is pulled in when the solenoid is excited and the shaft is returned (protruded) when the switch key is turned to OFF. Install the solenoid while it is not excited (its shaft is protruded), using the same procedure as mentioned before for the push type, so that the specified clearance between the solenoid shaft and injection-pump rack can be obtained.



■General

The glow plugs are used to help easy start of a cold engine by preheating the combustion chamber.

In the standard-specification engines, it is necessary to keep the starter key at the " H" position 20 to 30 seconds by hand in order to heat up the glow plugs.

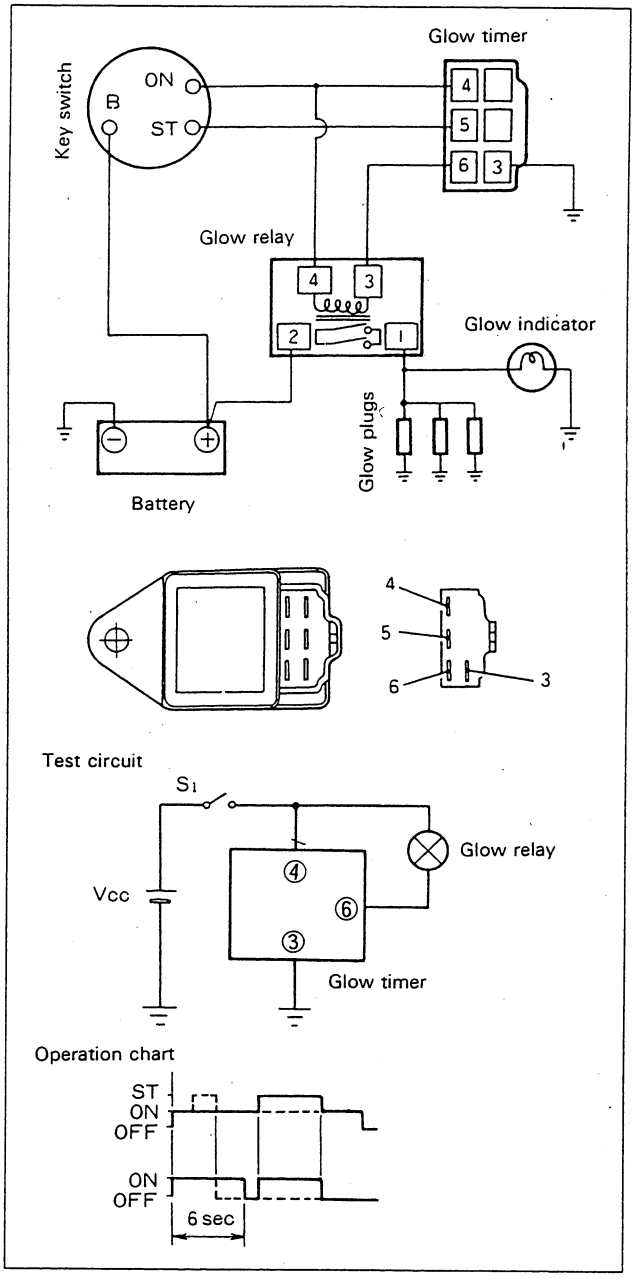
The glow timer system eliminates the necessity of keeping the key switch at the " H" position and shortens the glow plug heating time (6 seconds). This system remarkably simplifies the glow plug operation.

Unlike the conventional glow plug circuit, this system applies battery voltage directly to the glow plugs. Special care should be taken to prevent short circuit by faulty wiring.

■Glow Timer

Description	Specification
Model	S8INJ
Rated voltage	12 V DC
Working temperature	−40° to 85°C
Initial performance (at normal temperature, normal humidity, VCC : 12 V)	6±0.7sec (*1)

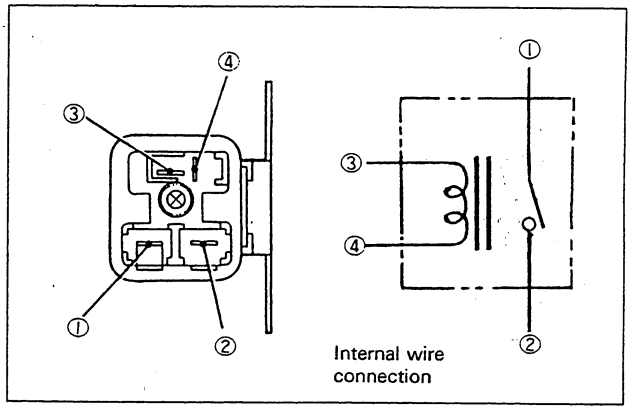
NOTE : *1 Using the test circuit shown, measure the time spent until the glow relay trips to ON after the switch S_1 is closed.



Glow.Timer System

■Glow Relay

Description	Specification
Model	G7ISP
Rated voltage	12 V DC
Continuous rating	1 min
Coil resistance	13Ω
Inductance	24 mH (at 1 kHz)



Glow Relay

Group 8	SERVICE SPECIFICATIONS AND STANDARDS	

Group No.

8-01 PERIODIC SERVICE CHART

■Periodic Service Chart　　○···Check, adjust or replenish　□···Clean　●···Replace　△···Drain

Unit and point \ Service interval		Before daily operation	After first 50 hrs	Every 100 hrs	Every 400 hrs	Every 800 hrs	Before storage	Remarks
ENGINE	Loose, damaged, or leaky parts	○						
	Exhaust, noise, and vibration	○						
	Retightening		○			○		
	Valve clearance		○		○			
	Engine idling		○		○			
	Cylinder compression pressure					○		
LUBRICATING SYSTEM	Engine oil	○	●	●				
	Oil filter (Cartridge type)		●	●				
	Oil filter (Disassembly type)			○.□	●			● : Replace element.
FUEL SYSTEM	Fuel	○					△	
	Fuel tank				□		□	
	Fuel filter			□	●			For cock type, replace element only.
	Water sedimenter	○		□				
	Fuel pump		□	□				Filter
	Injection pump					○		Adjust injection quantity.
	Nozzle				○			
INTAKE SYSTEM	Air cleaner (Paper-element type)			□	●			
	Air cleaner (Oil-bath type)	○		○.□				● : Change oil.
COOLING SYSTEM	Coolant	○	●			●	△	When no antifrees is used, drain after daily operation.
	Fan belt	○			○			
ELECTRICAL SYSTEM	Instruments (incl. pilot lamps)	○						
	Starter, alternator, and regulator				○	○*		* : Adjust for voltage and current.
	Glow plug				○			
	Solenoid switch	○						Check for proper function.

■Engine

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Cylinder compression pressure	28 kgf/cm² [2.7 MPa] (at 280 rpm)	25 kgf/cm² [2.5 MPa]	About 22 kgf/cm² [2.2 MPa]
Difference between cylinders (maximum)	2.5 kg/cm		
Fuel injection order	L2 : 1-2, L3 : 1-3-2		
Cylinder head			
Bottom surface distortion	Within 0.05	0.1	
Valve guide I.D. (IN and EX)	6.6		
Valve seat angle (IN and EX)	45°		
Valve seat width (IN and EX)	1.3~1.8	2.5	
Valve seat sinkage			−1
Valve clearance (IN and EX)	0.25 (Cold)		
Valves			
Valve head dia. (IN)	26.7		
(EX)	24.7		
Overall length	94		
Stem O.D.	6.6		
Stem to Guide clearance			
(IN)			0.10
(EX)			0.15
Valve face angle	45°		
Valve head thickness (Margin width)	1.0		0.5
Valve head sinkage (from cylinder head bottom face)	0.5		
Valve spring			
Free length	40.5	39.3	
Preload/Installed length	5.94 kg/35.5 mm		−15%
	14.84 kg/28 mm		−15%
Squareness	2°		3°
Rocker arm			
Rocker arm I.D.	12		
Rocker arm to Shaft clearance			−0.2
Cylinder block			
Camshaft hole dia.			
Front	(42) Ball bearing hole		
No.2	34		
No.3	33 (L3)		
Rear	33		

8-02 SPECIFICATIONS AND STANDARDS

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Cylinder bore			
L2A, L3A	65	+0.2	+0.70
L2C, L3C	70	+0.2	+0.70
L2E, L3E	76	+0.2	+0.70
Oversize finish tolerance	0~0.03 for each oversize		
Cylindricity	Within 0.01		
Gasket fitting surface distortion	Within 0.05	0.1	
Piston			
Type	Solid type		
Material	Alumium alloy		
O.D. (Skirt end)			
L2A, L3A	65		
L2C, L3C	70		
L2E, L3E	76		
Clearance to cylinder			0.2
Oversize	0.25, 0.50,		
Protrusion from cylinder block top surface	0.9		
Piston pin			
Type	Semi-floating type		
O.D.	18 or 21		
Piston pin to Piston clearance			0.08
Piston pin to Connecting rod clearance	Press-fit load : 1000±500 kg		(Within standard range)
Piston rings			
Number of rings	2 { No.1 : Chrome plated, semi-keystone type; No.2 : Tapered		
Compression			
Oil	1 (Chrome plated ring with coil expander)		
Ring width			
Compression (No.2)	2		
Oil	3		
Ring side clearance			
Compression No.1			
No.2	0.05~0.09		0.2
Oil ring	0.03~0.07		0.2
Ring gap	0.15~0.40		1.5
Connecting rod			
Type	Forged I-beam		
Bend and twist	Within 0.05		0.15 max.
Big end thrust clearance	0.1~0.35		0.5

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Connecting rod bearing			
Type	Aluminum metal with back metal		
Oil clearance			0.15
Under size	0.25, 0.50		
Crankshaft			
Type	Fully counterbalanced		
Bend	Within 0.03		0.05
End play	0.05～0.175		
Journal O.D.	43	−0.15	−0.70
Pin O.D.	40	−0.15	−0.70
Under size finishing			
Journal U.S.			
0.25	42.715～42.730		
0.50	42.465～42.480		
Pin U.S.			
0.25	39.715～39.730		
0.50	39.465～39.480		
Main bearing			
Type	Aluminum metal with back metal		
Oil clearance	(No.2 : Flanged metal)		0.10
Under size	0.25, 0.50		
Camshaft			
Driving method	Gear drive		
Front journal	Ball bearing		
Journal to Cylinder block hole clearance			0.15
Major diameter of cam (IN and EX)	27.37		−1.0
Oil clearance			0.15
Injection pump camshaft			
Driving method	Gear drive		
Bearing	Ball bearing (Front and rear)		
Major diameter of cam	30		−0.7
Tappet			
O.D.	19		
Tappet to Cylinder block clearance			0.15
Push rod			
Bend	Within 0.3		

■Lubricating System

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Oil specification			
API service classification	Class CC or higher		
Viscosity { above : 20 °C	SAE30 or 10W − 30		
5 °C − 20 °C	SAE20 or 10W − 30		
below : 5 °C	SAE10W − 30		
Oil capacity			
L2 (standard) : Upper limit/Lower limit	2.4/1.4 ℓ (excl. 0.5 ℓ in oil filter)		
L3 (standard) : Upper limit/Lower limit	3.0/1.5 ℓ (excl. 0.5 ℓ in oil filter)		
L3 (large) : Upper limit/Lower limit	3.6/1.8 ℓ (excl. 0.5 ℓ in oil filter)		
: Upper limit/Low limit	4.8/3.0 ℓ (excl. 0.5 ℓ in oil filter)		
Oil pump			
Type	Gear type		
Check valve opening pressure	3.0±0.3kgf/cm² [0.3±0.03MPa] (1000rpm)		
Outer rotor to Housing clearance	0.100～0.196	0.3	
Outer rotor thrust clearance	0.04～0.10	0.25	
Oil pressure switch			
Contact closing pressure (Standard type)	0.5±0.1 kgf/cm² [0.05±0.01 MPa]		

■Fuel System

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Fuel specification	Diesel fuel JIS No.2 (JIS No.3 in cold weather)		
Fuel filter			
Type	Paper-element type		
Fuel pump			
Type	Electromagnetic diaphragm type		
Delivery	0.37 ℓ/min (12V, at 20°C)		
Fuel pump			
Type	Electromagnetic Plunger type		
Delivery : Common type	0.9 ℓ or more/min (12V, at 20°C)		
: Compact type	0.4 ℓ/min (12V, at 20°C)		
Fuel pump			
Type	Mechanical drive type		
Delivery	0.225 ℓ/min		
Fuel injection pump	For exclusive L2, L3 use Model		
type	ND-PFR2NC or ND-PFR3NC		

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Nozzle Type Injection start pressure	 Throttle type 140^{+1}_{-0} kgf/cm² [$13.7^{+1.0}_{-0}$ MPa]	 Within Standard range	

■Governor System

Unit : mm

Description	Specification or standard	Reapir limit	Service limit
Governor Type	 Centrifugal weight type		

■Cooling System

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Cooling fan Type L2 : Standard L3 : Standard Option	 uneven pitch, suction 4-blade, (260ϕ) 4-blade, (290ϕ) See page		
Fan belt Type Lengh (Standard) Option	 HM type 890 See page		
Water pump Type	 Centrifugal impeller type		
Thermostat (76.5 °C specification) Type Valve cracking temperature Full-opening temperature at 8 mm valve lift	 Wax type 76.5 °C + 1.5 °C 90 °C		
Thermostat (71°C specification) Type Valve cranking tomperature Full-opening temperature at 8mm valve lift	 Wax type 71 °C 95 °C		
Thermo switch Type Model (Part No.) Contact closing temperature	 Bimetal type FW065102G220 (MM432104) 111±3 °C		
Temperature gauge unit Type Model (Part No.) Standard (°C/Ω)	 Thermistor type A20−WEu (MD001380) 70/104±13.5, 115/23.8±2.5		

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Temperature gauge unit			
Type	Thermistor type		
Model (Part No.)	YM−016−02−Wo=Tu (MM435133)		
Standard (℃/Ω)	(35/670), (50/350), 80/118±6, (100/63.5), (105/54.5), 115/42±2.5, (120/36.2), (140/22)		
Thermometer unit			
Type	Thermistor type		
Model (Part No.)	51400−K002−0 (0452510100)		
Standard (℃/Ω)	50/80±10, 60/56.3±5, 80/29.5±2.5 100/16.5±2.5, 106/14.3±0.5		

■Electrical System

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Starter			
Type	Solenoid shift type		
Model	M2T53681 (MM317604)		
	M2T52381 (MM433174)		
Voltage−Output	12 V−1.2 kW		
Direction of rotation	Clockwise as viewed from pinion side		
No-load characteristics			
Terminal voltage	11.5 V		
Current	100 A or less		
Speed	3000 rpm or more		
Load characteristics			
Terminal voltage	7.7 V		11.5
Current (torque)	300 A (0.93 kg.m or more)		0.7
Speed	850 rpm or more		
Pinion gap	0.5～2.0		
Thrust gap	0.5 or less		

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Alternator			
Type	AC type with built-in IC regulator		
Model	A7TA0171(30A6800800)		
	A0T25371 (MM435752)		
Output	12 V−40 A		
Direction of rotation	Clockwise as viewed from pulley side		
Output characteristics (Hot)			
Terminal voltage	13.5 V		
Currect／Speed	21 A／2500 rpm		
	37 A／5000 rpm		
Regulated voltage	14.7±0.3V		
Glow plug (Quick-heat type)			
Type	Sheath type		
Model : Y-145T	(With hex. nut)		
Voltage−Current	10.5 V−9.7 A		
Resistance	0.16 Ω		
Glow plug indicator (Quick-heat type) for L2			
Type	Red-hot type		
Model	DH-139V-19		
Rated current	19 A		
Voltage across terminals (at 19 A)	1.5 V±0.2 V		
Glow plug indicator (Quck-heat type) for L3			
Type	Red-hot type		
Model	DH-139V-29		
Rated current	29 A		
Voltage across terminals (at 29 A)	1.7 V±0.2 V		
Fuel cutoff solenoid			
Type	Electromagnetic ETS push type		
Coil resistance	1.6Ω±10% (at 20°C)		
Working voltage	10～15 V DC		
Stroke	10±0.5		
Temperature range	−30°C to 120°C		

Unit : mm

Description	Specification or standard	Repair limit	Service limit
Fuel cutoff solenoid			
Type	Electromagnetic ETR pull type		
Rated voltage	12−V DC		
Rated temperature	20°C		
Coil resistance	Pull 0.25 Ω ±10% Hold 13.5 Ω ±10%		
Reted pull current	50-AMPS		
Reted hold current	1−AMP		
Control timer			
Input voltage	9 V～15 V DC		
Load	Solenoid (Coil resistance 1.7Ω or more)		
Working temperature	−30°C to 80°C		
Glow timer			
Model	S81NJ		
Rated voltage	12 V DC		
Working temperature	−40°C～85°C		
Initial characteristic (Normal temperature, normal humidity, Vcc = 12 V)	6± 0.7 sec		
Environmental characteristic (−30°C to 70°C, Vcc = 7 to 15 V)	6± 1.3 sec		
Glow relay			
Model	G71SP		
Rated voltage	12 V DC		
Continuous rating	1 minute		
Coil resistance	13 Ω		
Inductance	24 mH (at 1 kHz)		
Working temperature	−40°to 100°C (70° to 100°C for 20 sec or less continued use)		

Injection timing : BT-DC on Compression Stroke (At SS)

Model	Specification or standard	Repair limit
L2A-61DA, L2E-61WM, L2E-61SDG, L2E-61DA, L2E-61SD, L3A-61TG, L3A-61WM, L3C-61WM, L3C-61DA, L3C-63WM, L3C-63WMA, L3E-61DA, L3E-61WM, L3E-61SD, L3E2-62ES, L3E2-63ESA	15° ±1.5°	15° ±2.0°
L2A-61A, L2A-61RR, L2A-61SS, L2A-62SDG, L2C-61A, L2C-61CV, L2E-61HMG, L2E-61A, L2E-61ES, L2E-61SC, L2E-61SS, L2E-62SDG, L2E-61SA, L2E-61WH, L2E-62ES, L2E-61GS, L2E-61SHG, L2E-61SDH, L3A-61A, L3A-61RG, L3A-61ES, L3C-61A, L3C-61TG, L3C-61ES, L3C2-62TG, L3E-61A, L3E-61SS, L3E-61SA, L3E-61SC, L3E-61TG, L3E-61RG, L3E-31NSA, L3E-61DS, L3E-61HMG, L3E-61SHS, L3E-61LS, L3E-61KG, L3E-61KL, L3E-61SDH, L3E-61SC, L2E2-61ES	17° ±1.5°	17° ±2.0°
L2A-62A, L2A-62DA, L2A-62SS, L2A-61DM, L2C-62A, L2E-61TM, L2E-62A L2E-62DA, L2E-62WM, L2E-62SS, L2E-62PL, L2E-61DM, L2E-61IR, L3A-62A, L3C-62A, L3C-62A, L3C-62WM, L3C-62DA, L3E-61TM, L3E-62A, L3E-62DA, L3E-62WM, L3E-62SS, L3E2-62TG	19° ±1.5°	19° ±2.0°

8-03 TIGHTENING TORQUE CHART AND SEALANT CHART

Parts to be tightened	Size(Width across flat of hex.head)	Tightening torque[N.m]	
Cylinder head bolt , main	M10 (14)	7.5～8.5	[73.5～83.3]
Cylinder head bolt , sub	M 8 (12)	2.0～3.0	[19.6～29.4]
Connecting rod cap nut	M 8 (14)	3.2～3.5	[31.3～34.3]
Flywheel bolt	M10 (17)	8.5～9.5	[83.3～93.1]
Crankshaft pulley nut	M16 (24)	10.0～12.0	[98.0～117.6]
Main bearing cap bolt	M10 (17)	5.0～5.5	[49.0～53.9]
Rocker stay bolt	M 8 (12)	1.5～2.2	[14.7～21.5]
Rocker cover nut	M 6 (10)	0.5～0.7	[4.9～6.8]
Nozzle holder (fitting to engine)	M20 (21)	5.0～6.0	[49.0～58.8]
Nozzle union color fixing nut	M12 (17)	2.0～3.0	[19.6～29.4]
Nozzle retaining nut	M16 (21)	3.5～4.0	[34.3～39.2]
Fuel injection pipe nut	M12 (17)	2.5～3.5	[24.5～34.3]
Delivery valve holder	M16 (17)	3.5～3.9	[34.3～38.2]
Injection pump hollow screw	M10 (14)	1.0～1.5	[9.8～14.7]
Injection pump air vent screw	M 6 (10)	0.5～0.7	[4.9～6.8]
Solenoid locknut	M30 (36)	4.0～5.0	[39.2～49.0]
Water temperature gauge joint	M16 (23)	2.0～3.0	[19.6～29.4]
Thermoswitch	M16 (19)	1.9～2.7	[18.6～26.4]
Thermo gauge unit	M16 (17)	1.9～2.7	[18.6～26.4]
Oil filter	M20	1.1～1.3	[10.0～12.7]
Oil relief plug	M18 (22)	4.0～5.0	[39.2～49.0]
Oil drain plug	M18 (19)	5.0～6.0	[49.0～58.8]
Glow plug	M10 (12)	1.5～2.0	[14.7～19.6]
Glow plug lead wire fitting nut	M 4 (7)	0.1～0.15	[0.9～1.4]

■Tightening Tor que for Common bolts and Nuts

Unit: kgf·m (lbf·ft) [N·m]

Thread diameter	Identification on head		
	4	7	
M6	0.4 ± 0.1 (3 ± 0.7) [3.9 ± 1]	0.9 ± 0.1 (6.5 ± 0.7) [8.8 ± 1]	
M8	1.1 ± 0.1 (8 ± 0.7) [10.8 ± 1]	1.85 ± 0.35 (13.4 ± 2.5) [18 ± 3]	
M10	2.15 ± 0.35 (15.6 ± 2.5) [21 ± 3]	3.6 ± 0.6 (26 ± 4.3) [35.3 ± 6]	
M12	3.6 ± 0.6 (26 ± 4.3) [35.3 ± 6]	6.5 ± 1 (47 ± 7) [63.7 ± 10]	
M14	6 ± 1 (43 ± 7) [59 ± 10]	9.5 ± 1.5 (69 ± 11) [93.2 ± 15]	

■Tightening Torque for Common Plugs

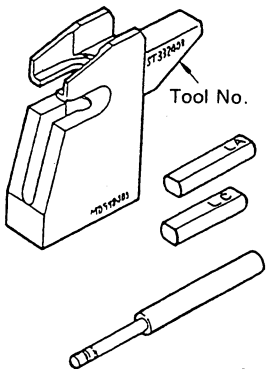
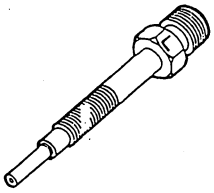
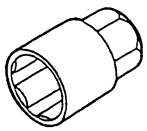
Unit: kgf·m (lbf·ft) [N·m]

Size	For aluminum materials	For ferrous materials
NPTF1/16	0.65 ± 0.15 (4.7 ± 1) [6.4 ± 1]	1 ± 0.2 (7.2 ± 1) [10 ± 2]
PT1/8	1 ± 0.2 (7.2 ± 1) [10 ± 2]	1.85 ± 0.35 (13.4 ± 2.5) [18 ± 3]
PT1/8, NPTF1/4	2.5 ± 0.5 (18 ± 4) [25 ± 5]	4 ± 0.5 (29 ± 4) [39 ± 5]
PT3/8	—	6.5 ± 1 (47 ± 7) [64 ± 10]

■Sealant Chart

Parts requiring sealant application		Surface	Sealant	Where sealant-coated parts are to be mounted
Threaded parts	Fuel cutoff solenoid	Effective screw threads	THREE-BOND 1212 or 1211	Cylinder block
	Water drain joint		HERMESEAL H1 or THREE-BOND 1344	Cylinder block
	Oil pressure switch			Gear case
	Taper plug (NPTF 1/16)			Cylinder block
press-fit part	Sealing cap	Periphery of press-fit part	HERMESEAL 52B	Cylinder head and cylinder block
	Expansion plug			Cylinder block
	Oil level gauge guide			
Other	Side seal	Periphery	THREE-BOND 1212 or 1211	Cylinder block
	Bearing cap	Contact surface with block	THREE-BOND 1212	

8-04 SPECIAL TOOLS

Tool No.	Tool name	Sketch	Application
ST332400	Piston pin setting too (Exclusive use for L series)		Removal and installation of piston pin Guide LA (92 ℓ) : for L2A, L3A Guide LC (89.5 ℓ) : for L2C, E, L3C, E
ST332270	Compression gauge adapter (Exclusive use for L series)		Measurement of cylinder compression (With "L" mark)
MD998054	Oil pressure switch socket wrench (26)		Removal and installation of oil pressure switch

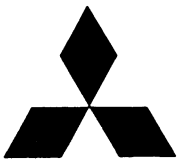
In addition to the above, commercially available general tools such as bearing pullers, valve seat cutters, valve guide installers, oil filter wrenches, etc. are required.

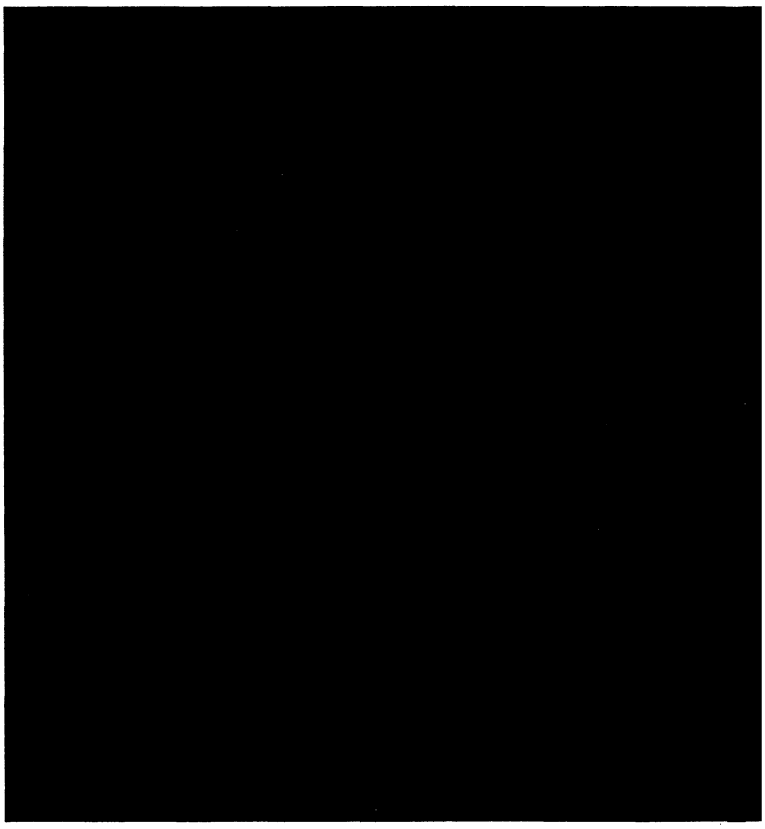
April 2001 SERVICE MANUAL

MITSUBISHI DIESEL ENGINE

L-SERIES

Pub.No. 99619-15180





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