HOW TO USE THIS MANUAL

1. Exploded views

In the exploded views, the component parts are separated but so arranged to show their relationship to the whole. Index numbering is used to identify the parts and to indicate a sequence in which the parts are to be removed for disassembly, or they are to be installed for assembly.

2. Symbols

The following symbols are used in this manual to emphasize important and critical instructions.

NOTE	Indicates a condition that is essential to highlight.
⚠CAUTION	Indicates a condition that can cause engine damage.
⚠WARNING	Indicates a condition that can cause personal injury or death.

3. Definition of locational terms

The fan end is "front" and the flywheel end is "rear." The words "left" and "right" are as these directions would appear from the flywheel end.

4. Dimensional or specification terms

Nominal size ---------- Is the named size which has no specified limits of accuracy.

Standard ---------- Is the dimension of a part to be attained at the time of assembly, or the standard performance.

Limit ----------Is the maximum or minimum permissible limit beyond which a part must be repaired or replaced.

5. Tightening torques

Tighten bolt, nuts, etc. in a wet condition (apply oil to threads) when specified as [WET]. Tighten them in a dry condition unless so specified. Use the general torques unless otherwise specified.

INTRODUCTION

This service manual has instructions and procedures for the subject on the front cover. The information, specifications and illustrations in this manual are on the basis of the Information that was current at the time this issue was written.

Correct servicing, test and repair procedures will give the engine a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective Sections of this manual to know all the components he will work on.

Continuing improvement of product design may have caused changes to your engine Which are not included in this manual.

Whenever a question arises regarding your engine, or this manual, consult your KUKJE dealer for the latest available information.

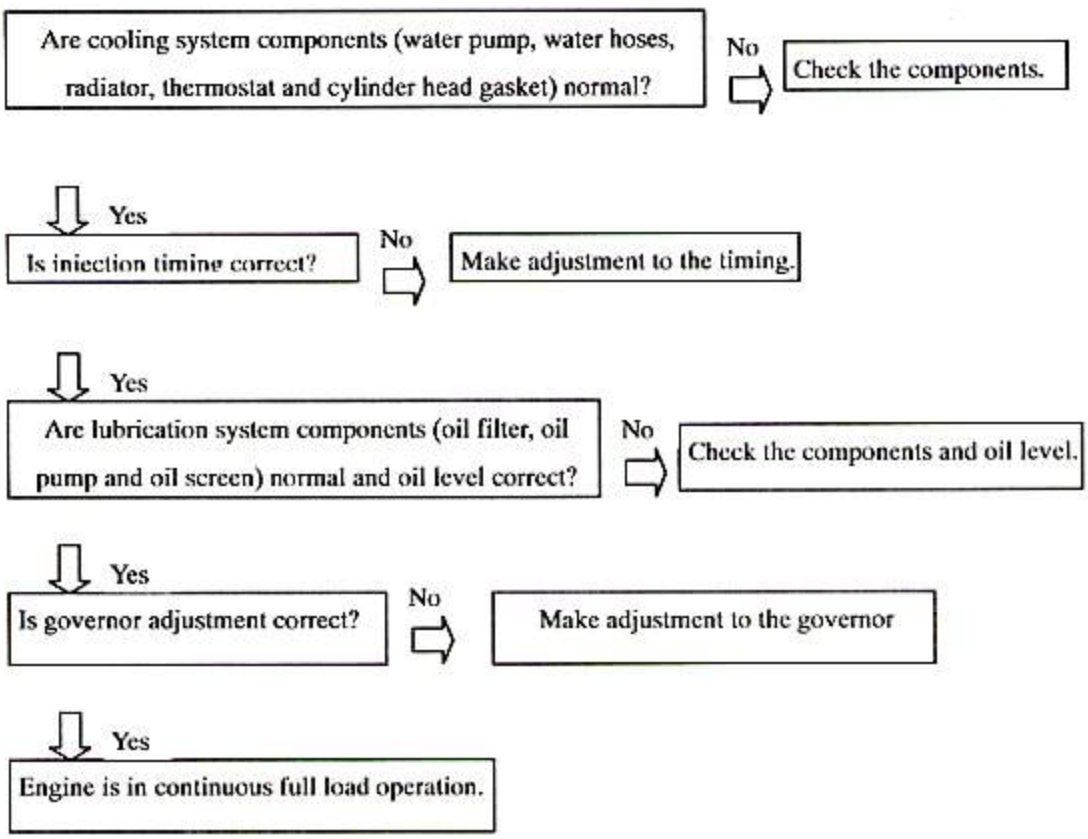
Problem 3: Overheating

(1) Items to be checked for ahead

Overheating might also be caused by abnormal operating conditions. If the engine is overheating but its cooling system is not contributing to this trouble, it is necessary to check the difference between the ambient temperature and coolant temperature when the engine is in normal operation (with the thermostat fully open). If the ambient temperature is higher than the normal coolant temperature by more than 60℃ (108℃), investigate other items than those related to the engine cooling system.

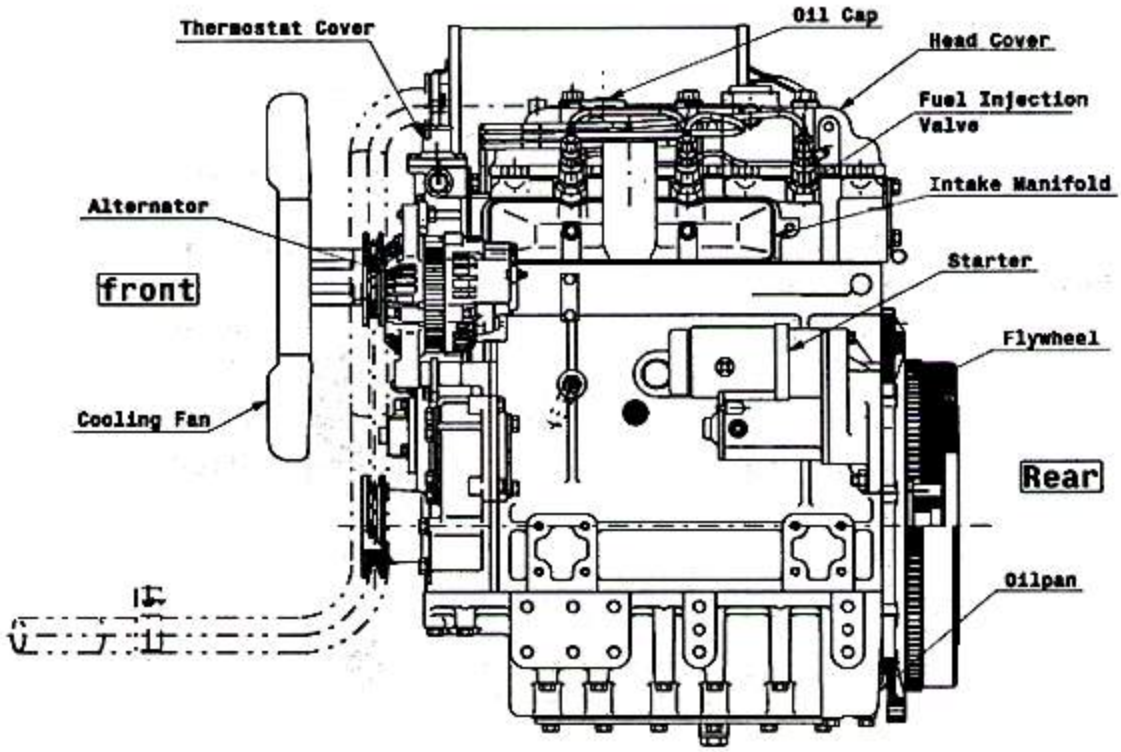
- Insufficient coolant and exterior coolant leaks
- Loose fan belt
- Radiator core openings plugged with dirt

(2) Inspection procedure

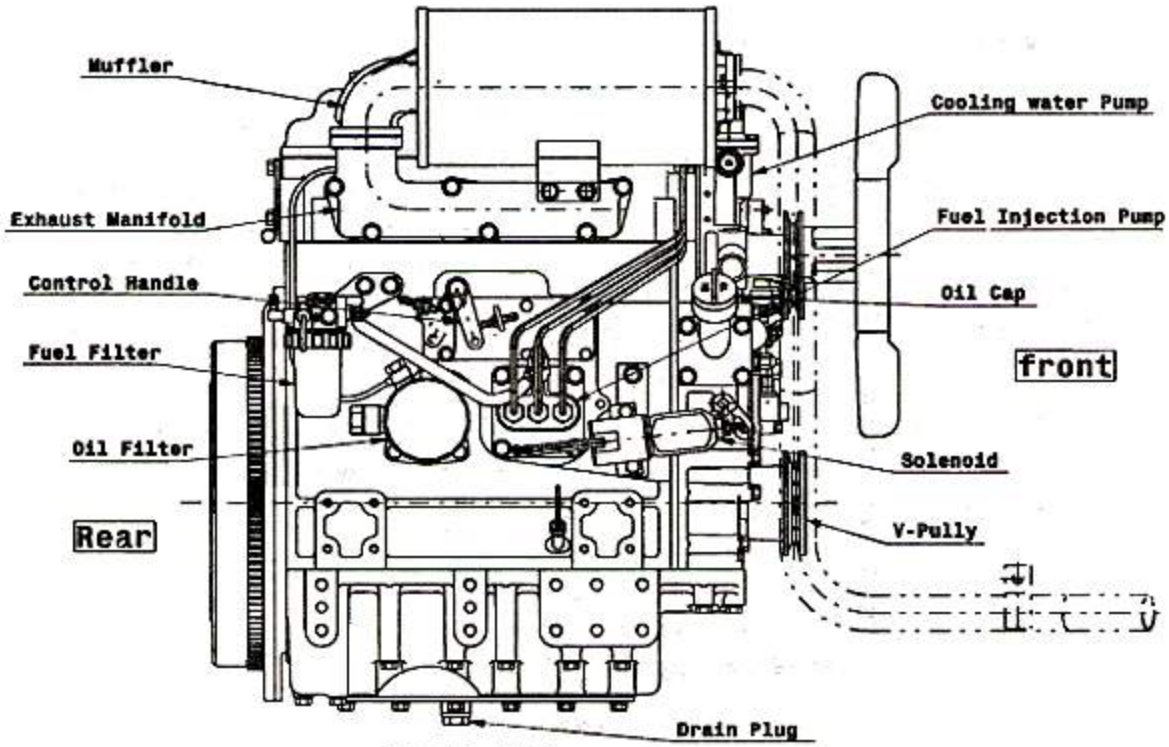


COMPONENT LOCATION

3T8 4 L-ATC



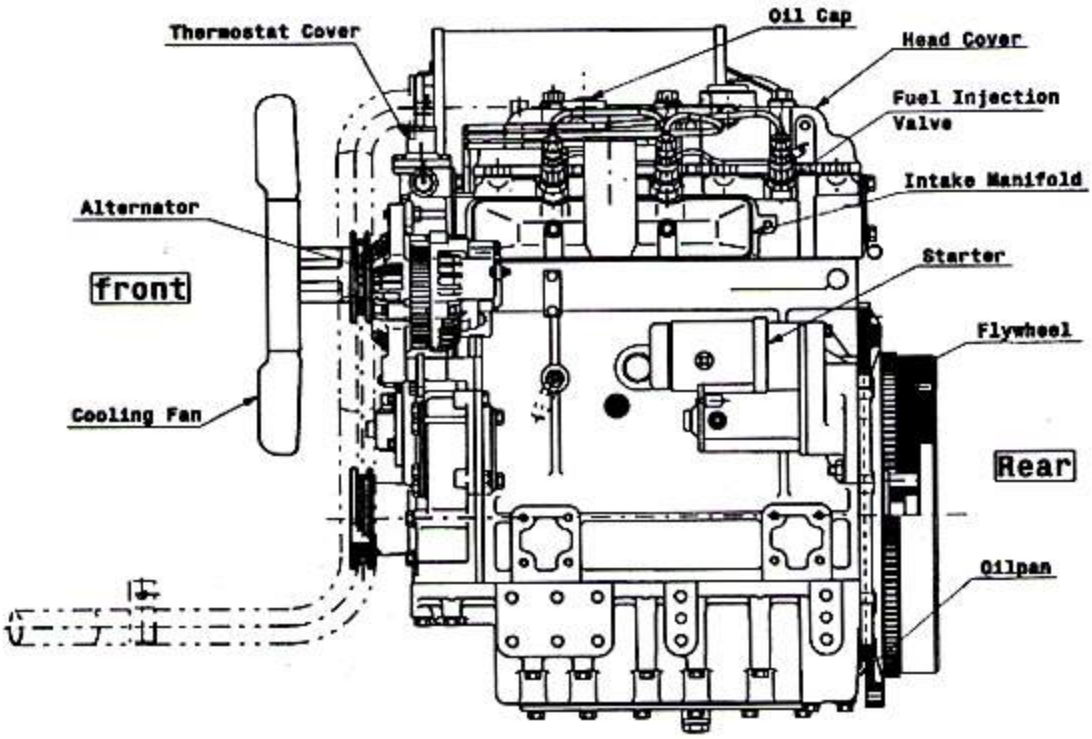
Left Side



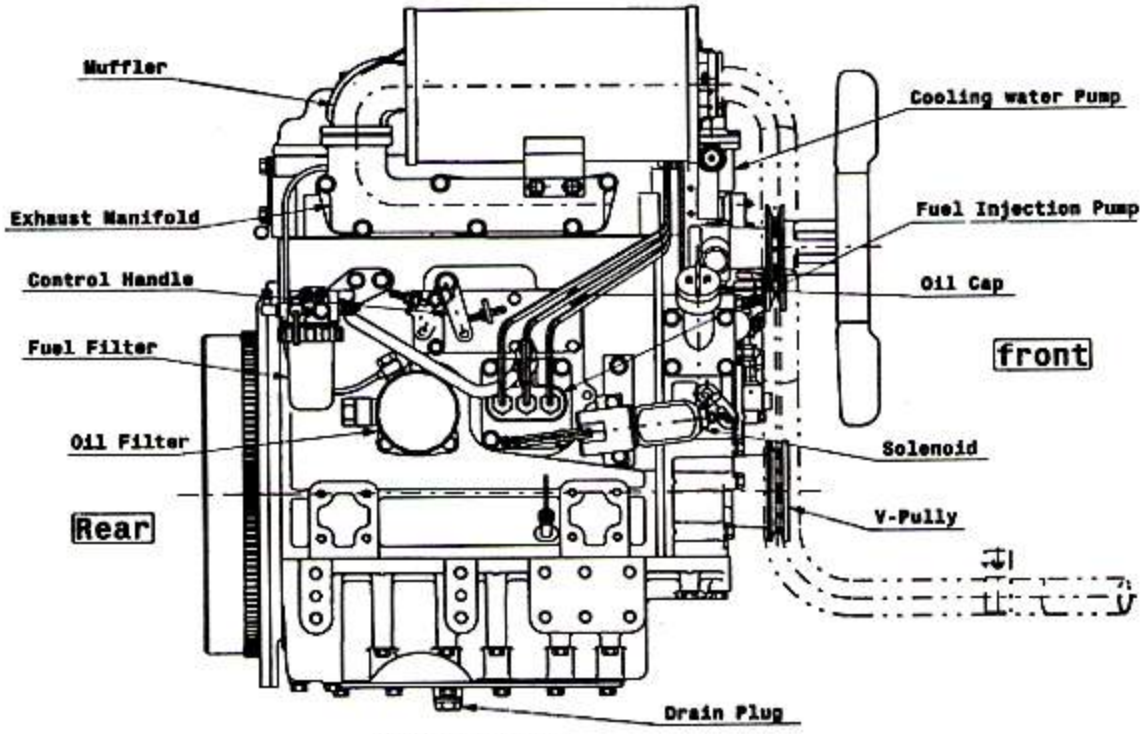
Right Side

COMPONENT LOCATION

3T90 L-ATC



Left Side



Right Side

SPECIFICATIONS

Engine model	Unit	3T84L-ATC	3T90L-ATC	3T90LT-ATC
Type		In line – 4 cycle, water cooled diesel engine		
Combustion system		Swirl – chamber		
NO. of cylinder		3		
Bore and Stroke	mm(in)	84 x 94 (3.31 x 3.7)	90 x 94 (3.54 x 3.7)	
Displacement	ℓ (cu.in)	1.562(95.36)	1.794(109.52)	
Compression ratio		20.7	21	
Aspiration		Naturally aspirated		Turbo Charger
Injection pressure	kg f/㎠ lbf/in² [kPa]	150 (2133) [14709]		
Fuel		ASTM No. 2-D		
Engine oil		API Service classification CD		
Direction of rotation		Counterclockwise(viewed from flywheel)		
Cooling system		Radiator (Forced cooling)		
Lubricating system		Forced lubrication with trochoid pump		
Starter	V – kW	12 – 2.0		
Alternator	V – A	12 – 50		
Lube. Oil Capacity / Max.	ℓ (US gal)	6.1 (1.61)		7.5 (1.98)
Lube. Oil Capacity / Effect	ℓ (US gal)	3.3 (0.87)		4.5 (1.19)
Cooling water Capacity (excluding radiator)	ℓ (US gal)	4.5 (1.19)		
Output	hp/rpm	28/2600	35/2600	40/2600
Max revolution speed at no road	rpm	2800±50		
Min revolution speed at no road	rpm	1000±50		
sfc	g/kW·h (lb/kW·h)	≤ 292 (0.64)		
Fuel injection timing		bTDC 20∧±1		bTDC19∧±1
Governor		Mechanical centrifugal governer		
Starting system		Electrical		

Dimension L×W×H	mm(in)	657.6×494.8 ×708.8 (25.89×19.48×27.91)	660.6×494.8 ×708.8 (26.01×19.48×27.91)	660.6×494.8 ×708.8 (26.01×19.48×27.91)
Dry weight	kgf(1bf)[N]	210(463) [2060.1]		225(496) [2207.25]

OVERHAUL INSTRUCTION

DETERMINING WHEN TO OVERHAUL THE ENGINE

TROUBLESHOOTING

1. General
2. Engine troubleshooting
   - Problem 1 : Hard starting
   - Problem 2 : Fuel knock
   - Problem 3 : Overheating
   - Problem 4 : Black exhaust smoke
   - Problem 5 : Erratic idle speeds
   - Problem 6 : Low power or loss of power
3. Starting system troubleshooting

BASIC PRECAUTIONS FOR DISASSEMBLY AND ASSEMBLY

1. Disassembly
2. Assembly

DETERMINING WHEN TO OVERHAUL THE ENGINE

Generally, when to overhaul the engine is to be determined by taking into account a drop in compression pressure as well as an increase in lube oil consumption and excessive blow-by gases.

Lower power or loss of power, an increase in fuel consumption, a drop in lube oil pressure, hard starting and excessive abnormal noise are also troubles. These troubles, however, are not always the result of low compression pressure and give no valid reason for overhauling the engine.

The engine develops troubles of widely different varieties when the compression pressure drops in it. Following are the typical troubles caused by the compression pressure failure:

(1) Low power or loss of power

(2) Increase in fuel consumption

(3) Increase in lube oil consumption

(4) Excessive blow-by through breather due to worn cylinders, pistons, etc.

(5) Excessive blow-by due to poor seating of worn inlet and exhaust valves

(6) Hard starting or failure to start

(7) Excessive engine noise

In most cases, these troubles occur concurrently. Some of them are directly caused by low compression pressure, but others are not. Among the troubles listed above, (2) and (6) are caused by a fuel injection pump improperly adjusted with respect to injection quantity or injection timing, worn injection pump plungers, faulty injection nozzles, or poor care of the battery, starter and alternator.

The trouble to be taken into account as the most valid reason for overhauling the engine is (4): in actually determining when to overhaul the engine, it is reasonable to take this trouble into account in conjunction with the other ones.

TROUBLESHOOTING

1. General

The diagnosis of troubles, especially those caused by a faulty fuel injection pump or injection nozzles, or low compression pressure, can be difficult. It requires a careful inspection to determine not which item is me cause, but how may causes are contributing to me trouble, someone of which is the primary cause. Several causes may be contributing to a single trouble.

On the following pages, there are troubleshooting charts on which engine troubles can be traced to their causes. Each chart has items to be verified ahead and suggested inspection procedure.

Diesel engines exhibit some marked characteristics during operation. Knowing these characteristics will help minimize time lost in tracing engine troubles to their source. Following are the characteristics of diesel engines you should know about for diagnosis:

- Combustion knock (diesel knock)
- Some black exhaust smoke (when the engine picks up load)
- Vibration (due to high compression pressure and high torque)
- Hunting (when the engine speed is quickly decreased)
- Some white exhaust smoke (when the engine is cold, or shortly after the engine has been started)

TROUBLESHOOTING

1. General

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- Hunting (when the engine speed is quickly decreased)
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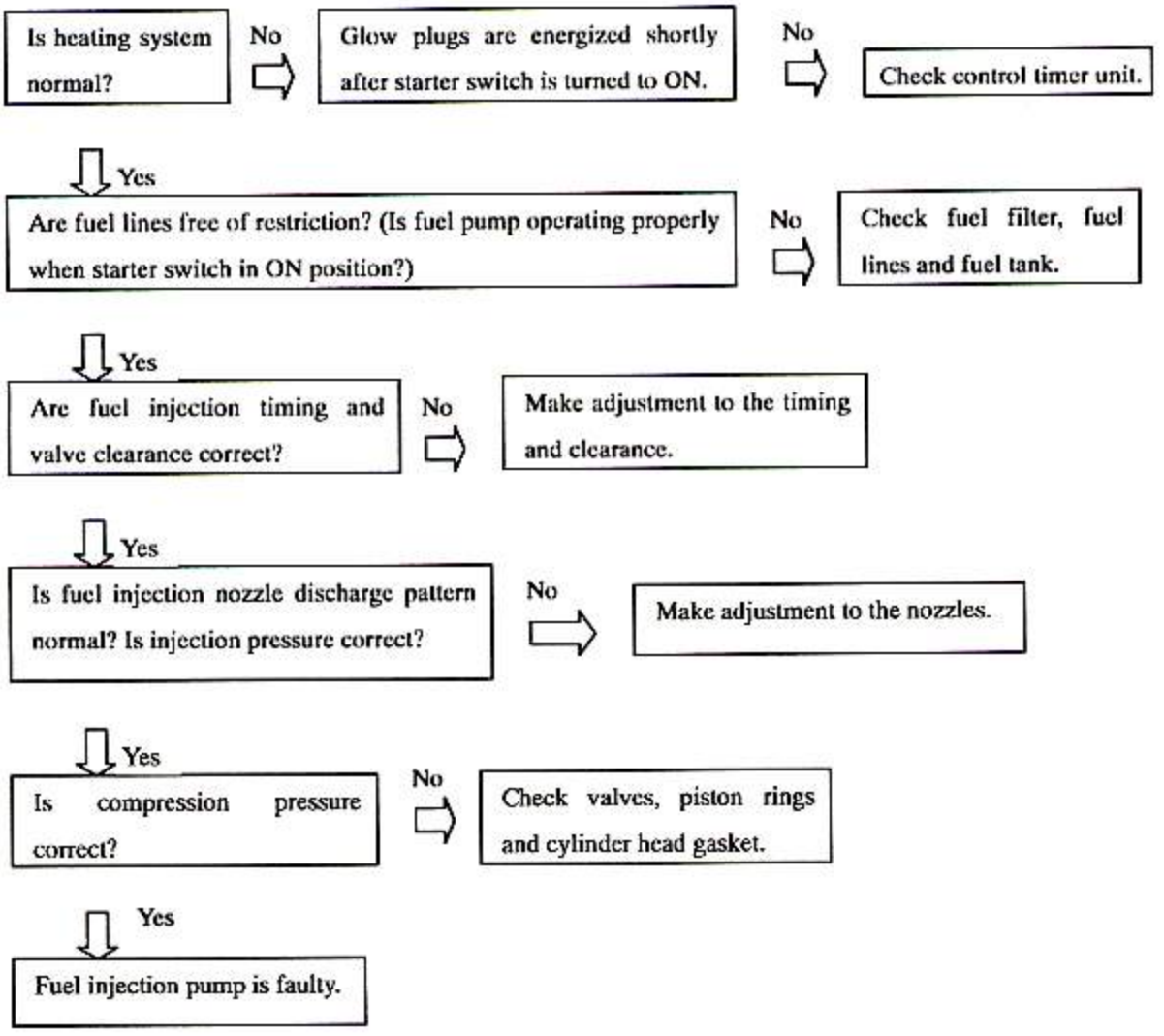
2.Engine troubleshooting

Problem 1: Hard starting

(1) Items to be checked for ahead

- Clogged air cleaner
- Wrong oil grade for weather conditions
- Poor quality fuel
- Low cranking speed

(2) Inspection procedure



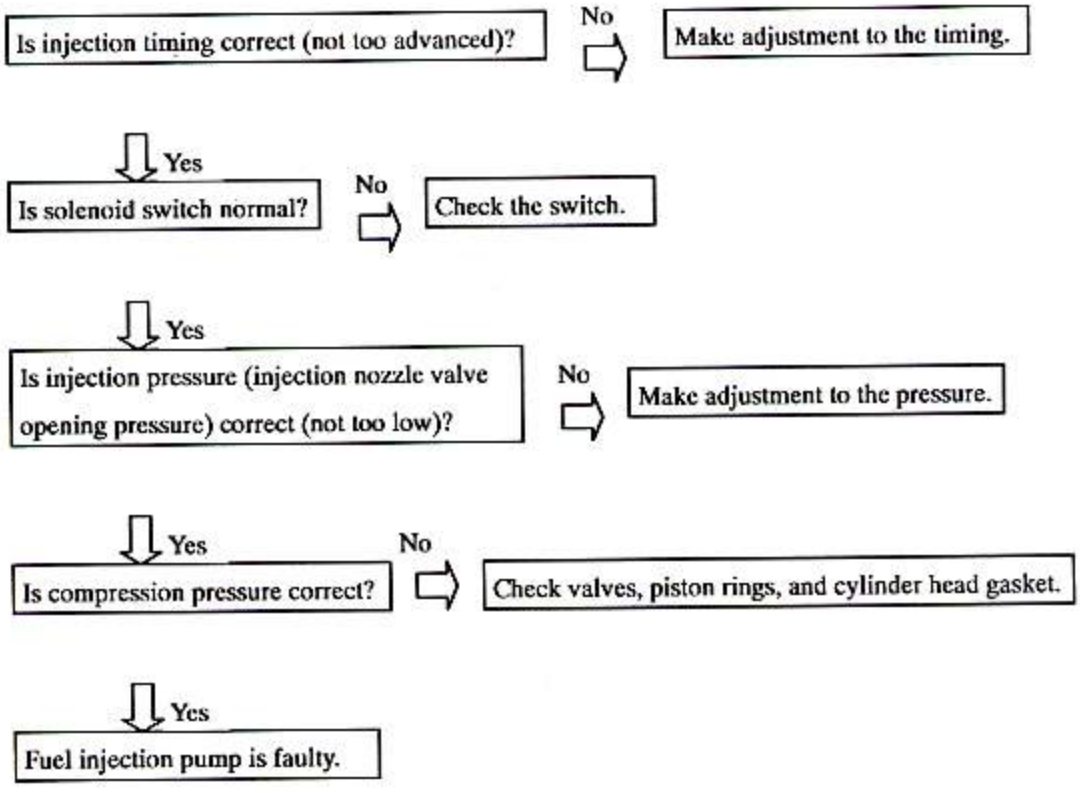
Problem 2: Fuel knock

More or less fuel knock occurs in diesel engines. This may be caused either by an excessively large delay period or by a too fast rate of fuel injection.

(1) Items to be checked for ahead

- Clogged air cleaner
- Poor quality fuel

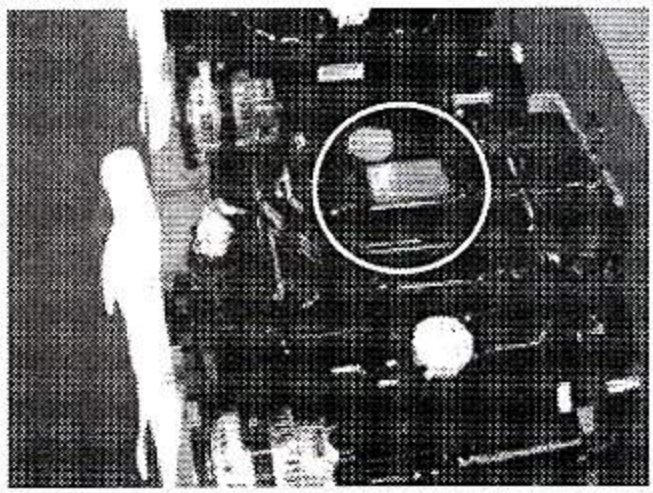
(2)Inspection procedure



MODEL IDENTIFICATION AND SERIAL NUMBER LOCATION

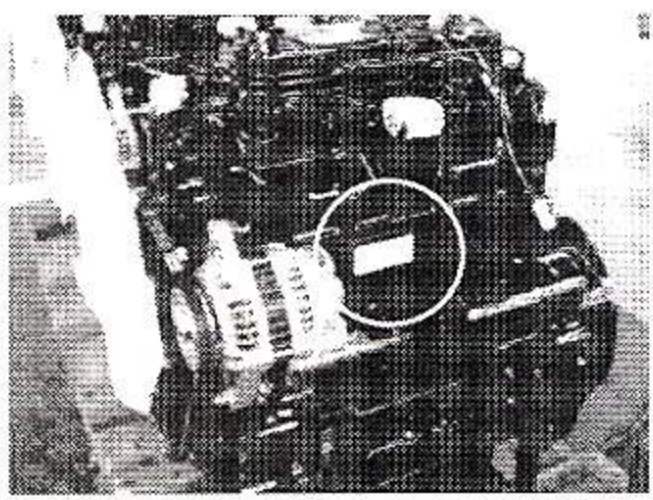
1. Model identification location

(a) The label of model identification is located on the cover of cylinder head .



2. Serial Number Location

The bar code of serial number is located the left hand side on the block.

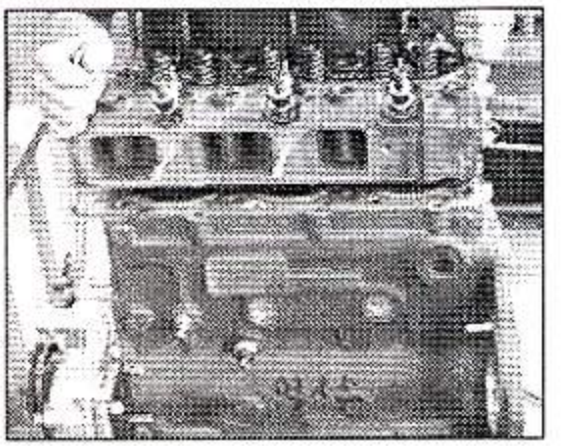


4. Cylinder head assembly removal

Lift the cylinder straight up with a hoist.

NOTE

If the gasket is seized and the cylinder head cannot be separated from the cylinder block, tap around the thick side portion of the cylinder head with a plastic hammer.



Removing cylinder head assembly

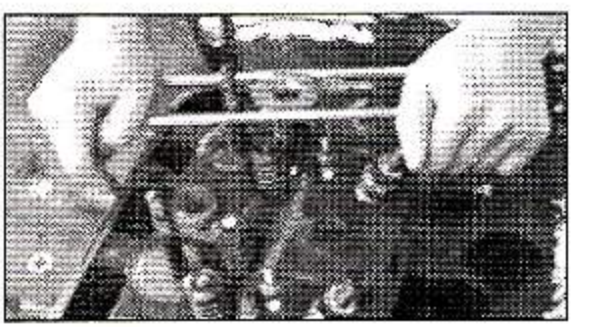
5. Valve and valve spring removal

(1) Compress the valve spring with a valve lifter and remove the valve lock.

(2) Remove the retainer, spring and valve

NOTE

.The valves, retainers, springs and valve locks must be set aside separately in groups, each tagged for cylinder number, for correct installation.



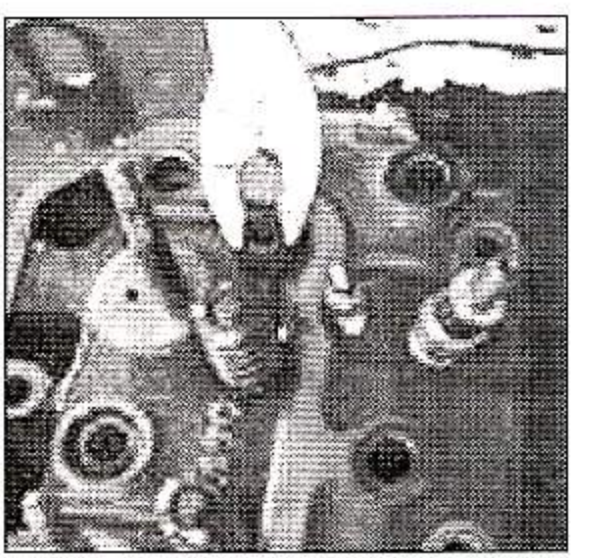
Removing valve spring

6. Valve stem seal removal

Remove the valve stem seal with a pliers.

NOTE

Do not reuse the valve stem seals.



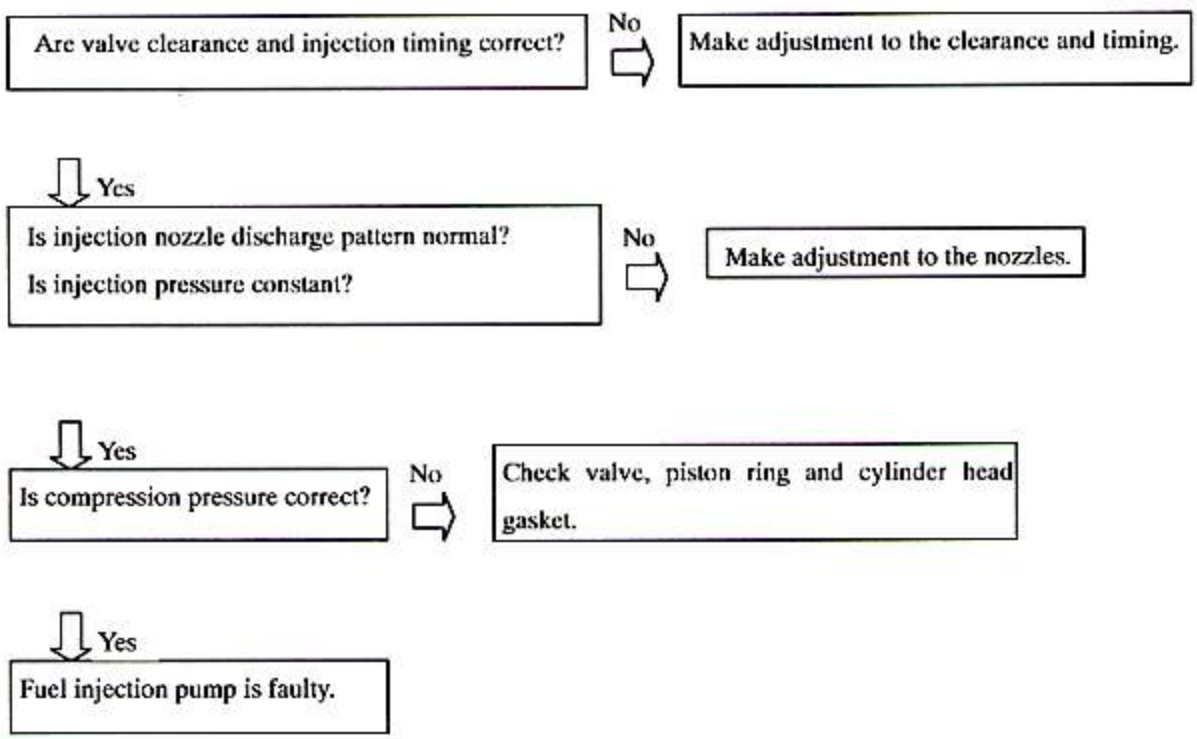
Removing valve stem

Problem 5: Erratic idle speeds

(1) Items to be checked for ahead

- Maladjusted engine control
- Wrong oil grade for weather conditions
- Poor quality fuel

(2) Inspection procedure

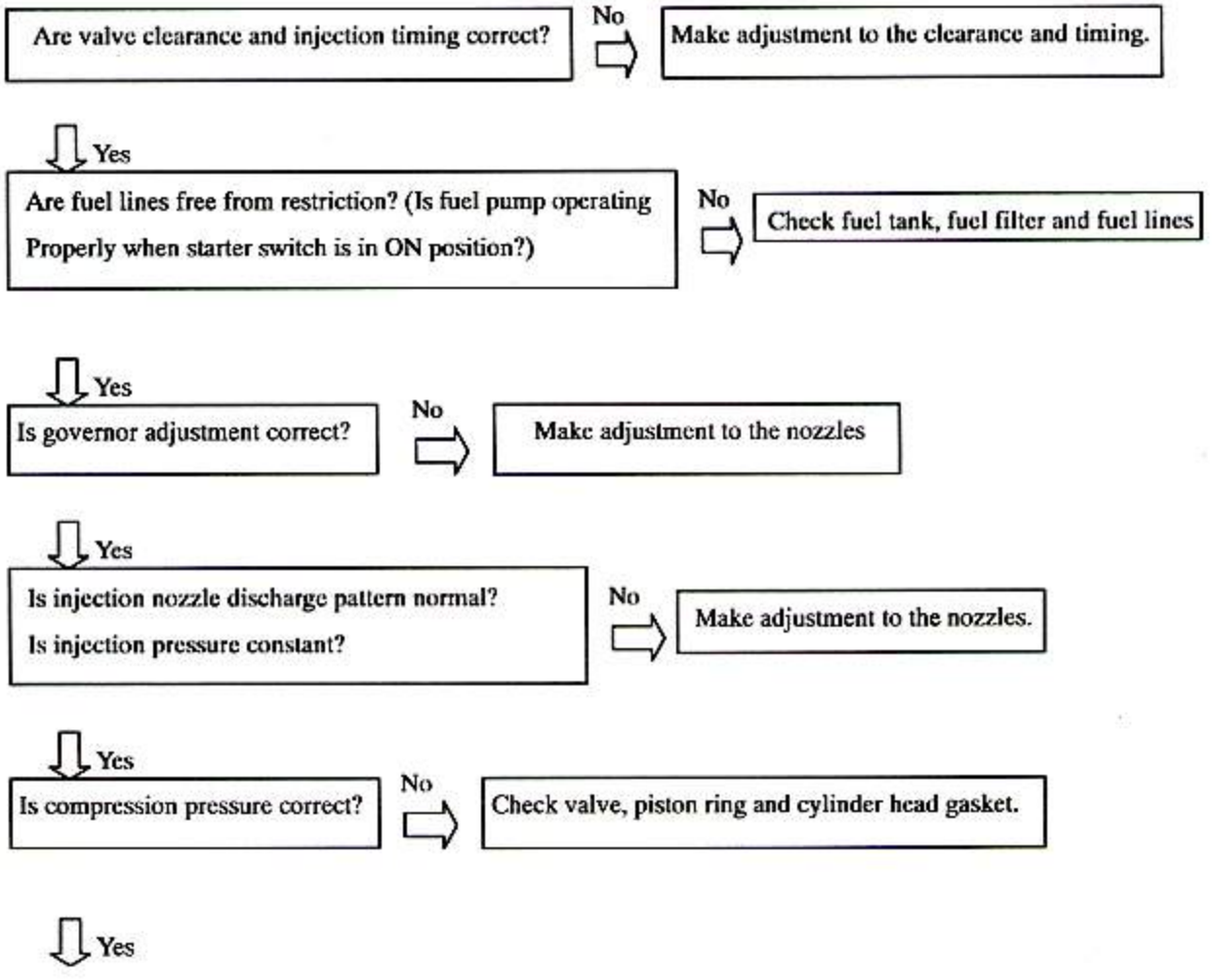


Problem 6: Low power or loss of power

(1) Items to be checked for ahead

- Stuck running parts
- Wrong oil grade for weather conditions
- Poor quality fuel
- Clogged air cleaner
- Restricted exhaust line
- Faulty power take–off

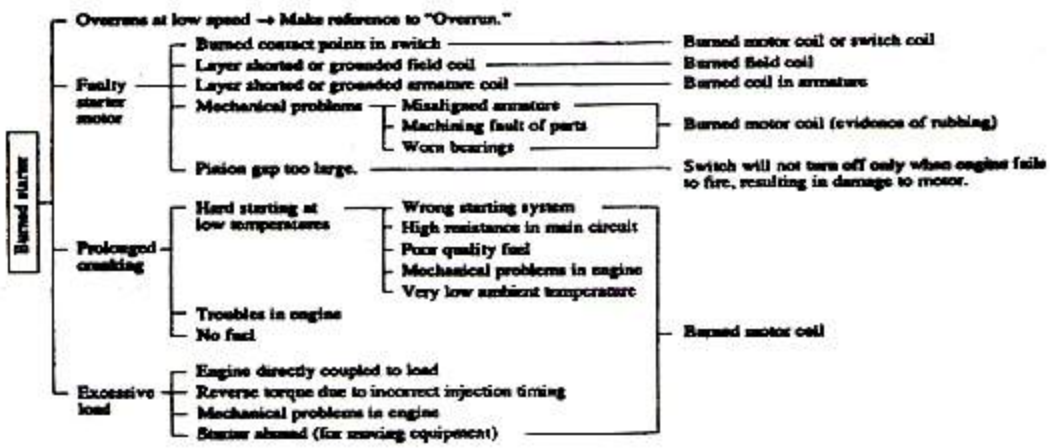
(2) Inspection procedure

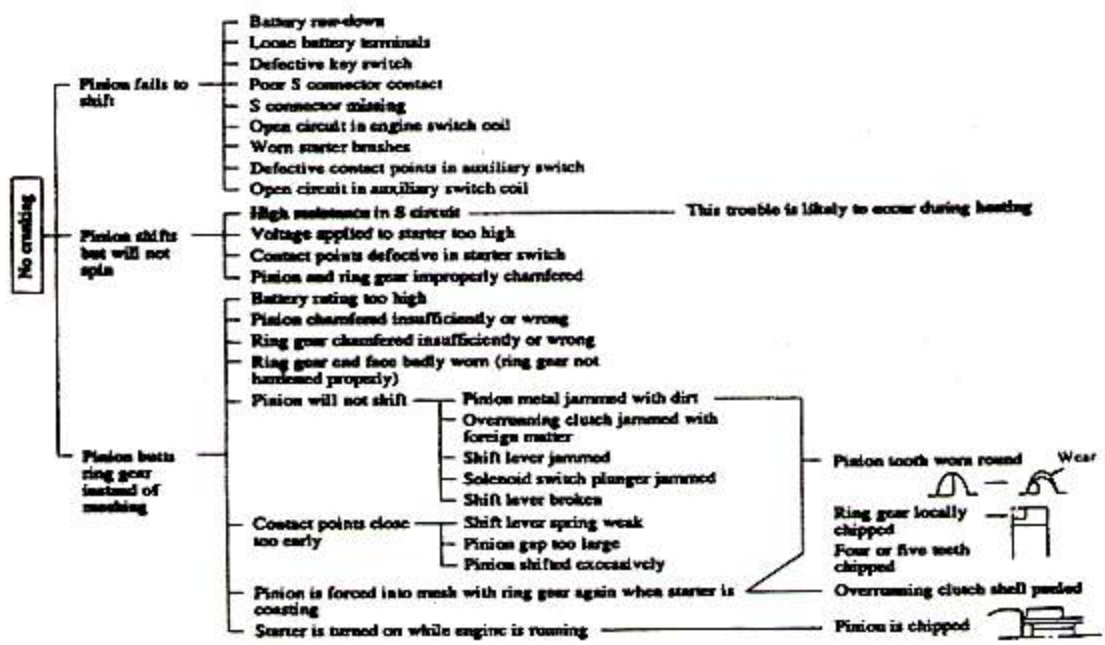


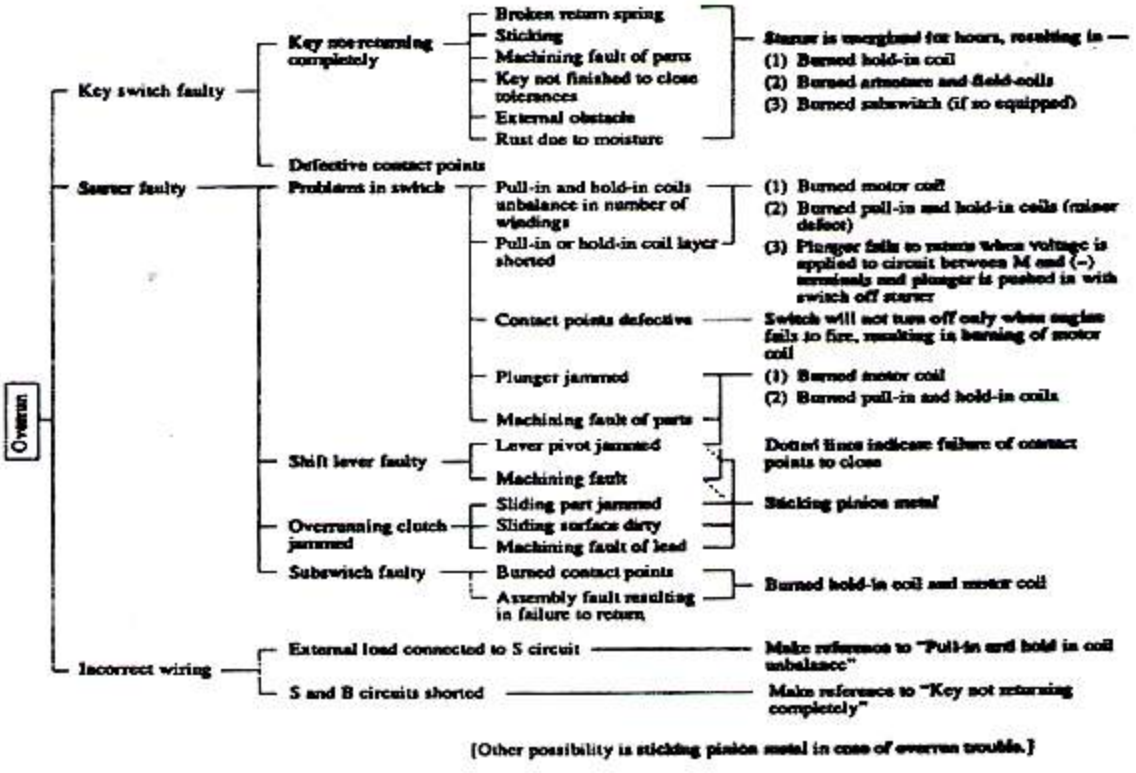
Fuel injection pump is faulty.

OVERHAUL INSTRUCTIONS

3. Starting system troubleshooting







[Other possibility is sticking pinion metal in case of overrun trouble.]

BASIC PRECAUTIONS FOR DISASSEAIBLY AND ASSEMBLY

This section outlines basic precautions recommended by KUKJE that should always be observed.

1. Disassembly

(1) Always use tools that are in good condition and be sure you understand how to use them before performing any job.

(2) Use an overhaul stand or a work bench, if necessary. Also, use bins to keep engine parts in order of removal.

(3) Parts must be restored to their respective components from which they were removed at disassembly. This means that all parts must be set aside separately in groups, each marked for its component, so that the same combination or set can be reproduced at assembly.

(4) Pay attention to marks on assemblies, components and parts for their positions or directions. Put on marks, if necessary, to aid assembly.

(5) Carefully check each pan or component for any sign of faulty condition during removal or cleaning. The part will tell you how it acted or what was abnormal about it more accurately during removal or cleaning.

(6) When lifting or carrying a part too heavy or too awkward for one person to handle, get another person's help and, if necessary, use a jack or a hoist.

2. Assembly

(1) Wash all parts, except for oil seals, 0-rings, rubber sheets, etc., with cleaning solvent and dry them with pressure air.

(2) Always use tools that are in good condition and be sure you understand how to use them before performing any job.

(3) Use only good-quality lubricants. Be sure to apply a coat of oil, grease or sealant to parts as specified.

(3)Be sure to use a torque wrench to tighten parts for which torques are specified.

(4)Any time the engine is assembled, new gaskets and 0-rings must be installed.

DISASSEMBLY

PREPARATION FOR DISASSEMBLY

1. Engine oil draining
2. Coolant draining

ELECTRICAL SYSTEM

1. Starter
2. Alternator

COOLING SYSTEM

1.Cooling fan removal
2.Thermostat case removal
3.water pump assembly removal

FUEL SYSTEM

1.Fuel injection pipe removal
2.Fuel injection nozzle removal
3.Governor assembly removal
4.Governor weight removal
5.Fuel injection pump removal

LUBRICATION SYSTEM

1. Oil filter removal
2.Pressure relief valve removal
3.Oil pressure switch removal

AIR INLET SYSTEM AND EXHAUST SYSTEM

1. Exhaust manifold removal
2. Air inlet cover removal

CYLINDER HEAD AND VALVE MECHANISM

1.Rocker shaft assembly removal
2.Rocker shaft disassembly
3.Cylinder head bolt removal
4.Cylinder head assembly removal
5.valve and valve spring removal
6.valve stem seal removal

TIMING GEARS AND FLYWHEEL

1. Flywheel removal
2. Rear plate removal
3. Oil seal case removal
4. Crankshaft pulley removal
5. Timing gear case removal
6. Timing gear backlash measurement
7. Idler gear removal
8. Oil pan removal
9. Oil screen removal

CRANKSHAFT, PISTONS AND CONNECTING ROD

1. Thrust clearance measurement for connecting rod big end
2. Connecting rod cap removal
3. Piston removal
4. End play measurement for crankshaft
5. Main bearing cap removal
6. Crankshaft removal
7. Piston separation from connecting rod
8. Removal cylinder liner

CAMSHAFT, TAPPET AND OIL PUMP

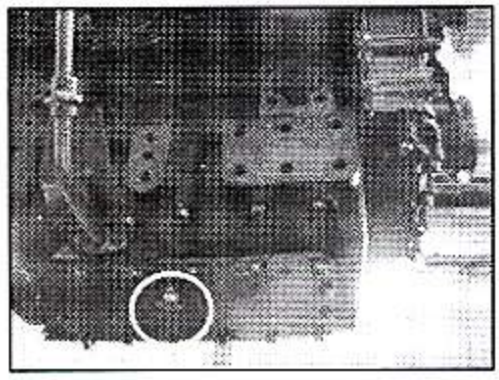
1. Camshaft removal
2. Tappet removal
3. Oil pump removal(when required)

PREPARATION FOR DISASSEMBLY

1. Engine oil draining

Remove the drain plug from the bottom of the oil pan and allow the oil to drain.

Refill capacities (high level excl. 0.5 liter (0.13 U.S. gal) of oil in oil filter, liter (U.S. gal)	3T84L-ATC	6.1 (1.61)
	3T90L-ATC	6.1 (1.61)
	3T90LT-ATC	7.5 (1.98)



Draining engine Oil

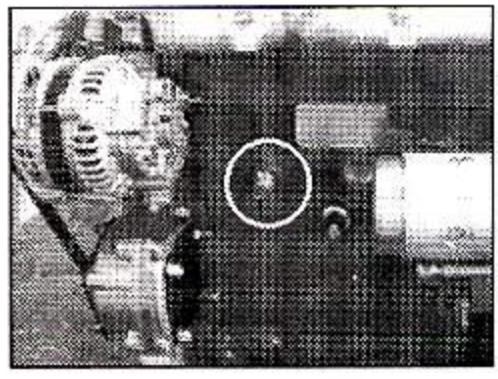
⚠ WARNING

Hot oil and component can cause personal injury. Do not allow hot oil or components to contact skin.

2. Coolant draining

Loose the drain plug on the right side of the cylinder block and allow the coolant to drain.

Refill capacities, Liter (U.S. gal)	3T84L-ATC	4.5ℓ (1.19)	Excluding radiator
	3T90L-ATC	4.5ℓ (1.19)	
	3T90LT-ATC	4.5ℓ (1.19)	



Draining coolant

ELECTRICAL SYSTEM

1. Starter

1.1. Testing before disassembly

(1) Clearance between pinion and housing (pinion clearance)

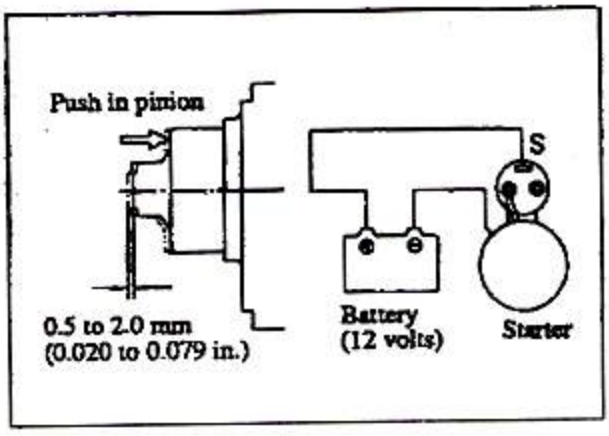
(a) Connect the starter to a 12 volt battery as shown in the illustration to cause the pinion to shift into cranking position and remain there.

⚠ CAUTION

Due to the amount of current being passed through the solenoid series winding, this test must be made within 10 seconds

(b) Push the pinion toward the commutator end by hand to measure its free movement (pinion clearance).

(c) The pinion clearance must be 0.5 to 2.0 mm (0.020 to 0.079 in.). If the clearance is out of this range, make an adjustment to it by adding or removing the packings on the magnetic switch. Adding the packings will decrease the clearance.

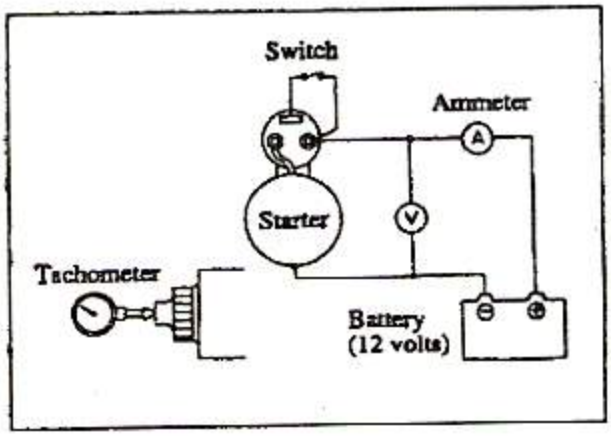


Connections for measuring pinion clearance

(2) No-load characteristics

(a) Connect the starter to a 12 volt battery With an ammeter capable of indicating several hundred amperes as shown in the illustration.

(b) Close the switch to make sure the pinion shifts into cranking position properly and the starter runs at speeds higher than is specified. If the current draw and/or operating speed is out of the standard, disassemble the starter for inspection and repairs.

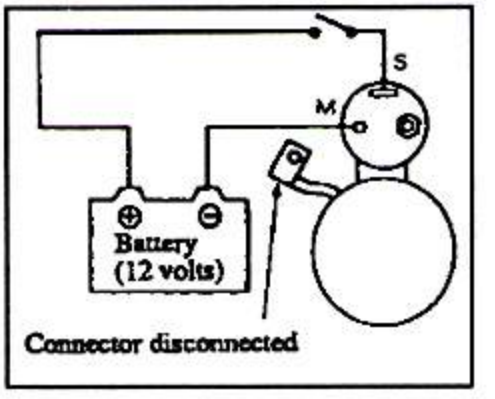


Connections for testing no-load characteristics

⚠CAUTION

a) The size of wires used for this test must be as large as possible. Tighten the terminals securely.
b) This starter has a reduction gear. Do not confuse gear noise with some abnormal noise else.
c) When measuring the starter speed at the end of the pinion, be ready for accident shifting of the pinion.

(3) Magnetic switch
(a) Disconnect the connector from the M terminal of the magnetic switch.
(b) Connect the magnetic switch to a 12 volt battery with a switch as shown in the illustration to test the pull-in coil. Close the switch to see if the pinion shifts. If the piston fails to shift, the magnetic switch is faulty.

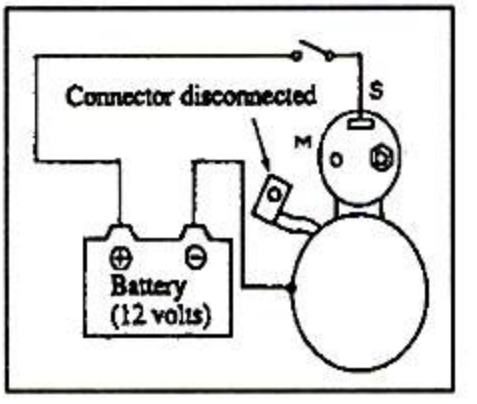


Connection for testing pull-in coil

⚠CAUTION

Due to the amount of current being passed Through the solenoid series winding, this test must be made within 10 seconds.

(c) Connect the magnetic switch to a 12 volt battery with a switch as shown in the illustration to test the hold-in coil. Close the switch and pull the pinion away from the commutator end by hand. Release the pinion to see if it remains there. If the pinion returns, the magnetic switch is faulty.

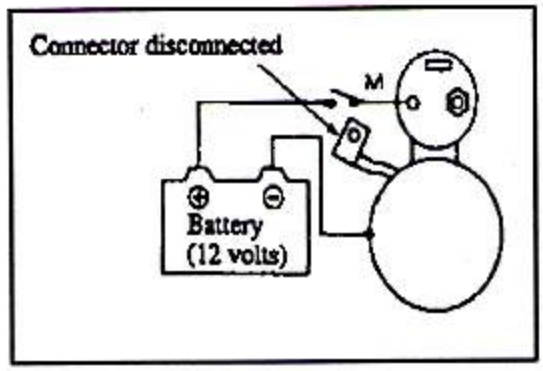


Connections for testing hold-in coil

⚠CAUTION

Due to the amount of current being passed Through the solenoid series winding, this test must be made within 10 seconds.

(d) Connect the magnetic to a 12 volt battery with a switch as shown in the illustration to make a pinion return test. Close the switch and pull the pinion away from the commutator end by hand. Release the pinion to see if it returns immediately when released. If the pinion fails to so return, the magnetic switch is faulty.



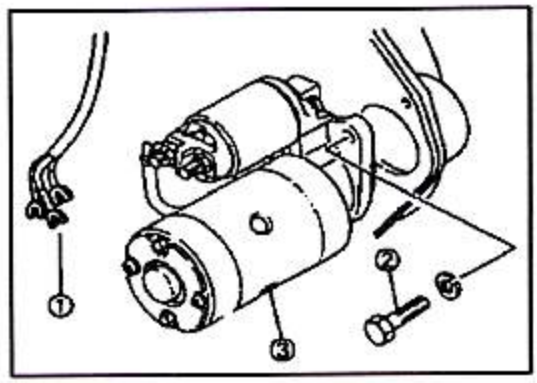
Connections for pinion return test

CAUTION

Due to the amount of current being passed through the solenoid series winding, this test must be made within 10 seconds.

1.2. Removal

(1) Disconnect the battery wires. Disconnect the negative (-) wire first.
(2) Disconnect wire (1) from the starter.
(3) Loosen bolts (2) (two) holding starter (3) in position and remove the starter.



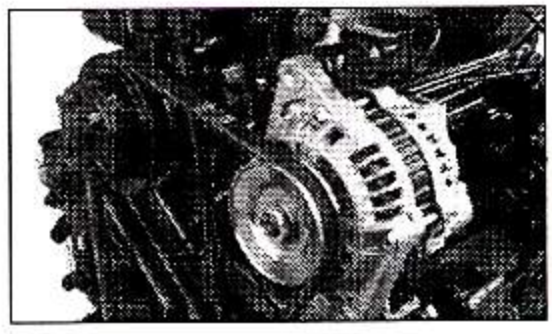
Removing starter

2. Alternator

1.1. Inspection before removal

The correct diagnosis of the charging system requires a careful inspection with the alternator on the engine to determine whether or not it is necessary to remove the alternator from the engine for further inspection. The following chart, in which two troubles are listed with four possible causes of each, will help locate the cause of the trouble:

Alternator charge too high	Voltage regulator setting too high
	Ground return circuit defective
	Wiring incorrect
	Series resistor or winding open-circuited
Alternator give no charge	Alternator drive belt loose
	Voltage regulator setting too low
	Alternator output low
	Brushes worn



Alternator On engine

2.2 Precautions for removal

Following is a list of basic precautions that should always be observed for removal:

(1) When installing the battery, care must be used the make sure the negative (-) terminal is grounded.

(2) Do not use a megger (an instrument for high resistance of electrical materials).

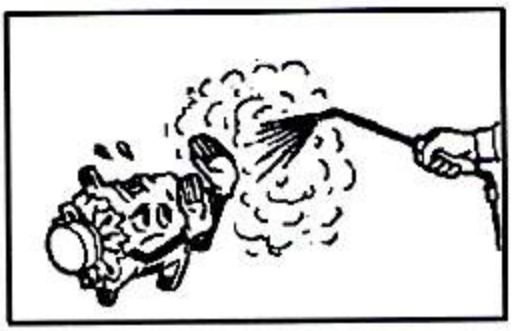
(3) Disconnect the battery cables before charging the battery.

(4) Do not attempt to disconnect the lead from the B terminal of the alternator when the engine is running.

(5) Battery voltage is being applied to the B terminal of the alternator. Do not ground it.

(6) Do not short or ground the L terminal of the alternator with a built-in IC regulator.

(7) Do not blow a spray from the steam cleaner nozzle at the alternator.



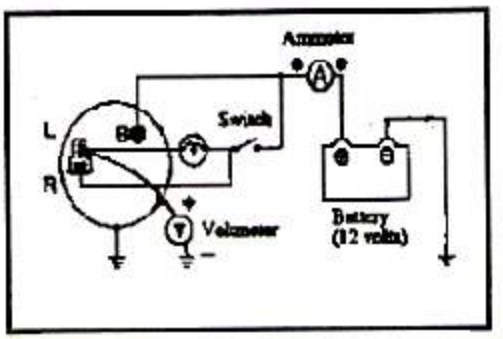
2.3 Testing voltage setting

(1) Connect the alternator to a 12 volt battery with an ammeter, a voltmeter and a switch as shown in the illustration.

(2) The voltmeter reading must be zero (0) when the starter switch is in OFF position. It must be lower than the battery voltage when the switch is in ON position (the engine will not start).

(3) With one ammeter lead short-circuited, start the engine.

(4) Read the voltmeter when the ammeter reading is below five amperes and the engine is running at 1800 rpm and also at 2500 rpm with all electrical loads turned off. The voltage setting varies with alternator temperature. Generally, the higher the alternator temperature, the lower the voltage setting.



Connections for testing voltage setting

Item	Standard
Voltage setting [at 20°C (68°F)]	14.5 ± 0.3 V

2.4 Testing output characteristics

(1) Disconnect the battery ground (negative) cable.

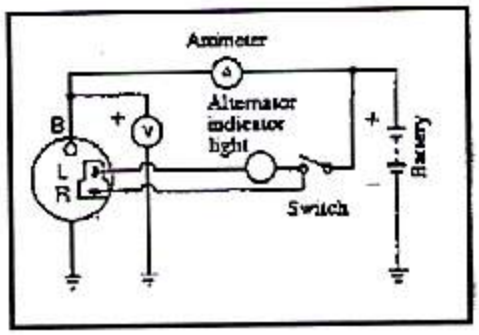
(2) Connect one ammeter lead to the B terminal of the alternator and the other lead to the positive terminal of the battery. Connect one voltmeter lead to the B terminal and the other lead to the ground.

(3) Connect the battery ground cable.

(4) Start the engine.

(5) Turn on all electrical loads.

(6) Increase the engine speed. Measure the maximum output current at the specified alternator speed when the voltmeter reading is 13.5 volts.



Connections for testing output character istics (alternator with built-in regulator)

Guaruntee 120°C [68°F]

Voltage	Output Current		Speed
	Hot	Cold	
13.5V	11A	(17A)	1500rpm
	32A	(40A)	2500rpm
	45A	(53A)	5000rpm

2.5 Removal

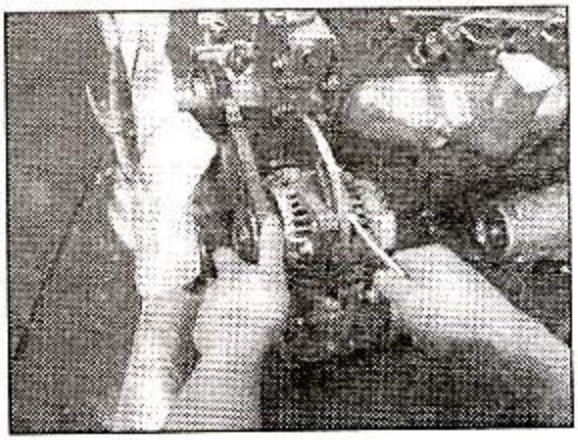
(1) Disconnect the battery cables.

(2) Disconnect the lead from the B terminal of the alternator.

(3) Disconnect the connector from the alternator.

(4) Loosen the brace and support bolts. Move the alternator toward the engine and remove the drive belt.

(5) Remove the alternator.



Removing alternator

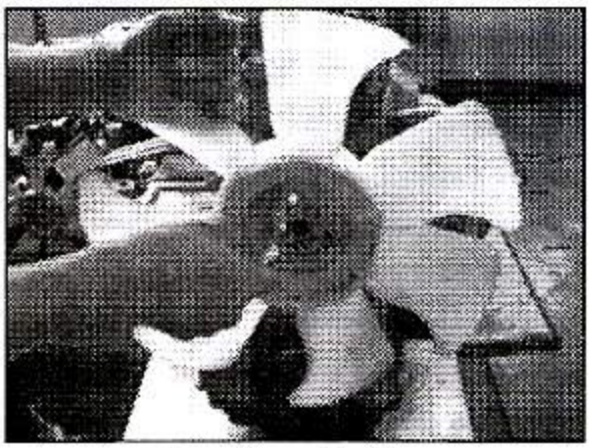
COOLING SYSTEM

1. Cooling fan removal

Hold the fan by one hand and remove the four bolts that hold the fan in position. Remove the fan and spacers.

NOTE

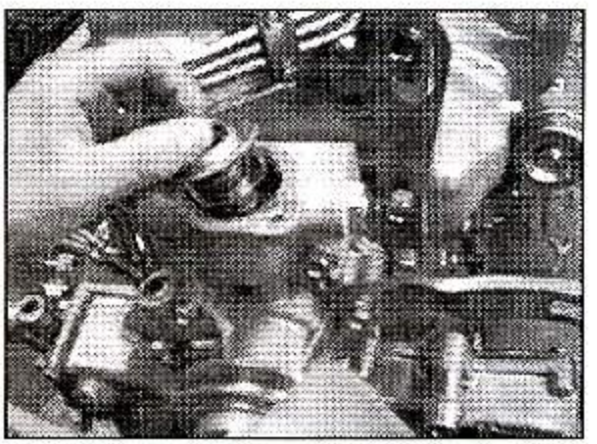
Keep the spacers with the fan for installation.



Removing cooling fan

2. Thermostat case removal

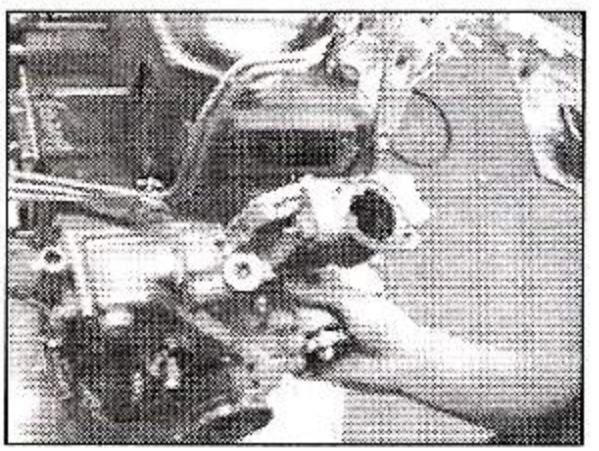
Remove the thermostat case assembly containing thermostat.



Removing thermostat

3. Water pump assembly removal

Remove the water pump assembly.



Removing water pump assembly

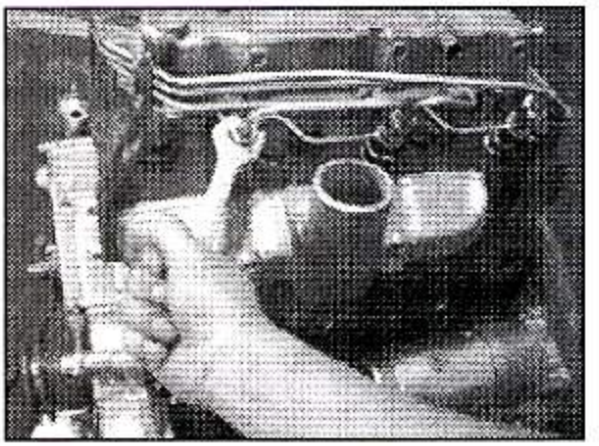
FUEL SYSTEM

1. Fuel injection pipe removal

Disconnect the fuel injection pipe and fuel leak-off pipe from the fuel injection pump and nozzles.

NOTE

Put plugs or caps on the opening of the injection pump and nozzle connectors.



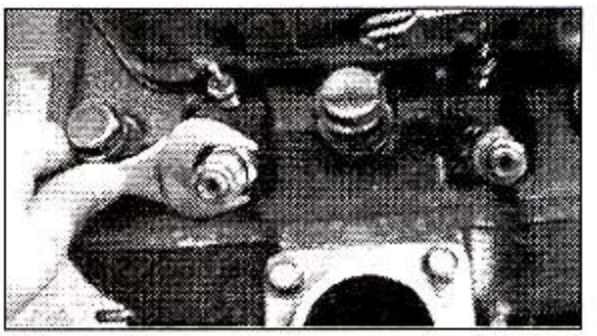
Removing fuel injection pipe

2. Fuel injection nozzle removal

Loosen the fuel injection nozzle with a wrench. Remove the nozzles and gaskets from the cylinder head.

NOTE

Remove the gaskets from the cylinder head with a screwdriver or the like. Discard defective gaskets.

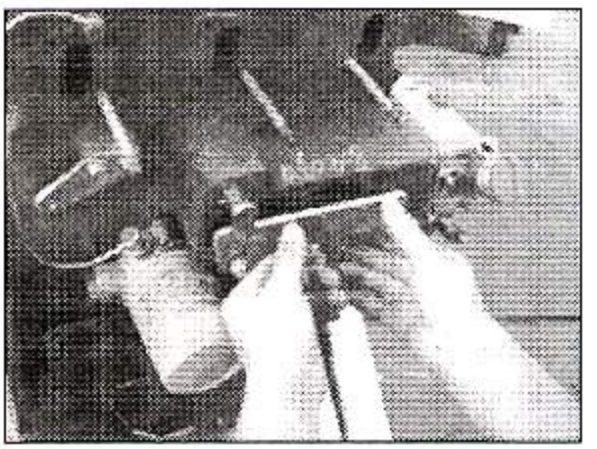


Removing fuel injection nozzles

3. Chamber Cover of fuel injection pump removal

(1) Remove the chamber cover of injection pump.

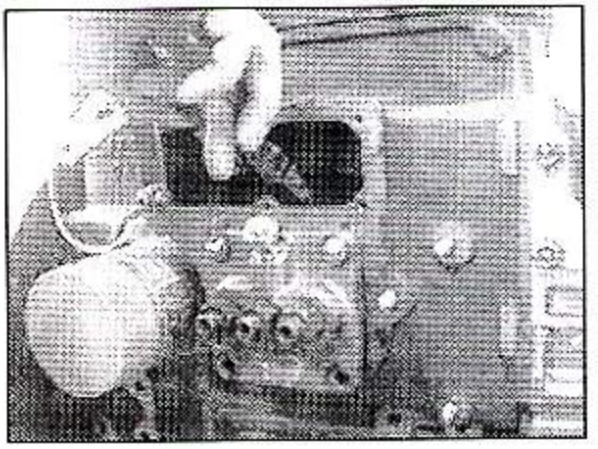
(2) Remove the governor spring.



Removing chamber cover of fuel injection

4. Pin removal

Remove the pin engaged with fuel control rack.



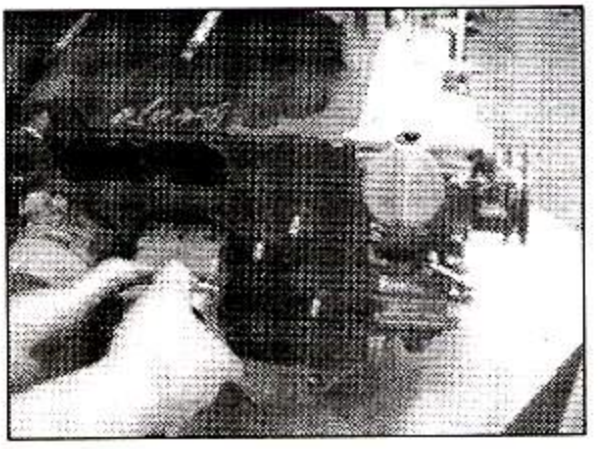
Removing the pin engaged with fuel control rack

5. Fuel injection pump removal

Remove the fuel injection pump.

NOTE

Keep a record of the thickness of shims for installation.



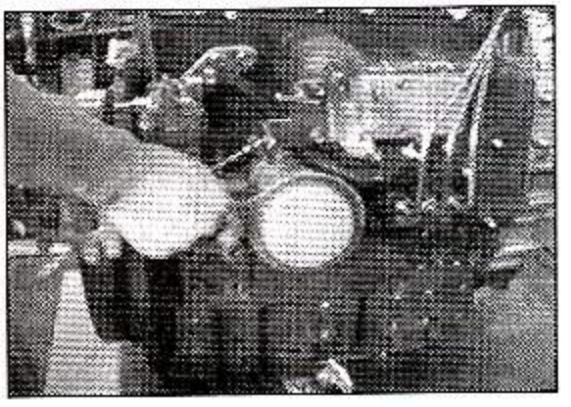
Removing governor assembly

LUBRICATION SYSTEM

1. Oil filter removal

(1) Put container under the oil filter to catch the oil.

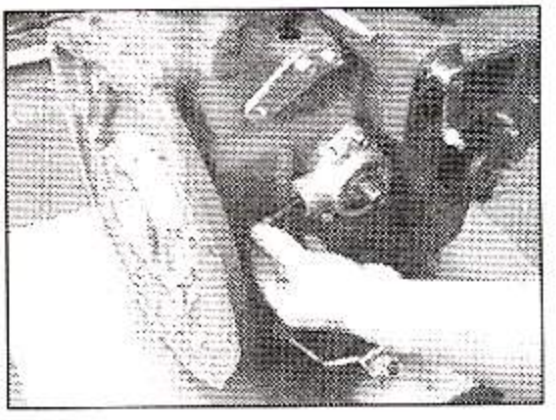
(2) Remove the oil filter from the cylinder block with a filter wrench.



Removing Oil Filter

2. Pressure relief valve removal

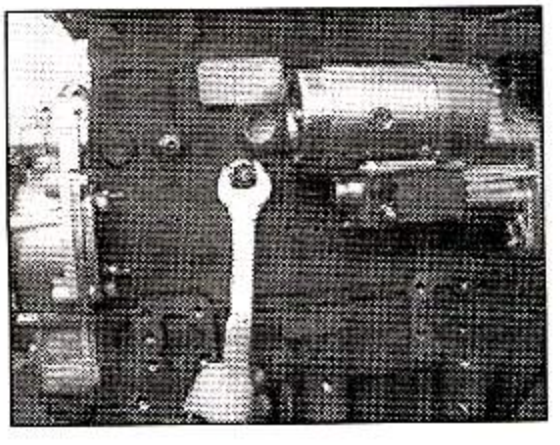
Remove the pressure relief valve from the cylinder block.



Removing oil relief valve

3. Oil Pressure switch removal

Remove the oil pressure switch with Oil Pressure Switch Socket Wrench.

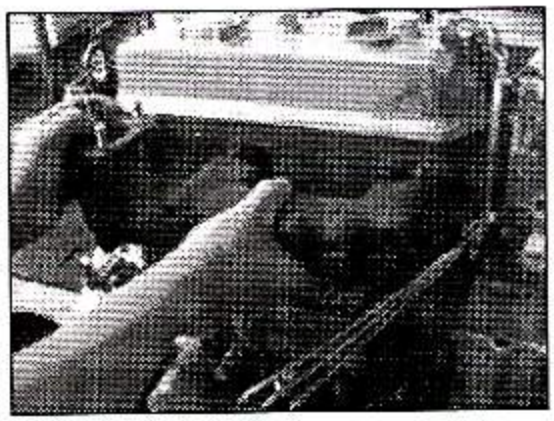


Removing oil pressure switch

AIR INLET SYSTEM AND EXHAUST SYSTEM

1. Exhaust manifold removal

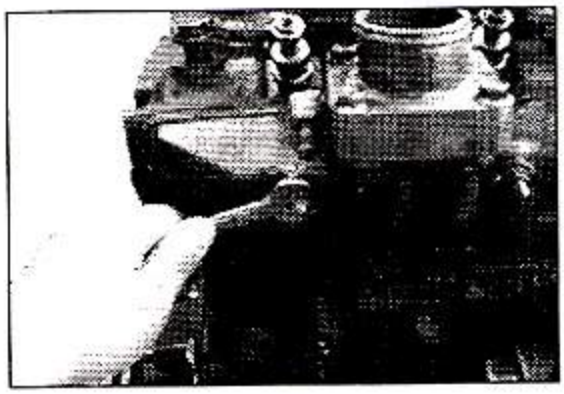
Remove the exhaust manifold from the cylinder head.



Removing Exhaust manifold

2. Air inlet cover removal

Remove the air inlet cover from the cylinder head.



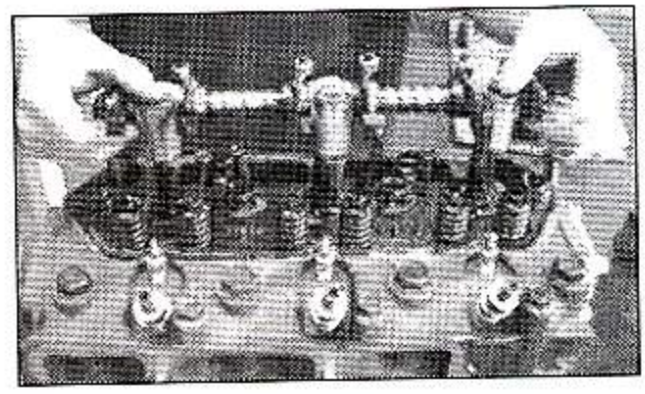
Removing air inlet cover

CYLINDER HEAD AND VALVE MECHANISM

1. Rocker shaft assembly removal

(1) Remove the bolts that hold the rocker stays in position and remove the rocker shaft assembly.

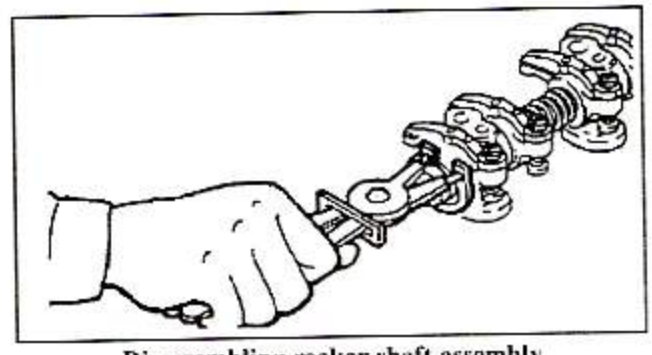
(2) Remove the valve caps.



Removing rocker shaft assembly

2. Rocker shaft disassembly

Put identification on each rocker arm as to its location on rocker shaft.



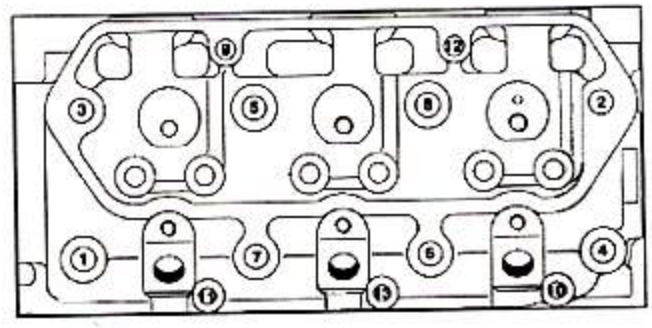
Disassembling rocker shaft assembly

3. Cylinder head bolt removal

Loosen the cylinder head bolts in two or three steps in the sequence shown.

NOTE

If any parts on the cylinder head are faulty, check the cylinder head bolts for tightness with a torque wrench before loosening them.



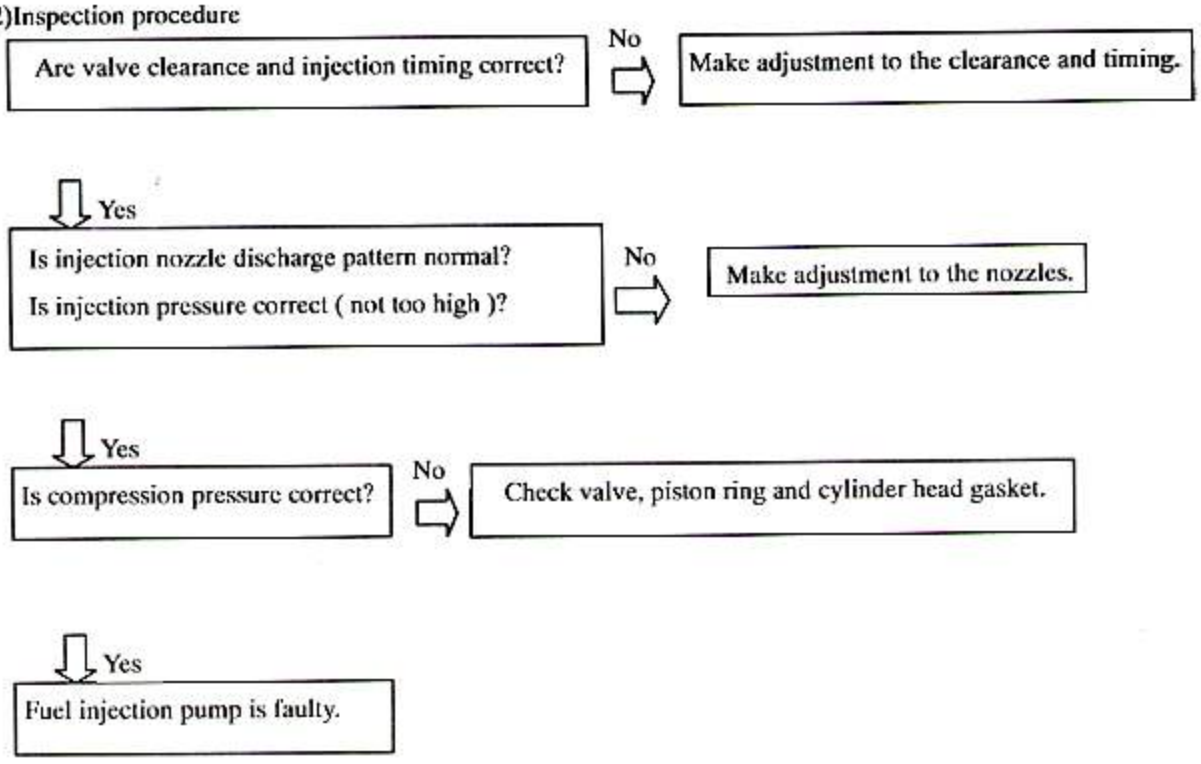
Cylinder head bolt loosening sequence

Problem 4: Black exhaust smoke

(1)Items to be checked for ahead

- Clogged air cleaner
- Poor quality fuel

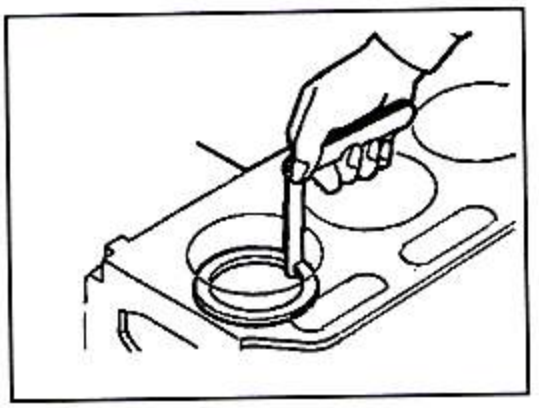
(2)Inspection procedure



(b) If the clearance still exceeds the limit after new piston rings have been installed, replace the piston.

(3) Clearance between ends of piston ring

Put the piston ring in a gauge or in the bore in a new cylinder block and measure the clearance between the ends of the ring with a feeler gauge as shown in the illustration. If the clearance exceeds the limit, replace all the rings.



Measuring clearance between ends of piston ring

NOTE

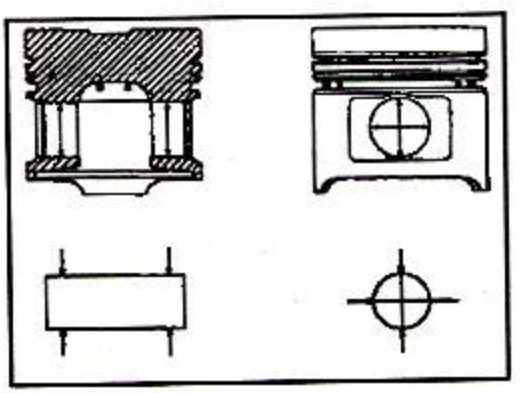
Put the piston ring in the gauge or cylinder squarely with the piston.

Unit : mm (in.)

Item		Standard	Limit
Clearance Between Ends of Piston Ring	No. 1 Compression Ring	0.2~0.35 (0.00787~0.0138)	1.0 (0.0394)
	No.2 Compression Ring	0.4~0.55 (0.016~0.022)	
	Oil ring	0.2~0.4 (0.00787~0.016)	

(4) Clearance between piston pin and piston

Measure the diameter of the piston pin and the bore in the piston for the pin as shown in the illustration to find the clearance. If the clearance exceeds the limit, replace the piston or pin whichever is badly worn.



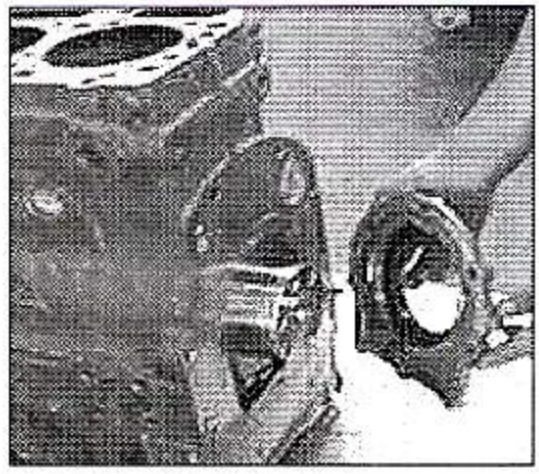
Measuring piston pin and bore in piston for pin

3. Oil seal case removal

Remove the bolts that hold the oil case in position. Remove the case from the cylinder block with a screwdriver or the like

⚠ CAUTION

Do not cause damage to the oil seal



Removing oil seal case

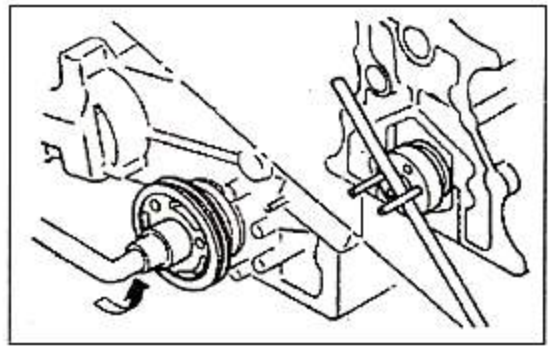
4. Crankshaft pulley removal

(1) Install two safety bars (M12 x 1.25) into the threaded holes in the rear end of the crankshaft . Put a bar between the safety bars to hold the crankshaft to prevent it from rotating.

(2) Remove the crankshaft pulley.

⚠ WARNING

When removing the crankshaft pulley, be prepared to stop the job in case the ba slips off the crankshaft to prevent in jury



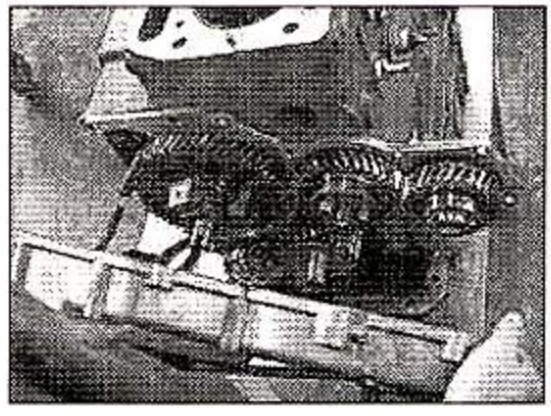
Removing crankshaft pulley

5. Timing gear case removal

Remove the bolts that hold the timing gear case in position and remove the case

⚠ CAUTION

The front plate is bolted inside the timin gear case. Do not attempt to remove thi plate along with the timing gear case by tapping



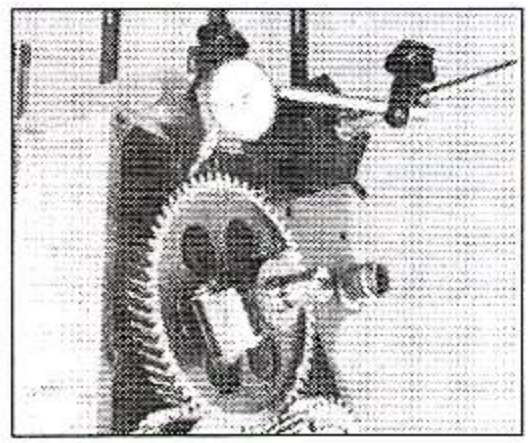
Removing timing gear case

6. Timing gear backlash measurement

Measure the backlash of each gear and keep a record of it for correct installation. Replace the gears if the backlash exceeds the limit.

Unit : mm (in.)

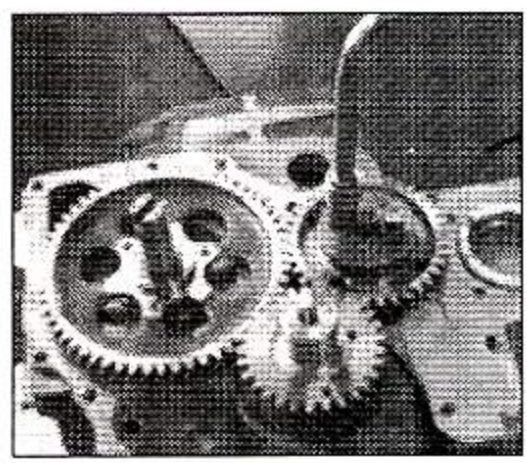
Item	Standard		Limit
Timing gear backlash	Crankshaft gear And idler gear	0.04 to 0.12 (0.0016~0.0047)	0.30 (0.0118)
	Idler gear and camshaft gear		
	Idler gear and fuel injection pump camshaft gear		
	Fuel injection pump camshaft gear and oil pump gear	0.07~0.20 (0.0028~0.0079)	
	Camshaft gear and PTO gear	0.08~0.19 (0.0028~0.0075)	



Measuring timing gear backlash

7. Idler gear removal

Remove the idler gear, rotate the gear in a direction of the helix of the teeth to pull it out of mesh

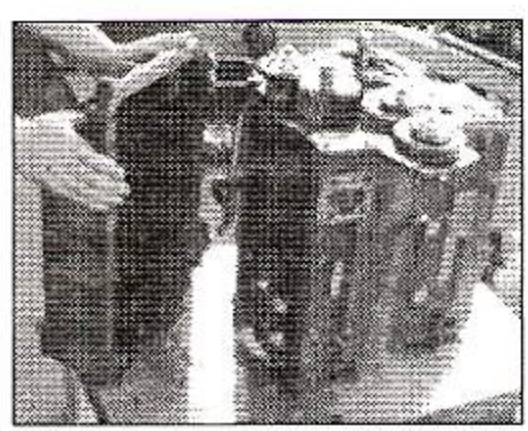


Removing idle gear

8. Oil pan removal

(1) Turn the engine upside down

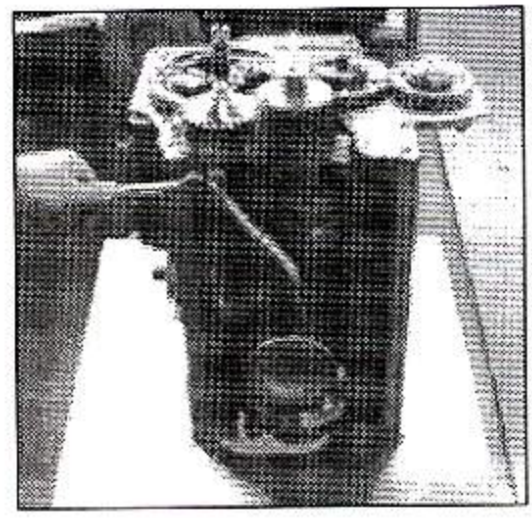
(2) Tap the bottom corners of the oil pan with a plastic hammer to remove the oil pan



Removing Oil pan.

9. Oil screen removal

Loosen the nut that holds the oil screen in position and remove the screen.



Removing Oil strainer

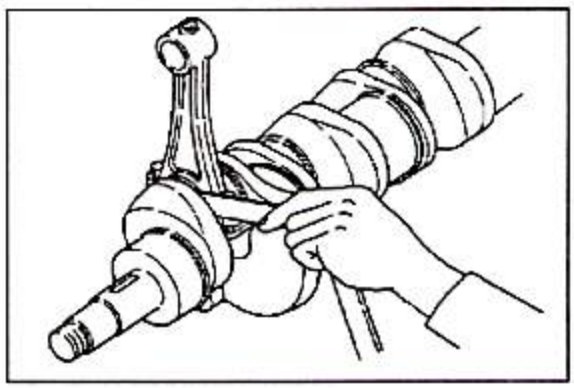
CRANKAHFT, PISTON AND CONNECTING ROD

1. Thrust clearance measurement for connecting rod big end

Measure the thrust clearance with a feeler gauge. If the clearance exceeds the limit, replace the connecting rod.

Unit : mm (in.)

Item	Standard	Limit
Thrust clearance for connecting rod big end	0.10 to 0.35 (0.0039 to 0.0138)	0.50 (0.0197)



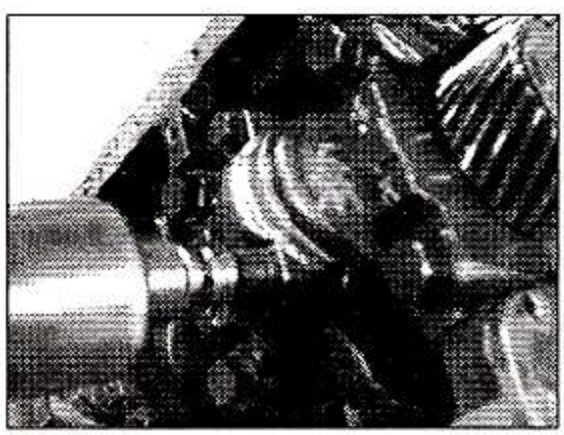
Measuring the trust clearance

2. Connecting rod cap removal

(1) Lay the cylinder block on its side

(2) Put identification on each connecting rod and cap combination as to its location in the engine

(3) Remove the caps.

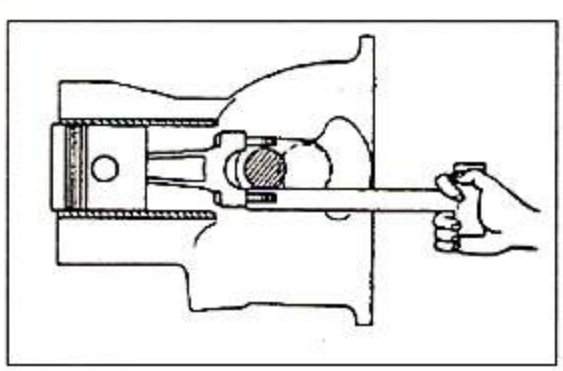


Removing connecting rod cap

3. Piston removal

(1) Turn the crankshaft until the piston is at top center.

(2) Push the piston and connecting rod away from the crankshaft with the handle of a hammer or the like until the piston rings are above the cylinder. Remove the piston and connecting rod. Do Steps (1) and (2) for the removal of the other pistons.



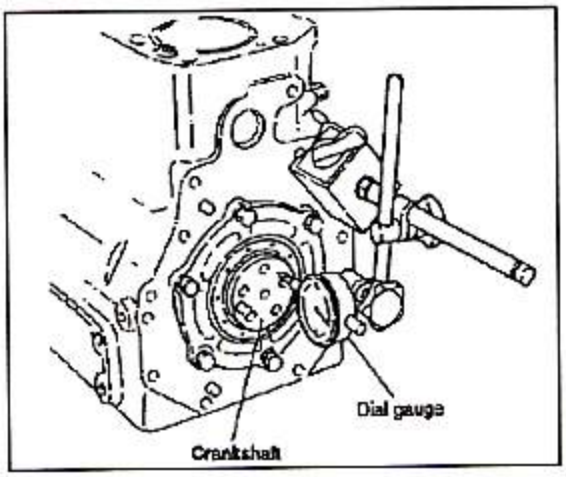
Removing piston

4. End play measurement for crankshaft

Set a dial indicator so that it will touch the end of the crankshaft and measure the end play. If the end play exceed the limit, replace No.3 flanged bearing.

Unit : mm (in.)

End play for crankshaft end play	0.050 to 0.500 90.00197 to 0.00689	0.500 (0.01969)



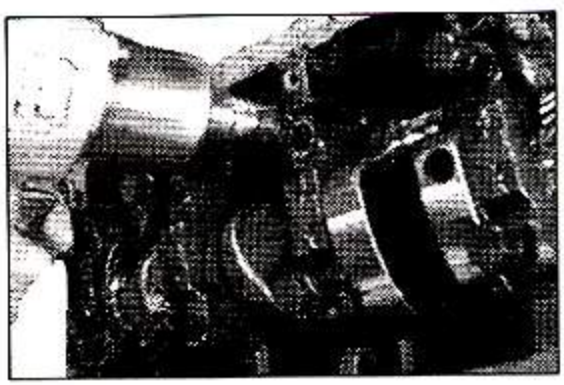
Measuring end play for crankshaft

5. Main bearing cap removal

(1) Lay the cylinder block with its bottom (Oil pan)side up

(2) Remove the bolts that hold the main bearing caps in position. Remove the caps

(3) Remove the front and rear bearing caps with a sliding hammer



Removing main bearing cap

6. Crankshaft removal

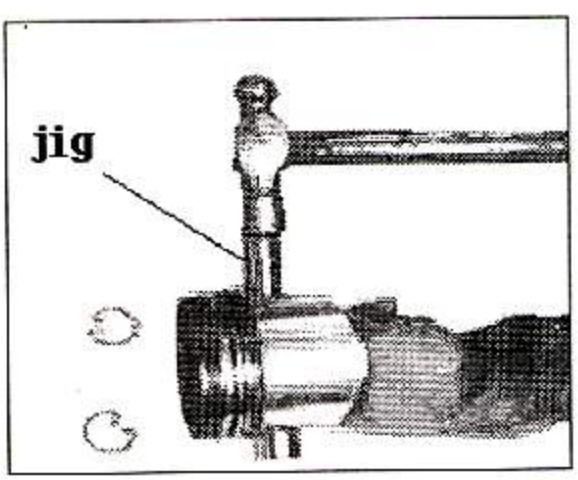
Remove the crankshaft

⚠ CAUTION

Do not cause damage to the bearing

NOTE

Put identification on each main bearin as nto its location in the engine

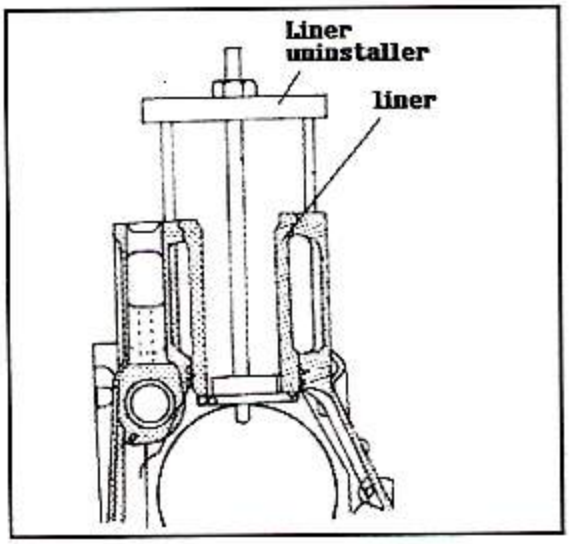


Removing piston pin

7. Piston separation from connecting rod

8.Removal cylinder liner

1) Install liner uninstaller to cylinder block
2) Remove cylinder liner
3) Remover Oil ring

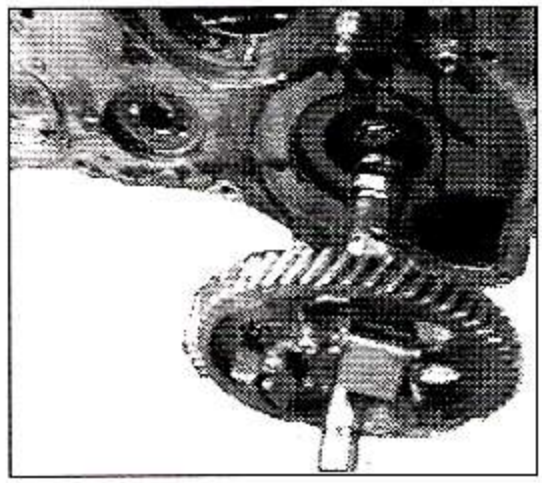


CAMSHAFT, TAPPET AND OIL PUMP

1. Camshaft removal

(1) Remove the bolts that hold the thrust plate.

(2) Pull the camshaft out of the cylinder block.



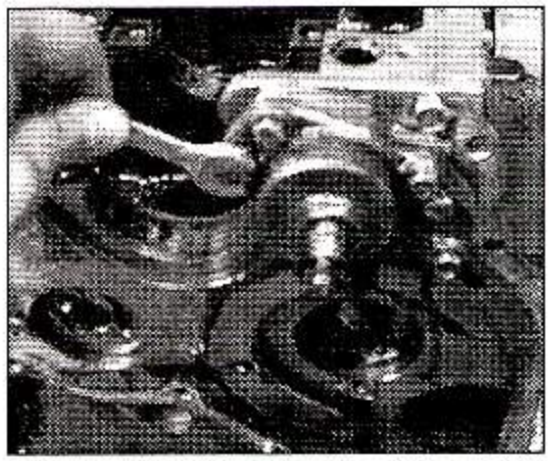
Removing camshaft

2. Tappet removal

Remove tappets.

3. Oil pump removal (when required)

Remove the bolts that hold the oil pump to the cylinder block and remove the pump.



Removing Oil pump

INSPECTION

CYLINDER HEAD AND VALVE MECHANISM

1. Cylinder head
2. Rocker arms and rocker shaft
3. Valve spring
4. Valve push rods
5. Valves, valve guide and valve seats
6. Combustion jet replacement

TIMING GEARS AND FLYWHEEL

1. Camshaft
2. Fuel injection pump camshaft
3. Tappets
4. Idler gear
5. Flywheel and ring gear

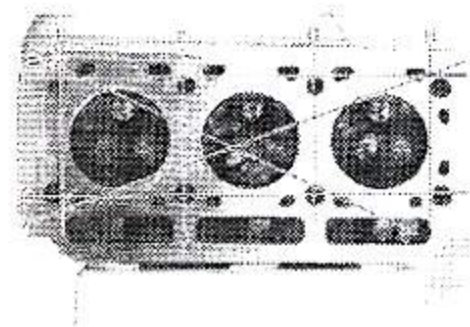
CYLINDER BLOCK, CRANKSHAFT, PISTONS AND OIL PAN

1. Pistons, Piston Rings and Piston Pins
2. Connecting rods
3. Crankshaft
4. Cylinder block

CYLINDER HEAD VALVE MECHAISM

1. Cylinder head

Using a heavy accurate straight edge and a feeler gauge, check the bottom face for warpage in tree positions Lengthwise, two crosswise and two widthwise as shown in the illustration . If warpage exceeds the limit , reface the bottom face with a surface grinder.



Checking cylinder head bottom face fo warpage

Unit : mm (in.)

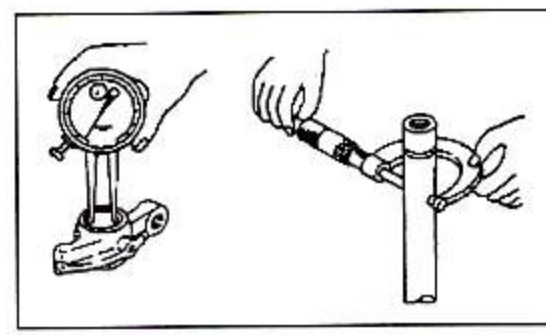
Item	Standard	Limit
Warpage of cylinder head bottom face	0.03(0.0012)	0.10 (0.0039)

2. Rocker arms and rocker shaft

Measure the bore in the rocker arm for the rocker shaft and the diameter of the rocker shaft to find the clearance between the arm and shaft. If the clearance has reached the limit, replace the rocker arm . If it exceeds the limit, replace both arm and shaft

Unit : mm (in.)

Item	Standard	Limit
Bore in rocker arm for shaft	Φ17 $^{+0.02}_{0}$ (Φ0.67 $^{+0.00079}_{0}$)	-
Diameter of shaft for arm	Φ17 $^{-0.016}_{-0.034}$ (Φ0.67 $^{-0.00063}_{-0.0013}$)	-
Clearance between rocker arm and shaft	0.016 ~ 0.014 (0.00063 ~ 0.0021)	-



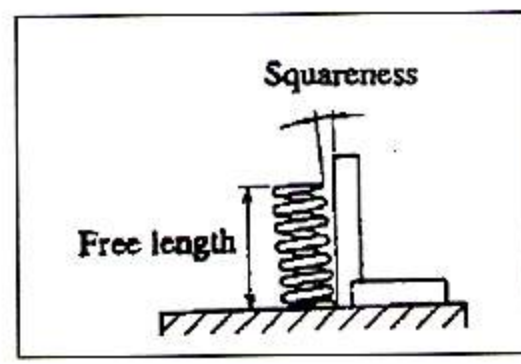
Measuring rocker arm and rocker shaft

3. Valve springs

Check the squareness and free length. If the squareness and/or free length exceeds the limit, replace the spring.

Unit : mm (in.)

Item		Standard	Limit
Free length		40 (1.57)	-
Squareness		1.5° max	-
Test force Kgf (lbf)[N]	Length under test force: 33.25 (73.3) [326.18]	15.255 (33.63)	-
	Length under test force:23.5(51.80) [230.54]	37.29 (82.21)	



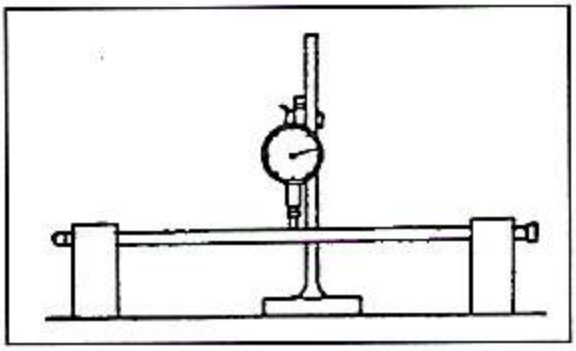
Testing valve spring

4. Valve push rods

Using V-blocks and a dial indicator, check for bend. If the bend exceeds the limit, replace the push rod.

Unit : mm (in.)

Item	Limit
Bend (dial indicator reading) of valve push rod	Max 0.25 (0.0098)



Checking bend of valve push rod

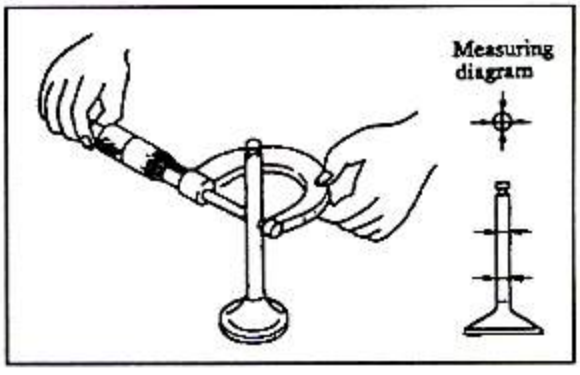
5. Valves, valve guides and valve seats

(1) Diameter of valve stem

Measure the diameter of the valve stem as shown in the illustration. If the stem is worn beyond the limit , or if it is abnormally worn, replace the valve

Unit : mm (in.)

Item		Standard	Limit
Diameter of valve stem	Inlet Valve	Φ8 -0.030 -0.040 (Φ0.32 -0.0012 -0.0016)	
	Exhaust Valve	Φ8 -0.030 -0.040 (Φ0.32 -0.0012 -0.0016)	



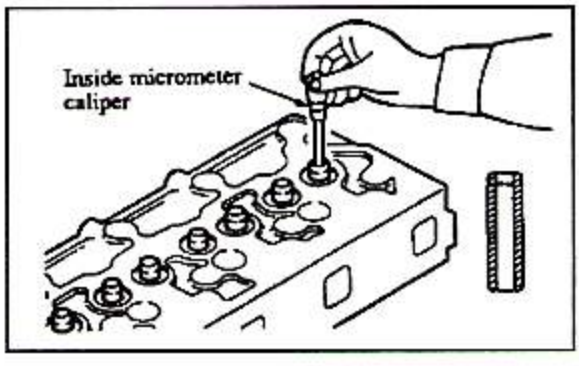
Measuring valve stem

(2) Clearance between valve stem and valve guide

The valve guide wears more rapidly at its both ends than at any other parts. Measure the bore in the guide for the stem at its ends with an inside micrometer caliper to find the clearance between the stem and guide. If the clearance exceeds the limit, replace the guide or valve whichever is badly worn.

Unit : mm (in.)

Item		Standard	Limit
Clearance between valve stem and valve guide	Inlet valve	0.040 ~ 0.065 (0.0016 ~ 0.0026)	0.15 (0.0059)
	Exhaust valve	0.045 ~ 0.070 (0.0018 ~ 0.0028)	0.15 (0.0059)



Measuring valve guide

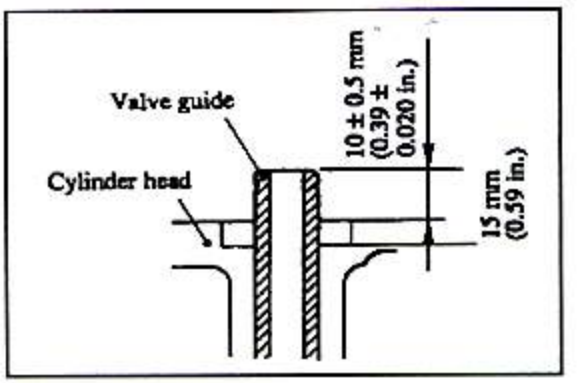
(3) Valve guide replacement

(a) Remove the guide from the cylinder head by pushing it with a tool and an arbor press from the bottom side of the head

(b) Install a new guide into the cylinder head by pushing it with an arbor press from the upper side of the head until the specified height to the top of the guide is obtained.

(c) Insert a new valve into the guide and make sure the valve slides in the guide freely

(d) After the valve guide has been replaced. Check the valve contact with its seat



Height to top of valve guide

(4) Valves

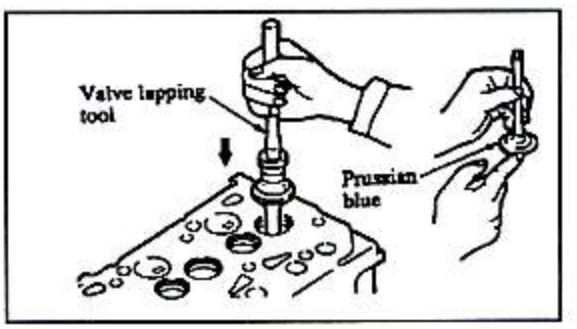
(a) Put a small amount of Prussian blue or read lead on the valve face. Hold the valve with a valve lapping tool (commercially available) and press it against the seat to check its contact.

(b) The width of contact must be uniform all the way around both seat valve . If the contact is bad, reface the valve and seat

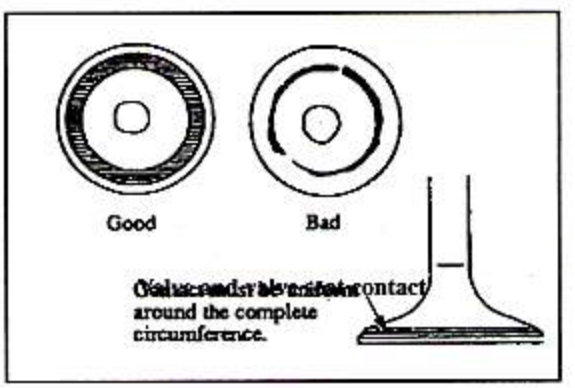
(c) If the valve margin (valve lip thickness) Exceeds the limit, replace the valve

Unit : mm (in.)

Item		Standard			Limit
		3T84L-ATC	3T90L-ATC	3T90L T-ATC	
Valve margin (lip thickness)	Inlet	1.1 (0.0433)	1.1 (0.0433)	1.3 (0.0512)	0.5 (0.020)
	Exh-aust	1.1 (0.0433)	1.1 (0.0433)	1.0 (0.0394)	



Checking valve contact with seat

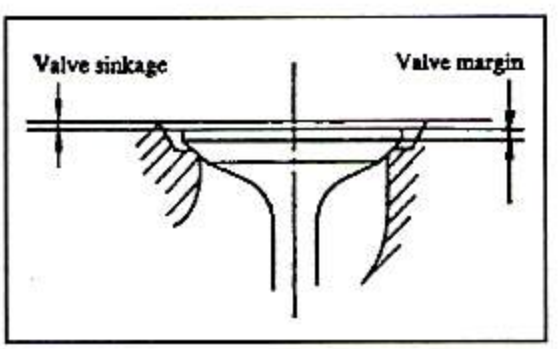


Valve and valve seat contact

(d) If the valve sinkage (the dimension from the top of a closed valve to the face of cylinder head) exceeds the limit, recondition the valve seat or replace the cylinder head assembly

Unit : mm (in.)

Item		Standard			Limit
		3T84L-ATC	3T90L-ATC	3T90LT-ATC	
Valve sinkage (dimension from top of closed valve to face of head)	Inlet	0.65 (0.0256)	0.65 (0.0256)	0.56 (0.0221)	1.5 (0.059)
	Exh-aust	0.65 (0.0256)	0.65 (0.0256)	0.75 (0.0295)	



Valve margin and sinkage

(5) Valve refacing

(a) Set the valve refacer at an angle of 45° and grind the valve

(b) The valve margin must be not less than the limit. If the margin seems to be less than the limit when the valve is refaced, replace the valve

(6) Valve seat refacing

(a) Before refcing the valve seat, check the clearance between the valve and guide, and replace the guide if necessary.

(b) Cut the valve seat with a valve seat cutter (commercially available), or grind it with a valve seat grinder, and finish the width of valve seat and angle of seat face to the correct values.

Unit : mm (in.)

Item		Posi -tion	Standard		
			3T84L-ATC	3T90L-ATC	3T90LT-ATC
Angle of seat face	Inlet	A	45°	45°	60°
	Exhaust	B	45°	45°	45°
Width of valve seat	Inlet	C	2.12 (0.084)	2.12 (0.084)	1.73 (0.068)
	Exhaust	C	2.12 (0.084)	2.12 (0.084)	2.12 (0.084)

(c) After refacing the valve seat, put lapping compound on the valve face and lap the valve in the valve seat.

(7)Valve lapping

Be sure to lap the valves in the seats after refacing or replacing the valves or valve seats.

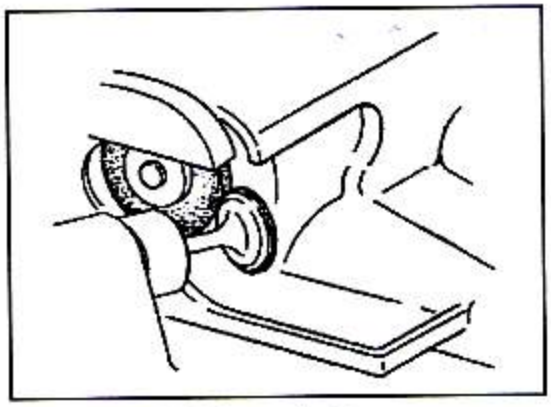
(a) Put a small amount of lapping compound on the valve face

NOTE

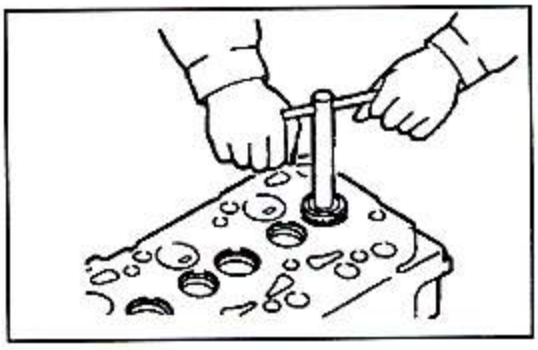
a) Do not put lapping compound on the valve

b) Use a lapping compound of 120 to 150 mesh for initial lapping and a compound of finer than 200 mesh for finish lapping.

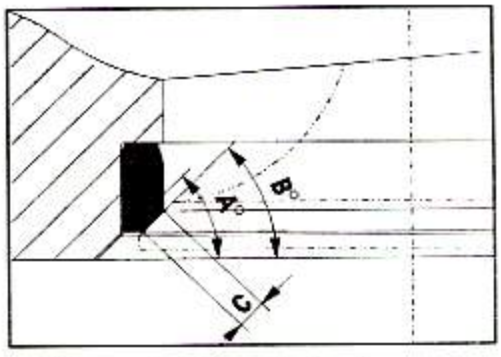
c) Mixing the compound with a small amount of engine oil will help put the compound on the valve face uniformly



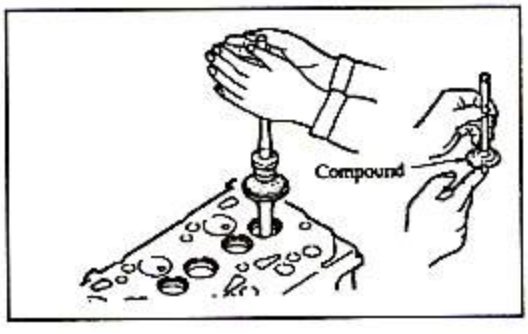
Refacing valve face



Refacing valve seat



Valve seat width and valve face angle



Lapping valve in seat

(b) Using a lapping tool, hold the valve against the seat and rotate it only a part of a turn, then raise the valve off its seal, rotating it to a new position. Press the valve against the seal for another part of a turn. Repeat this operation until the compound wears and loses its cutting property.

(c) Wash the valve and valve seat with dry cleaning solvent.

(d) Apply engine oil to the valve and lap it in the seat.

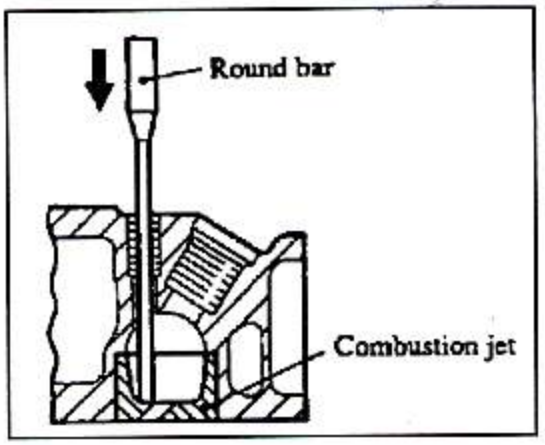
(e) Check the valve face for contact.

6. Combustion jet replacement

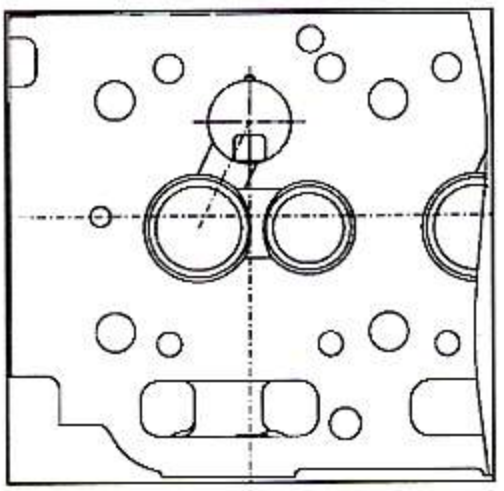
Replace the combustion jets only when they are cracked or defective.

(1) To remove the jet, insert a 6mm(0.24 in) diameter round bar through the bore in the cylinder head for the glow plug and tap around the jet.

(2) To install a new jet, put the jet in position in the head with its tangential orifice in alignment with the center of the main chamber and tap it with a plastic hammer.



Removing combustion jet



Installing combustion jet

TIMING GEARS AND FLYWHEELINSPECTION

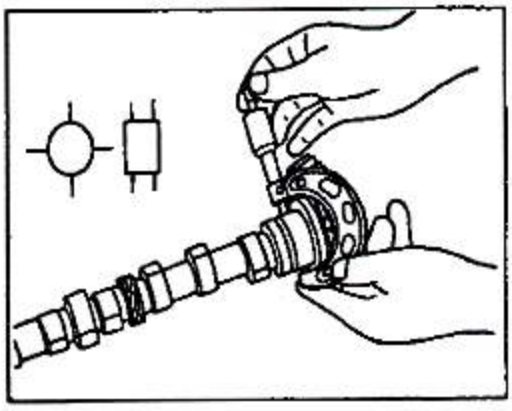
1. Camshaft

(1) Clearance between journal and bushing

Measure the diameter of the journal and the bore in the bushing for the shaft to find the clearance as shown in the illustration. If the clearance exceeds the limit, replace the bushing.

Unit : mm (in.)

Item	Standard
Clearance between camshaft journal and bushing	0.05 ~ 0.100 (0.002 ~ 0.004)



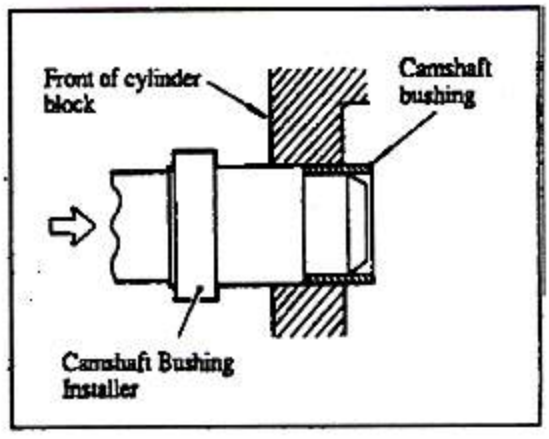
Measuring camshaft journal

(2) Bushing replacement

Use Camshaft Bushing Installer (ST332340) (special tool) for camshaft bushing replacement.

(a) Removal

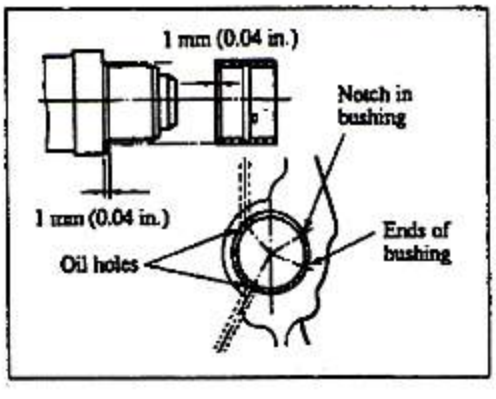
Remove the oil pan. Using a "remover" end of the Installer, push out the bushing into the cylinder block. Crush and take out the bushing from the block.



Removing camshaft bushing

(b) Installation

Install a new bushing in position with its oil holes in alignment with those of the oil gallery.



Installing camshaft bushing

(3) Lobe lift

Measure the lobe height and base circle as shown in the illustration. Subtract the base circle from the lobe height to find the lobe life. If the lobe lift exceeds the limit, replace the camshaft.

Unit : mm (in.)

Item	Standard	Limit
Lobe height of Camshaft	38.63 (1.52)	

2. Fuel injection pump camshaft

Measure the lobe height and base circle as shown in the illustration. Subtract the base circle from the lobe height to find the lobe life. If the lobe lift exceeds the limit, replace the camshaft.

Unit : mm (in.)

Item	Standard	Limit
Lobe height of fuel Injection pump Camshaft	35 (1.38)	-

3. Tappets

(1) Cam contact face

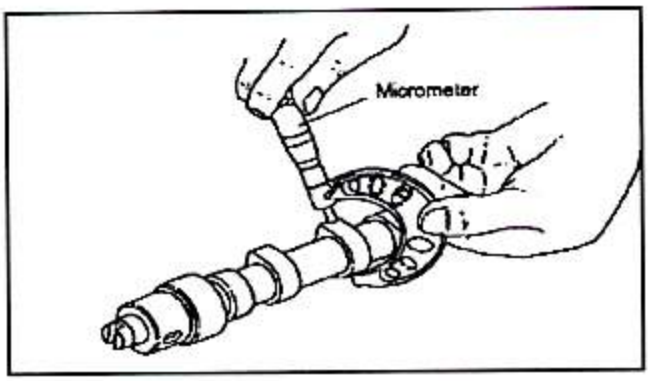
Check the cam contact face of each tappet for abnormal wear. Replace the tappet if the face is defective.

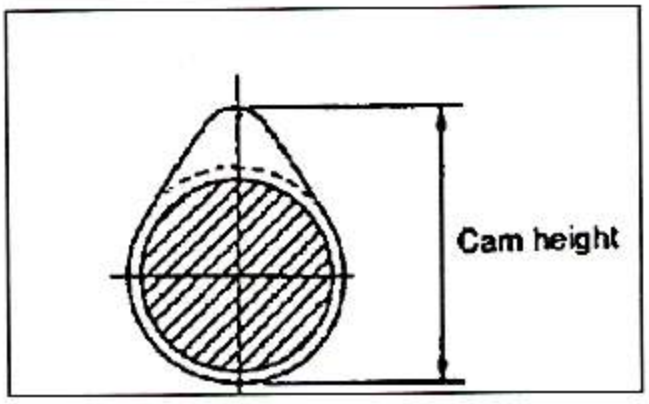
(2) Clearance between tappet and cylinder block

Measure the diameter of the tappet and the bore in the cylinder block for the tappet to find the clearance. If the clearance exceeds the limit, replace the tappet.

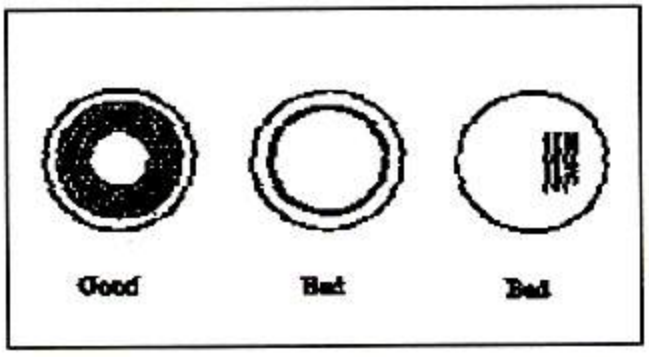
Unit : mm (in.)

Item	Standard
Clearance between tappet And cylinder block	0.006 ~ 0.035 (0.00024 ~ 0.0014)

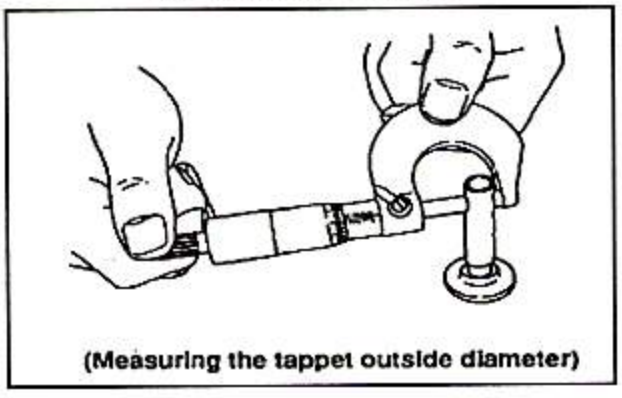




Measuring lobe height of camshaft and fuel injection pump camshaft



Cam contact face of tappet



(Measuring the tappet outside diameter)

4. Idle gear

(1) Clearance between idler gear and shaft

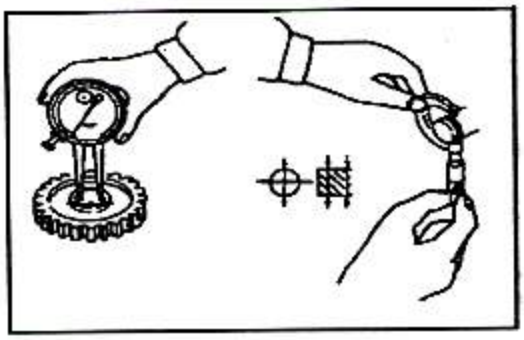
Measure the bore in the idler gear for the shaft and the diameter of the shaft to find the clearance. If the clearance exceeds the limit, replace the gear or shaft whichever is badly worn.

Unit : mm (in.)

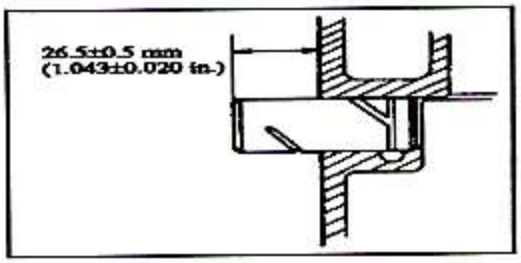
Item	Standard	Limit
Clearance between Idler gear and shaft	0.08 ~ 0.16 (0.0032 ~ 0.0063)	0.3 (0.012)

(2) Idler shaft replacement

Install a new idler shaft to the cylinder block so that its dimension from the face of the block is 26.5±0.5 mm (1.043±0.020 in.).



Measuring idler gear and shaft



Idler shaft dimension

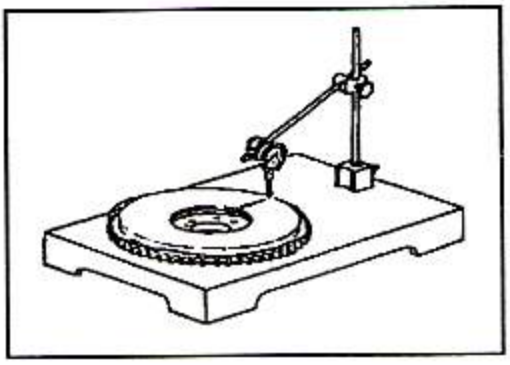
5. Flywheel and ring gear

(1) Flatness (difference between lower and higher measurements) of flywheel

Put the flywheel on the surface plate. Set a dial indicator at one side of the friction (clutch contact) face and move it over to the opposite side of the face as shown in the illustration to find the flatness. If the flatness exceeds the limit, grind the face.

Unit : mm (in.)

Item	Standard	Limit
Flatness of Flywheel	0.15 (0.005 9) maximum	0.50 (0.019 7)



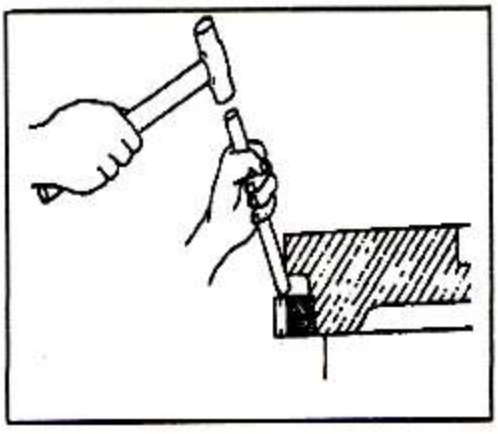
Measuring flywheel flatness

(2) Ring gear replacement

Check the ring gear and replace it if its teeth are abnormally worn or chipped.

(a) Removal

Heat the ring gear evenly with an acetylene torch. Tap the ring gear all the way around with a bar and a hammer as shown in the illustration to remove it from the flywheel.



Removing ring gear

(b) Installation

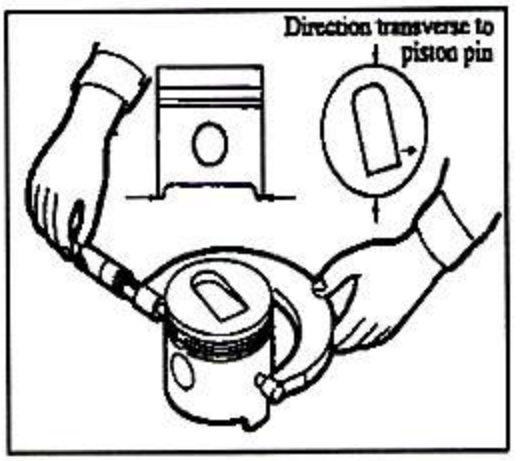
Heat a new ring gear up to a temperature of 150°C (302°F) with a piston heater and install it to the flywheel with its unchamfered side foremost.

CYLINDER BLOCK, CRANKSHAFT, PISTON AND OIL PAN

1. Pistons, Piston Rings and Piston Pins

(1) Diameter of piston

Measure the diameter of the piston at its skirt in a direction transverse to the piston pin with a micrometer as shown in the illustration. If the diameter exceeds the limit, replace the piston. Select a new piston so that the difference between average weight of all pistons in one engine does not exceed the standard.



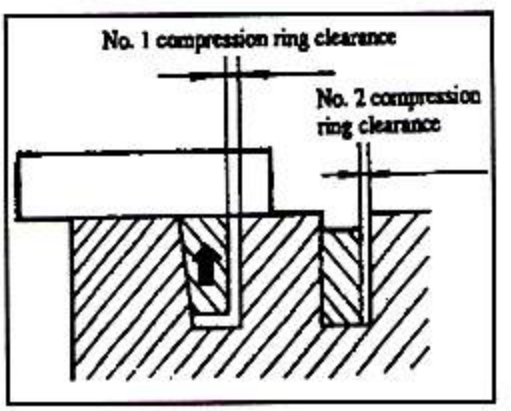
Measuring diameter of piston

Unit : mm (in.)

Item			Standard	Limit
Diameter Of piston	Standard	3T84L -ATC	Φ83.915 ~ Φ83.905 (Φ3.3037 ~ Φ3.3033)	77.80 (3.063 0)
		3T90L -ATC	Φ89.935 ~ Φ89.925 (Φ3.5407 ~ Φ3.5403)	
		3T90LT-ATC		

(2) Clearance between piston ring and groove

(a) Measure the clearance between the groove and piston with a straight edge and a feeler gauge as shown in the illustration. If the clearance exceeds the limit, replace the ring.



Measuring clearance between piston ring and groove

Unit : mm (in.)

Item	Standard	Limit
No. 1 compression Ring	0.07 ~ 0.11 (0.0028 ~ 0.0043)	0.30 (0.011 8)
No. 2 compression Ring	0.04 ~ 0.08 (0.0016 ~ 0.0031)	0.20 (0.007 9)
Oil ring	0.03 ~ 0.07 (0.0012 ~ 0.0028)	0.20 (0.007 9)

TIMING GEARS AND FLYWHEEL

1. Flywheel removal

(1) have someone hold the crankshaft pulley with a wrench to prevent the flywheel from rotating

(2) Remove one of the bolts that hold the flywheel in position.

⚠ WARNING

Always signal each other to prevent possible personal injury

(3) Install a safety bar (M12 x 1.25) into the threaded hole in the flywheel from which the bolt was removed in Step(2). Remove the remaining bolts.

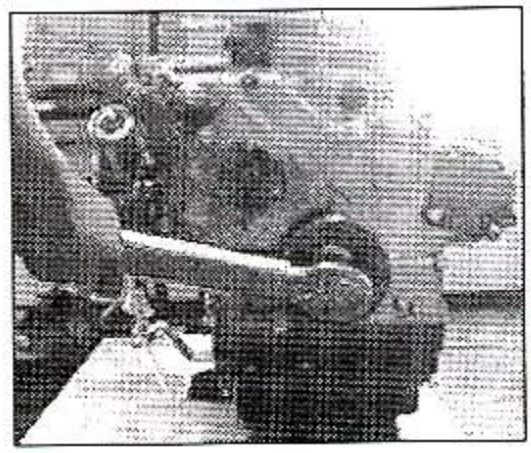
(4) Hold the flywheel by hands and withdraw it from the crankshaft. Joggling the flywheel back and forth will facilitate removal

⚠ WARNING

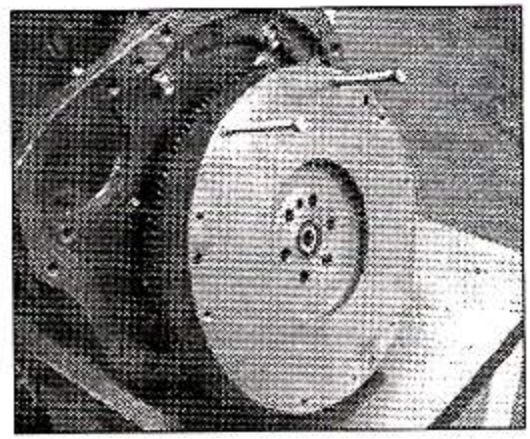
When removing the fly wheel, wea heavy gloves to avoid hand injury

2. Rear plate removal

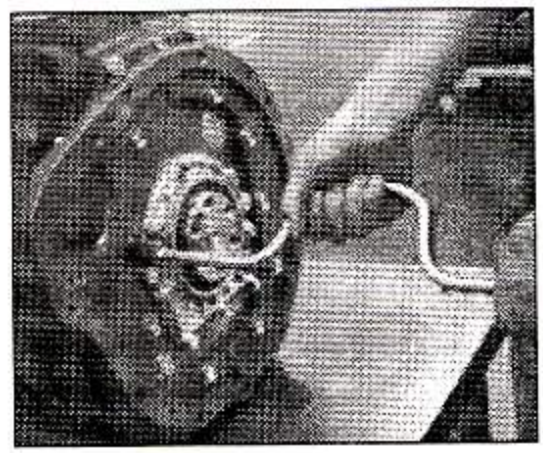
The rear plate is doweled in position. Pull the plate as straight as possible when removing it.



Holding flywheel



Using the safety bar



Removing rear plate

Unit : mm (in.)

Item	Standard	Limit
Diameter of Piston pin	Φ30 $^{-0}_{-0.019}$ (Φ1.18 $^{-0}_{-0.00035}$)	-
Clearance Between Piston pin and Piston	0.025~0.047 (0.00098~0.00185)	0.15 (0.0059)

2. Connecting rods

Check the connecting rod for bend or twist as follows:

(a) Measure "C" and "l." If "C" exceeds 0.05 mm (0.0020 in.) per 100 mm (3.94 in.) of "l," straighten the connecting rod with a press.

Unit : mm (in.)

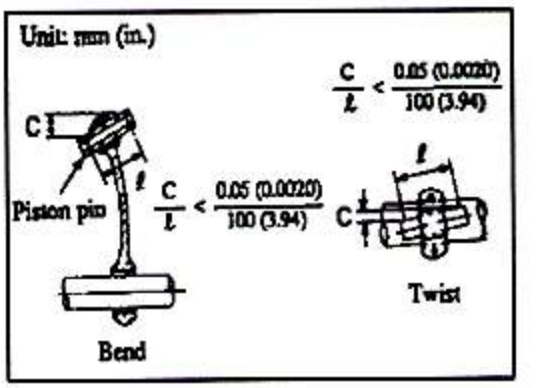
Item	Standard	Limit
Bend or twist of Connecting rod	0.05/100 (0.002 0/3.94) maximum	0.15/100 (0.005 9/3.94)

(b) Generally, a connecting rod aligner is used to check the connecting rod for bend or twist.

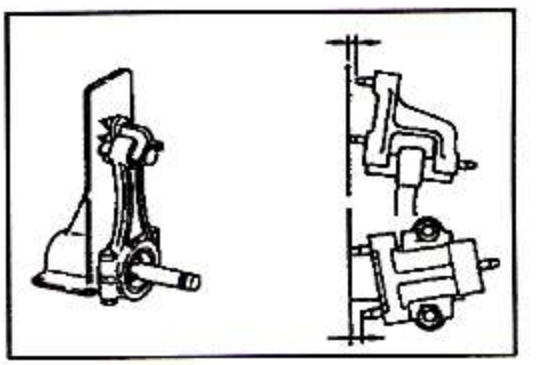
NOTE

To check the rod for bend, install the cap to the connecting rod and tighten the cap nuts to the specified torque.

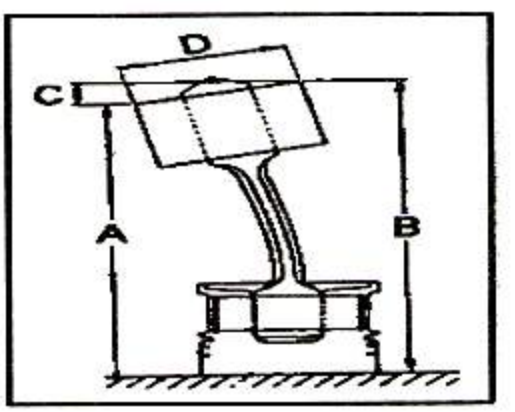
(c) To check the connecting rod fitted to the piston for bend, put the connecting rod and piston on the surface plate as shown in the illustration, insert a round bar having a diameter equal to that of the crankpin into the bore in the big end of the rod and measure "A" and "B" with a dial indicator. Subtract "A" from "B" to find the bend ("C").



Checking connecting rod for bend or twist



Checking connecting rod on a connecting rod aligner



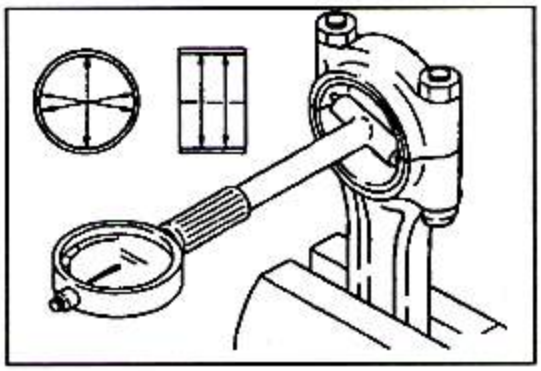
Checking connecting rod for bend with a dial indicator

3. Crankshaft

(1) Clearance between crankpin and connecting rod bearing

(a) Install the bearing (upper and lower halves) and cap to the big end of the connecting rod and tighten the cap nuts to the specified torque. Measure the bore in the bearing for crankpin as shown in the illustration.

Tightening torque	6.5±0.25 kgf·m (47.01±1.81lbf·ft) [63.74±2.45N·m]



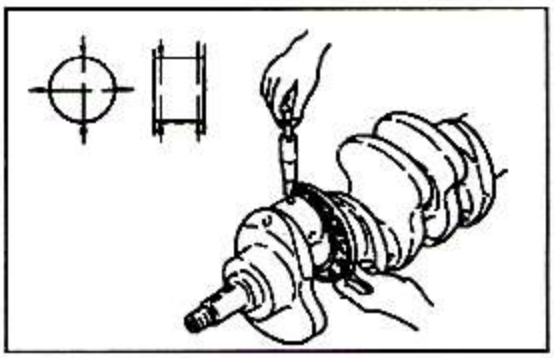
Measuring bore in connecting rod bearing

(b) Measure the diameter of the crankpin as shown in the illustration to find the clearance between the crankpin and connecting rod bearing.

Unit : mm (in.)

Item	Standard	Limit
Diameter of crankpin (standard)	Φ52 $^{-0.036}_{-0.050}$ (Φ2.05 $^{-0.0014}_{-0.00197}$)	—
Clearance between crankpin and connecting rod bearing	0.036 ~ 0.095 (0.0014 ~ 0.00374)	0.15 (0.00596)

(c) If the clearance exceeds the limit, install a new bearing and check the clearance again.

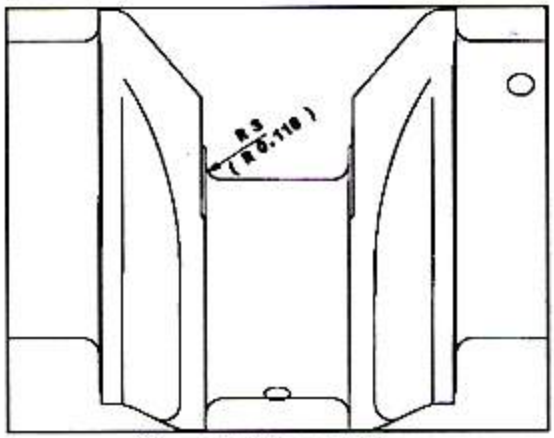


Measuring diameter of crankpin

(2) Clearance between journal and main bearing

(a) Install the main bearing (upper and lower halves) and cap to the cylinder block and tighten the cap bolts to the specified torque. Measure the bore in the bearing for the journal as shown in the illustration.

Tightening torque	16 ± 1.0 kgf·m (115.73±7.23lbf·ft) [156.91±9.81N·m]

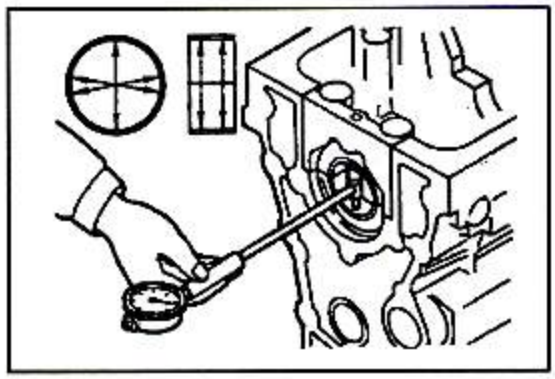


Crankpin filler radius

(b) Measure the diameter of the journal as shown in the illustration to find the clearance between the journal and main bearing.

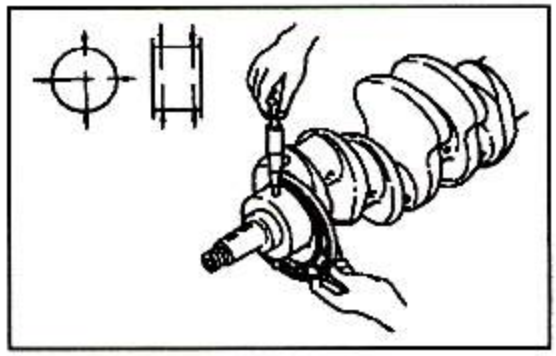
Unit : mm (in.)

Item	Standard	Limit
Diameter of journal (standard)	Φ70 $^{-0.036}_{-0.050}$ (Φ2.76 $^{-0.0014}_{-0.0019}$)	—
Clearance between journal and main bearing	0.076~0.095 (0.00249~0.00374)	0.100 (0.003 94)



Measuring bore in main bearing

(c) If the clearance exceeds the limit, install a new bearing and check the clearance again.



Measuring diameter of journal

(3) Runout

Support the crankshaft on its front and rear journals in V-blocks or in a lathe and check runout at the center journal with a dial indicator as shown in the illustration. Depending on the amount of runout, repair the crankshaft by grinding or by straightening with a press. If runout exceeds the limit, replace the crankshaft.

Unit : mm (in.)

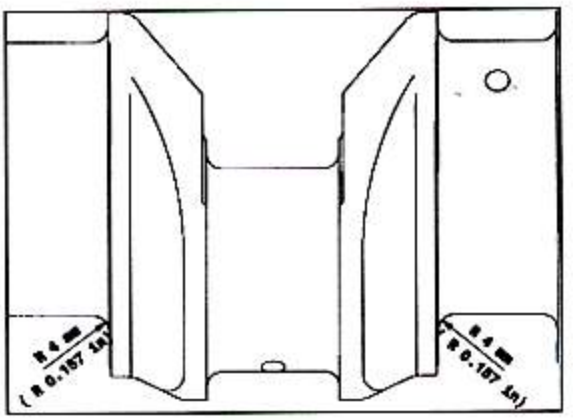
Item	Standard	Limit
Crankshaft runout	0.025 (0.000 98)	0.05 (0.002 0)

(4) Crankshaft gear removal

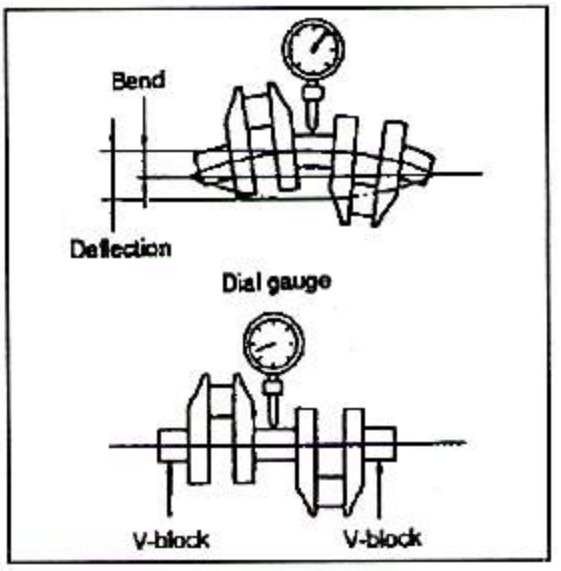
Use a gear puller to remove the gear from the crankshaft.

NOTE

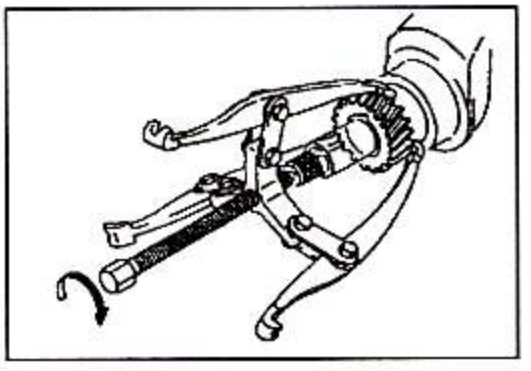
Do not remove the gear unless the gear or crankshaft is defective.



Journal fillet radius



Checking crankshaft runout

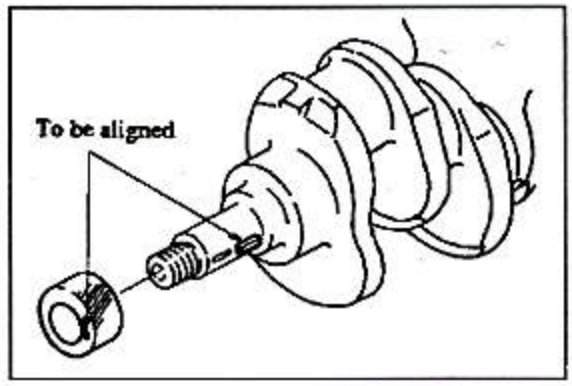


Removing crankshaft gear

(5) Crankshaft gear installation

(a) Install the key in position on the crankshaft.

(b) Install the gear in position with its keyway in alignment with the key as shown in the illustration.



Installing crankshaft gear

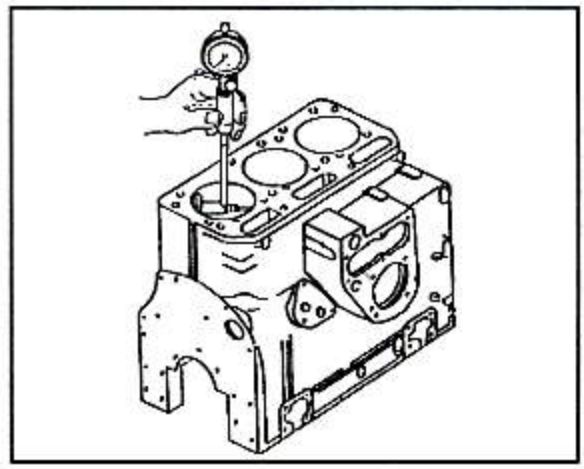
4. Cylinder block

(1) Bore (Liner)

Measure the bore at the top, middle and bottom points on axes A and B with a cylinder bore gauge as shown in the illustration. If any one of the cylinders exceeds the limit, hone out all the bores for oversize pistons.

Unit : mm (in.)

Piston and piston ring		Bore	
Size	Size code	Standard	Limit
Standard	3T84L -ATC	Φ84.020 ~Φ84.010 (Φ3.308 ~Φ3.307)	Standard: +0.2 (+0.008)
	3T90L -ATC	Φ90.020 ~Φ90.010 (Φ3.544 ~Φ3.543)	
	3T90LT -ATC		
Taper and out-of-Round		0.01 (0.000 4) maximum	—



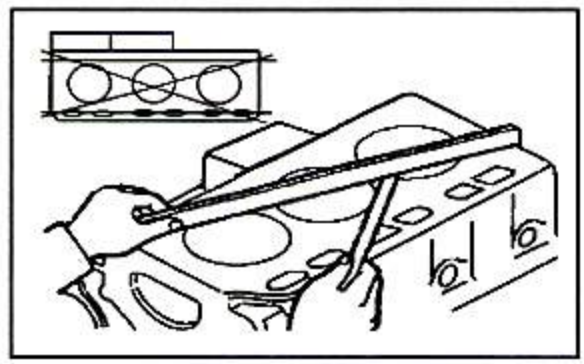
Measuring bore in cylinder block

(2) Warpage of top face

Using a heavy accurate straight edge and a feeler gauge, check the top face for warpage in two positions lengthwise, two crosswise and two widthwise as shown in the illustration. If warpage exceeds the limit, reface the top face with a surface grinder.

⚠ CAUTION

The maximum permissible amount of stock to be removed from the cylinder head and block by grinding is 0.2 mm (0.008 in.) in total.



Checking cylinder block top face for warpage

ASSEMBLY

CRANKSHAFT, GEAR AND OIL PAN

1. Front plate installation
2. Main bearing installation
3. Crankshaft installation
4. Main bearing cap installation
5. Camshaft and tappet installation
6. Piston assembling to connecting rod
7. Piston ring installation
8. Piston and connecting rod installation
9. Connecting rod cap installation
10. Idle gear and hydraulic oil pump gear installation
11. Governor weight installation
12. Oil pump installation
13. Governor lever and sleeve installation
14. Timing gear case installation
15. Crankshaft pulley nut tightening
16. Oil screen installation
17. Oil pan installation
18. Oil seal case installation
19. Rear plate (or mount flange) installation
20. Flywheel installation

CYLINDER HEAD, FUEL INJECTION PUMP AND ACCESARRY

1. Cylinder head bottom face cleaning
2. Valve stem seal installation
3. Valve spring installation
4. Cylinder head gasket installation
5. Cylinder head installation
6. Cylinder head bolt tightening
7. Valve push rod installation
8. Rocker shaft assembling
9. Rocker shaft assembly installation
10. Valve clearance adjustment
11. Cylinder head cover installation

AIR INLET SYSTEM AND EXHAUST SYSTEM

1. Air inlet cover installation
2. Exhaust manifold installation

FUEL SYSTEM

1. Fuel injection nozzle installation
2. Fuel injection pump installation
3. High pressure pipe installation

LUBRICATION SYSTEM

1. Pressure relief valve installation
2. Oil filter installation
3. Oil pressure switch installation

COOLING SYSTEM

1. Water pump installation
2. Thermostat installation
3. Cooling fan installation
4. Thermoswitch and thermounit combination installation

ELECTRICAL SYSTEM

1. Glow plug installation
2. Alternator installation

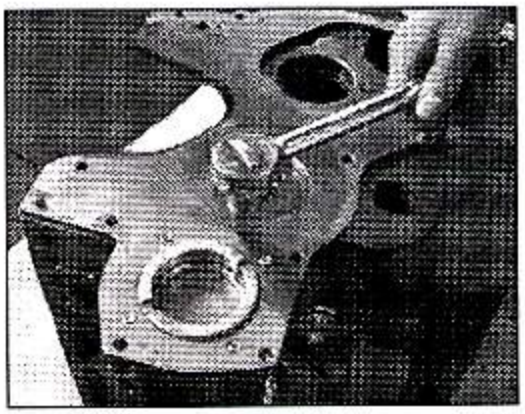
CRANKSHAFT, PISTON, GEAR CASE AND OIL PAN

1. Front plate installation

(1) Scrape the gasket from the cylinder block and front plate.

(2) Coat the gasket contact surface of cylinder block with adhesive and put a new gasket in position, making sure the holes in the gasket are all in alignment with the holes in the cylinder block.

(3) Put the front plate in position. Install four bolts and tighten them.



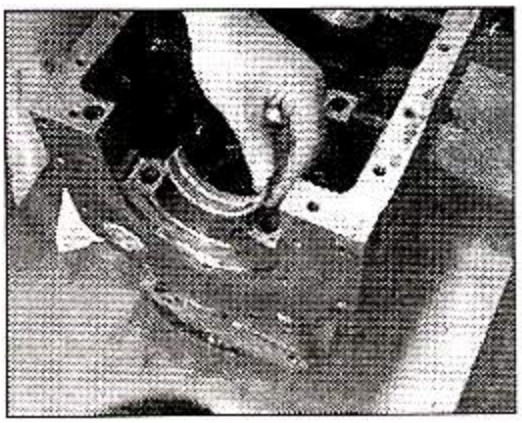
Assembling front plate

2. Main bearing installation

(1) Install the upper halves of the main bearings in the cylinder block and the lower halves in the main bearing caps so their tabs fit into the notches in the cylinder block and the main bearing caps.

(2) Install the flanged bearing in the No. 3 journal.

(3) Lightly lubricate the inside surfaces of the bearings with engine oil.



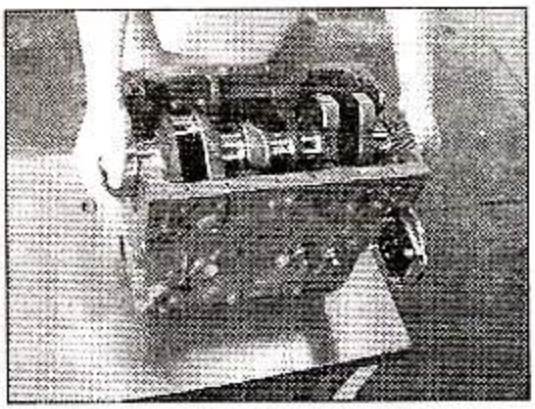
Installing main bearings

3. Crankshaft installation

(1) Clean the crankshaft with cleaning solvent and blow dry with compressed air.

(2) Fasten a hoist to the crankshaft and hold it in horizontal position. Carefully put the crankshaft in position in the cylinder block.

(3) Lightly lubricate the crankshaft journals with engine oil.



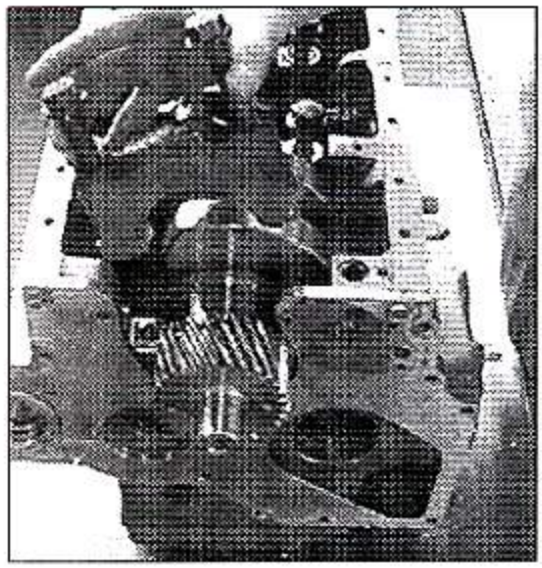
Installing crankshaft

4. Main bearing cap installation

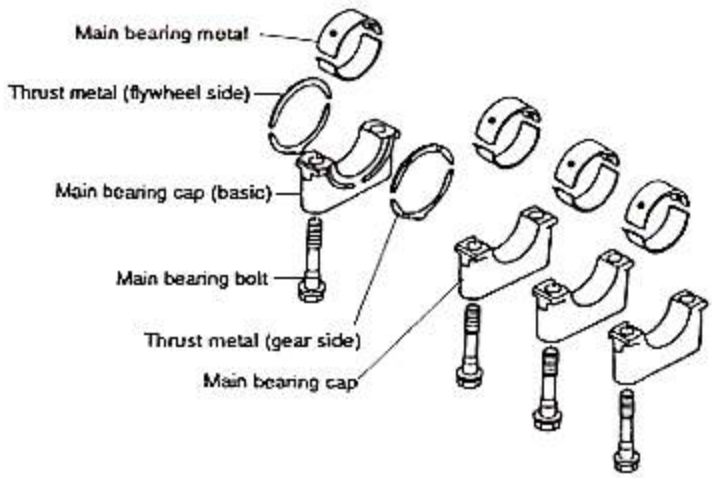
(1) Coat the mating surfaces of the rear bearing cap and cylinder block with Three Bond 1212.

(2) Install the main bearing caps in position. Make sure the number (arrow head) on the main bearing cap is toward the front of the engine.

(3) Tighten the main bearing cap bolts finger tight only.



Installing main bearing caps



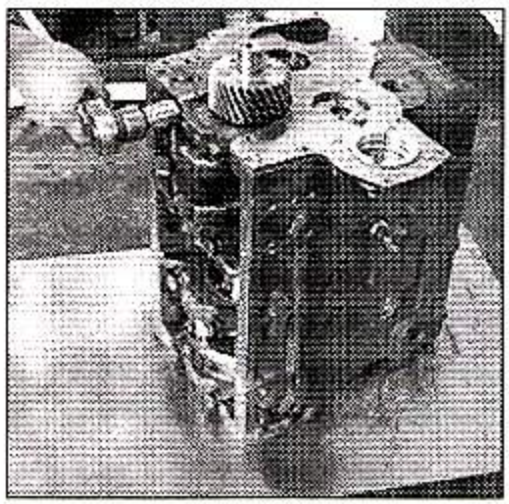
Installing with thrust metal

⚠ CAUTION

Install the front and rear thrust bearing .

(4) Tighten the bolts holding the main bearing caps in steps to the specified torque.

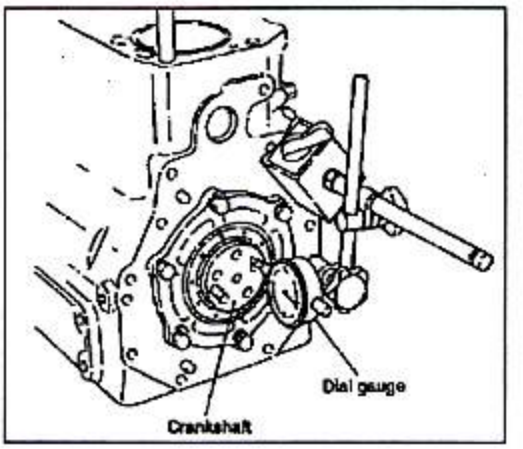
Tightening torque	16±1 kgf·m (115.73±7.23 lbf·ft) [156.91±9.81 N·m]



Tightening bolts holding main bearing cap

(5) Make sure the crankshaft rotates freely without binding or catching.

(6) Measure the end play for the crankshaft. Make reference to "End play measurement for crankshaft" (page 42). If the end play is incorrect, loosen the bolts holding the main bearing caps once and tighten them again.



Measuring the end play for the crankshaft

5. Installation of Camshaft and tappet

(1)Lubricate the tappets with engine oil

(2)Insert the tappets in cylinder

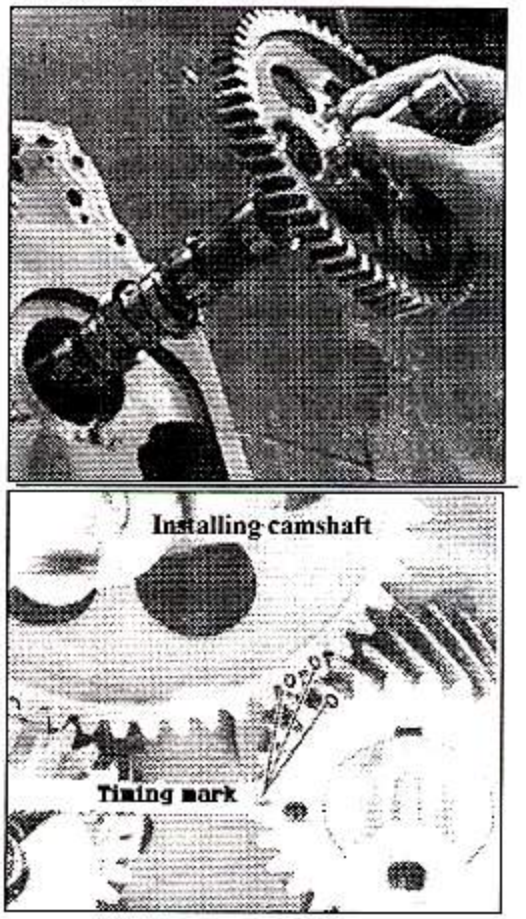
(3)Lubricate the lobes and journals with engine oil.

(4)Put the camshaft (with gear) in position in the cylinder block

⚠ CAUTION

Do not cause damage to the lobes and journals when camshaft is installed.

(5) Align the timing mark on the camshaft gear and crankshaft gear

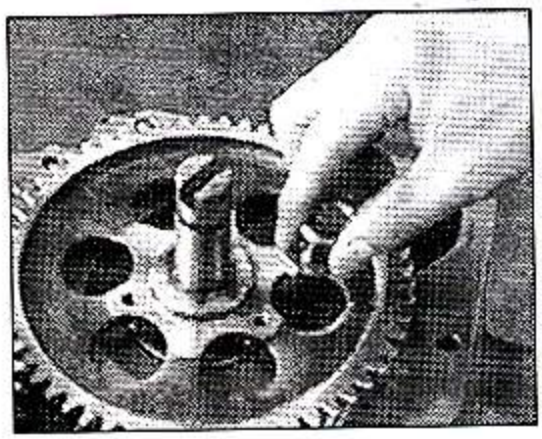


Align thee timing mark on the gear

(6) Tighten the bolts that hold the thrust plate to the specified torque.

Tightening torque	1.1 ± 0.1kgf·m (7.96 ± 0.72 lbf·ft) [10.79 ± 0.98N·m]

(7) Make sure the camshaft rotates freely. Check the end play for the camshaft.



Installing stopper

6. Piston assembling to connecting rod

(1) Coat piston pin hole of piston and connecting rod with Oil .

(2) Install piston pin through piston hole and connecting rod.

(3) Install clip on groove of piston hole in both side

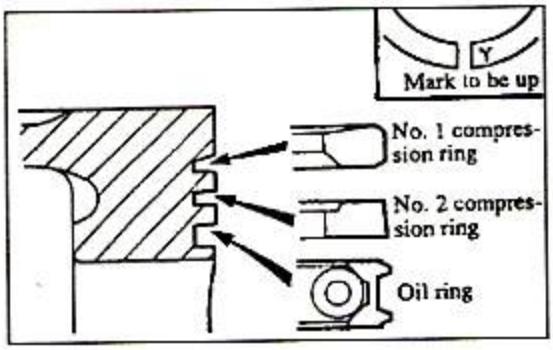
Installing piston pin

7. Piston ring installation

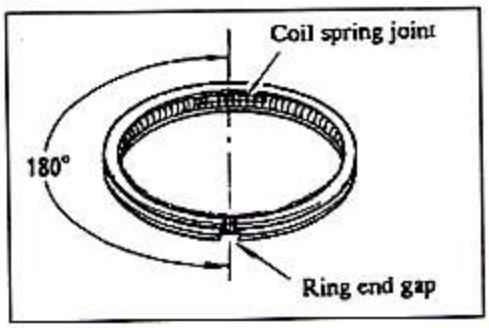
(1) Using a piston ring pliers, install the piston rings on the piston.

NOTE

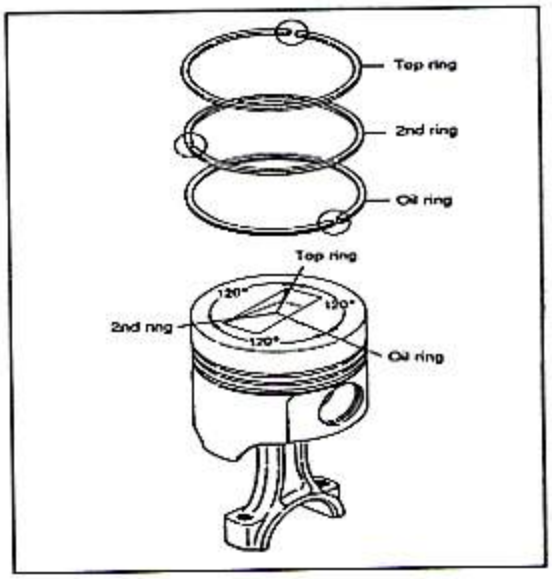
a) The piston rings must be installed with the side that has the mark "Y" toward the top of the piston.
b) The oil ring must be installed with the ring end gap 180° apart from the coil spring joint.
c) The rings may be installed with each other end gap 120° .



Installing piston ring



Assembling Oil ring



Installing rings with interval

8. Piston and connecting rod installation

(1) Lubricate the piston and piston rings with engine oil.

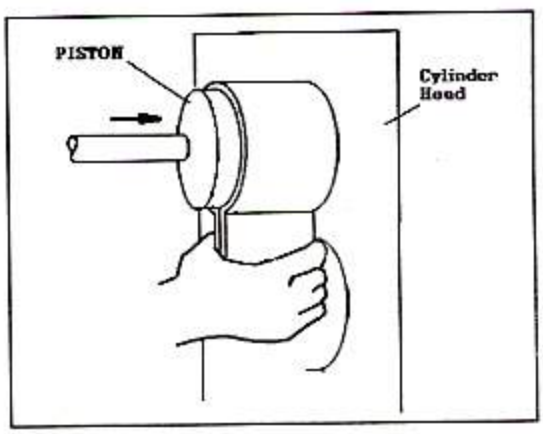
(2) Move the piston rings on the piston so that the end gaps are apart from a direction parallel to, or transverse to, the piston pin.

(3) Install the connecting rod bearing (upper half) to the rod, making sure the tab in the back of the bearing is in the notch of the connecting rod.

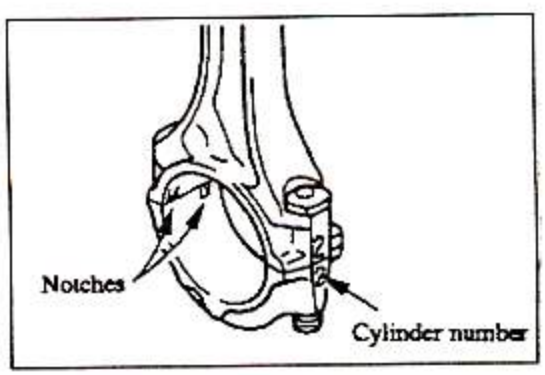
(4) Turn the crankshaft until the crankpin for the piston and connecting rod to be installed is at the top center.

(5) Hold the piston and connecting rod with "FRONT" mark (arrow head) on the top of the piston toward the front (timing gear case side) of the engine.

(6) Using a piston guide (commercially available), put the piston and connecting rod into the cylinder from the top of the cylinder block.



Installing piston assembly to cylinder block



Installing connecting rod cap

⚠ CAUTION

Do not hit the piston with a hammer to install the piston and connecting rod. This will put force on the piston and connecting rod and cause damage to the piston rings and crankpin.

9. Connecting rod cap installation

(1) Push the piston into position until the big end of the connecting rod is put into position over the crankpin. Then turn the crankshaft 180° while pushing on the top of the piston.

(2) Install the lower half of the connecting rod bearing in the connecting rod cap, making sure the tab in the back of the bearing is in the notch of the cap.

(3) Install the bearing cap to the connecting rod.

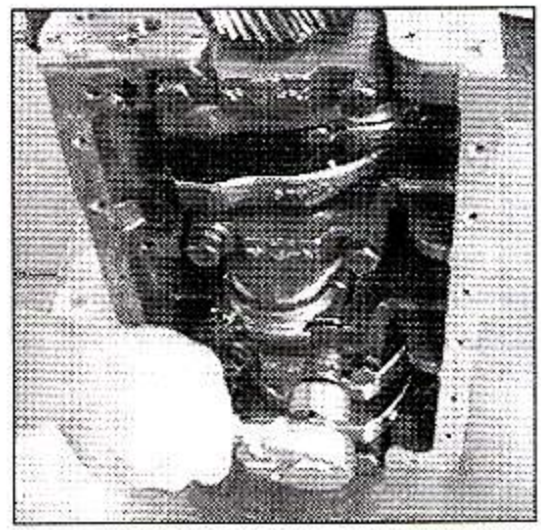
NOTE

a) Make sure that number on the cap is the same as the number on the connecting rod.
b) In case of a new connecting rod having no cylinder number, install the cap to the rod with the notches on the same side.

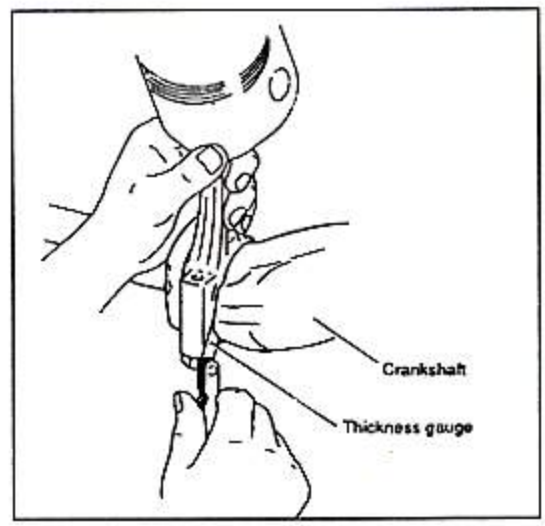
(4) Tighten the connecting rod cap nuts in steps to the specified torque.

Tightening torque	6.5 ± 0.25kgf·m (47.01 ± 1.81 lbf·ft) [63.74 ± 2.45 N·m]

(5) Check the thrust clearance for the connecting rod big end.



Tightening connecting rod cap nuts



Check the trust clearance

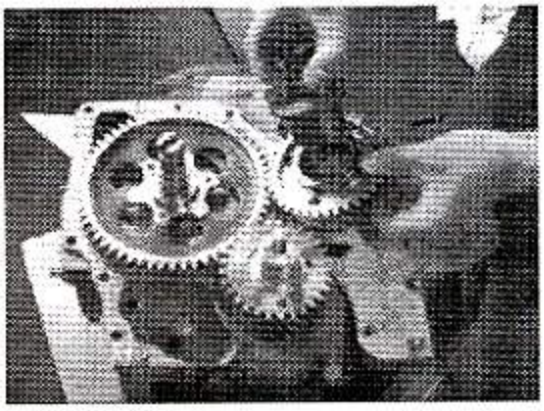
10. Idler gear and hydraulic Oil pump gear installation

(1) Lubricate the idler gear with engine oil.

(2) Install the idler gear.

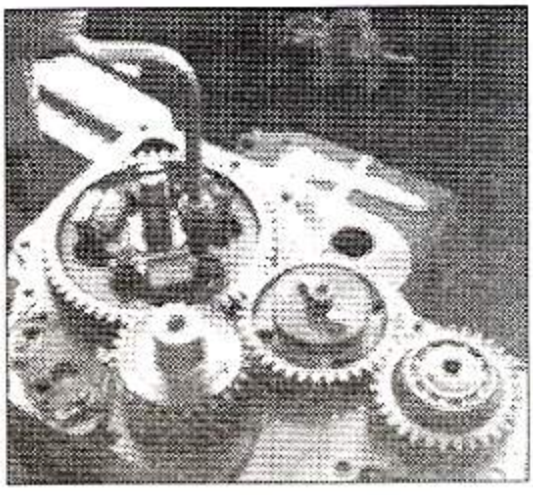
(3) Install the hydraulic Oil pump gear.

(4) Check the backlash of the gears. Make reference to "Timing gear backlash measurement."



Assemble Idle gear

11. Governor weight installation



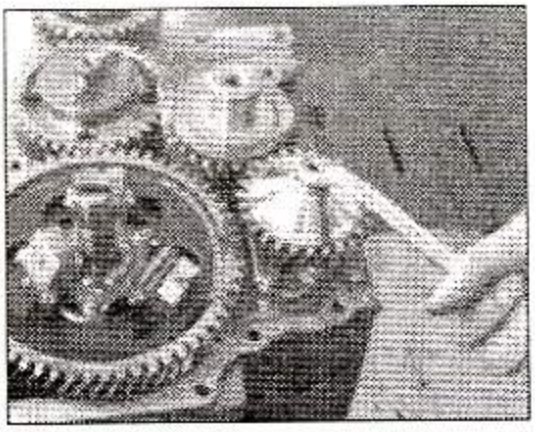
Installing governor weight

12. Oil pump installation

(1) Make sure the packing has been put in position on the oil pump.

(2) Put the oil pump in position on the cylinder block. Install three bolts and tighten them evenly.

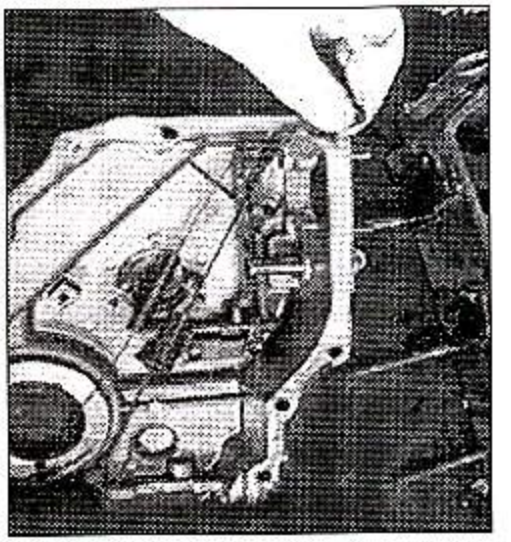
(3) Make sure the oil pump gear rotates freely.



Installing oil pump and gear

13. Governor lever and sleeve installation

1) Assemble governor lever, shaft and springs
2) Install governor lever assembly to gear case.
3) Install the sleeve of governor to weight

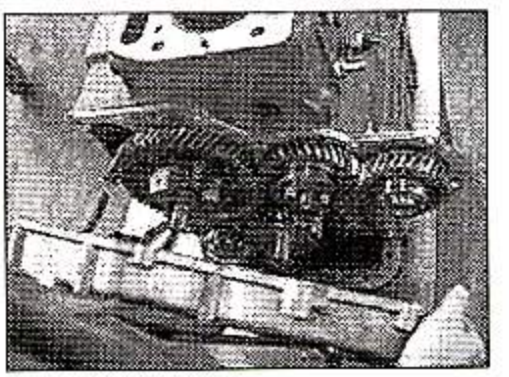


Install governor lever assembly

14. Timing gear case installation

(1) Coat the gasket with adhesive and put it in position on the front plate.

(2) Tighten the bolts that hold the timing gear case.



Assemble gear case

15. Crankshaft pulley nut tightening

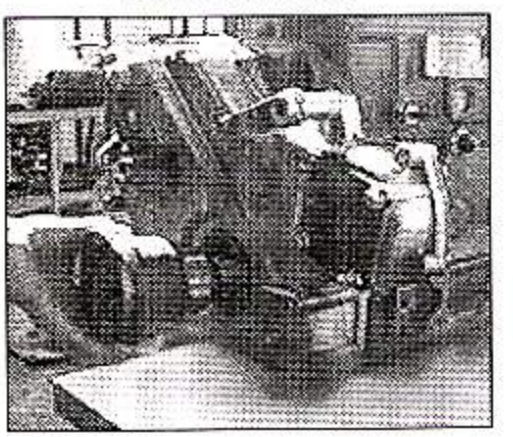
(1) Install two bolts (M12×1.25) in the flywheel bolt holes in the crankshaft and hold the crankshaft.

(2) Tighten the crankshaft pulley nut to the specified torque.

Tightening torque	6.5 ±0. 25kgf·m (47.01 ± 1.81 lbf·ft) [63.74 ± 2.45 N·m]

⚠ WARNING

Check the strength of the bolts and bar used for holding the crankshaft.



Installing crankshaft pulley

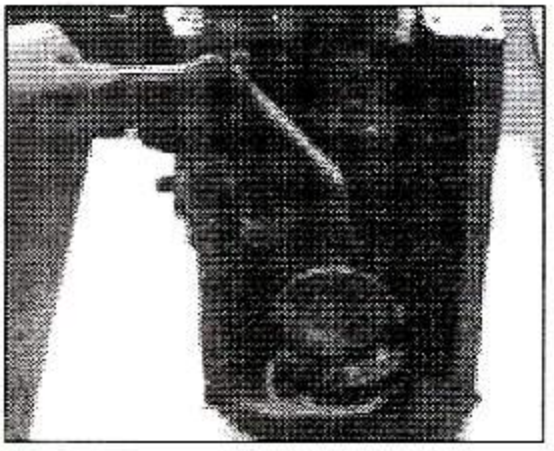
16. Oil screen installation

(1) Lay the cylinder block with the bottom (oil pan side) up.

(2) Install the oil screen in position.

NOTE

The oil screen must be installed in position so that it is below the oil level line and away from the oil pan.



Assemble oil strainer

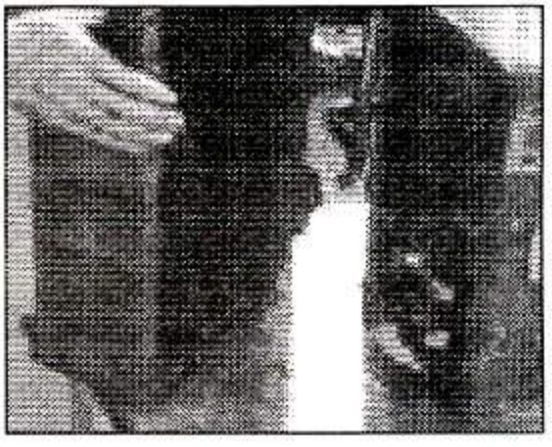
17. Oil pan installation

(1) Clean the mating surfaces of the oil pan and cylinder block and coat them with Three Bond 1207C.

(2) Install the packing

(3) Tighten the bolts that hold the oil pan to the cylinder block in a crisscross pattern to the specified torque.

Tightening torque	Cast oil pan: 2.8 ± 0.3kgf·m (20.25±2.17 lbf·ft) [27.46±2.94N·m] Plate oil pan: 1.15 ± 0.15kgf·m (8.32±1.08 lbf·ft) [11.28±1.47N·m]



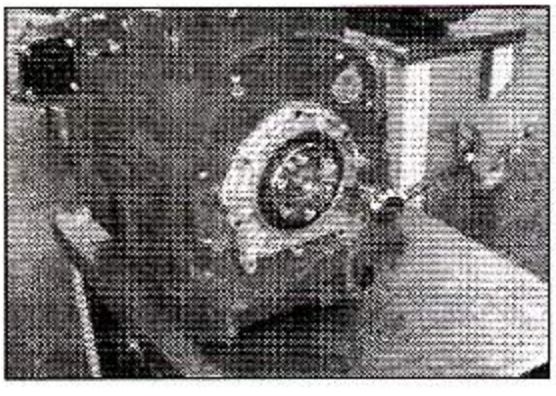
Installing Oil pan

(4) Assemble Oil gauge guide

18. Oil seal case installation

(1) Put a new gasket in position on the oil seal case.

(2) Lubricate the oil seal lip with engine oil and install the oil seal in position in the cylinder block.

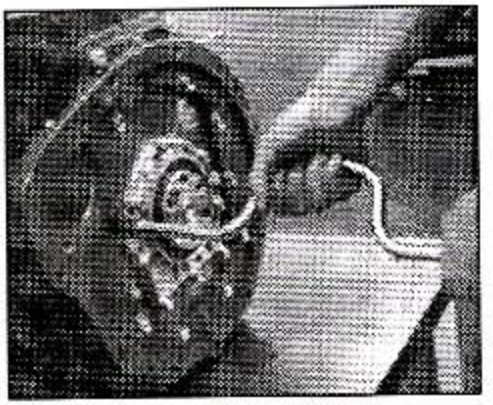


Installing Oil seal case

19. Rear plate (or mount flange) installation

(1) Put the rear plate in position on the cylinder block with its dowel holes in alignment with the dowels. Tighten the bolts that hold the rear plate to the specified torque.

Tightening torque	6.5 ± 1kgf·m (47 ± 7 lbf·ft) [64 ± 10 N·m]



Installing rear plate

NOTE

Install the starter to the rear plate before installing the plate to the cylinder block for convenience of rear plate installation

20. Flywheel installation

(1) Install a safety bar (M12×1.25) in the rear end of the crankshaft.

(2) Put the flywheel in position in alignment with the safety bar.

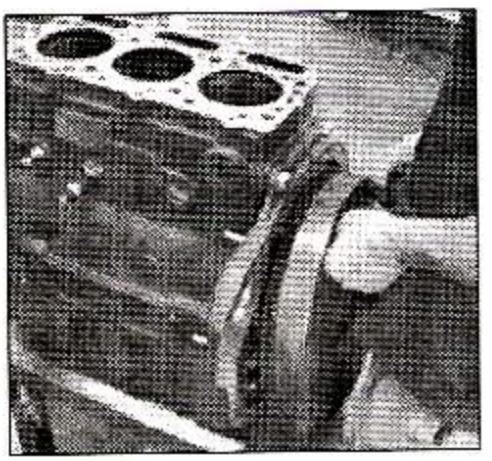
(3) Install three of four bolts in the flywheel and tighten them finger tight only.

(4) Remove the safety bar. Install the last bolt in the flywheel and tighten it finger tight only.

(5) Have someone hold the crankshaft pulley with a wrench to prevent the flywheel from rotating.

(6) Tighten the five bolts that hold the flywheel to the specified torque.

Tightening torque	10 ± 0.5kgf·m (72.33 ± 3.62 lbf·ft) [98.07 ± 4.90 N·m]



Installing flywheel

⚠ WARNING

Always signal each other to prevent possible personal injury.

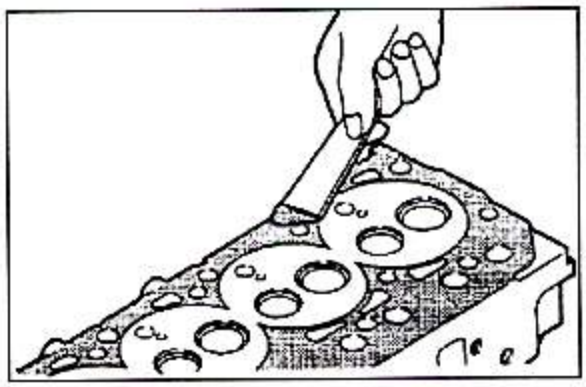
CYLINDER HEAD, FUEL INJECTION PUMP AND ACCESARRY

1. Cylinder head bottom face cleaning

Scrape the gasket from the bottom face of the cylinder head.

NOTE

After scraping the gasket, rub off gasket remnants from the face with an oilstone smeared with engine oil and thoroughly clean the face.



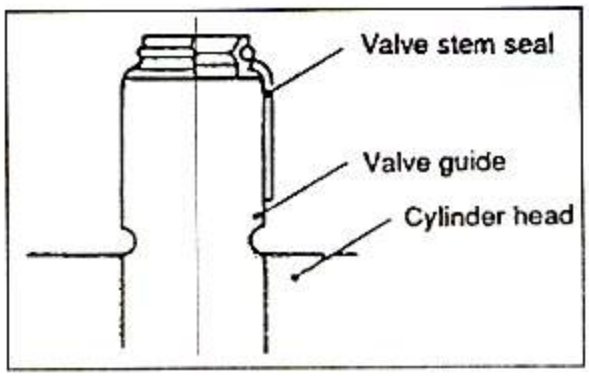
Removing cylinder head gasket

2. Valve stem seal installation

Using Box 12, install the valve stem seal in position in the valve guide. After installation, make sure the seal is in its correct position.

NOTE

Improper stem seal installation can cause a failure to seal against downward flow of oil along the stem.



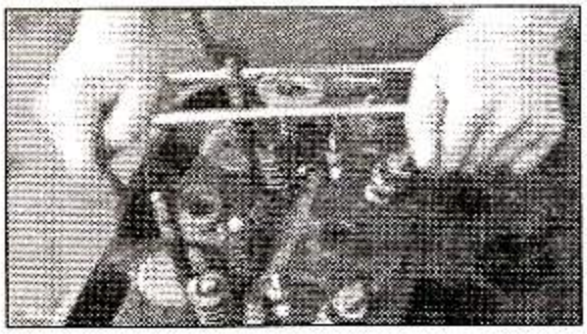
Installing valve stem seal

3. Valve spring installation

1) Install valve with coated engine oil .
2) Put the valve spring and retainer
3) While pressing the valve spring with tool, insert the cotter between spring and retainer .

CAUTION

Do not put excessive compression on the valve spring. This can cause the retainer to hit and damage the stem seal.



Installing valve spring

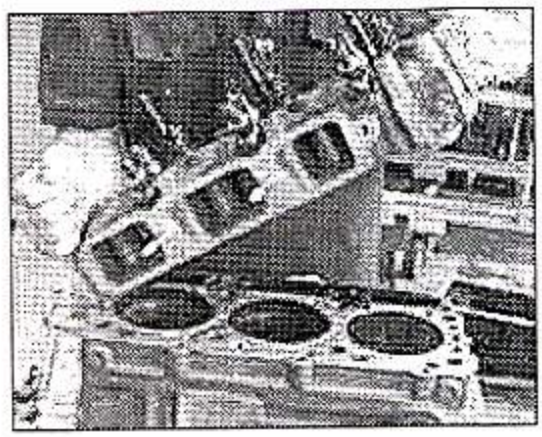
4. Cylinder head gasket installation

(1) Thoroughly clean the top faces of the cylinder block and pistons.

(2) Put a new cylinder head gasket in position on the cylinder block.

⚠ CAUTION

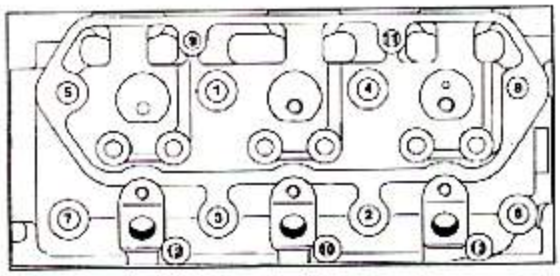
Do not use any gasket adhesive or other substances on the top face of the cylinder block.



Installing cylinder head

5. Cylinder head installation

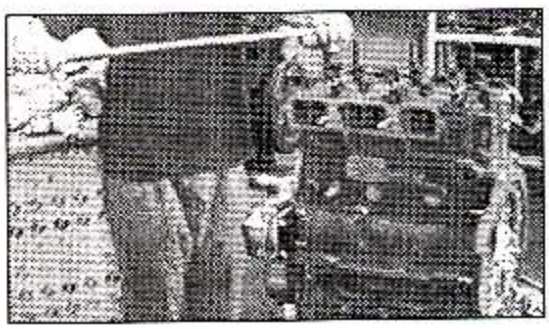
Put the cylinder head in position on the cylinder block, making sure the guide bolts are all in alignment with their respective bolt holes in the head.



6. Cylinder head bolt tightening

(1) Tighten the bolts in number sequence in two or three steps to the specified torque.

Tightening torque	1-8	20 ± 1.0kgf·m (144.66±7.23lbf·ft) [196.13±9.81N·m]
	9-13	8 ± 0.5kgf·m (57.86±3.62lbf·ft) [78.45 ± 4.9 N·m]

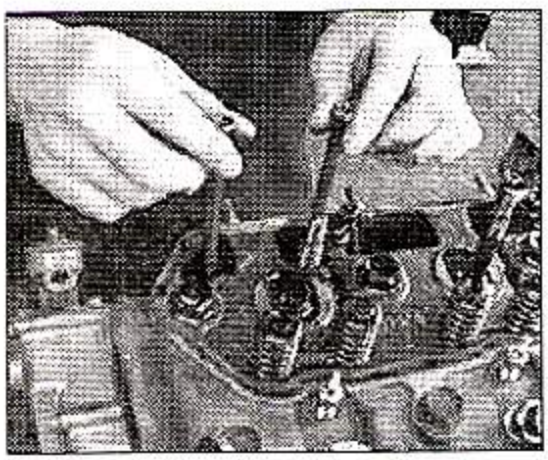


Tightening Cylinder head bolts

7. Valve push rod installation

(1) Put the valve push rod into position through the bore in the cylinder head.

(2) Make sure the ball end of the push rod has been put into position over the top of the tappet.

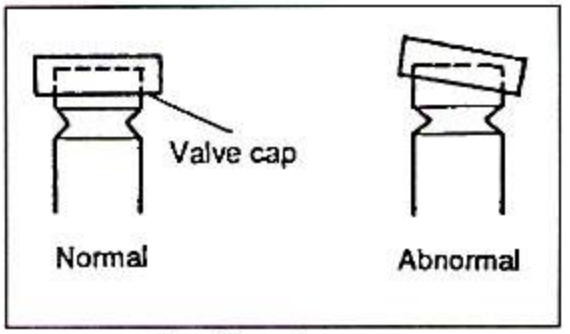


Installing push rod

8. Rocker arm shaft assembling

(1) Install the rocker arms, brackets and springs on the rocker shaft. Secure the brackets to the shaft by tightening the bolts.

(2) Make sure the rocker arms move freely.



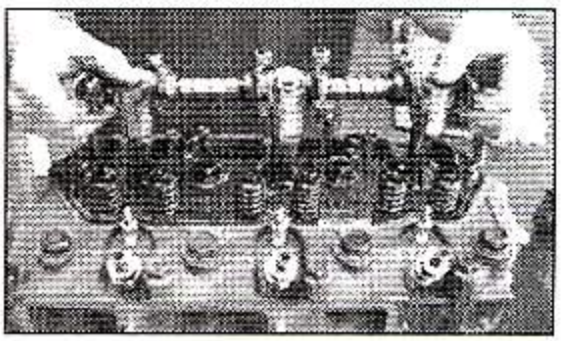
Installing valve cap

9. Rocker shaft assembly installation

(1) Install the valve caps in position on the top of the valves.

(2) Put the rocker shaft assembly in position on the cylinder head. Tighten the bolts that hold the rocker shaft assembly to the specified torque.

Tightening torque	1.5 ± 0.5kgf·m (10.85 ± 3.62 lbf·ft) [14.71 ± 4.9 N·m]



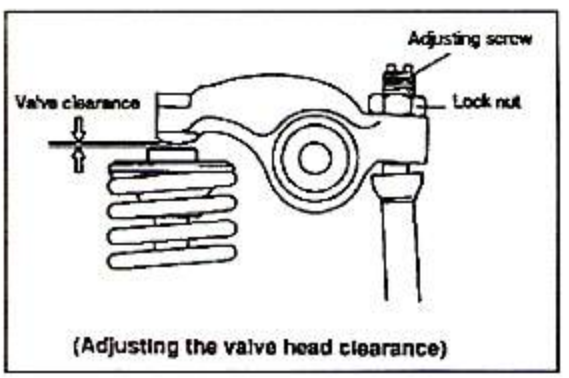
Installing rocker arm shaft assembly

10. Valve clearance adjustment

Adjust valve clearance..

mm (in)

Standard	0.2 mm (0.00787)



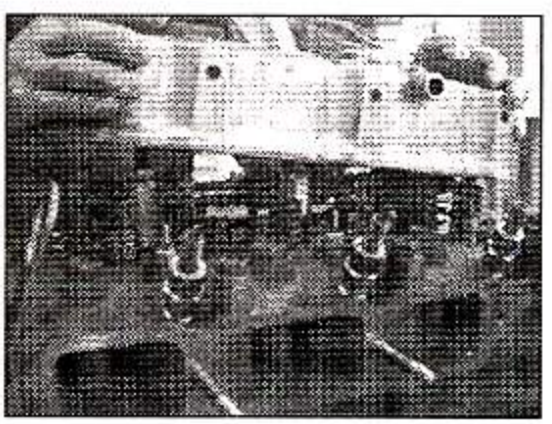
(Adjusting the valve head clearance)

12. Cylinder head cover installation

(1) Make sure the packing is put on the rocker cover.

(2) Tighten the bolts that hold the rocker cover to the specified torque.

Tightening torque	1.15 ± 0.15kgf·m (8.32 ± 1.08 lbf·ft) [11.28 ± 1.47 N·m]



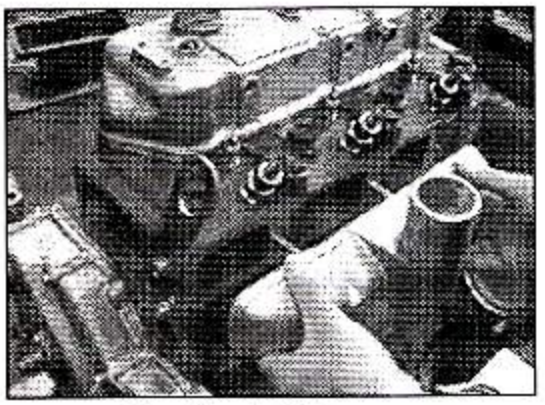
Installing cylinder head cover

AIR INLET SYSTEM AND EXHAUST SYSTEM

1.Air inlet cover installation

Tightening the bolts that hold the air inlet cover to the specified torque.

Tightening torque	1.85 ± 0.35kgf·m (13.38 ± 2.53 lbf·ft) [18.14 ± 3.43 N·m]



Installing air inlet cover

2.Exhaust manifold installation

Tightening the bolts that hold the air inlet cover to the specified torque.

Tightening torque	1.85 ± 0.35kgf·m (13.38 ± 2.53 lbf·ft) [18.14 ± 3.43 N·m]

Installing exhaust manifold

(4) Bearings

Replace the bearings if they are noisy or fail to run freely.

(5) Overrunning clutch

Replace the overrunning clutch assembly if—

(a) The pinion is not locked when spun counterclockwise, or if it does not rotate freely when spun in the reverse direction (clockwise).

(b) The pinion is worn or chipped.

⚠ CAUTION

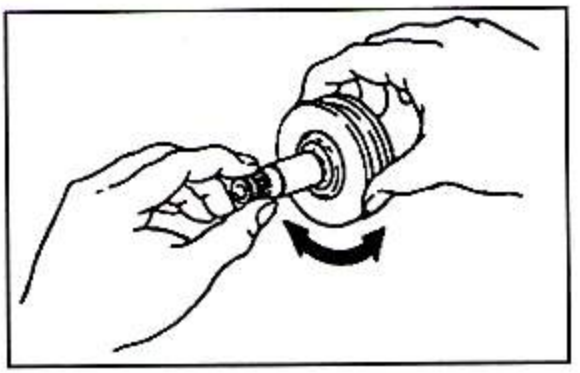
Do not wash the overrunning clutch with cleaning solvent.

(6) Front bracket

Replace the front bracket assembly if the ball bearing is noisy or fails to rotate freely.

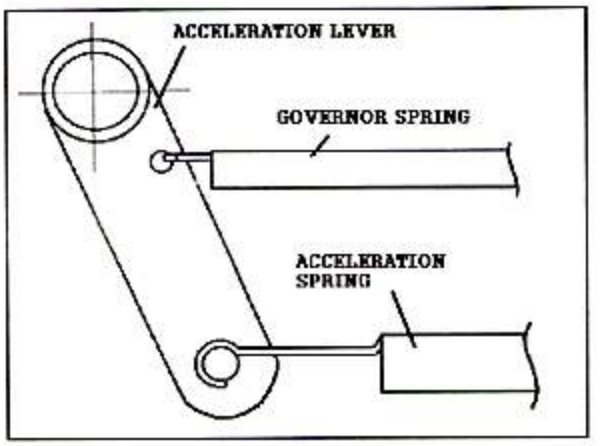
(7) Reduction gears

Replace the reduction gears if they are worn or damaged.



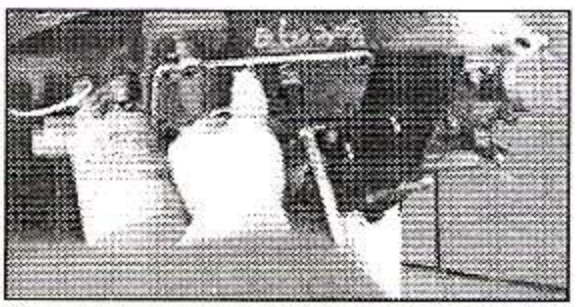
Testing over running clutch

(3) Engage governor spring to acceleration lever



Installing governor spring

(4) Assemble the chamber cover.

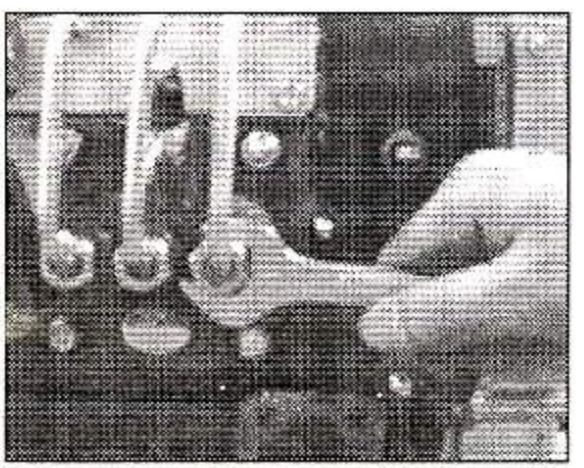


Installing the chamber cover

3. High pressure pipe installation

(1) Put the fuel leak-off line in position and connect it to the fuel injection nozzles.

(2) Put the fuel injection lines in position and connect them to the fuel injection pump. Install the clamps.



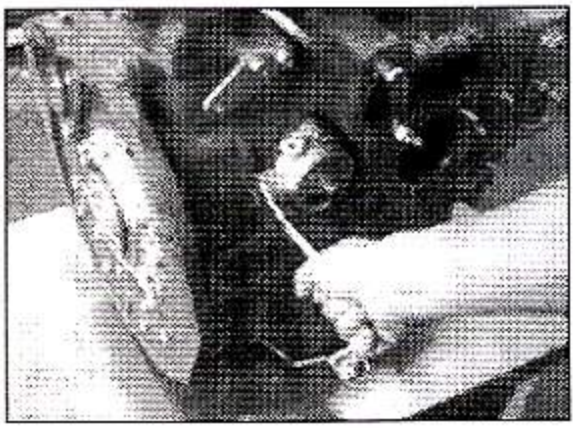
Connecting high pressure pipe to pump

LUBRICATION SYSTEM

1. Pressure relief valve installation

Put the relief valve in position on the cylinder block and tighten it to the specified torque.

Tightening torque	5 ± 0.5kgf·m (36.16 ± 3.62 lbf·ft) [49.03 ± 4.9 N·m]

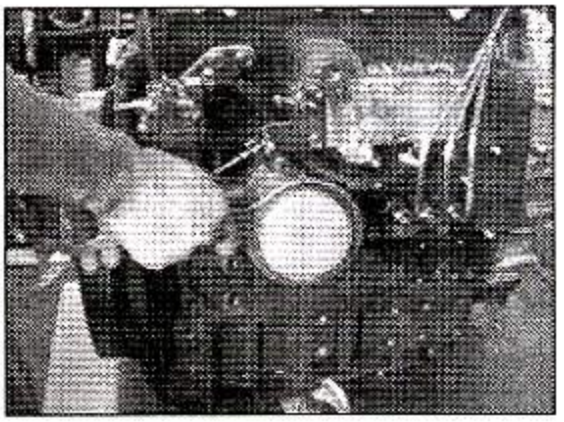


Installing pressure relief valve

2. Oil filter installation

(1) Lightly lubricate the gasket with engine oil.

(2) Install the new filter element by hand. When the gasket contacts the base, tighten one turn more.



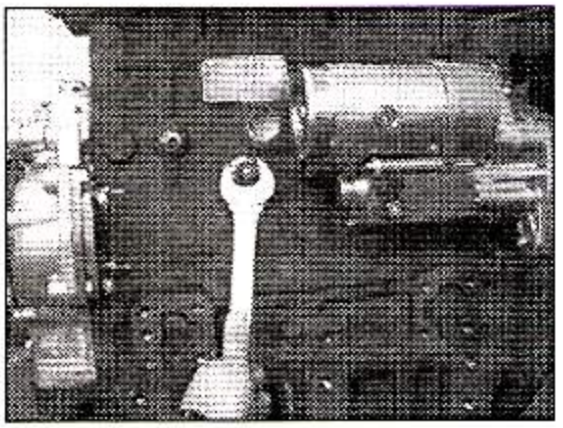
Installing Oil filter

3. Oil pressure switch installation

Coat the threads of the switch with thread sealant (Three Bond 1102). Use Oil Pressure Switch Socket Wrench (MD998054) (special tool) to install the oil pressure switch.

⚠ CAUTION

(a) Put the sealant on the threads only.
(b) Do not over-tighten the oil pressure switch when it is installed.

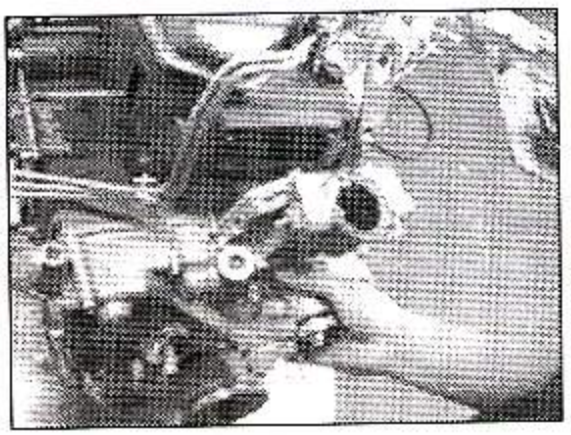


Installing Oil pressure switch

COOLING SYSTEM

1. Water pump installation

Put a new gasket in position on the water pump flange. Install the water pump in position on the cylinder block.

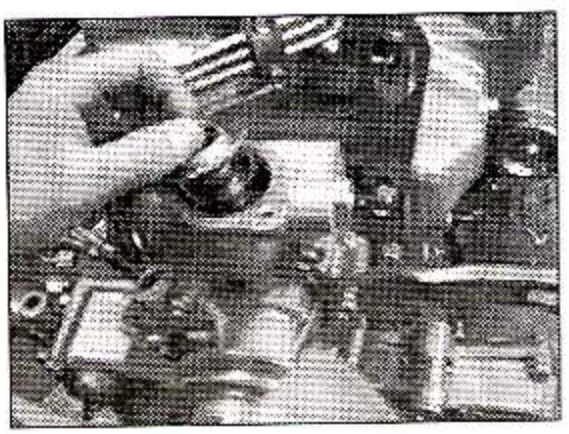


Installing the water pump

2. Thermostat installation

(1) Put the thermostat in the thermostat case.

(2) Put a new gasket in position on the thermostat case. Install the thermostat assembly in position on the cylinder head.

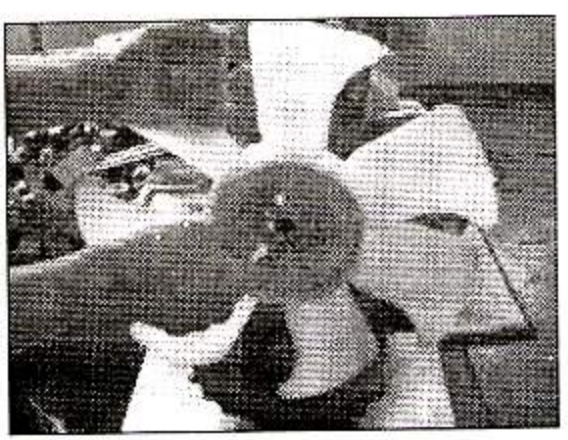


Installing the thermostat

3. Cooling fan installation

(1) Install the spacers in position in the fan as shown.

(2) Install the pulley in position on the water pump. Install the fan and spacer combination in position on the pulley.

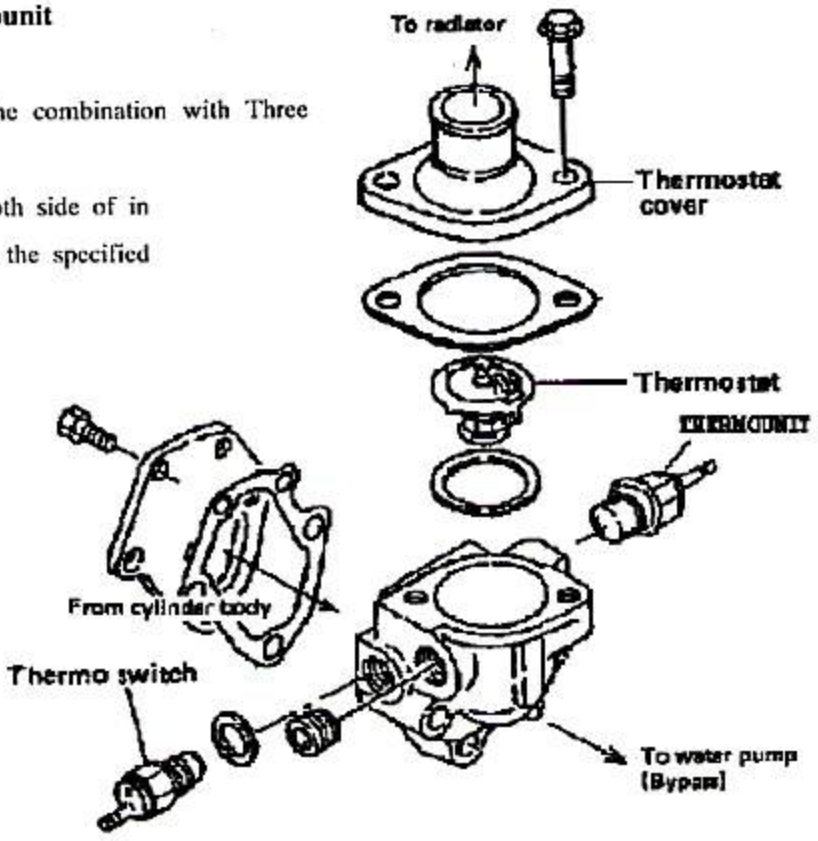


Installing cooling fan

4. Thermoswitch and thermounit combination installation

(1).Coat the threads of the combination with Three Bond 1104.

(2)Put the combination both side of in thermostat and tighten it to the specified torque.

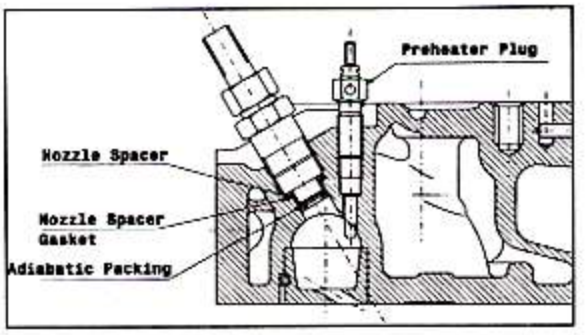


ELECTRICAL SYSTEM

1. Glow plug installation

Install the glow plug in position in the precombustion chamber and tighten it to the specified torque.

Tightening torque	1.75 ± 0.25kgf·m (12.66 ± 1.81 lbf·ft) [17.16 ± 2.45 N·m]



Installing the glow plugs

2. Alternator installation

(1) Put the alternator in position. Install the adjusting plate bolt in position to hold the alternator in position.

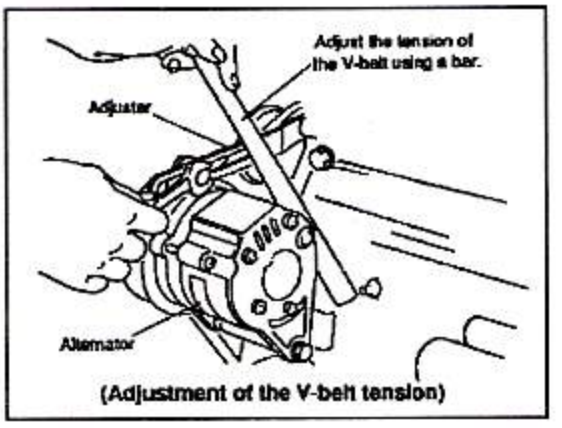
(2) Put the belt in position on the pulley. Move the alternator away from the engine to make an adjustment to the belt.

(3) Tighten the bolts.

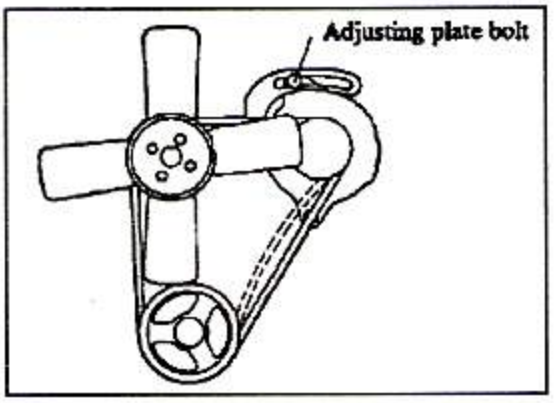
(4) Make sure the deflection (tension) of the belt is correct.

Unit : mm (in.)

Deflection under 10 kgf (22.05 lbf) [98.07 N] force	10 to 12 (0.4 to 0.5) (0.39 to 0.47)



Installing generator



Adjusting tension of belt

ELECTRICAL SYSTEM

GENERAL

1. Schematic
2. Specifications (standard)

STARTER

1. Disassembly
2. Inspection
3. Assembly

ALTERNATOR

1. Disassembly
2. Inspection
3. Assembly

KEY SHUTOFF SYSTEM

1. Schematic

AUTOMATIC GLOW PLUG SYSTEM

1. General
2. Glow plug timer specifications (standard)
3. Glow plug relay specifications (standard)
4. Glow plug inspection

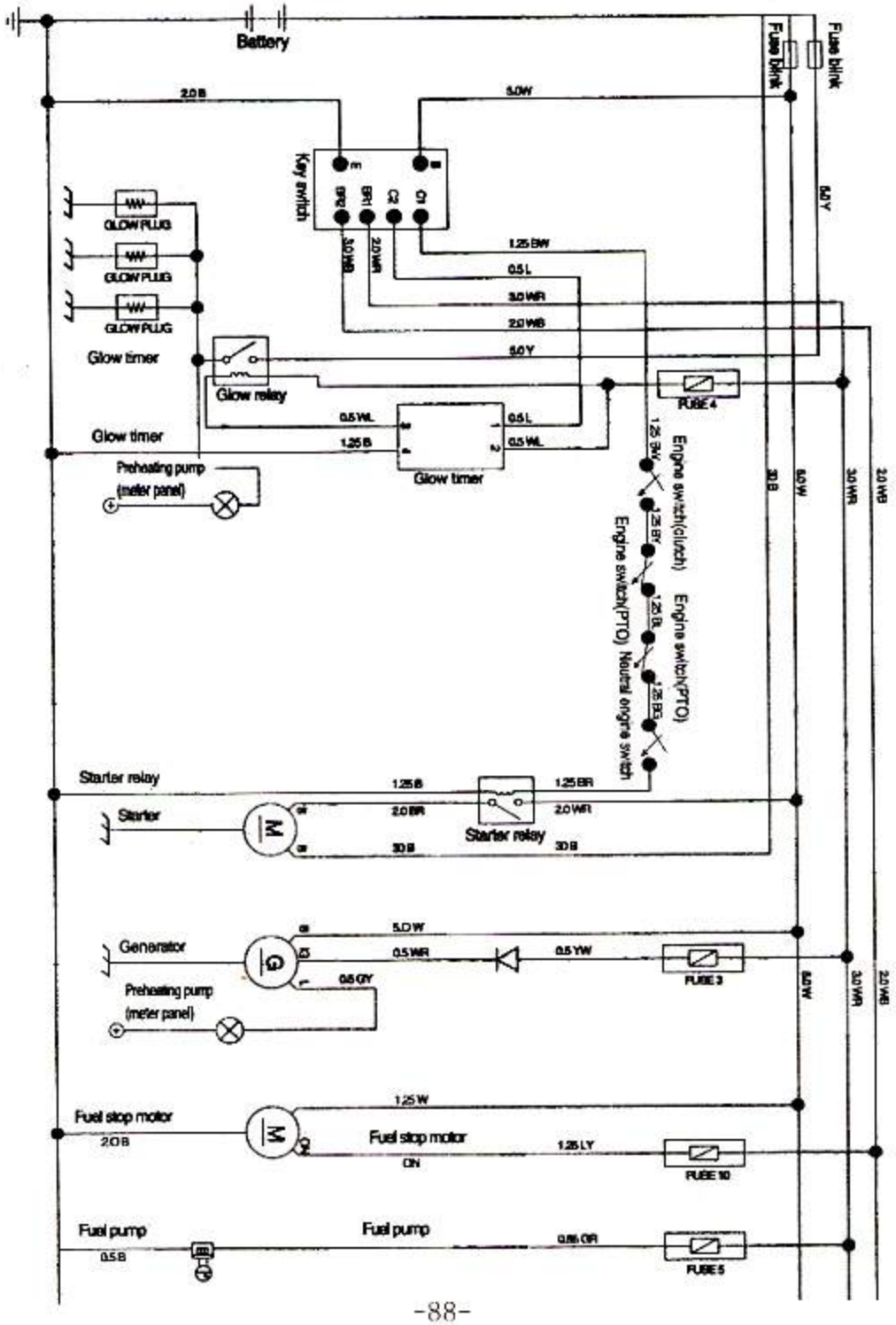
GENERAL

1. Schematic

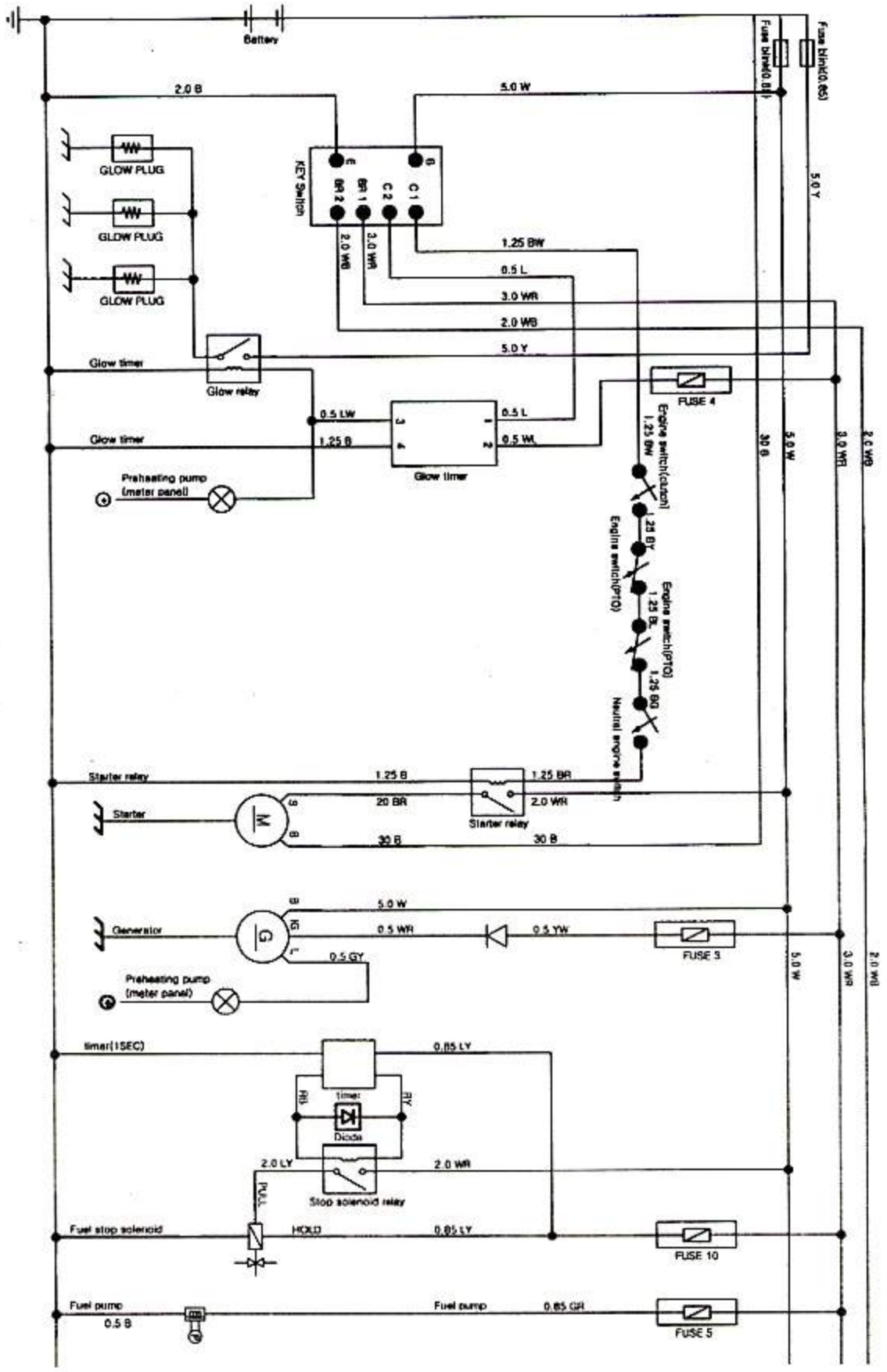
(1) Figure indicates a nominal size of automotive low-tension line (JIS C 3406).

(2) This schematic shows the electrical system of the standard engine equipped with a key shut down solenoid and glow plugs.

Schematic of Electric System of (For Stop Motor)



Schematic of Electric System of (For Stop Solenoid)

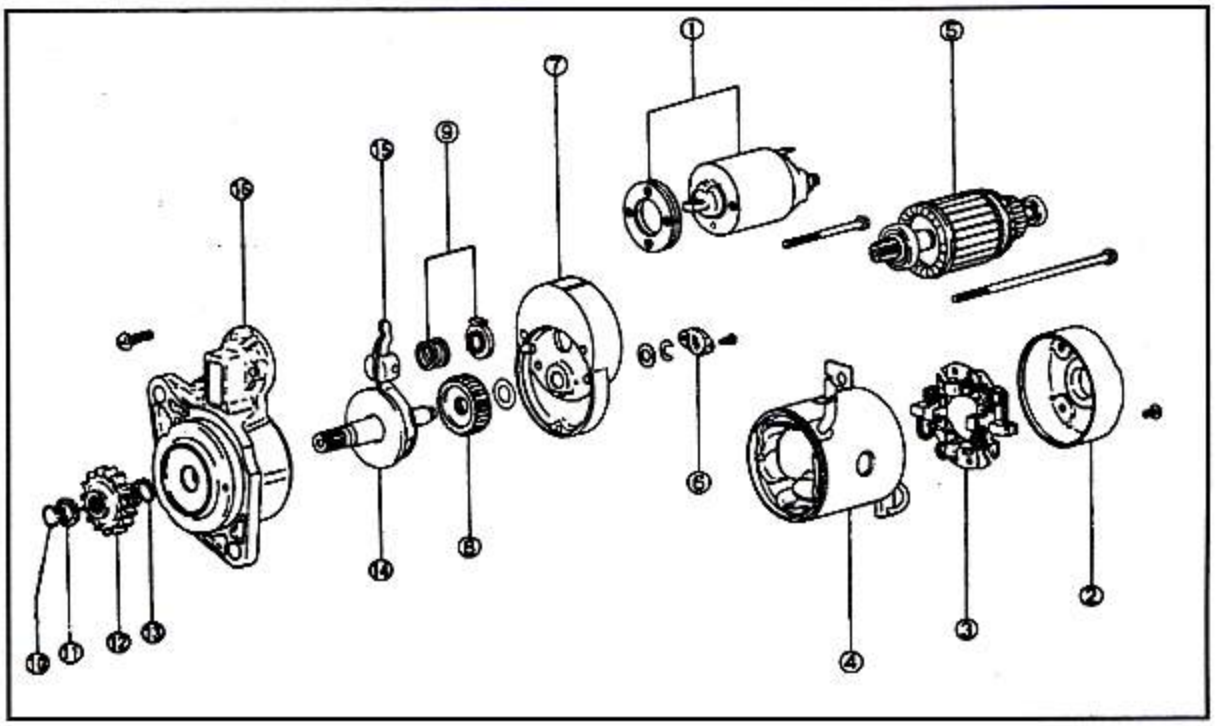


2. Specifications (standard)

Engine model		3T84L-ATC / 3T90L-ATC / 3T90LT-ATC
Starter	Model	HA15010000A1
	Type	Dic Solenoid Shift
	Nominal output, V-kW	12, 20
Alternator	Model	HM24120000A2
	Regulator, type	HIC genecator
	Nominal output, V-A	12-50
Glow plug	Model	HK15170000A4
	Type	Sheathed
	Rated voltage, V	12
	Current draw, A	30
Glow plug Relay	Model	FTB9160000A3
	Rated voltage, V	PC 12
	Continuous rating	
	Resistance in coil, Ω	40
Control timer Unit	Model	NTG1300000A4
	Input voltage range, V	12
	Load	

STARTER

1. Disassembly



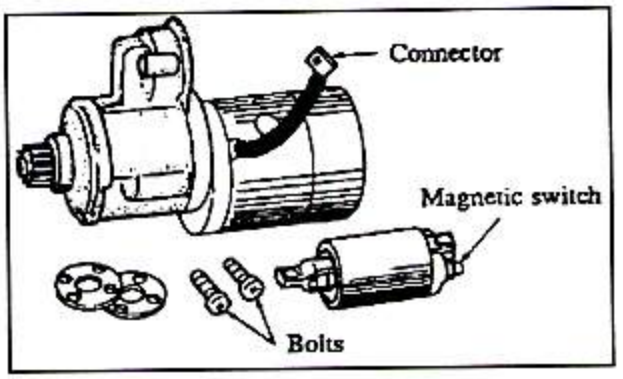
1. Magnetic switch	6. cover	11. Stopper
2. Rear bracket	7. Center bracket	12. pinion
3.Brush holder	8. Gear	13.Spring
4. Yoke	9. Spring set	14.pinion shaft
5. Armature	10. Stopper ring	15. Front bracket

Disassembly procedure

(1) Magnetic switch

(a) Loosen the nut that holds the connector to the M terminal of the magnetic switch and disconnect the connector from the magnetic switch.

(b) Remove the bolts (two) that hold the magnetic switch in position and remove the magnetic switch.



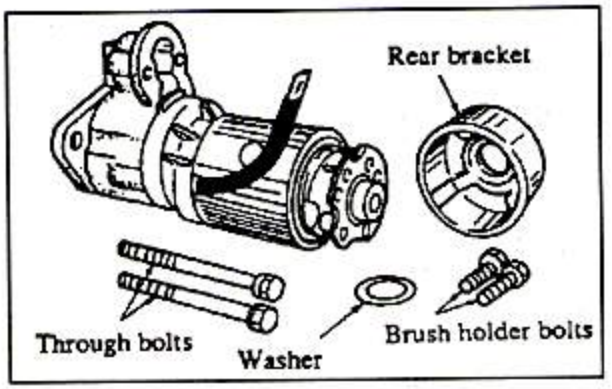
Removing magnetic switch

(2) Rear bracket removal

Remove the through bolts (two) and the bolts (two) that hold the brush holder in position. Remove the rear bracket.

NOTE

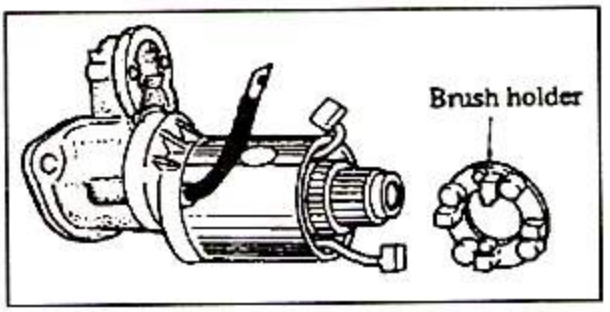
Keep the rear bracket with washer for installation.



Removing rear bracket

(3) Brush holder removal

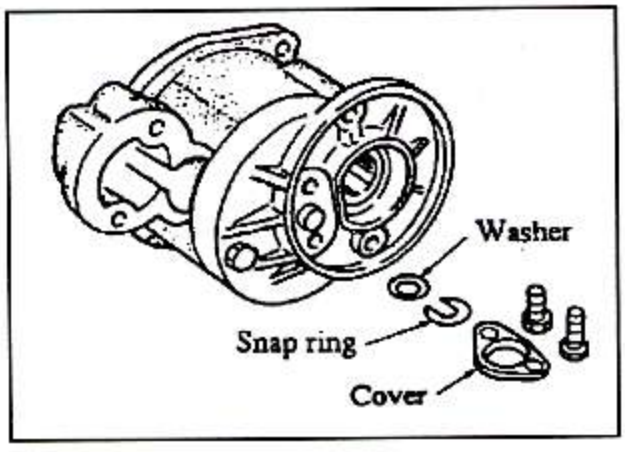
With the brushes (two) kept apart from the commutator, remove the yoke and brush holder assembly. Remove the armature.



Removing brush holder

(4) Cover removal

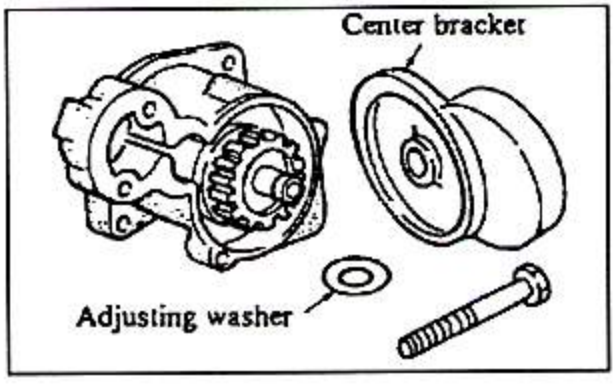
Remove the cover and remove the snap ring and washer.



Removing cover

(5) Center bracket removal

Remove the bolt and remove the center bracket. Remove the washer for adjusting the end play for the pinion shaft.



Removing center bracket

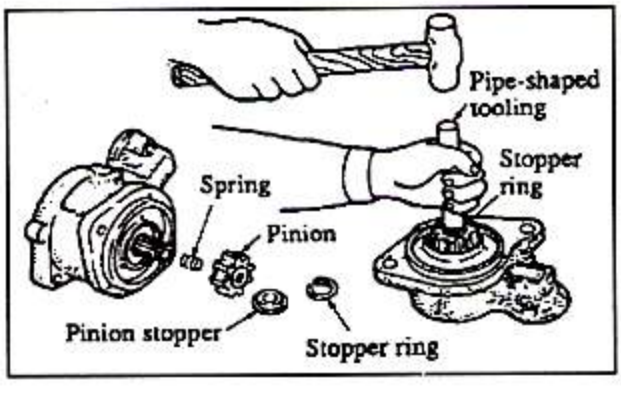
(6) Pinion removal

(a) Put a pipe-shaped tooling on the pinion stopper and hit the stopper with a hammer to expose the stopper ring.

(b) Remove the stopper ring with a pliers and remove the pinion.

NOTE

Any time the pinion is removed, a new stopper ring must be installed.



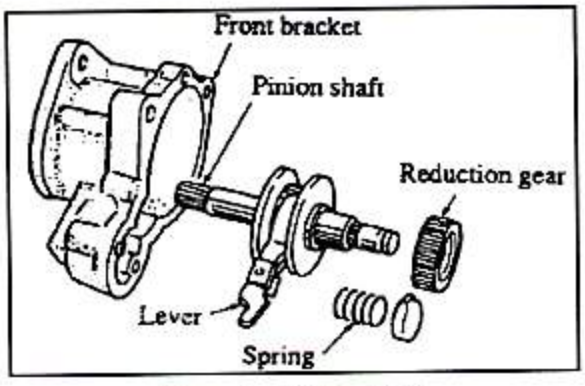
Removing pinion

(7) Piston shaft removal

Remove the spring, lever, reduction gear and pinion shaft from the front bracket.

NOTE

Do not mix the sequence of spring, lever and reduction gear when the pinion shaft is removed.

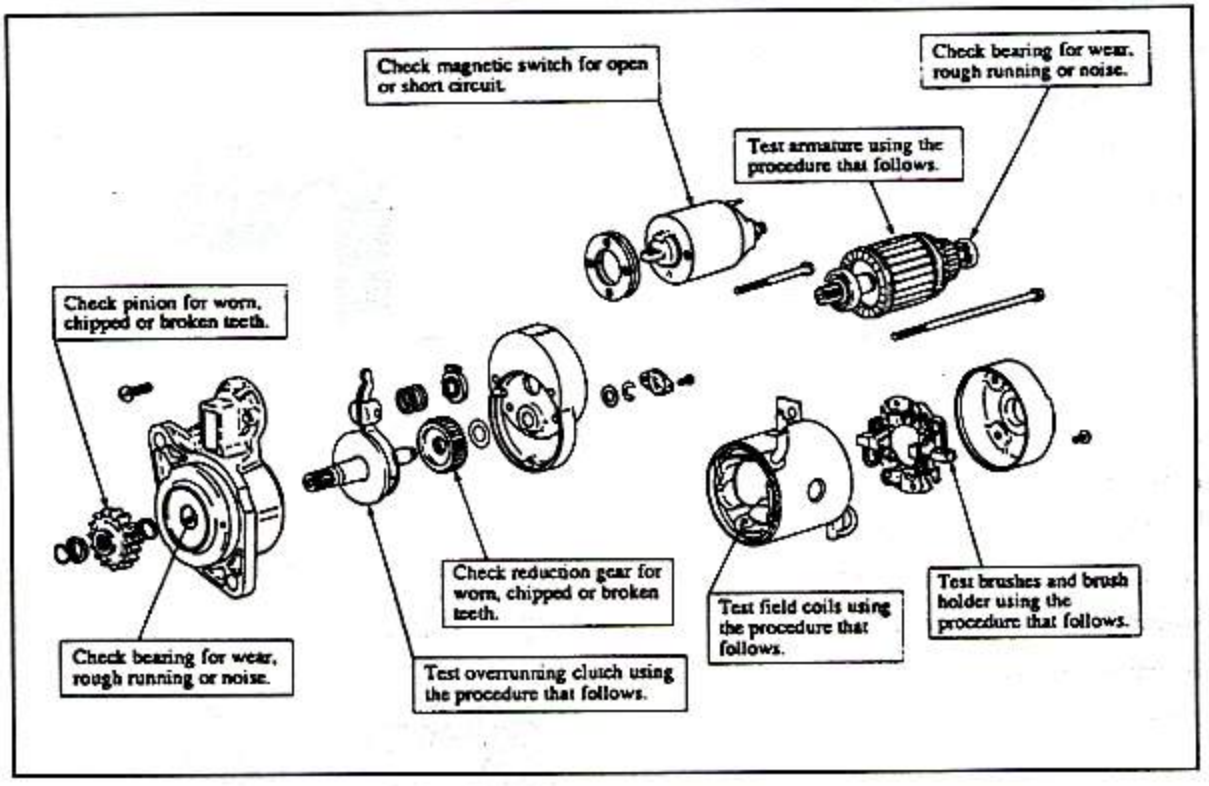


Removing pinion shaft

(8) Bearing removal

To remove the ball bearing from the ends of the armature, use a bearing puller. The bearing fitted in the front bracket is not replaceable. Replace the front bracket assembly if this bearing is defective.

2. Inspection

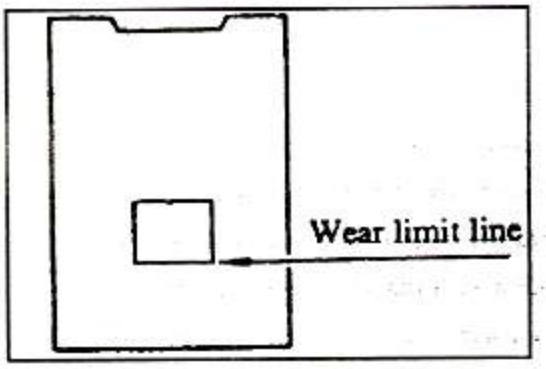


Inspection procedure

(1) Brushes

(a) Wear

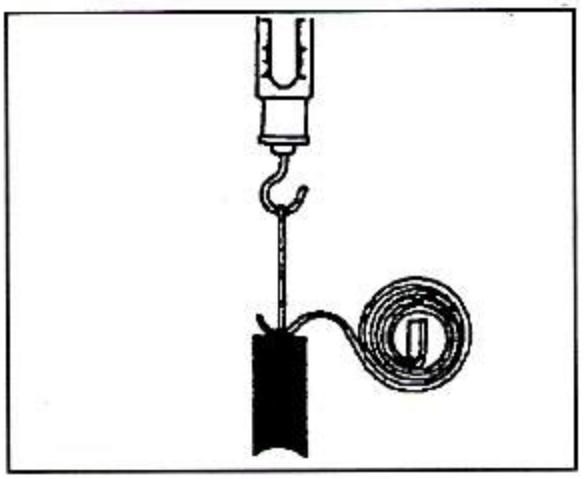
Replace the brushes if they are worn down to the wear limit line which is the bottom of the border for Mitsubishi mark. Replace the brush holder assembly if the brushes are worn beyond the wear limit line.



Checking brush

(b) Brush spring tension

Test the spring tension using a new brush as shown in the illustration. Read the load when the spring just moves off the brush. If the tension is below the limit, replace the spring.

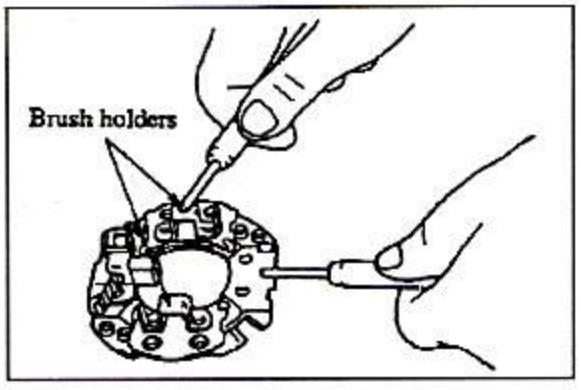


Unit: kgf (lbf) [N]

Item	Standard	Limit
Brush spring Tension	1.6 (3.52) [15.7]	1.8 (4.0) [17.7]

(c) Brush holders

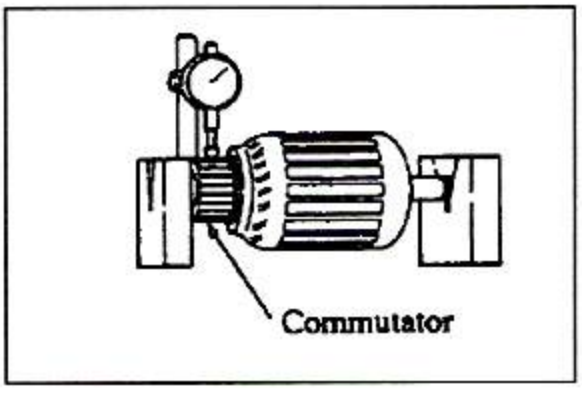
Test for no continuity between the positive brush holder and brush holder base as shown in the illustration. If there is any continuity between them, replace the brush holder. Also, check the brush holder for loose staking.



(2) Armature

(a) Commutator runout

Support the armature in V-blocks and measure the commutator runout with a dial indicator. If runout exceeds the limit, turn the commutator in a lathe. The cut should be made within the limit of the commutator diameter.



Unit : mm (in.)

Item	Standard	Limit
Runout of commutator	0.03 (0.001 2)	0.10 (0.003 9)

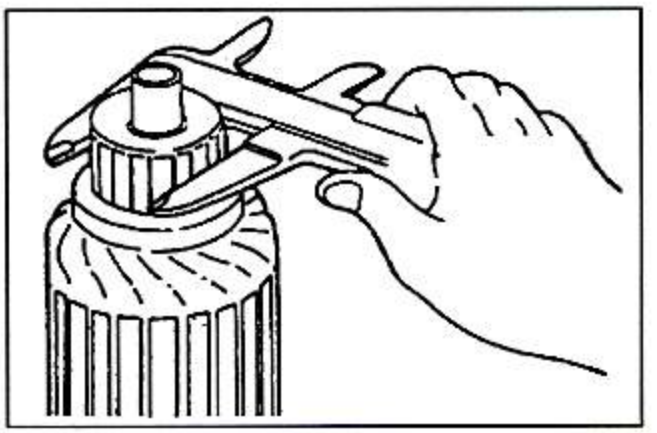
(b) Diameter of commutator

Measure the diameter of the commutator.

If it exceeds the limit, replace the armature.

Unit : mm (in.)

Item	Standard	Limit
Diameter of commutator	32(1.26)	31(1.22)



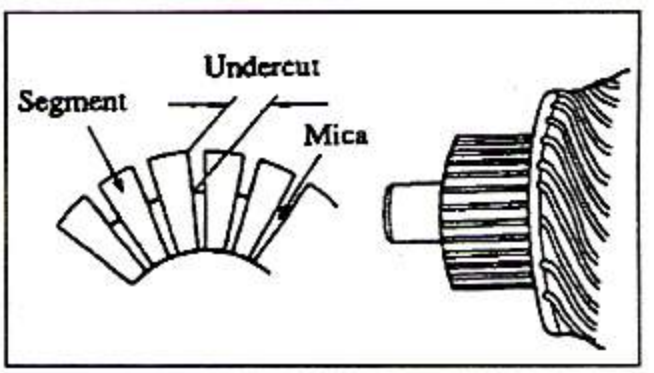
Measuring commutator diameter

(c) Mica undercut

Measure the undercut of mica insulation between the adjacent segments. If undercut exceeds the limit, recondition the mica, or replace the armature.

Unit : mm (in.)

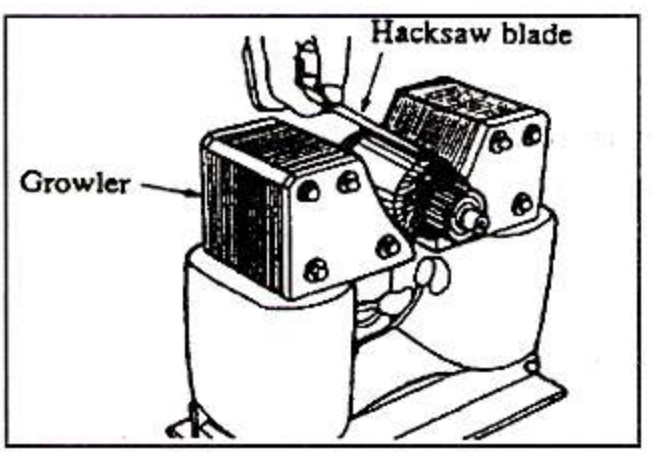
Item	Standard	Limit
Undercut of mica	0.5 (0.020)	0.2 (0.008)



Undercut of mica

(d) Testing for short circuit

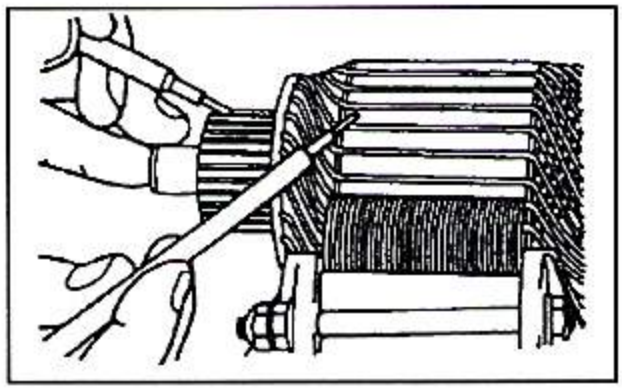
Place the armature on a growler and slowly rotate it with a hacksaw blade held above the armature core. The hacksaw blade vibrates against the core when it is above a slot containing a shorted winding. A shorted armature should be replace.



Testing armature for short circuit

(e) Testing for grounded circuit

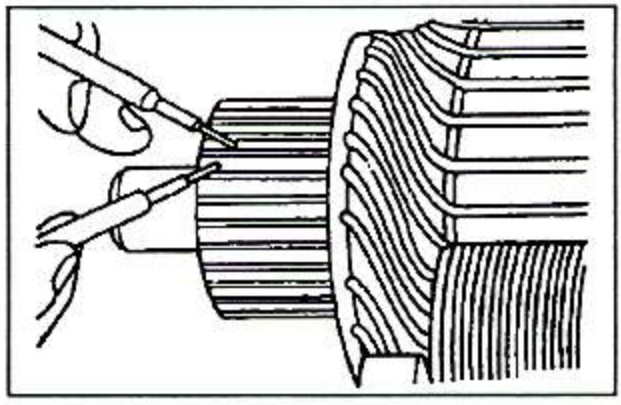
Test the armature for grounded circuit as shown in the illustration. If there is any continuity between commutator segment and coil, the armature is grounded and should be replaced.



Testing armature for grounded circuit

(f) Testing for open circuit

Test the armature for open circuit as shown in the illustration. If there is no continuity between the segments, the armature is open circuited and should be replace.



Testing armature for open circuit

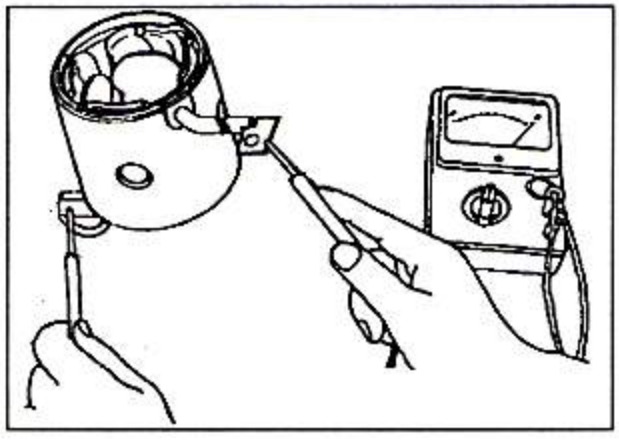
(3) Field coils

Replace the yoke assembly if —

(a) There is any continuity between the brush and yoke.

(b) There is no continuity between the brushes.

(c) The pole piece or coil is loosen.



Testing field coils

FUEL SYSTEM

1. Fuel injection nozzle installation

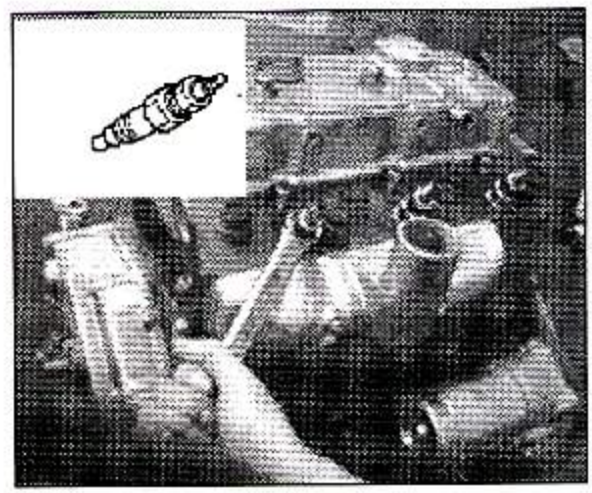
(1) Put the gasket on the nozzle.

(2) Put the nozzle assembly in position in the cylinder head and tighten it to the specified torque.

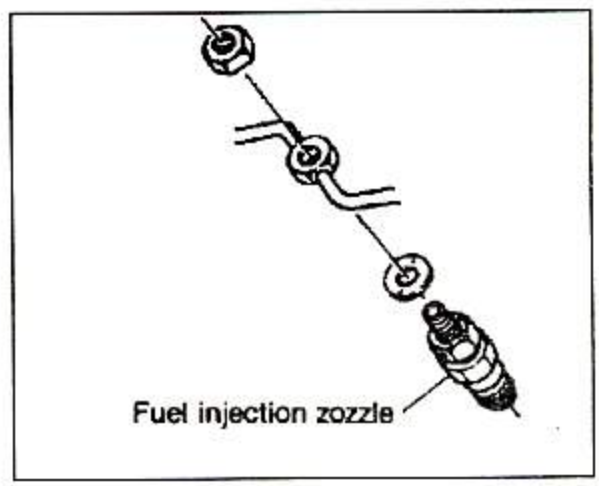
Tightening torque	5.5 ± 0.5kgf·m (39.78 ± 3.62 lbf·ft) [53.94 ± 4.9 N·m]

(3) put the washer and return Oil pipe

(4) Tighten nuts



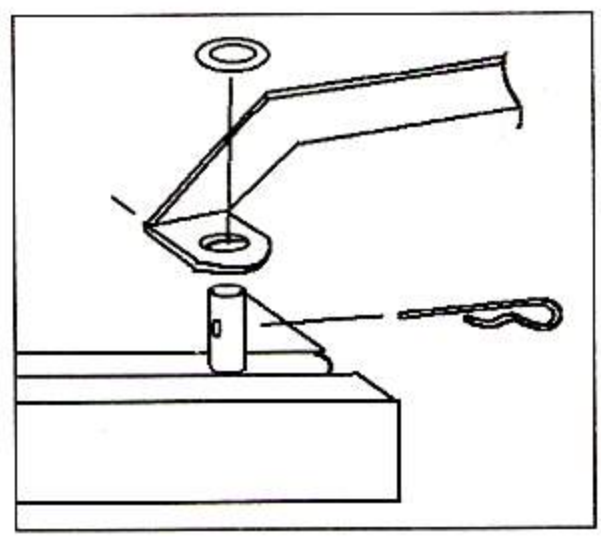
Installing injection nozzles



2. Fuel injection pump installation

(1) Put the pump and shims in position on the cylinder block and tighten the bolts that hold the pump to the specified torque.

(2) Connect the fuel injection control rack and governor link with pin

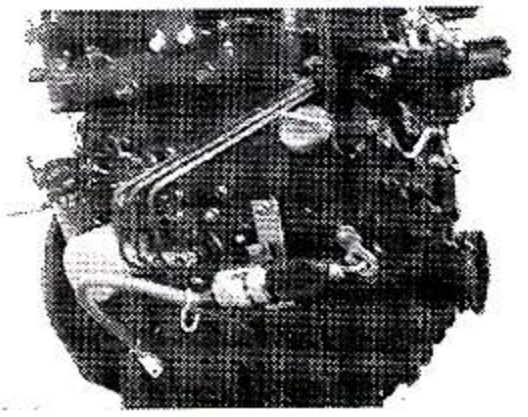


Installing the pin

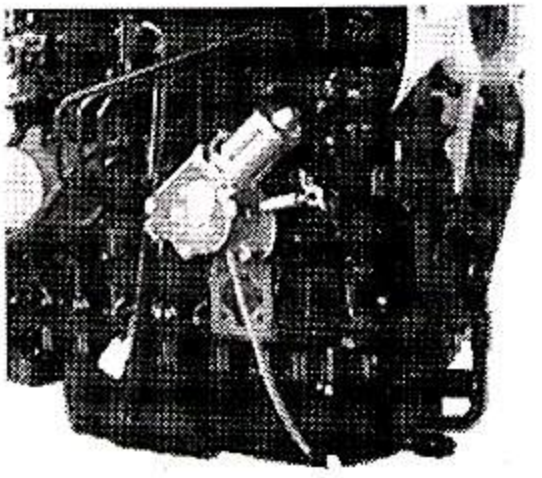
a) When power is on, the lever of stop motor is in "ON" position as like above. Governor lever is not pushed by stop lever.

b) When power is off the lever of stop motor rotate to "OFF" position and push governor lever. Then governor lever pull rack of fuel injection pump to reduce injecting fuel. So engine is stopped by lack of fuel.

C) When power is ON, the terminal of NO and COM in the stop motor is charged in positive. As key is switched to negative by operator (The terminal of COM become negative), stop motor rotate until that the tip of motor push the lever that press the switch. As the switch is released, terminal of NC is connected to the terminal of COM(-). Then motor is stopped.



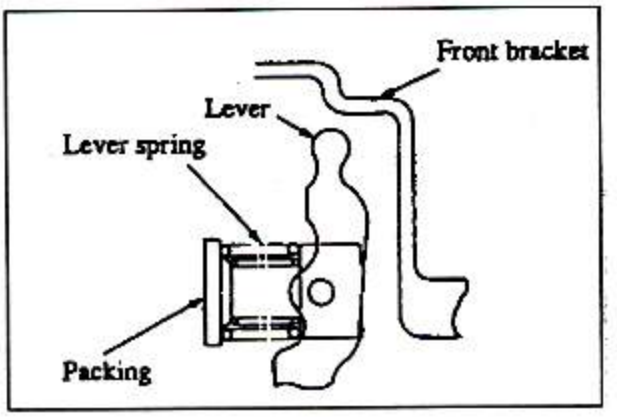
Installed stop solenoid



Installed stop motor

(4) Lever installation

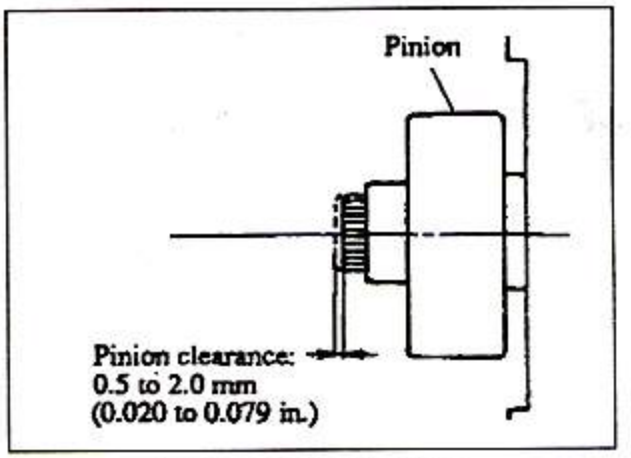
Install the lever in correct position.



Installing lever

(5) Pinion clearance adjustment

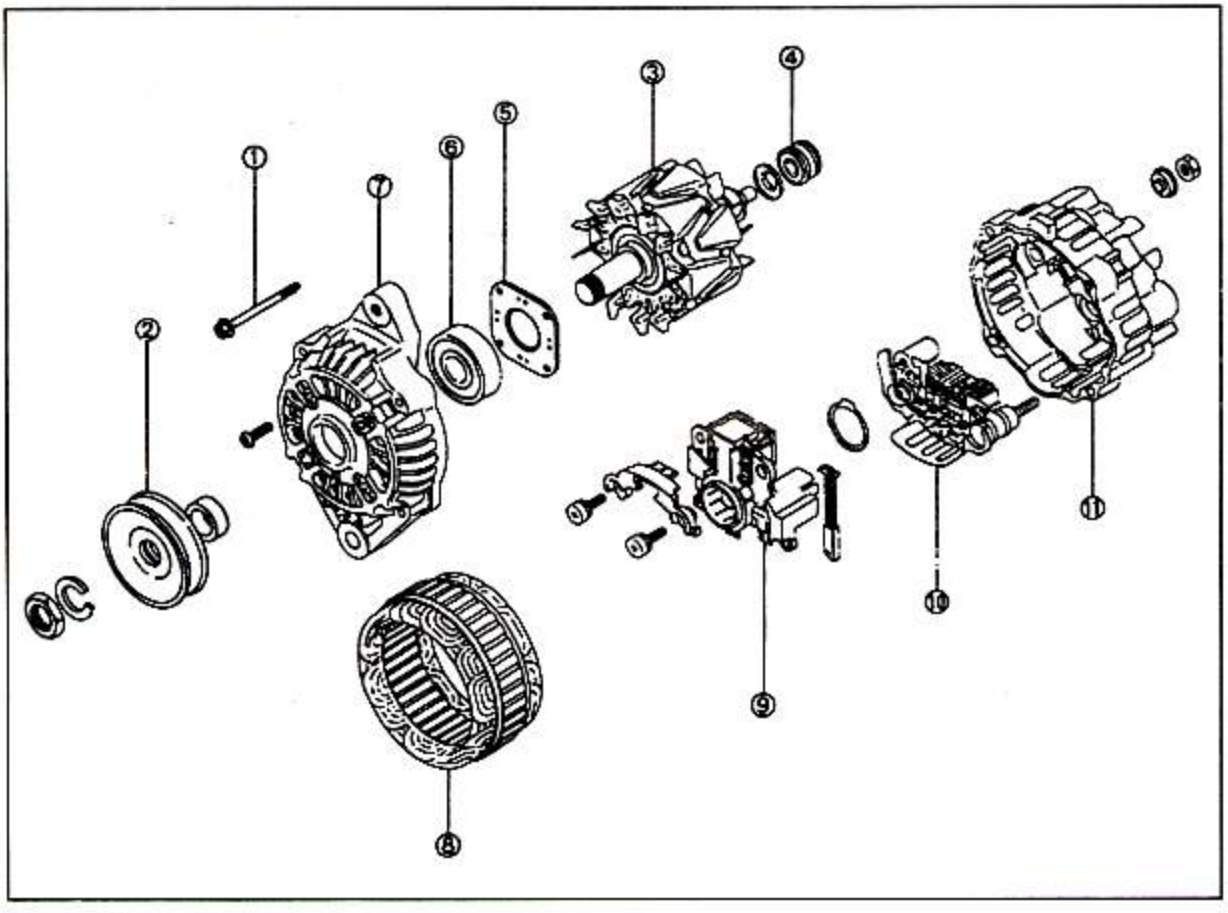
The pinion clearance must be 0.5 to 2.0 mm (0.020 to 0.079 in.). With the pinion held in cranking position, lightly push it toward commutator end to measure free movement (clearance). If the clearance is not correct, make adjustment to it. Increase the amount of packings if the clearance is too small.



Adjusting pinion clearance

ALTERNATOR

1. Disassembly



Disassembly sequence

1. Through bolt
2. Pulley
3. Rotor
4. Rear bearing
5. bearing retainer
6. Front bearing
7. front bracket
8. Stator core
9. brush holder
10. Rectifier
11. rear bracket

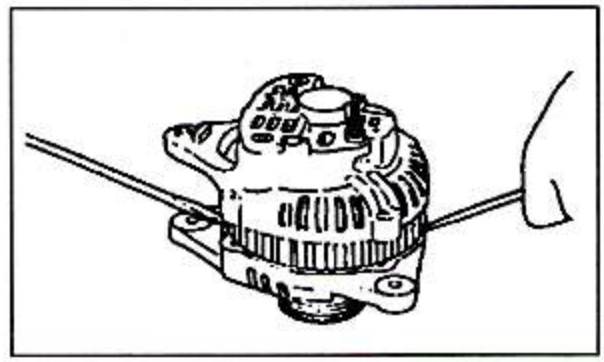
Disassembly procedure

(1) Stator core separation from front bracket

(a) Pry the stator core off the front bracket with a screwdriver as shown in the illustration.

⚠CAUTION

Be careful not to insert the screwdriver too deep. Damage to the stator core can be the result.

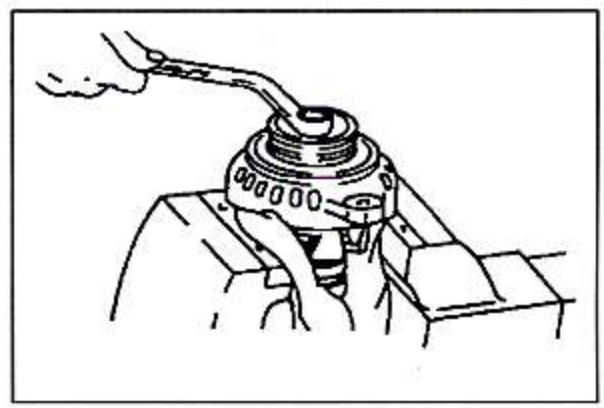


Disassembling alternator

(2) Pulley removal

(a) Hold the rotor assembly in a vise by using thick cloth as shown in the illustration. Remove the nut that holds the pulley in position, and remove the pulley and spacer.

(b) Remove the rotor assembly from the front bracket.



Removing pulley

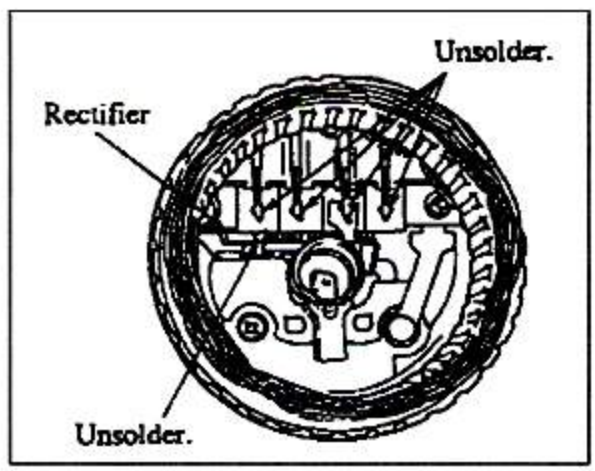
(3) Stator core and rectifier removal

(a) Unsolder the leads from the rectifier and remove the stator core from the rectifier.

⚠CAUTION

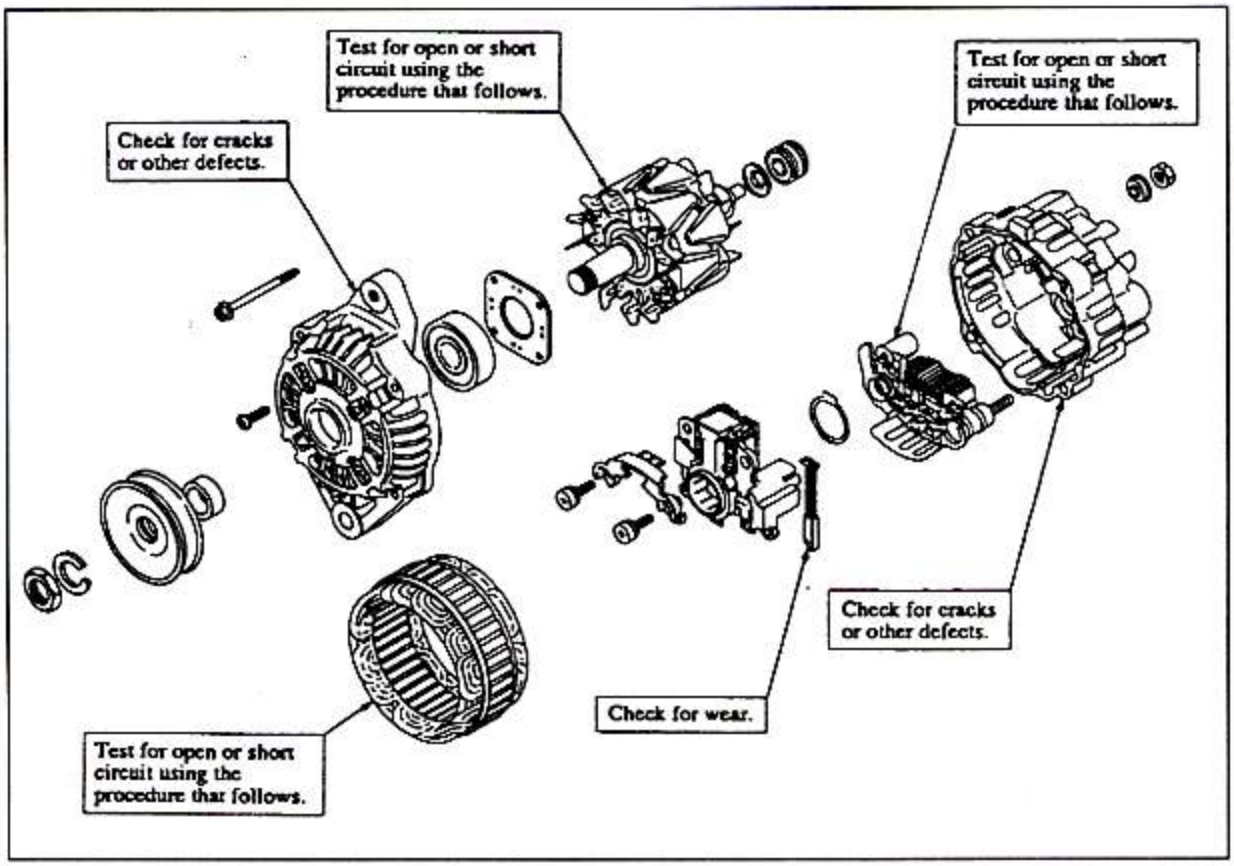
Unsolder the leads as quickly as possible to prevent damage to the diodes in the rectifier.

(b) Remove the screw that hold the rectifier in position and remove the rectifier.



Removing stator core

2. Inspection



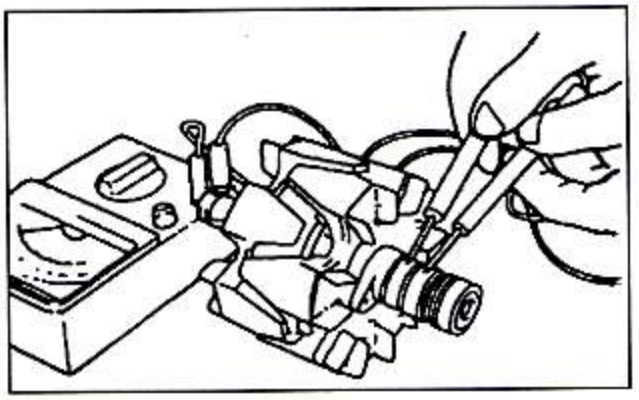
Inspection procedure

(1) Diodes

(a) Test the resistance between the diode and heat sink. First touch the positive (+) prod of an ohmmeter to the diode, then the negative (–) prod. If the resistance is infinite in both cases, the diode is open. If it is nearly zero in both cases, the diode is shorted. Do the same step for the remainder of the diodes. If any diode is open or shorted, replace the rectifier.

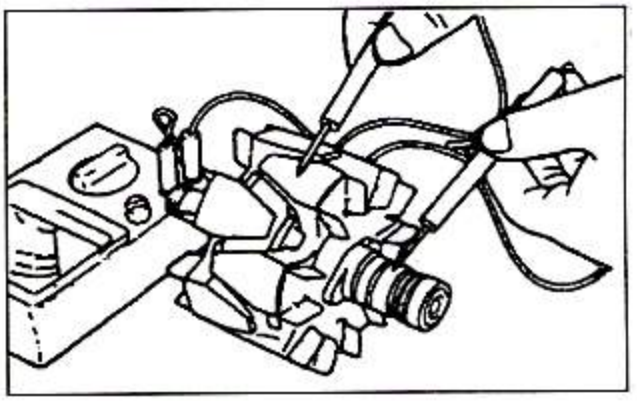
(2) Field coil

(a) Test for continuity between the slip rings as shown in the illustration. No continuity shows there is an open circuit in the field coil. Replace the field coil.



Testing field coil for open circuit

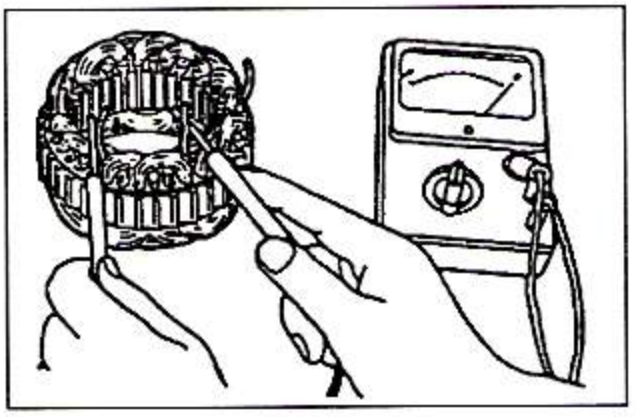
(b) Test for no continuity between the slip ring and shaft (or core) as shown in the illustration. Any continuity shows there is a grounded circuit in the field coil. Replace the field coil.



Testing field coil for grounded circuit

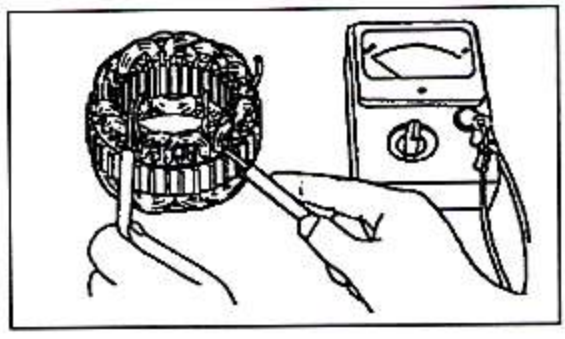
(3) Stator core

(a) Test for continuity between the leads as shown in the illustration. No continuity shows there is an open circuit in the stator core. Replace the stator core.



Testing stator core for open circuit

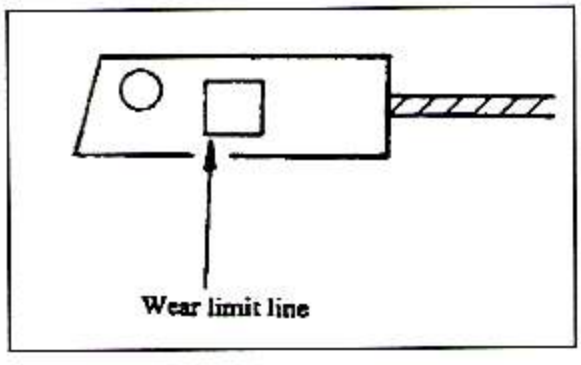
(b) Test for no continuity between each lead and stator core as shown in the illustration. Any continuity shows there is a grounded circuit in the stator core. Replace the stator core.



Testing stator core for grounded circuit

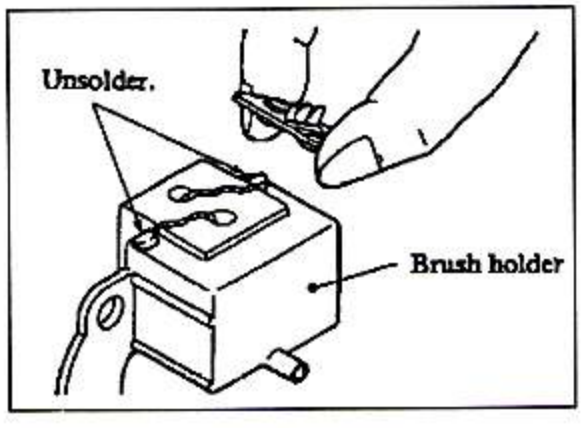
(4) Brushes

(a) Make replacement of brushes that have been worn down to, or beyond, the wear limit line.



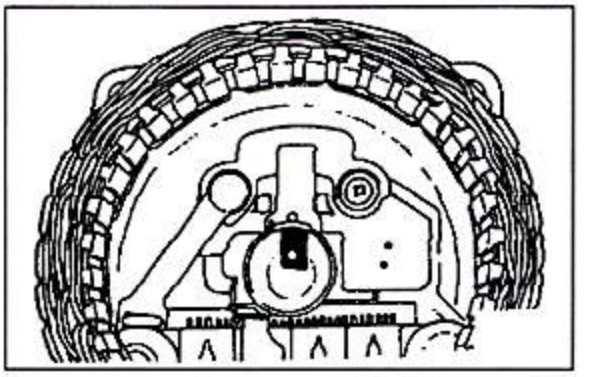
Checking brush for wear

(b) To remove the brushes from the brush holder for replacement, unsolder the leads from the brushes. This will permit removal of the brushes and springs.



Removing brushes for replacement

(c) To install the new brushes, put them in position in the brush holder and solder the leads to the brushes



Installing new brushes

3. Assembly

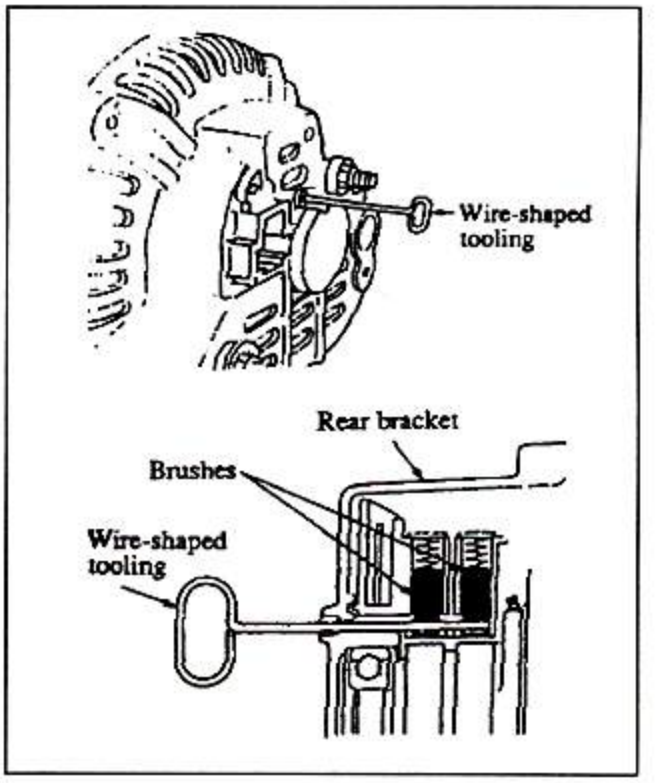
Follow the reverse of disassembly and use the procedure that follows.

(a) The rear bearing has a groove for the snap ring. Install the snap ring in this groove, making sure its tab is in the deep portion of the groove.

(b) When installing the new rear bearing, put it in position with the side that has a groove toward the slip rings of the rotor.

(c) To install the rear bearing in the rear bracket, heat the rear bracket.

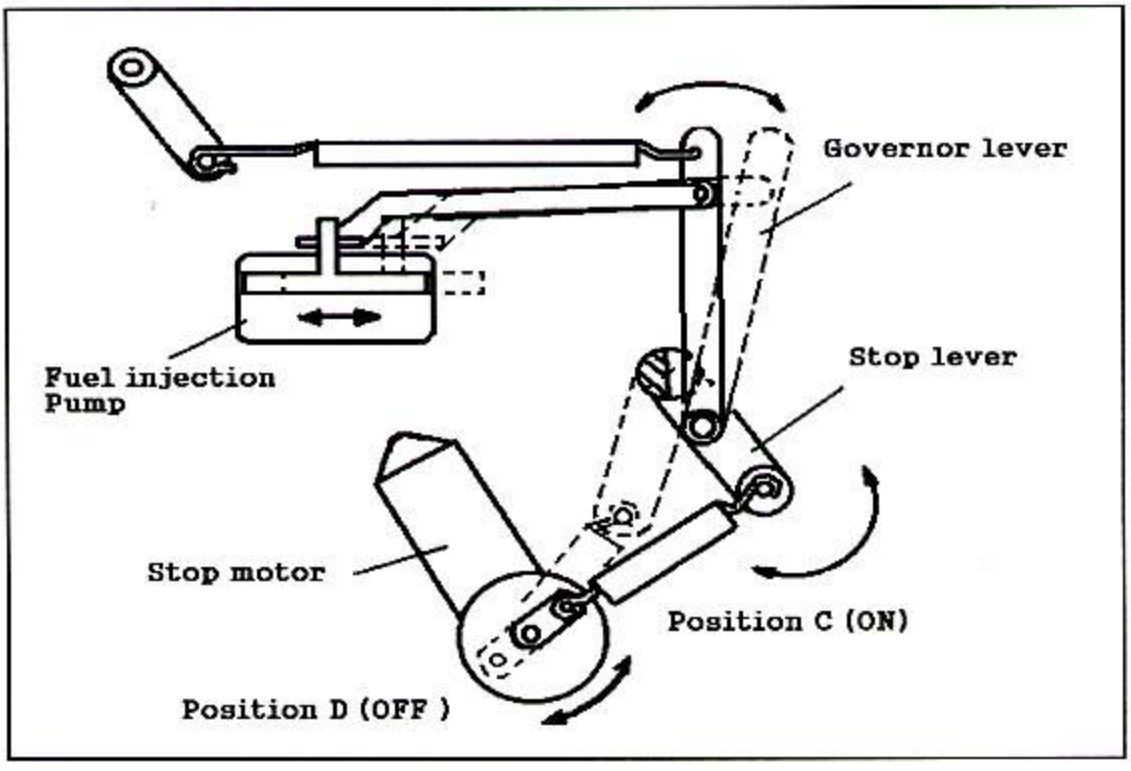
(d) Before installing the rotor in the rear bracket, insert a wire-shaped tooling into the hole in the rear bracket to lift the brushes off the slip rings. Remove the tooling after the rotor has been installed in position.



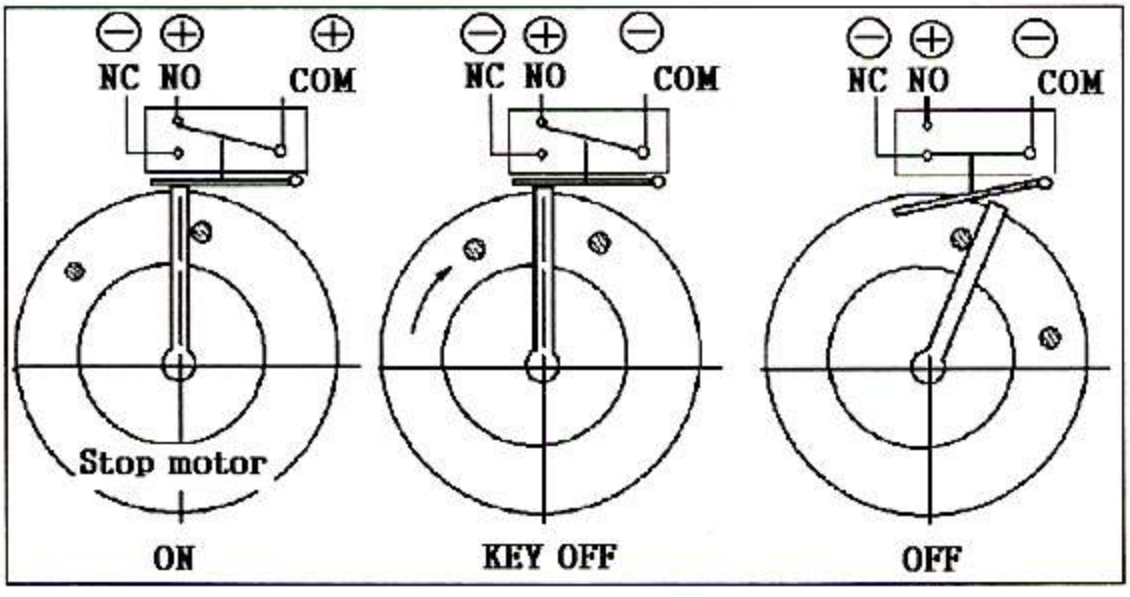
Assembling alternator

KEY SHUTOFF SYSTEM

1. SCHEMATIC



Mechanism of stopping Engine



Mechanism of Stop Motor

3. Assembly

Follow the reverse of disassembly and use the procedure that follows.

Assembly procedure

(1) Lubrication

Lubricate the following starter components with grease after the starter has been assembled:

(a) Armature shaft gear and reduction gear

(b) Bearings

(c) Washer and stopper ring of pinion shaft

(d) Pinion

(e) Sliding surfaces of lever

⚠ CAUTION

Do not put grease on the starter mounting face, brushes, commutator and other electrical parts.

(2) Stopper ring installation

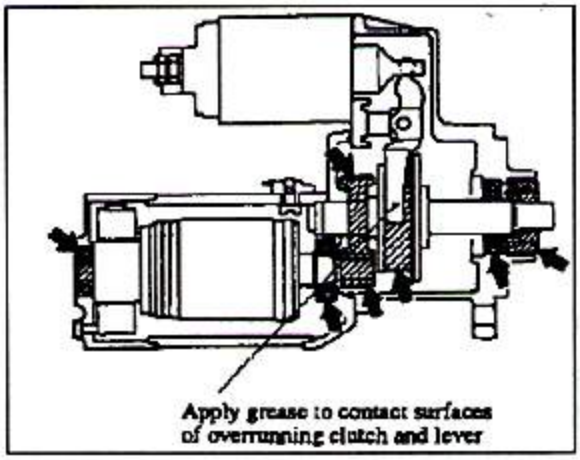
Put the stopper ring on the pinion shaft. Using a puller, pull the pinion stopper to fit the ring in the groove.

(3) Pinion shaft end play adjustment

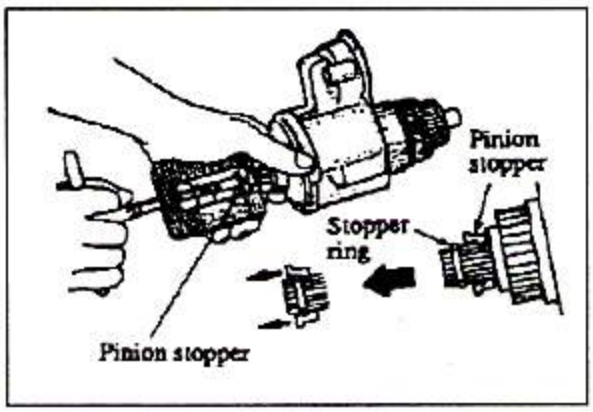
The maximum permissible limit of the end play (thrust gap) for the pinion shaft is 0.5 mm (0.020 in.).

(a) Put the pinion shaft, reduction gar washer and snap ring in position in the center bracket.

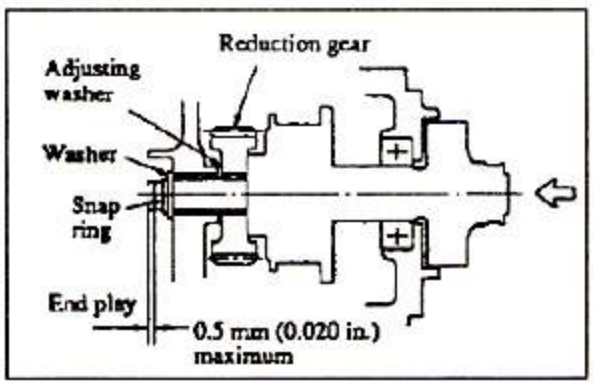
(b) Move the pinion shaft in the axial direction to measure the end play. If the end play exceeds 0.5 mm (0.020 in.), make adjustment to it by adding adjusting washer.



Lubrication points on starter



Installing stopper ring



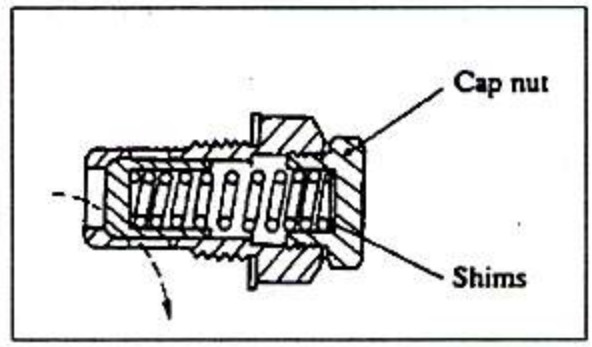
Adjusting pinion shaft end play

3. Pressure relief valve

(a) Check the valve seat for contact. Check the spring for damage.

(b) Measure the oil pressure at which the relief valve opens (the oil pressure with the engine running at the rated rpm). If the pressure is not correct, remove the cap nut and increase or decrease the amount of shims. The engine oil pressure tap is located on the right side of the engine.

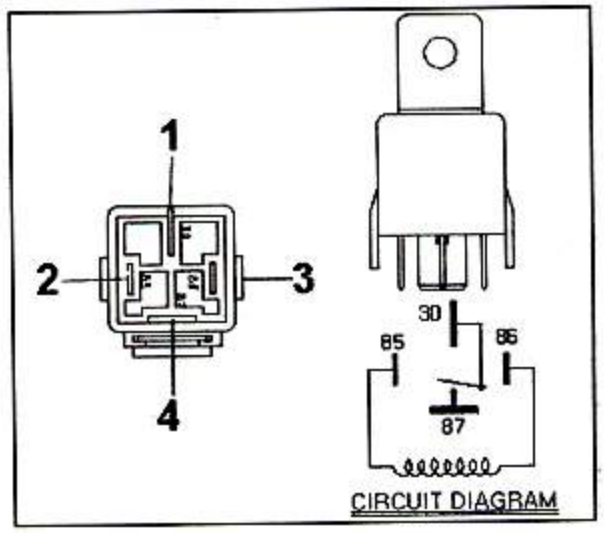
Relief valve opening pressure	3.5 ± 0.5 kgf/cm² (49.78 ± 7.11 lbf/in²) [343.23 ± 49.03 kPa]



Checking pressure relief valve

3. Glow plug relay specifications (standard)

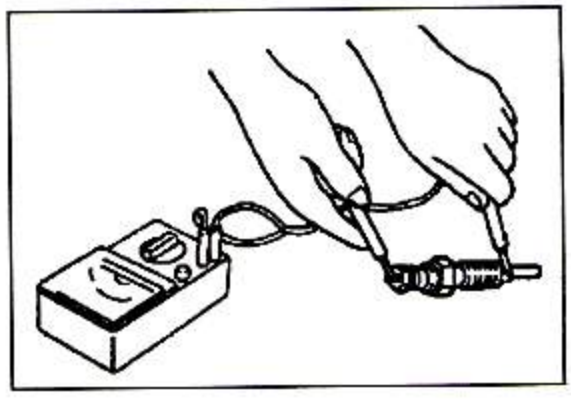
Model	FTB9160000A3
Rated voltage	DC 12 V
Continuous rating	1 minute
Coil resistance	60Ω
Operating temperature range	-40°C to +100°C (-40°F to +212°F)



4. Glow plug inspection

Test for continuity between the terminal and body as shown in the illustration.

Item	Standard
Resistance	0.8Ω



COOLING SYSTEM

GENERAL

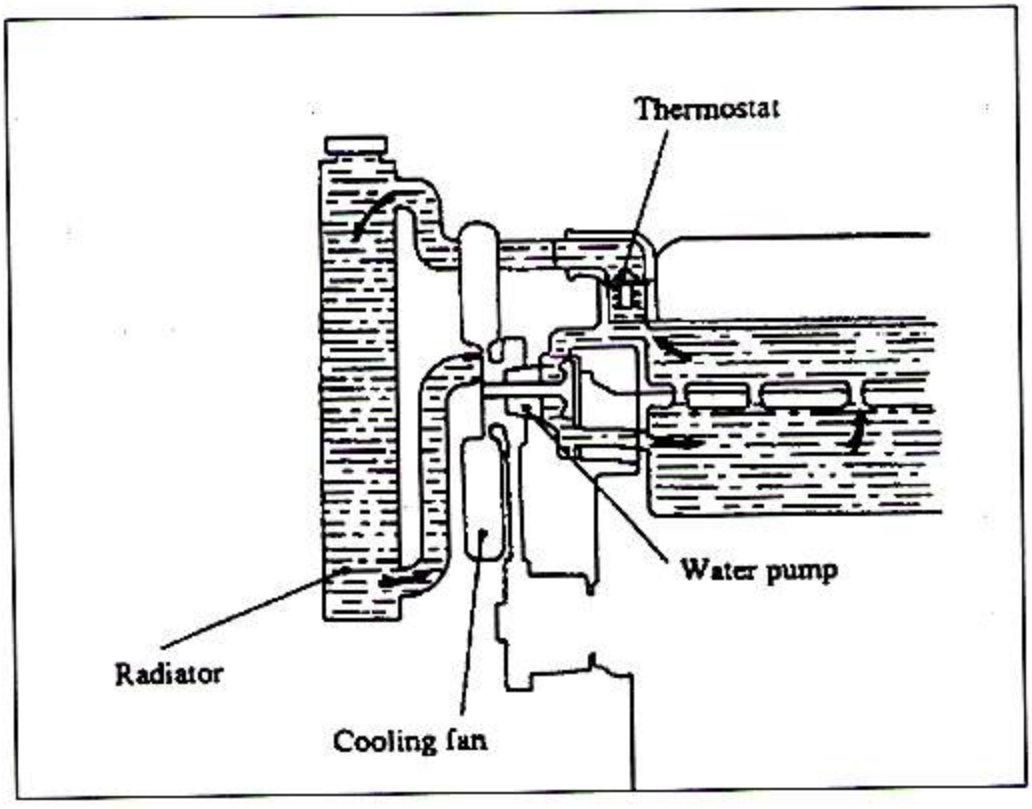
1. Schematic
2. Specifications (standard)

INSPECTION

1. Water pump
2. Thermostat (standard)
3. Thermoswitch (standard)
4. Thermounit (standard)

GENERAL

1. Schematic



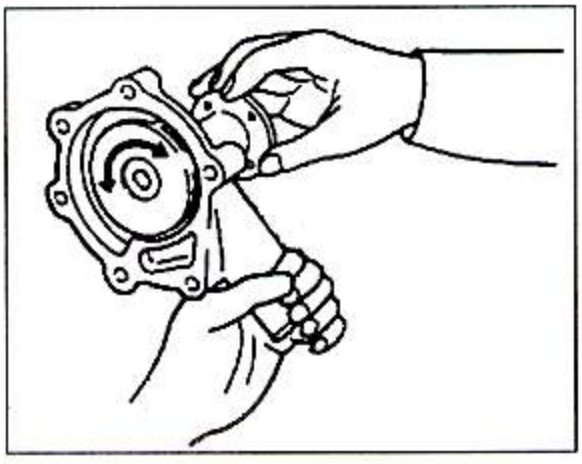
2. Specifications (standard)

Engine model		3T84L-ATC / 3T90L-ATC / 3T90LT-ATC
Fan belt (for farm or industrial engine)		35"
Thermostat	Temperature at which valve starts opening	85 ± 1.5 °C (180 ± 2.7 °F)
	Temperature at which valve lift is 8 mm (0.3 in.)	95 °C (203 °F)
Thermoswitch	Type	Bimetal
	Temperature at which switch is turned ON	111 ± 3.5 °C (232 ± 6.3 °F)
	Temperature difference for ON-OFF control	8 ± 3.5 °C (46.4 ± 6.3 °F)

INSPECTION

1. Water pump

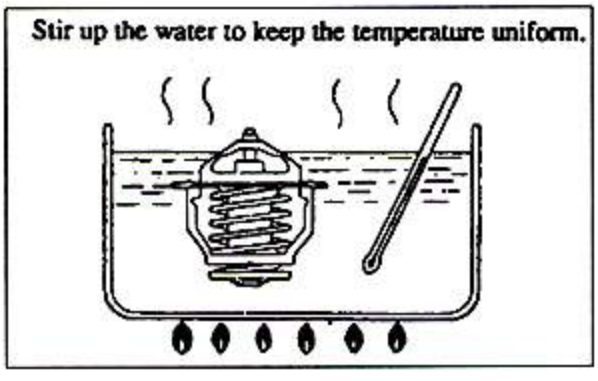
Check the impeller and shaft for rotation. If they do not rotate freely or have noise, replace the water pump assembly.



Checking water pump

2. Thermostat (standard)

Hang the thermostat in the pan of water as shown in the illustration. The thermostat must be away from the sides of the pan. Heat the water uniformly in the pan and measure a temperature at which the valve starts opening and a temperature at which the valve lift (distance) is 8 mm (0.3 in.). Replace the thermostat if defective.



Testing thermostat

Temperature at which valve starts opening	85 ± 1.5°C (180 ± 2.7°F)
Temperature at which valve lift is 8 mm (0.3 in.)	95°C (203°F)

⚠ WARNING

Water in the pan is hot. Any contact can cause severe burns.

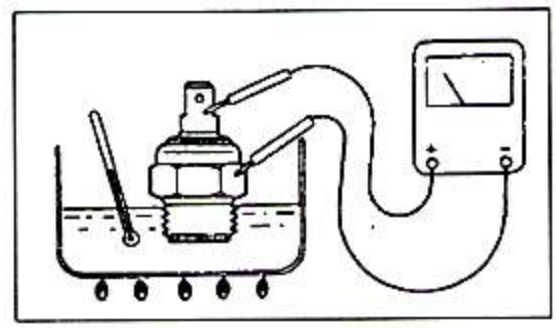
3. Thermoswitch (standard)

Hang the thermoswitch in the pan of oil with its temperature sensing end below the surface of oil and measure the resistance while heating the oil as shown in the illustration. If the resistance is incorrect, replace the thermo-switch

Resistance at 120°C (248°F)	30 mΩ
Temperature at which switch is turned ON	111 ± 3.5°C (232 ± 6.3°F)

⚠ WARNING

Oil in the pan is hot. Any contact can cause severe burns.



Testing thermoswitch

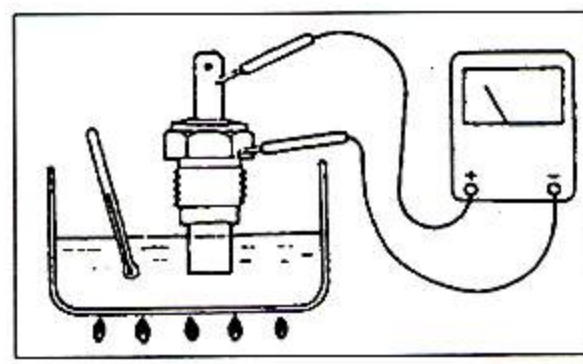
4. Thermounit (standard)

Hang the thermounit in the pan of antifreeze with its temperature sensing end below the surface of antifreeze and measure the resistance while heating the antifreeze as shown in the illustration. If the resistance is incorrect, replace the thermounit.

Standard	50°C (122°F) : 80 ± 10 Ω 80°C (176°F) : 29.5 ± 2.5 Ω 120°C (248°F) : 10 ± 0.3 Ω

⚠ WARNING

Antifreeze in the pan is hot. Any contact can cause severe burns.



Testing thermounit

LUBRICATION SYSTEM

GENERAL

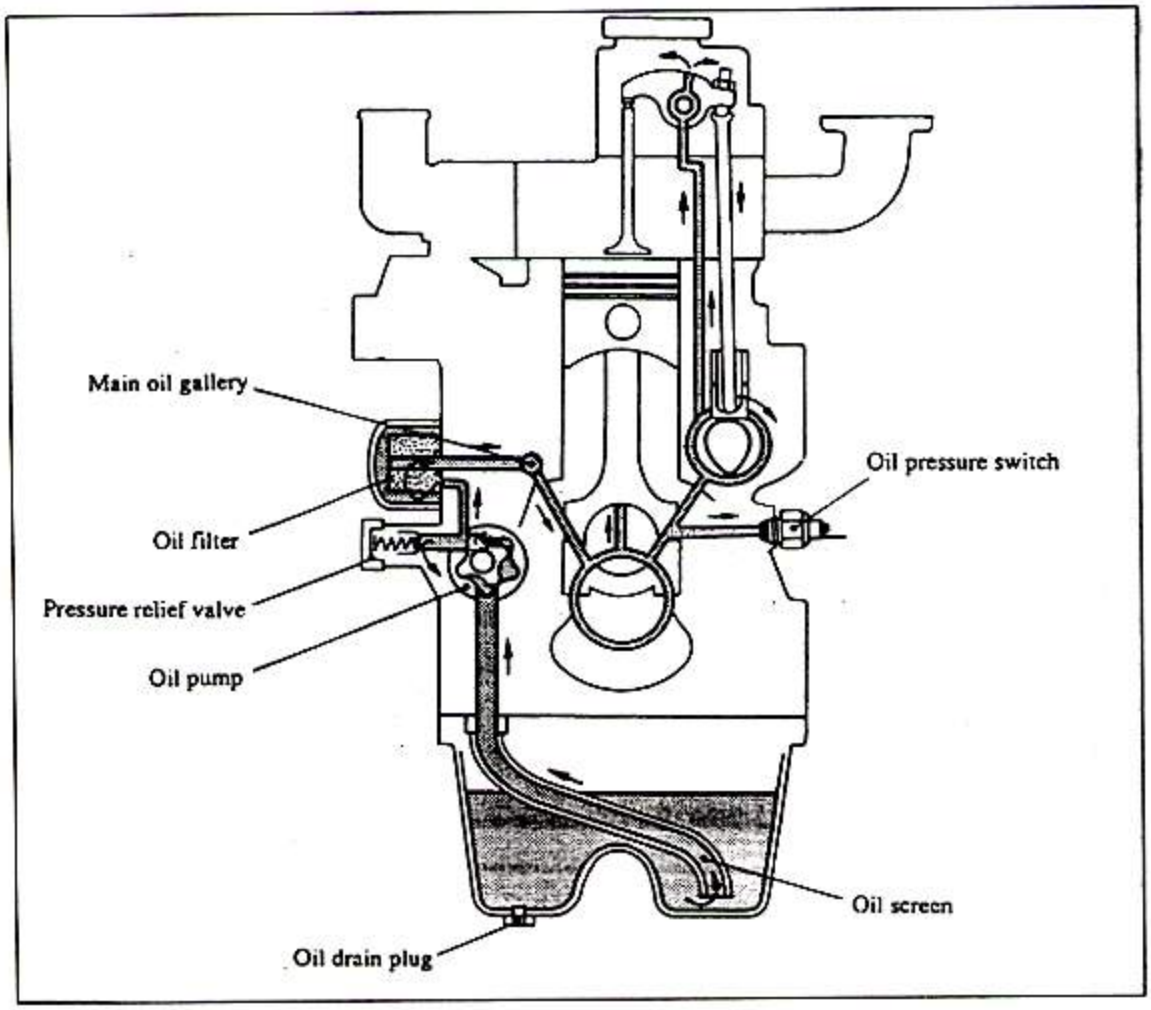
1. Schematic
2. Specifications

INSPECTION

1. Oil pump
2. Oil pressure switch
3. Pressure relief valve

GENERAL

1. Schematic



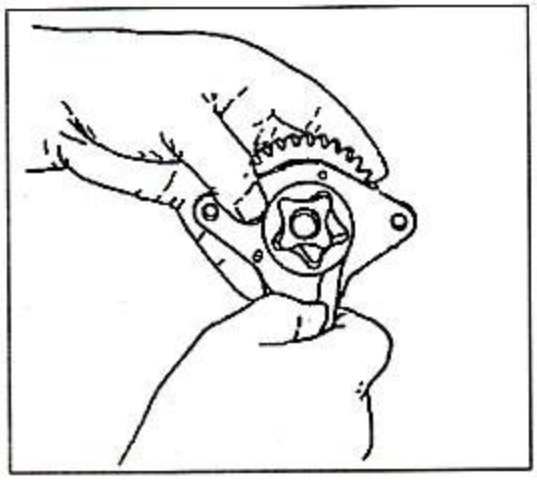
2. Specifications

Engine model		3T84L-ATC	3T90L-ATC	3T90LT-ATC
Type		Forced feed		
Oil		API Service Classification CD		
Capacity (high level excel. 0.5 liter (0.13 U.S. gal) of oil in oil filter), liter (U.S. gal)		6.0(1.61)		7.5(1.98)
Oil pump	Type	Trochoid		
	Driven by	Crankshaft gear		
Relief valve opening pressure		3.5±0.5kgf/cm^2(49.78±7.11lbf/in^2)[343.23±49.03kPa]		
Pressure difference at which oil pressure switch is closed (indicator light comes on)		0.5±0.1kgf/cm^2(7.11±1.42lbf/in^2)[49.03±9.81kPa]		
Oil filter		Paper-element cartridge(fullflow) type		

INSPECTION

1. Oil pump

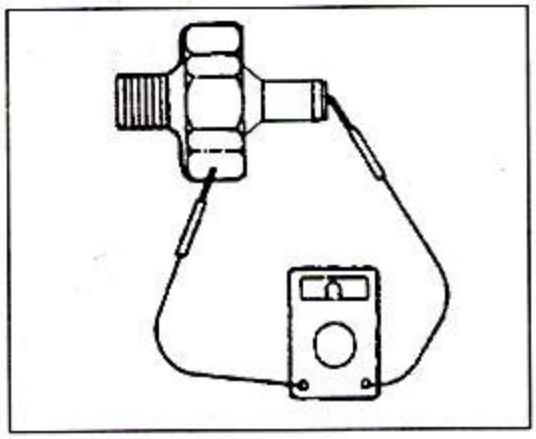
Visually check the pump for rough rotation or other defects. Replace the pump assembly if defective.



Checking Oil pump

2. Oil pressure switch

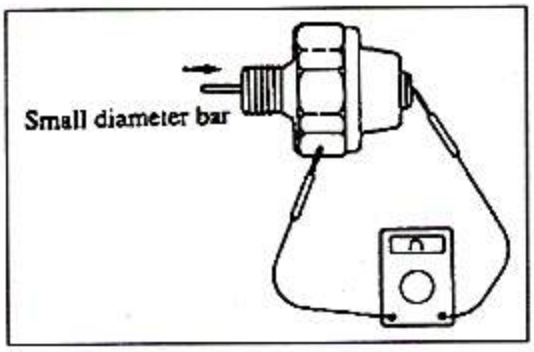
(1) Test for continuity between the terminal and body with an ohmmeter as shown in the illustration. No continuity is the cause for replacing the switch.



Testing oil pressure switch

(2) Insert a small diameter bar into the oil hole in the switch and lightly push it in to test for no continuity as shown in the illustration. Any continuity is the cause for replacing the switch.

(3) Apply a pressure air of 0.5 kgf/cm^2 (7 psi) [49 kPa] to the switch through the oil hole to test for no continuity. Any continuity is the cause for replacing the switch. Also, check for air leaks. Any air leak is an indication of a ruptured diaphragm. In such a case, replace the switch.



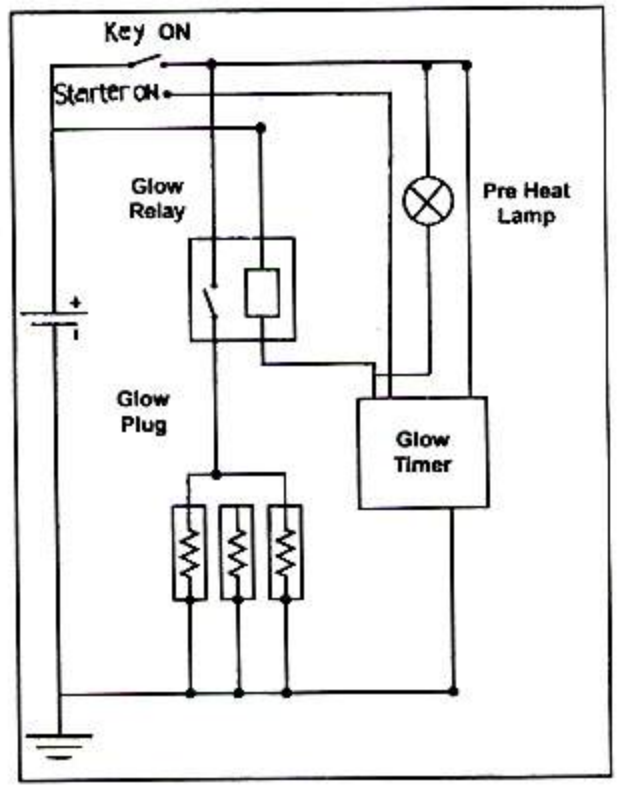
Testing oil pressure switch

AUTOMATIC GLOW PLUG SYSTEM

1. General

Turning the starter switch to ON position activates the glow plugs to heat the engine and causes the glow plug indicator to come on.

Heating time	6 seconds

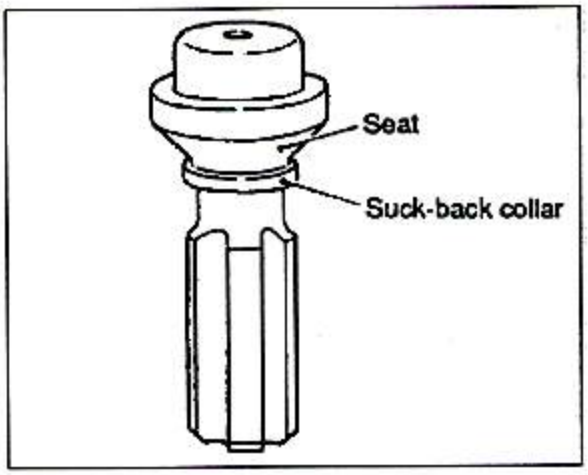


2. Glow plug timer specifications (standard)

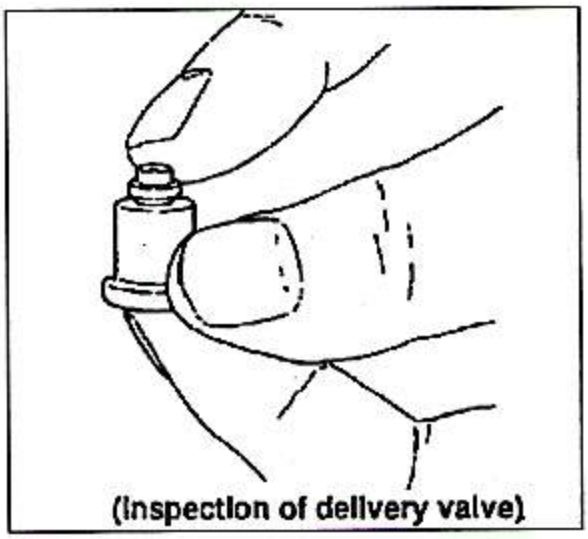
Model	HK15170000A4
Type	Quick heating
Rated voltage	DC 12 V
Operating voltage range	7 to 15V
Operating temperature range	-30°C to +70°C (-22°F to +158°F)
Storage temperature range	-40°C to +80°C (-40°F to +176°F)
Glow plug activating time	6 seconds

(5) Delivery valve

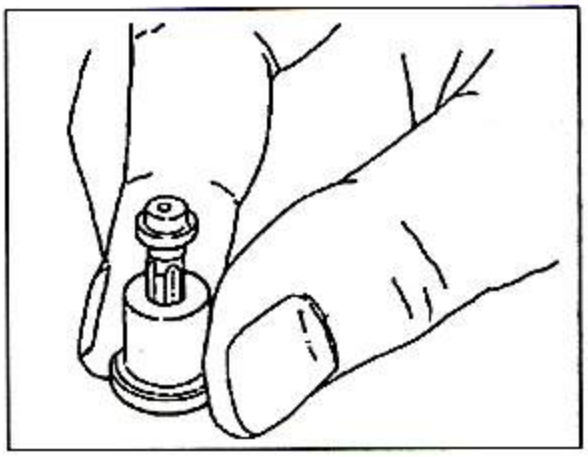
(a) If the suck-back collar or seat of the delivery valve is found scratched ,dented, worn, or other wise damaged, replace the whole delivery valve assembly.



(b) Stop up the hole in the bottom of the delivery valve holder and keep the seat as it is. Insert the delivery valve to the holder. While releasing your upper finger, check to see if the delivery valve springs back. If so, it is acceptable

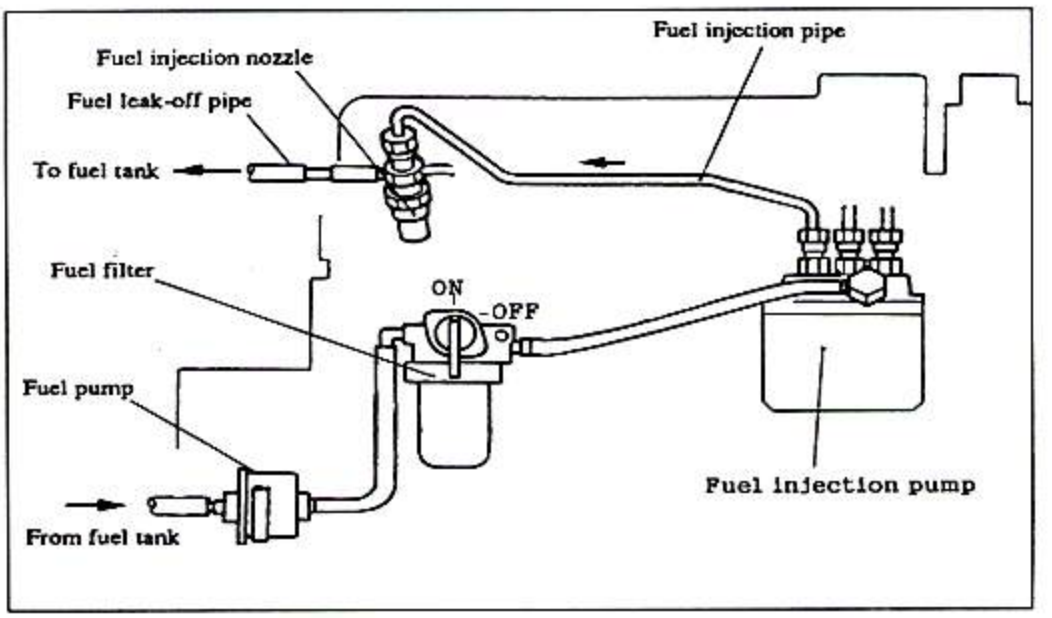

(Inspection of delivery valve)

(c) Likewise as described in (b), stop up the hole in the bottom of the delivery valve holder and check to see if the delivery valve perfectly falls by gravity, when the finger is released from the bottom hole. If so, the delivery valve is acceptable. If not, replace it.



GENERAL

1. Schematic



2.Specifications (standard)

Engine model		3T84L-ATC / 3T90L-ATC / 3T90LT-ATC
Fuel injection pump	Type	DOO WON PRECISION
	Model	HK11010000A2
	Plunger diameter	φ7.5 (φ0.295)
	MS retard (crank angle), deg	10
	Delivery valve, type	Bosch
	Air vent screw	No
Fuel injection Nozzle	Type	Semi-Throttle
	Model	-
	Injection pressure (valve opening pressure)	150^{+5}_{0} kgf/cm² (2133.5 $^{+71.12}_{0}$ lbf/in²) [14709.92 $^{+490.33}_{0}$ kPa]
Fuel filter (remote)	Type	Paper element
Fuel pump (remote)	Type	Electric (diaphragm)
	Capacity (at terminal voltage of DC 12 V and 20°C (68°F)	400cc (24.4 cu in.)/min minimum

FUEL INJECTION NOZZLE

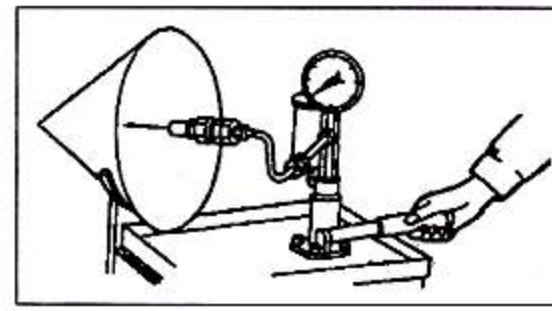
1. Inspection

(1) Injection pressure (valve opening pressure) test

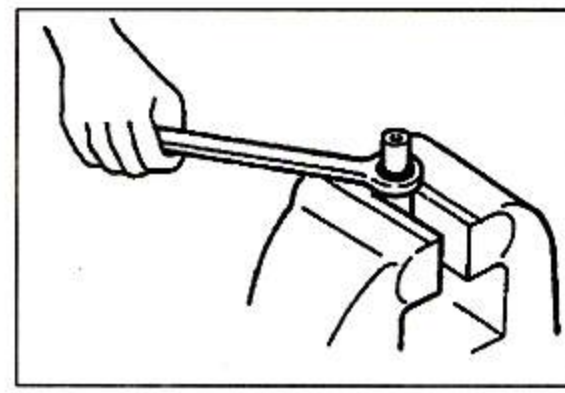
(a) Install the injection nozzle on the tester. Slowly operate the tester handle to bleed (remove) air from the tester.

(b) Operate the tester handle at a speed of one stroke per second to make a slow increase in pressure until the valve in the injection nozzle starts to open. Read the maximum gauge pressure at the instant fluid flows from the tip

(c) If the injection pressure is incorrect, disassemble the nozzle and change the thickness of the washer.



Fuel injection nozzle ready for test



Removing tip from injection nozzle

Injection pressure (valve opening pressure) Standard	150 $^{+5}_{0}$ kgf/cm^2 (2133.5 $^{+71\ 2}_{0}$ lbf/in^2) [14709.92 $^{+490\ 33}_{0}$ kpa]

NOTE

An increase or decrease of washer thickness by 0.1 mm (0.004 in.) will vary the injection pressure by 10 kgf/cm^2 (142 lbf/in^2) [981 kPa]. 10kinds of washer are available in thickness from 1.25 mm (0.049 2 in.) to 1.70 mm (0.066 9 in.) in increments of 0.05 mm (0.002 0 in.).

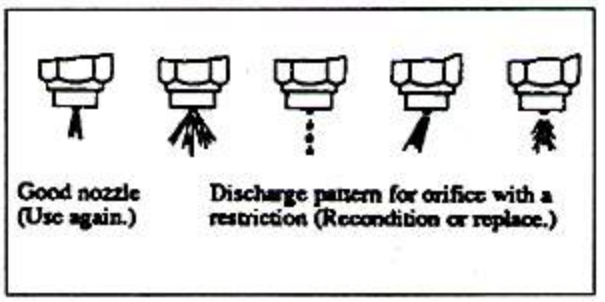
⚠ WARNING

When the injection nozzles are tested, be sure to wear eye protection. Fuel comes from the orifices in the nozzle tip with high pressure. The fuel can pierce serious injury to the operator. Keep the tip of the nozzle pointed away from the operator and into the fuel collector.

(2) Orifice restriction test

(a) Look at the orifice discharge pattern (shape of discharge) when fluid begins to flow through the injection nozzle. The discharge must be straight. Any Change is an indication of a bad nozzle.

(b) Operate the tester handle at a speed of one stroke per second to make sure the discharge is straight.



Orifice restriction test

(3) Nozzle tip washing and replacement

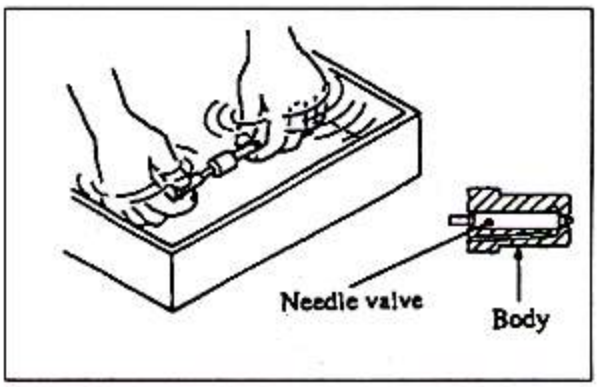
(a) Loosen the retaining nut and remove the tip from the injection nozzle. Wash the needle valve and body in clean diesel fuel. After washing, put the needle valve in the body in clean diesel fuel.

⚠ CAUTION

Do not hit the tip when removing it from the injection nozzle.

NOTE

Keep the need valves with their respective bodies. Do not use needle valves or bodies with other bodies or needle valves.



Washing nozzle tip

(b) After cleaning the tip, install it in the Nozzle and tighten the retaining nut to the specified torque.

Tightening torque	3.75±0.25 kgf-m (27.12±1.81 lbf-ft) [36.77±2.45 N·m]

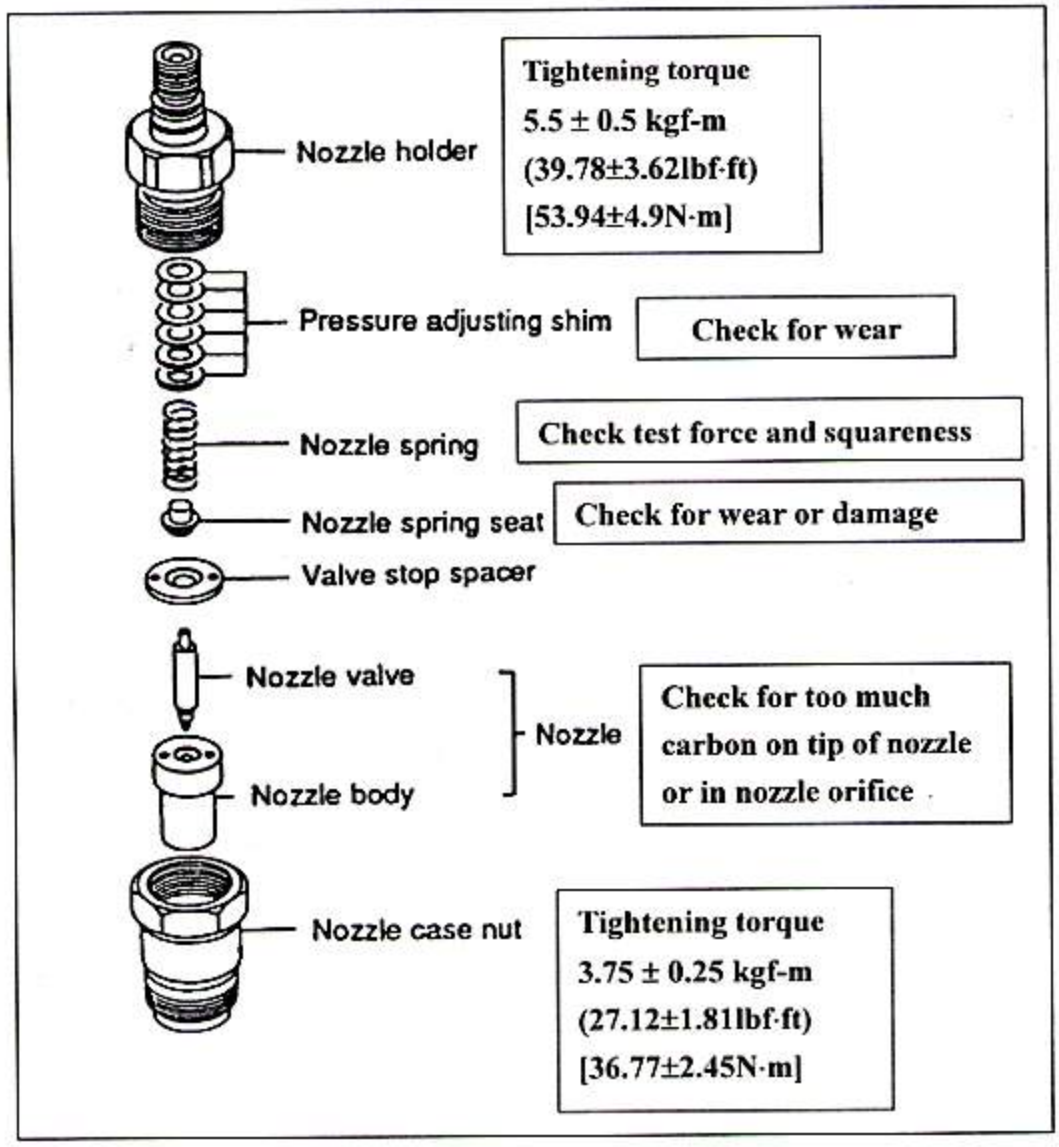
NOTE

a) Do not touch the sliding surface of the needle valve.

b) When installing the new nozzle tip, remove synthetic resin film from the tip and slide the needle valve in the body in clean diesel fuel to wash off inhibitor completely

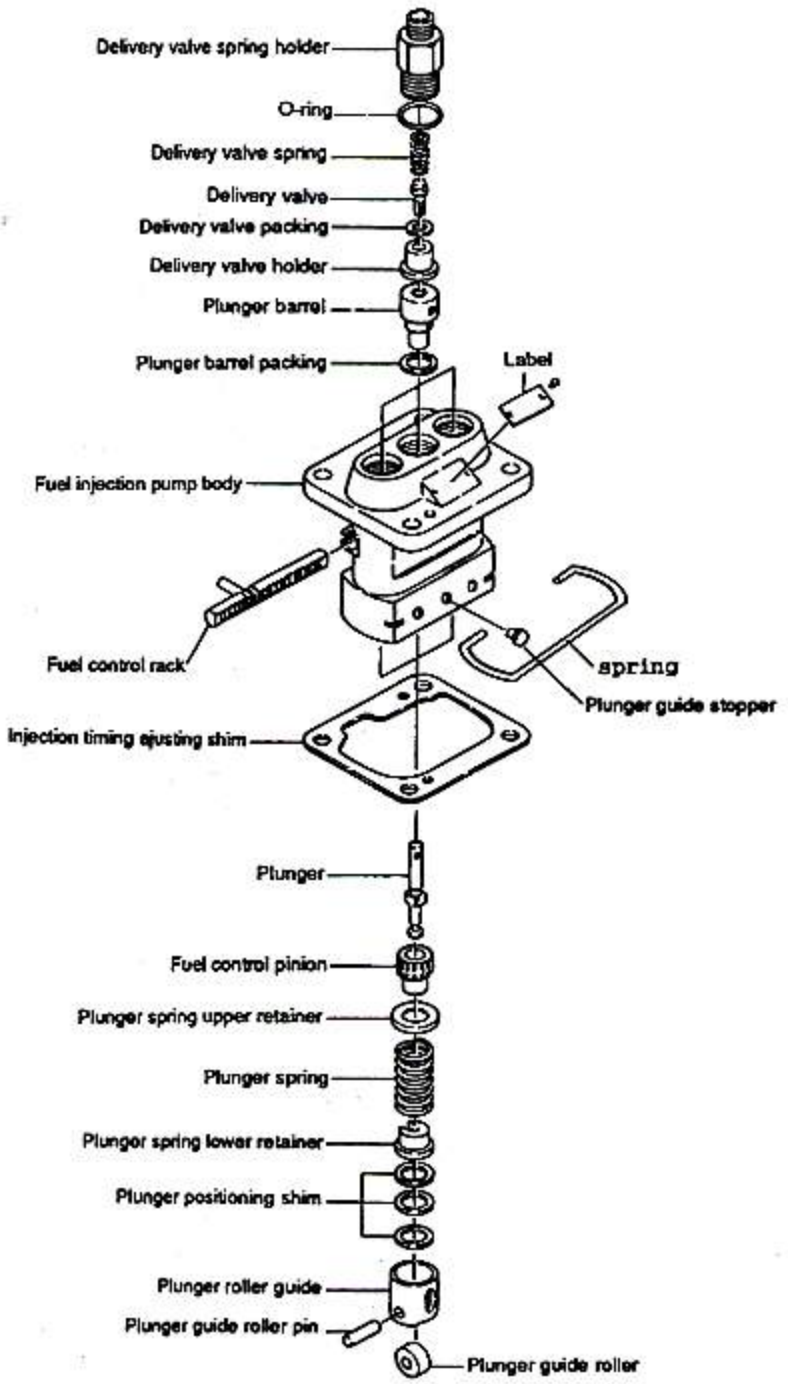
(c) If the injection nozzle is still bad after the tip has been washed, replace the tip.

2. Disassembly and assembly



FUEL INJECTION PUMP

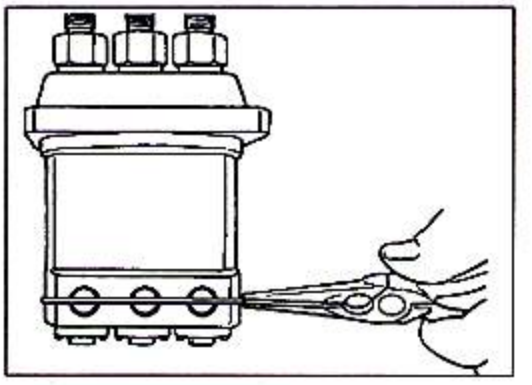
1. Disassembly



Disassembly procedure

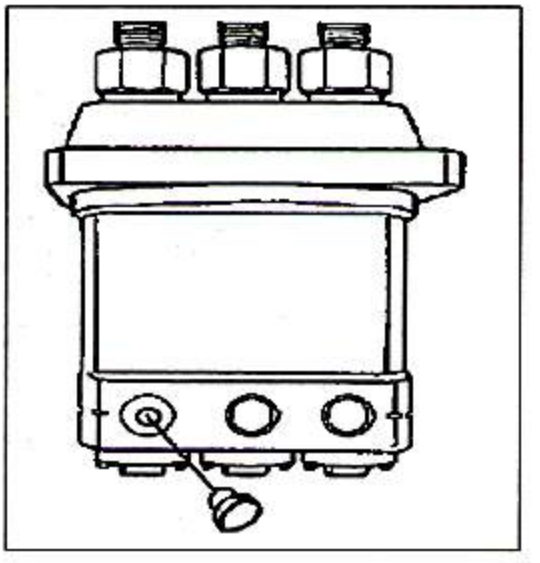
(1) Tappet removal

(a) Remove plunger roller guide stopper pin spring



Remove spring

(b) Remove stopper pin

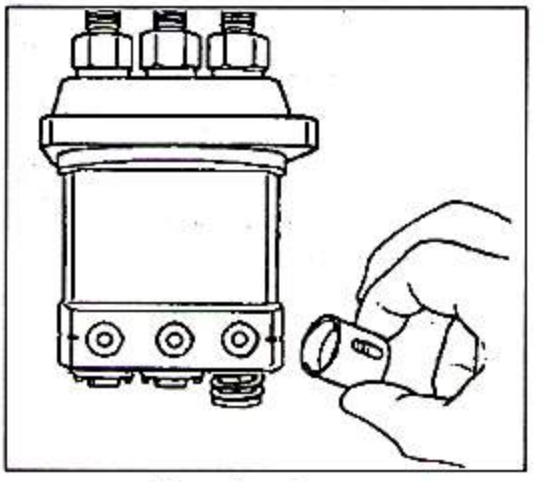


Remove plunger guide stopper

(c) Remove plunger roller guide.

⚠CAUTION

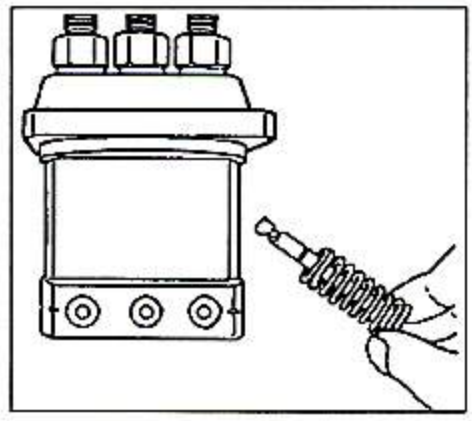
The tappet can be thrown from the housing when the tappet guide pin is removed. Hold the tappet to prevent it from falling.



Removing plunger

(2) Plunger removal

Remove the plunger position shim and plunger, spring , retainer..



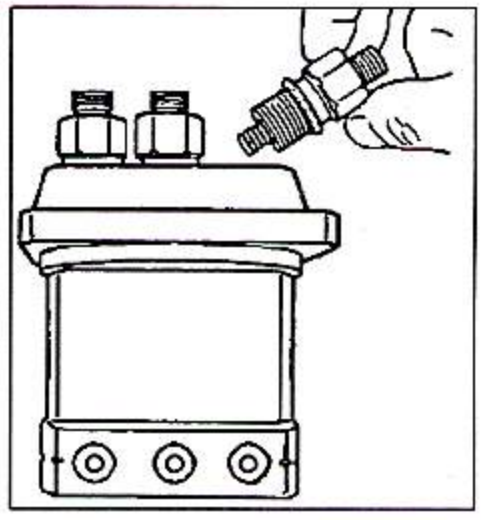
Removing Plunger spring

(3)Delivery valve removal

Remove the delivery valve, spring, holder.

⚠CAUTION

The delivery valves are finely finished parts. Keep them as clean as possible.



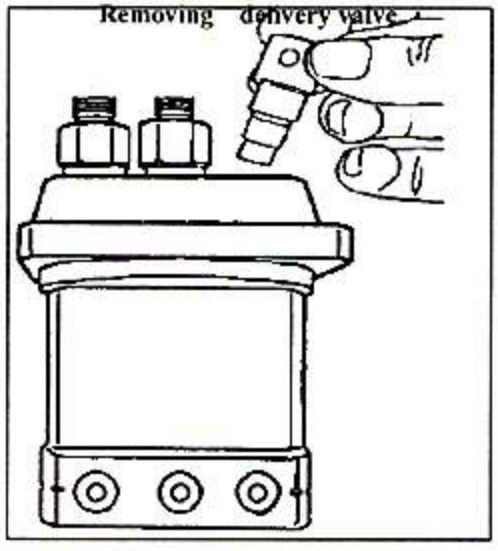
Removing delivery valve

(4) Barrel removal

(a) Remove the barrels from the housing.

⚠CAUTION

a) The plungers and barrels are finely finished parts. Keep them as clean as possible.
b) Keep the plungers with their respective barrels for installation. Do not use plungers or barrels with other barrels or plungers.



Removing plunger barrel

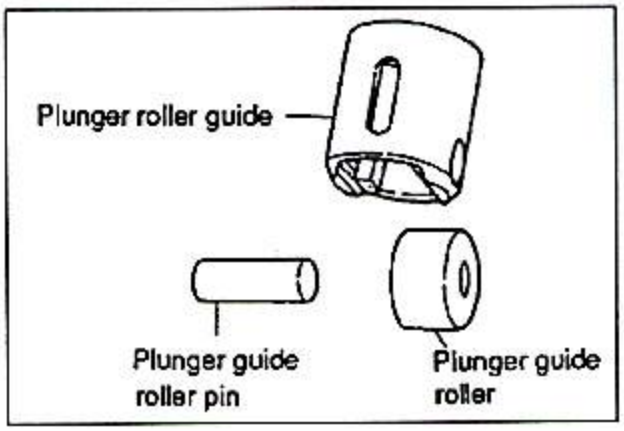
NOTE

a) When replacing the plungers and barrels or delivery valves, do not loosen the adjusting plates between the pumping elements.
b) After these parts have been replaced, the injection quantity must be measured. Pump Tester Cam Box is needed for measurement of injection quantity.
c) Keep the disassembled injection pump parts in clean diesel fuel.

2. Inspection

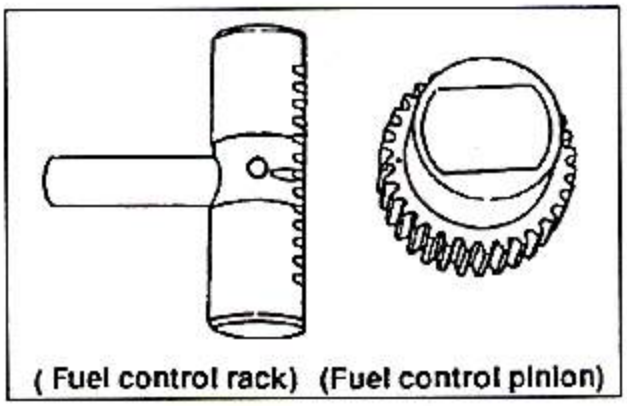
(1) Plunger guide roller and roller guide

Inspect for wear and scratches with the plunger guide roller and roller guide



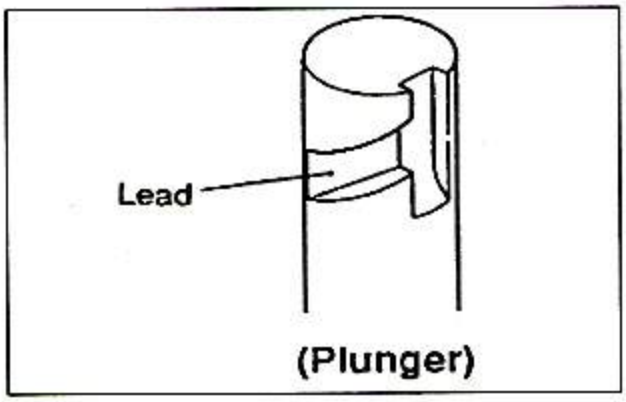
(2) Fuel control rack and fuel control pinion

Inspect for bending of fuel control rack and wear or deformation of engaged surface of fuel control pinion and fuel control rack.



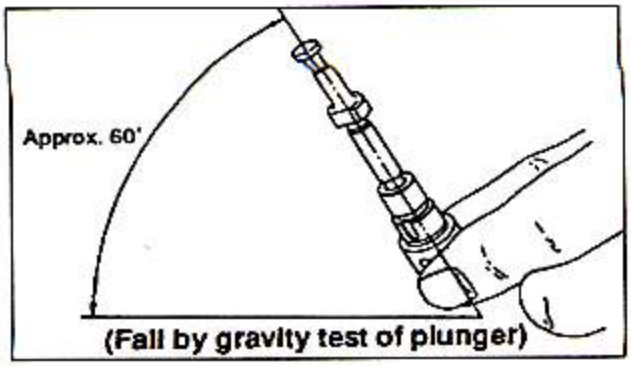
(3) Plunger

Throughly clean the plunger. If any plunger lead is scratched or discolored, replace the plunger assembly with a new one.



(4) Test the plunger

Hold the plunger barrel tilted approx 60° and check to see if it slides down smoothly. If so, the plunger is acceptable. While turning the plunger repeat the test several times. If any plunger slides down too quickly or slowly and jams in the midway, correct it or replace the whole plunger assembly.



FUEL SYSTEM

GENERAL

1. Schematic
2. Specifications (standard)

FUEL INJECTION NOZZLE

1. Inspection
2. Disassembly and assembly

FUEL INJECTION PUMP

1. Test on engine
2. Disassembly
3. Inspection
4. Assembly

GOVERNOR

1. Disassembly
2. Adjusting of max high idle speed
3. The principal of government
4. Setting of the torque spring

FUEL PUMP

Inspection

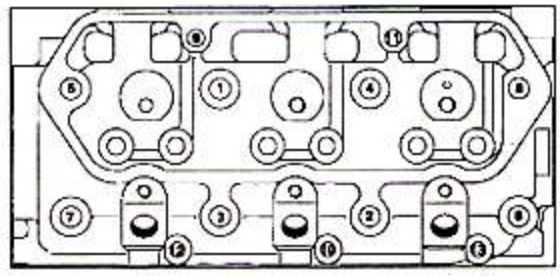
FUEL FILTER

VALVE CLEARANCE

NOTE

Make an adjustment to the valve clearance when the engine is cold.

(1) Slightly loosen the cylinder head bolts and retighten them to the specified torque in number sequence.



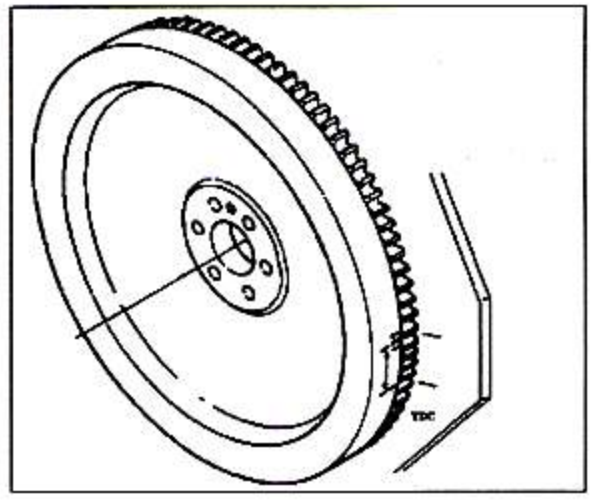
Tightening torque	1 ~ 8	20 ± 1.0kgf·m (144.66 ± 7.2 lbf·ft) [196.13±9.81N·m]
	9 ~ 13	8 ± 0.5kgf·m (57.86 ± 3.6lbf·ft) [78.45±4.9N·m]

(2) Find top dead center compression position for No. 1 piston by using the procedure that follows.

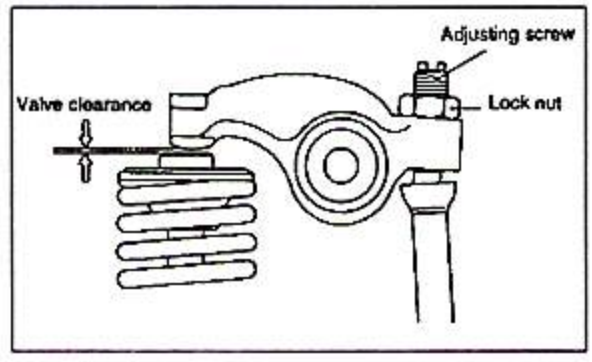
(a) Turn the crankshaft until TDC mark on the flywheel is aligned with the mark on the rear plate.

(b) With No. 1 piston at top dead center on the compression stroke, the rocker arms will not be moved when the crankshaft is turned approximately 20° in both directions.

(a) If the rocker arms move, No. 1 piston is at top dead center on the intake or exhaust stroke. In such a case, turn the crankshaft 360° in the direction of engine rotation again. No. 1 piston is now at top dead center on the compression stroke.



(3) Loosen the lock nut for the adjusting screw. With a feeler gauge inserted between the rocker arm and valve cap, adjust the valve clearance by turning the adjusting screw.



Unit : mm (in.)

Item	Standard
Valve clearance (both inlet and exhaust valves)	0.2 (0.0079)

(6) Insert the plunger adjusting shim. Press the plunger guide assembly by hand. While aligning the plunger guide stopper pin with the matching hole of the stopper pin of the fuel injection pump body, attach the plunger guide stopper pin.

(7) Assemble plunger guide stopper pin spring.

Inspection after assembly

After the injection pump has been assembled, check to see if the control rack moves, freely without any binding or catching.

(1) If the control rack fails to move freely, the possible causes are:

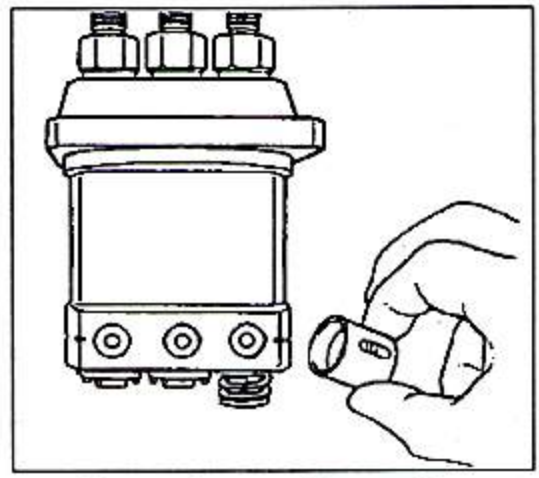
(a) Pumping particles lodged between control rack and sleeves

(b) Foreign particles lodged between control rack and sleeves

(c) Over-tightening of delivery valve holder(s)

(2) Disassemble and check the injection pump to locate the cause of the trouble.

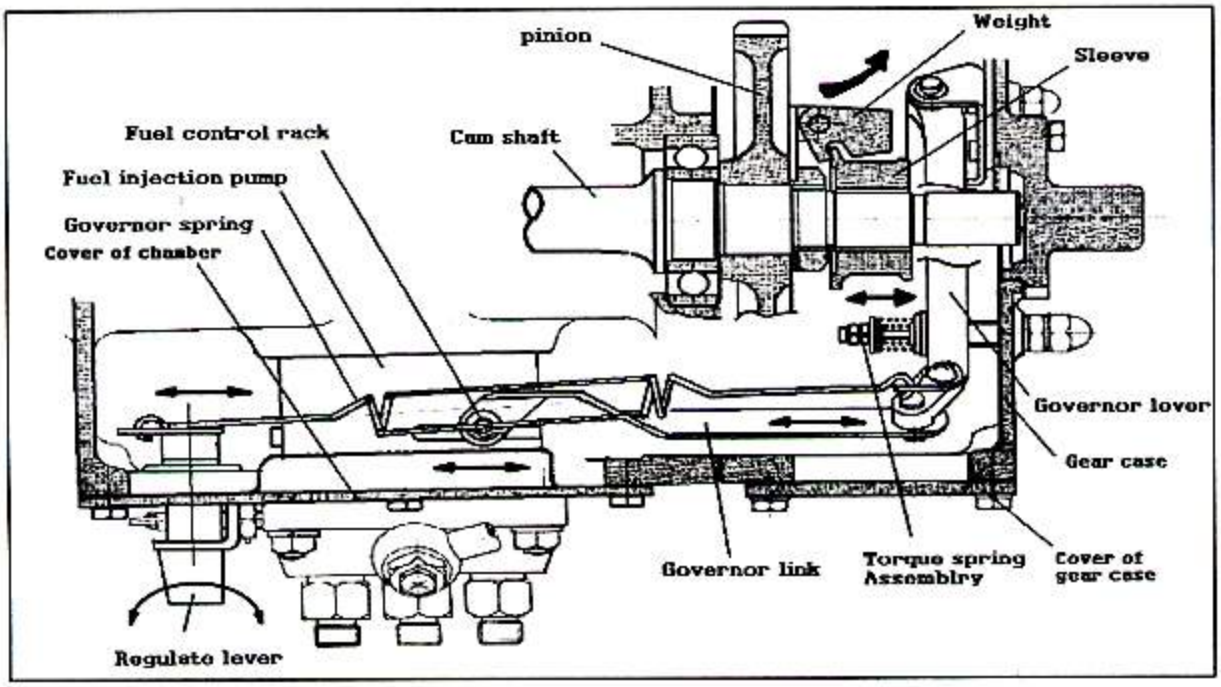
(3) After the injection pump has been finally assembled, check the injection timing.



Insert plunger guide assembly

GOVERNOR

1. Disassembly



a) Remove the cover of chamber for fuel injection pump

b) Remove the cover of gear case

c) Remove the governor spring

d) Remove the pin engaged with fuel control rack

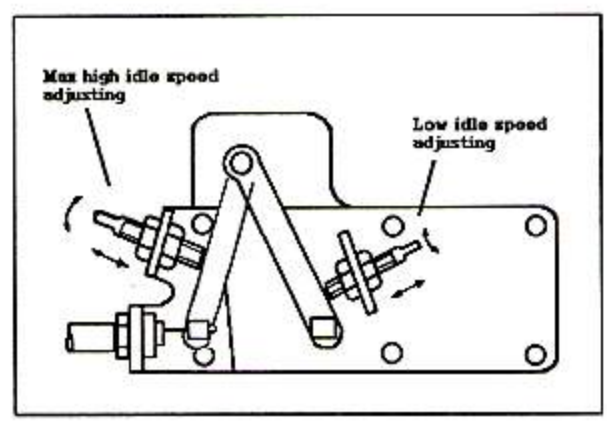
e) Remove the gear case

f) Remove the torque spring assembly

g) Remove the governor lever , sleeve and weight

2. Adjusting of max high idle speed

If max speed of engine is out of the range of the specification, adjust max speed stopper . If low idle speed is out of the range of the specification, adjust low speed stopper .

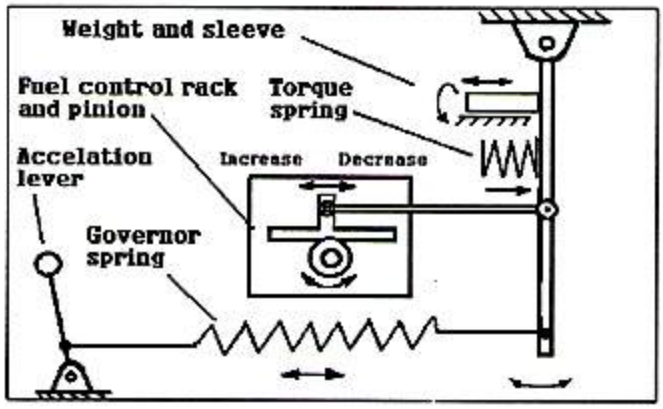


Item	Max speed	Low idle speed
3T84L-ATC 3T90L-ATC 3T90LT-ATC	2800 ±50rpm	1000±50rpm

3. The principal of government

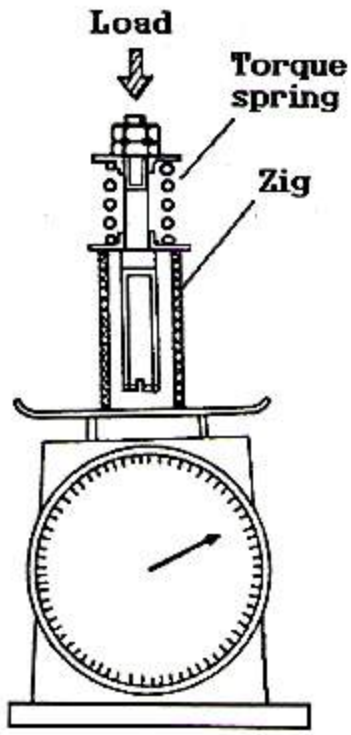
When Engine is run with no-load at max speed after engine started , Pulling force of acceleration lever equilibrate pushing force due to centrifugal force of weight. and torque spring is not pressed .

As Load of engine is increased slowly, speed of engine and centrifugal force are decreased. And governor lever push fuel control rack and torque spring to increase the injected fuel until pulling force of acceleration lever equilibrate pushing force due to centrifugal force of weight and torque spring . Then output of engine meet with increased load.



4. Setting of the torque spring

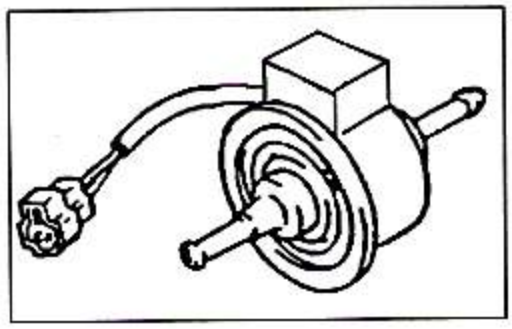
The torque spring control the characteristic of torque rising for the load. If needed, set the torque spring at 135 ± 5 g (0.2976 ±0.0551 lb).



FUEL PUMP

Inspection

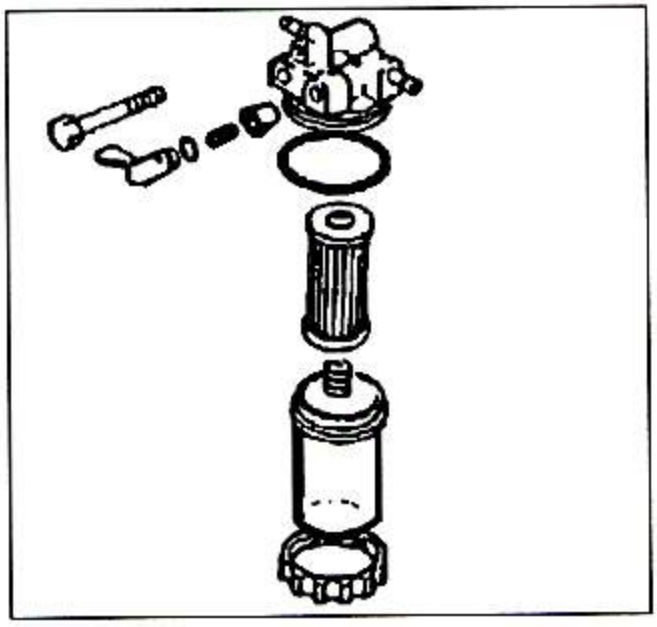
Look outside the pump for defects and test its performance. Do not attempt to disassemble the pump.



FUEL FILTER

(1) Normally, the fuel filter is not to be disassembled. Only element removal for cleaning or replacement is recommended.

(2) When installing the valve lever after washing, coat the O-ring for the lever with silicone oil and the washer with grease.



MAINTENANCE

LUBRICATION AND MAINTENANCE CHART

ENGINE OIL AND OIL FILTER

1. Engine oil specifications
2. Oil level check
3. Oil change
4. Oil filter change

VALVE CLEARANCE

FUEL INJECTION TIMING

1. Preparation
2. Inspection
3. Adjustment

FUEL INJECTION NOZZLE

1. Injection pressure (valve opening pressure) test
2. Orifice restriction test
3. Nozzle tip washing and replacement
4. Installation

FAN BELT

LUBRICATION AND MAINTENANCE CHART

(1) Recommended service should be performed at the specified intervals. Under extremely severe, dusty or wet operating conditions, more frequent lubrication than is specified in this chart may be necessary.

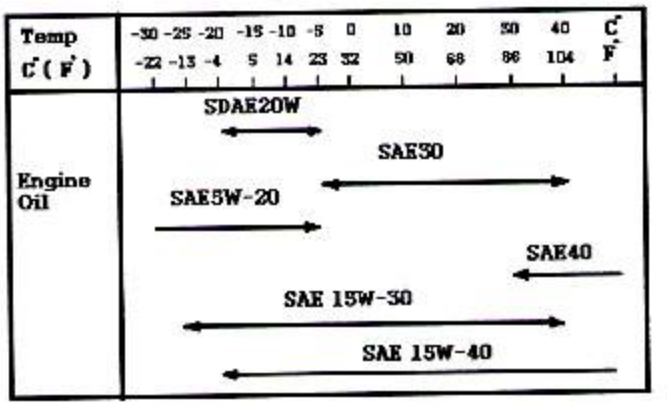
(2) Perform service on items at multiples of the original requirement. For example, at Every 500 Service Hours, also service those items listed under Every 100 Service Hours, Every 50 Service Hours and Every 10 Service Hours.

Service interval	Item	Remarks (specification)
Every 10 Service Hours [Pre-Start Inspection]	Walk- around inspection	
	Check engine oil level	
	Check fuel level	
	Check coolant level	
Every 50 Service Hours	Drain water and sediment from fuel tank	
	Check battery electrolyte level and specific gravity	
First 50 Service Hours of New or Reconditioned Engine	Change engine oil	See SPECIFICATIONS
	Change oil filter	
	Retighten bolts and nuts	
Every 100 Service Hours	Change engine oil	See SPECIFICATIONS
	Change oil filter	
	Clean fuel filter element	After cleaning ,prime
	Clean radiator fins.	
Every 500 Service Hours	Check and adjust valve clearance	0.2mm (0.0079 in) for both inlet and exhaust valves
	Change fuel filter element	After changing, prime
	Check and adjust injection pressure	150 kgf/cm^2 (2133.5lbf/in^2) [14709.92kPa]
	Check and adjust fan belt	Deflection:13mm(0.5 in)
	Check glow plugs	
Every 1000 Service Hours	Retighten bolts and nuts	
	Check starter	
	Check alternator	
Every 2 years	Change coolant	See SPECIFICATIONS
When Required	Prime fuel system	
	Clean air cleaner element	
	Change air cleaner element	

ENGINE OIL AND OIL FILTER

1. Engine oil specifications

Use oils that meet the Engine Service Classification CC.



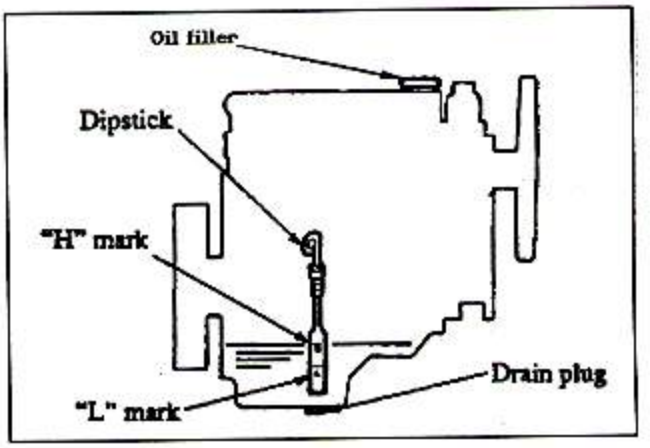
2. Oil level check

(1) Check the crankcase oil level with a dipstick with the engine kept level.

(2) If the oil level is at or below "L" (low level) mark on the dipstick, add oil to "H"(high level) mark on the dipstick.

NOTE

a) After adding oil, leave the engine standing for one minute and check the oil level.
b) Avoid mixing different brands of oils. In some cases, they are not compatible with each other and deteriorate when mixed. Use the same brand at successive intervals.
c) If the engine has been left standing for a long period of time, check the oil for level and contamination before starting the engine. Start and run the engine for a few minutes. Then stop the engine and check the oil level again.



3. Oil change

(1) Change the oil after the first 50 service hours of operation of a new or reconditioned engine and every 100 service hours thereafter.

(2) Warm up the engine. Remove the drain plug and allow the oil to drain in a container. Install the drain plug, tightening it to the specified torque, and refill the engine with the new oil.

(3) Refill to the "H" mark on the dipstick. Approximately 0.5 liter (0.5 qt) of oil is required for the oil filter and oil lines.

Tightening torque

4 ± 0.5 kgf-m

(28.93±3.62 lbf-ft)

[39.23±4.9N-m]