GENERAL CONTENTS

⚠ WARNING Beware of Falling Equipment

● Lift engine carefully

When lifting the engine, use wire ropes capable of supporting the entire weight of the engine.
Attach appropriate slings to the hangers provided on the engine to lift the engine.
Keep the engine balanced during lifting by considering center of gravity of the engine.
Keep the angle formed by wire ropes within 60°. If the angle exceeds this limit, excessive load is applied on the hangers and may damage the hangers.
If wire ropes contact the engine directly, place a cloth or other soft padding to prevent damage to the engine and wire ropes.

● Do not climb onto engine

Do not climb onto the engine, or set a foot on any part located on the side of the engine.
To work on parts located on the upper section, use a ladder, stand, etc., and be careful not to fall.
Climbing on the engine can damage engine parts, and a person may fall and get injured.

● Watch footing when conducting maintenance

When working on the upper part of the engine and other hard-to-reach places, use a stable work platform.
Standing on a decrepit stand or parts box may result in personal injury.
Do not place any item on a work platform.

⚠ CAUTION Cautions Regarding Engine Oil and LLC

● Use only specified fuel, engine oil and coolant

Use fuel, engine oil and coolant specified in this manual, and handle them carefully.
Use of other fuel, oil or coolant, and improper handling may cause various engine problems and malfunctions.
Obtain the MSDSs (Material Safety Data Sheets) issued by the fuel, oil and coolant manufacturers, and follow the directions on the MSDSs for proper handling.

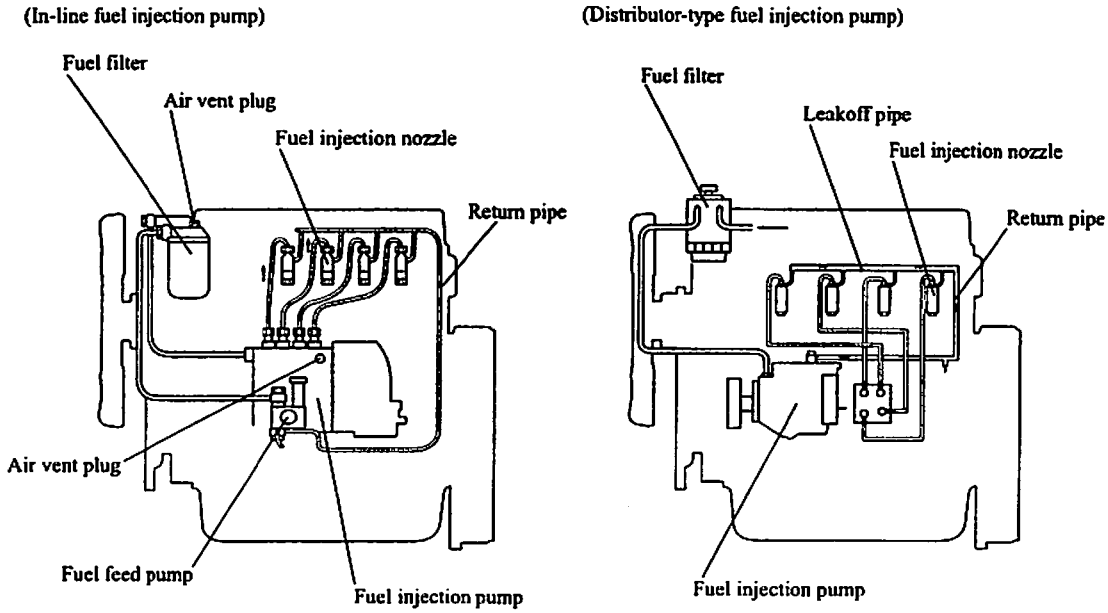
● Handle LLC (long life coolant) carefully

LLC contains strong alkali. Do not swallow or allow it to contact eyes.
Since drained coolant (containing LLC) is harmful, do not dispose of it into conventional sewage. Abide by the applicable law and regulations when discarding drained coolant.

● Properly disposed of drained oil and coolant

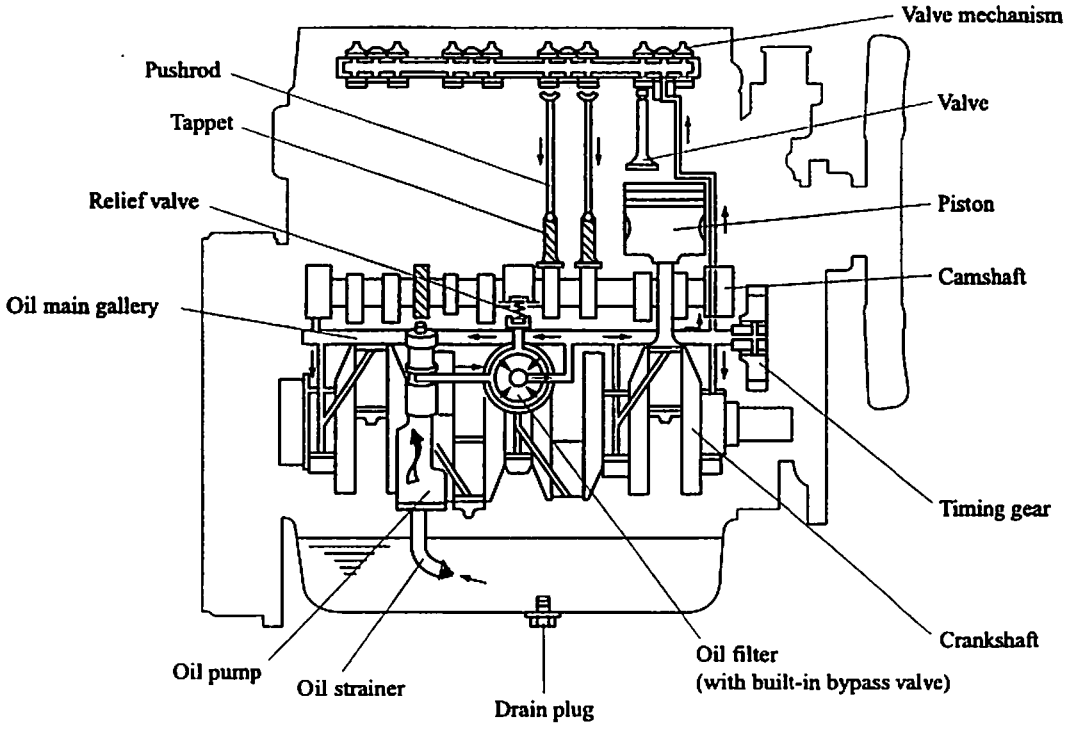
Do not disposed of drained engine oil or coolant into conventional sewage.
Laws and regulations prohibit disposal of oil and coolant into ordinary sewage systems.
When disposing oil waste, coolant and other environmentally hazardous waste, abide by the law and regulations.

1.2 Outline of Fuel System



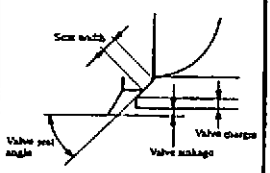
Outline of fuel system

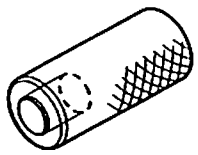
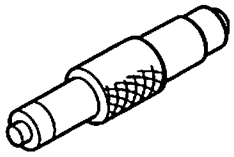
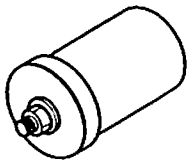
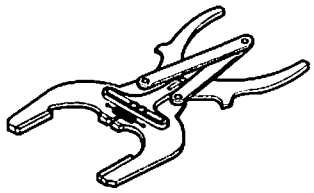
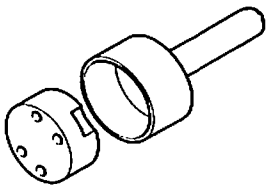
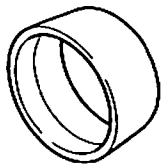
1.3 Outline of Lubrication System



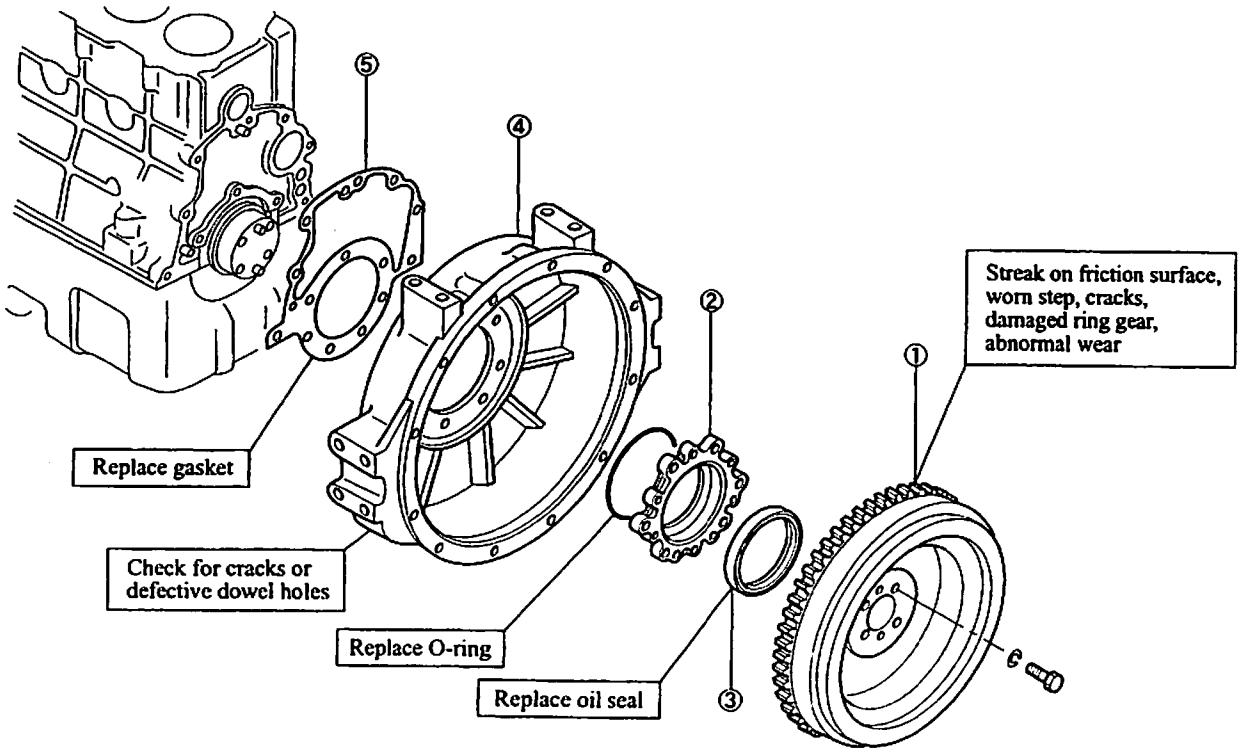
Outline of lubrication system

Unit mm [in.]

		Inspection point		Nominal value	Standard	Limit	Remarks
Engine main parts	Valve spring	Free length			48.85 [1.925]	47.60 [1.875]	
		Squareness			θ=1.5 or less Δ=1.3 or less [0.051] Lf=48.85 [1.925]	Δ=1.5 [0.060] Across the entire length	
		Set length/ Set force mm(in.)/N(kgf)[lbf]			43.0 [1.694]/ 176 to 196 (18 to 20) [40.00 to 44.10]	43.0 [1.694]/ 147 (15) [33.0]	
	Pushrod	Deflection			0.3 [0.012] or less		Measure runout (dial gage reading) with pushrod supported at centers of spherical sections on both ends
	Valve and valve guide	Valve stem diameter	Inlet	ϕ8 [0.3152]	7.940 to 7.955 [0.3128 to 0.3134]	7.900 [0.3112]	
			Exhaust		7.920 to 7.940 [0.3120 to 0.3128]	7.850 [0.3093]	
		Clearance between valve stem and valve guide	Inlet		0.065 to 0.095 [0.0026 to 0.0037]	0.150 [0.0059]	
			Exhaust		0.080 to 0.115 [0.0032 to 0.0045]	0.200 [0.0079]	
		Valve guide installation length		15.5 [0.6110]	15.1 to 15.6 [0.5950 to 0.6150]		
	Valve seat	Valve seat angle		30°			
		Valve sinkage		0.8 [0.0315]	0.7 to 0.9 [0.0276 to 0.0355]	1.3 [0.0512]	
		Seat width		1.18 [0.0465]	1.04 to 1.32 [0.0410 to 0.0520]	1.6 [0.0630]	
		Valve margin		1.70 [0.0670]		Refacing permissible up to 1.20 [0.0473]	
	Flywheel	Flatness			0.10 [0.0039] or less	0.50 [0.0197]	
		Runout			0.10 [0.0039] or less	0.50 [0.0197]	
	Idler gear	Clearance between idler gear and shaft			0.025 to 0.075 [0.0010 to 0.0030]	0.100 [0.0039]	Replace bushing.
		End play			0.05 to 0.20 [0.0020 to 0.0079]	0.35 [0.0138]	Replace thrust plate.
		Interference between shaft and crankcase bore			−0.039 to −0.076 [−0.0015 to −0.0030]		
	Timing gear backlash	Crankshaft gear –Idler gear			0.03 to 0.16 [0.0012 to 0.0063]	0.25 [0.0099]	Replace gears.
		Idler gear –Camshaft gear			0.04 to 0.17 [0.0016 to 0.0067]	0.25 [0.0099]	
		Idler gear –Injection pump gear			0.03 to 0.18 [0.0012 to 0.0071]	0.25 [0.0099]	

Application		Tool name/Part No.	Shape	Use
Engine main parts	Cylinder head valve mechanism	Valve guide installer 32C91-00300		Valve guide installation
	Timing gear	Idler bushing installer 30691-51900		Idler bushing removal/installation
		Idler shaft puller MH061077		Idler shaft removal
	Piston, crankshaft	Piston ring pliers 31391-12900		Piston ring removal/installation
		Crankcase oil seal sleeve installer set 30691-13010		Crankshaft rear oil seal sleeve installation
		Piston guide (installer) 30691-58100		Piston insertion

2. Flywheel



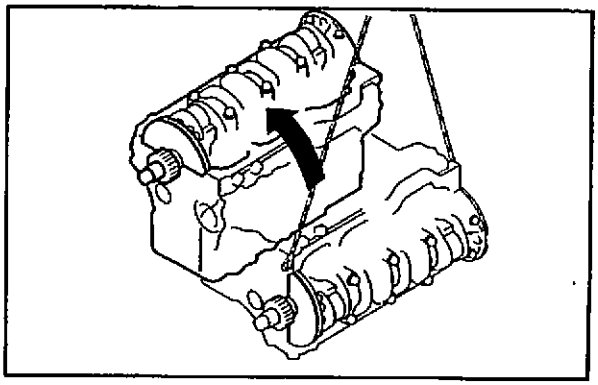
Disassembly and inspection of flywheel

< Disassembly sequence >

① Flywheel
② Oil seal case (option)
③ Oil seal
④ Flywheel housing
⑤ Gasket

4.8 Reversal of Crankcase

Gently stand the crankcase so that the oil pan mounting side faces up.



Reversal of crankcase

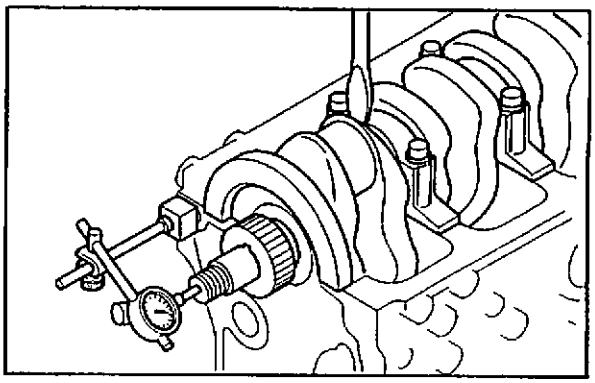
4.9 Measurement of Crankshaft End Play

(1) With a dial gage positioned at the end of the crankshaft, measure the end play.

(2) If the limit value is exceeded, replace the flanged bearing.

Unit mm [in.]

	Standard	Limit
Crankshaft end play	0.100 to 0.204 [0.0039 to 0.0080]	0.300 [0.0118]

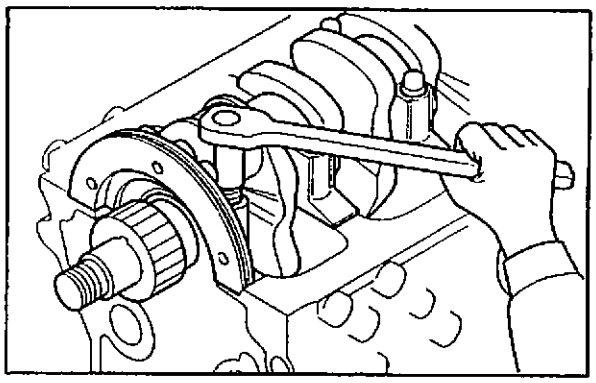


Measurement of crankshaft end play

4.10 Removal of Main Bearing Caps

Unscrew the main bearing cap mounting bolts, and remove the main bearing caps together with the bearings.

Note : Be careful not to damage the bearings. Arrange the removed bearings so that they can be reinstalled in the original positions during reassembly.



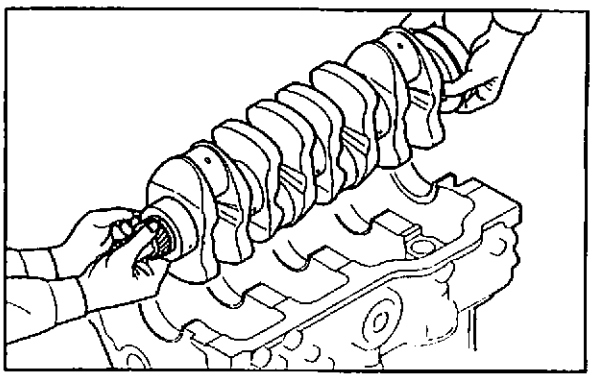
Removal of main bearing cap

4.11 Removal of Crankshaft

Gently lift the crankshaft to remove it from the crankcase.

⚠ CAUTION

Be careful not to damage the bearings during the removal of the crankshaft.



Removal of crankshaft

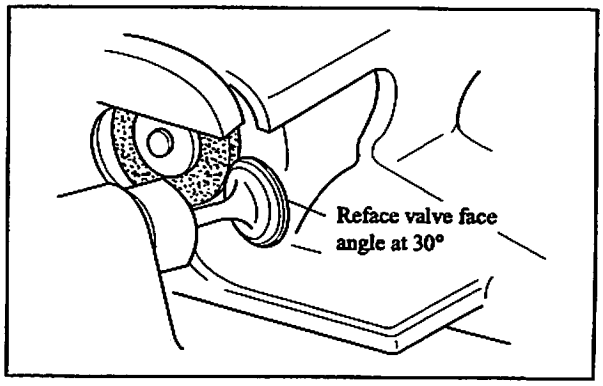
4.12 Arrangement of Bearings

Be sure to arrange the removed bearings so that they can be reinstalled in their original positions and combined with their matching halves.

1.10 Refacing Valve Faces

If the valve face is excessively worn, reface it with a valve refacer.

Note: (a) Reface the valve face to an angle of 30°.
(b) Be sure to ensure the valve margin limit. If the grinding does not result in the conformity of the dimension, replace the valve.

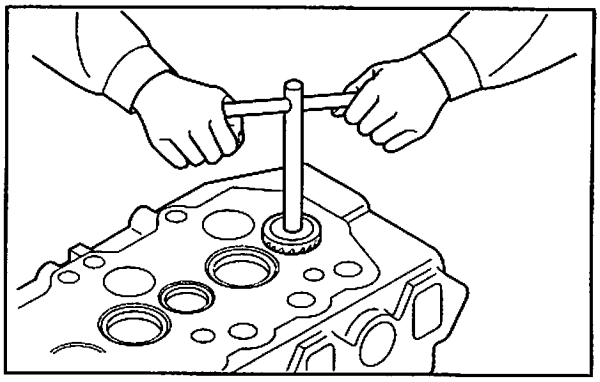


Refacing valve face

1.11 Regrinding Valve Seats

Use the valve seat cutter or valve seat grinder to reface the valve seat. After refacing, grind the seat lightly by inserting #400-grade sandpaper between the cutter and valve seat.

Note: (a) Grind the valve seat as little as possible.
(b) If the seat width exceeds the limit due to wear or as a result of grinding, replace the valve seat.



Regrinding valve seat

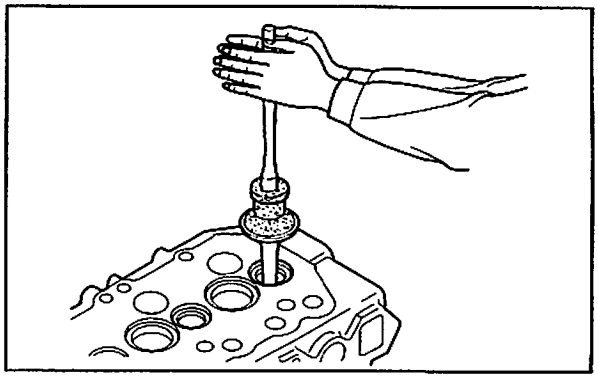
1.12 Lapping Valves against Valve Seats

Be sure to lap each valve in its valve seat after the valve or seat has been refaced or replaced.

(1) Coat the seat contact surface of the valve face lightly and evenly with a lapping compound.

Note: (a) Do not allow the compound to adhere on the valve steam.
(b) Use a compound of medium coarseness (120 to 150 mesh) for initial lapping, and use a finer compound (200 mesh or finer) for finishing.
(c) Mix a small amount of engine oil with the compound for smooth and even application.

(2) Use the valve lapper to lap the valve in the seat. To lap, strike the valve against the valve seat while rotating the valve a little at a time.
(3) Wash off the compound with diesel fuel.
(4) Coat the seat contact surface of the valve face with engine oil, then lap the valve again.
(5) Inspect the valve face for contact.



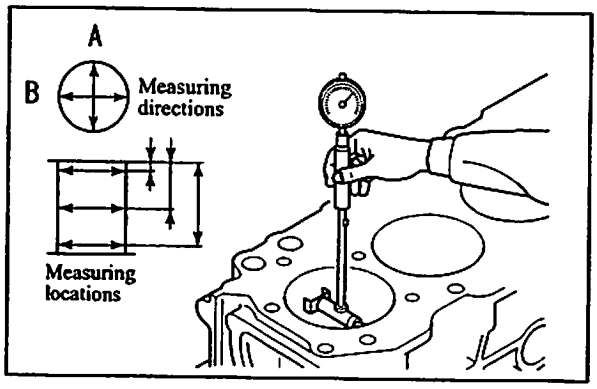
Lapping valve against valve seat

4.14 Measurement of Cylinder Bore

(1) Using a cylinder gage, measure the cylinder bore and cylindricity. If the limit value is exceeded even at one place, bore all cylinders and replace the pistons and piston rings with oversize pistons and piston rings.
Measure at three locations each in directions A and B shown in the diagram.

Unit mm [in.]

Type of piston and piston ring		Cylinder bore	
Size	Size code	Standard	Limit
S.T.D	STD	$\phi 88^{+0.035}_{0}$ [$3.46^{+0.0014}_{0}$]	Reference value +0.2 [+0.0079]
0.25 [0.01] O.S	25 [0.984]	$\phi 88.25^{+0.035}_{0}$ [$3.47^{+0.0014}_{0}$]	
0.50 [0.02] O.S	50 [1.969]	$\phi 88.50^{+0.035}_{0}$ [$3.48^{+0.0014}_{0}$]	
Cylindricity of cylinder bore		0.015 [0.00059] or less	–



Measurement of inside diameter of cylinder

(2) Boring of cylinders

(a) Since there are two piston oversizes (0.25 mm [0.0098 in.] and 0.50 mm [0.0197 in.] oversize) as indicated above, determine the appropriate piston size to be used based on the largest cylinder bore diameter.

(b) Measure the outside diameter of the piston to be used.
The piston diameter measuring points are shown in the diagram.

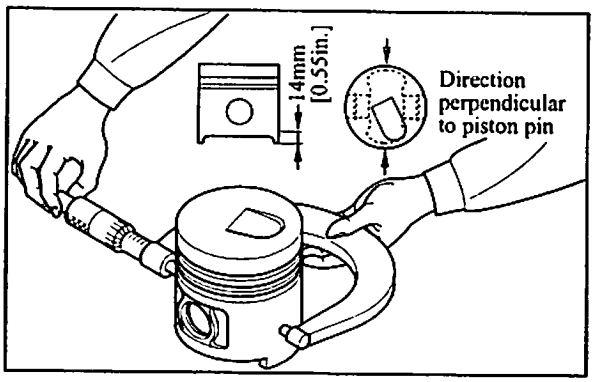
(c) Based on the measurements of the piston outside diameter, calculate the finishing dimension to be achieved by boring.

A: Piston outside diameter measurement (selected oversized piston) mm [in.]

B: Clearance between piston and cylinder (standard value) 0.03 mm [0.0012 in.]

C: Honing allowance 0.04 mm [0.0016 in.] or less in diameter

Finishing dimension = A + B - C



Measurement of piston outside diameter

(d) Bore the cylinders to the calculated dimension.

⚠ CAUTION

Bore the cylinders in the order of the cylinder numbers to prevent distortion due to the heat generated by the boring operation.

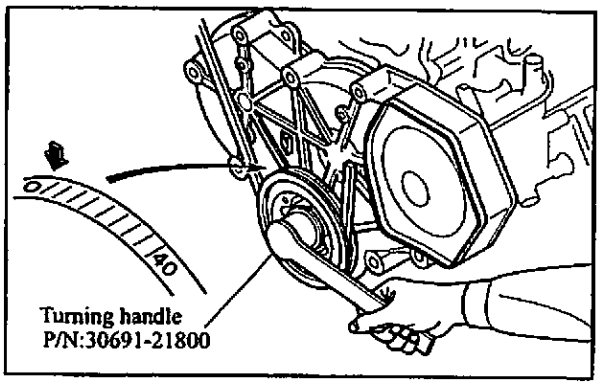
(e) Hone the cylinders to the final dimension (piston outside diameter + cylinder clearance).

4.9 Adjustment of Valve Clearances

(1) Confirming the top dead center on the compression stroke for cylinder No. 1

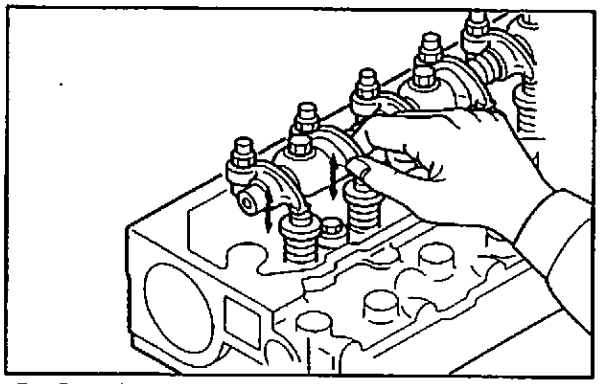
(a) By engaging the turning handle on the crankshaft pulley nut, turn the engine in the forward rotating direction (clockwise when viewed from the front of the engine).

(b) Stop turning when the "0" line stamped on the periphery of the crankshaft pulley aligns with the pointer on the timing gear case.



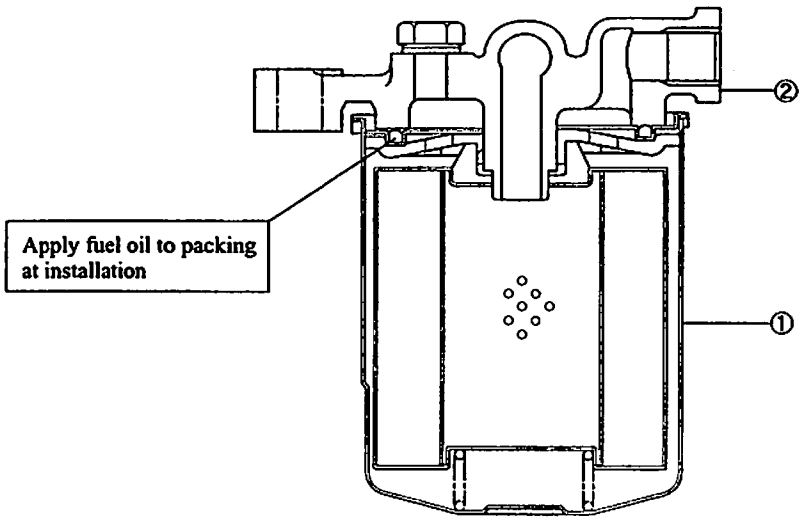
Turning engine

(c) Move up and down the inlet and exhaust valve rocker arms of cylinder No. 1 to make sure that they are not being pushed up by the pushrods.
The piston in cylinder No. 1 is at the top dead center on the compression stroke when the rocker arms are not being pushed by the pushrods (there is a clearance in each valve).
If the rocker arms are being pushed up by the pushrods, turn the crankshaft one more turn.



Confirmation of top dead center on compression stroke for cylinder No. 1

1.2 Reassembly of Fuel Filter
(For in-line fuel injection pump)



Reassembly of fuel filter (for in-line fuel injection pump)

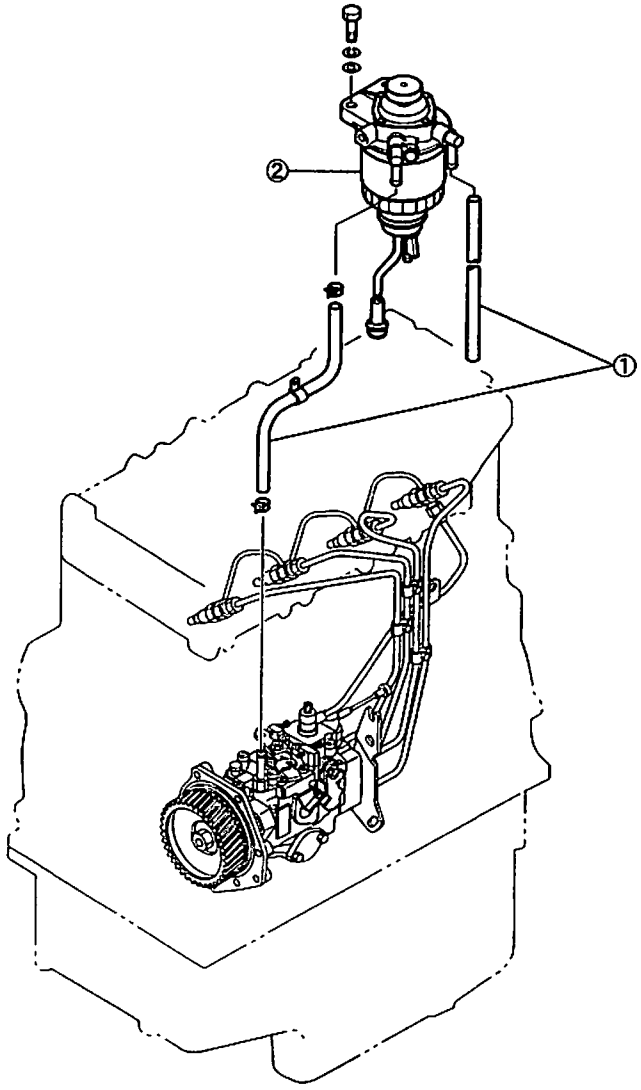
< Reassembly sequence >
②→①

Before installing the cartridge, clean the mounting surface of the cartridge, coat the gasket with clean fuel oil. Screw in the cartridge until the gasket contacts the seal surface of the bracket, then cartridge full turn by hand. (Do not use a filter wrench for installation.) Do not use a filter that has dents or scratches, since damaged filter can break during engine operation.

⚠ CAUTION

After installation, start the engine and check to make sure there is no fuel leak.

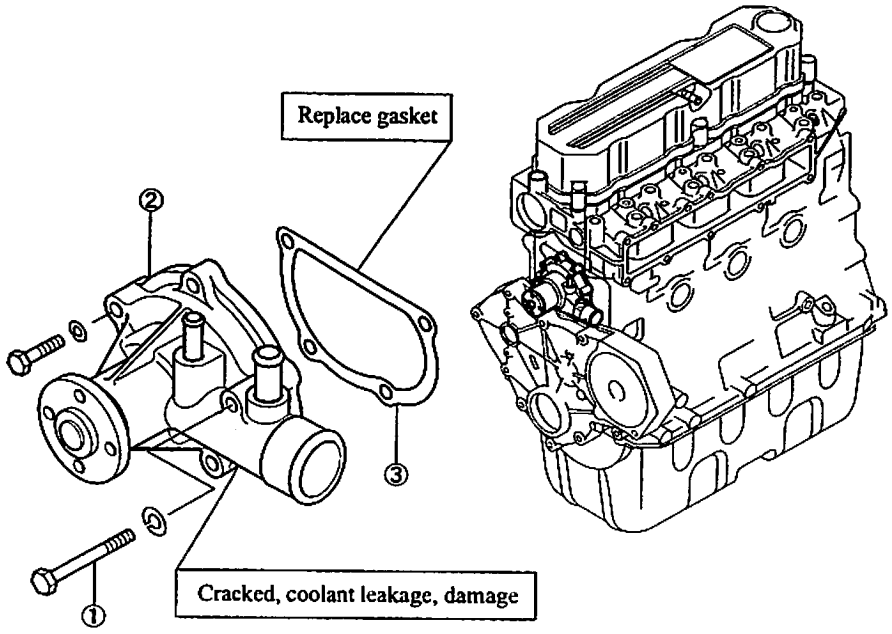
(For distributor-type fuel injection pump)



Installation of fuel filter (for distributor-type fuel injection pump)

< Installation sequence >
②→①

3. Water Pump

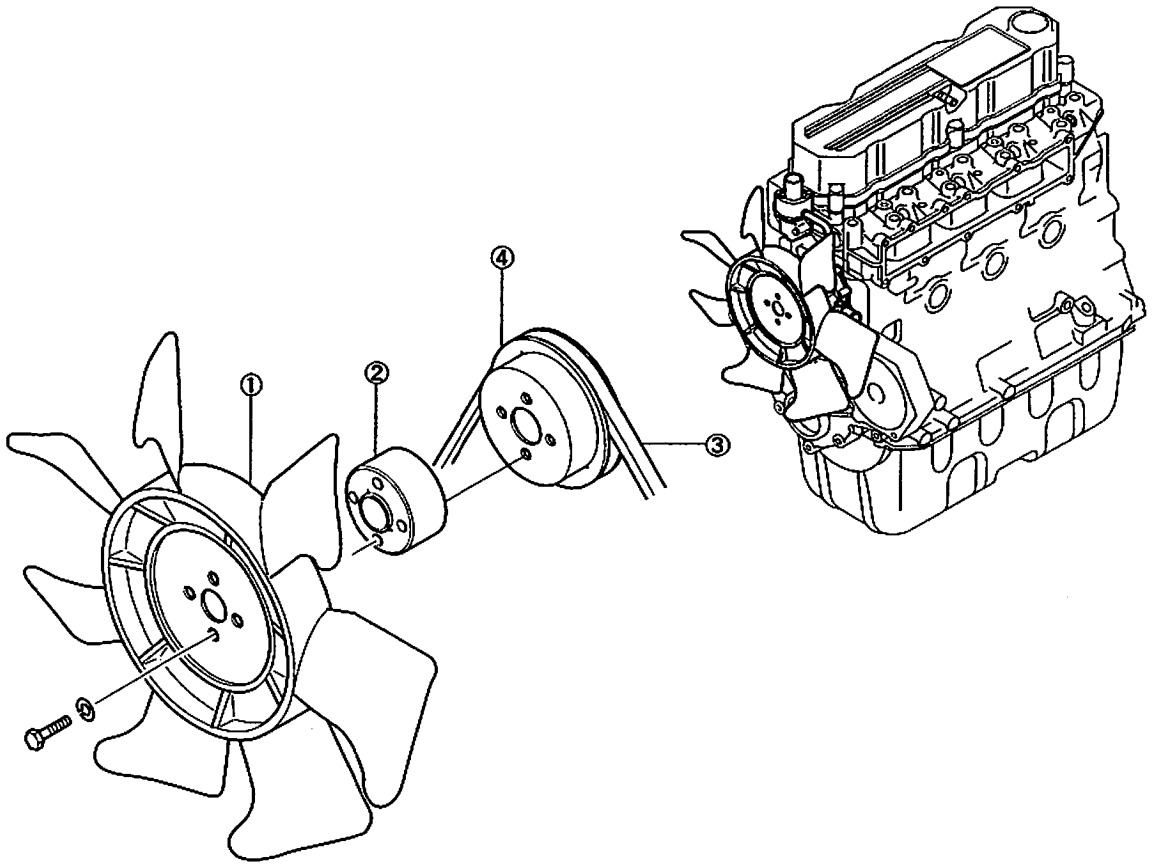


Removal of water pump

< Removal sequence >

① Bolt ② Water pump ③ Gasket

3. Cooling Fan, Fan Pulley and V-Belt

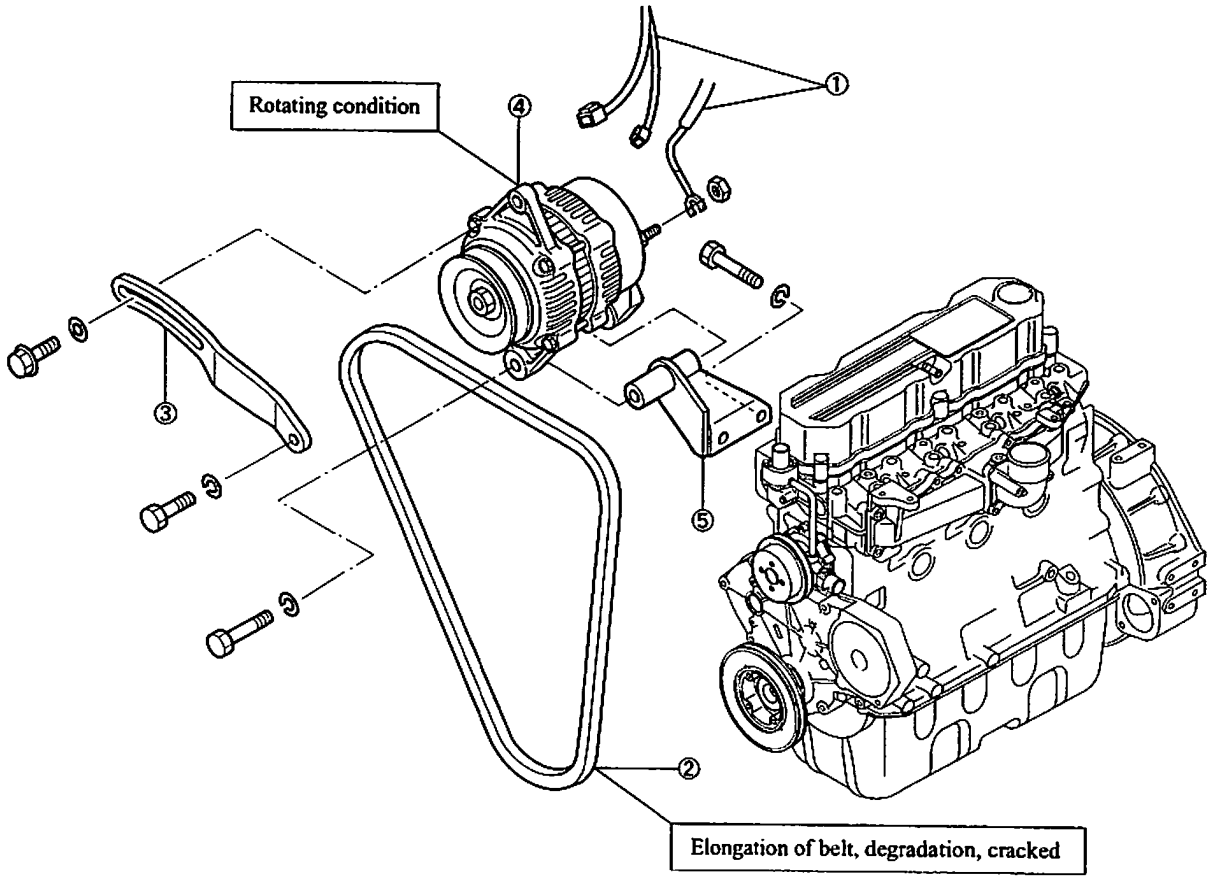


Installation of cooling fan, fan pulley and v-belt

< Installation sequence >

④→③→②→①

2. Alternator



Removal of alternator

< Removal sequence >

① Harness
② V-Belt
③ Adjusting plate
④ Alternator
⑤ Bracket