

CHAPTER 10

DISASSEMBLY AND REASSEMBLY

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1. Disassembly and Reassembly Precautions

(1) Disassembly

- Take sufficient time to accurately pin-point the cause of the trouble, and disassemble only those parts which are necessary.
- Be careful to keep all disassembled parts in order.
- Prepare disassembly tools.
- Prepare a cleaner and cleaning can.
- Clear an adequate area for parts and prepare container(s).
- Drain cooling water (sea water, fresh water) and lube oil.
- Close the Kingston cock.

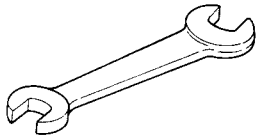
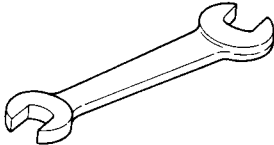
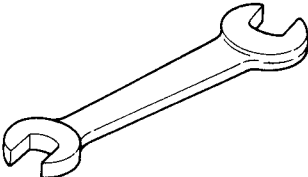
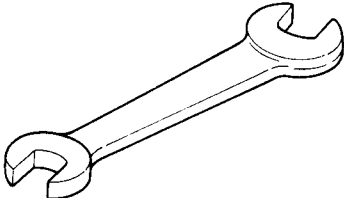
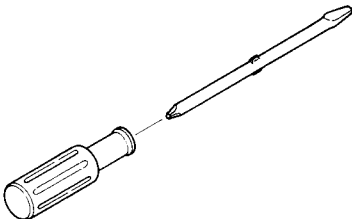

(2) Reassembly

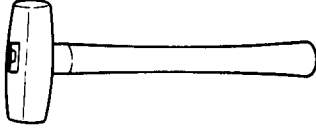
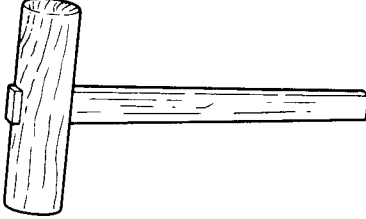
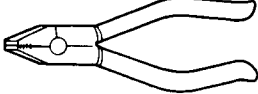

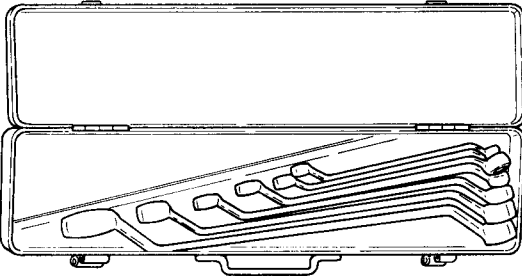
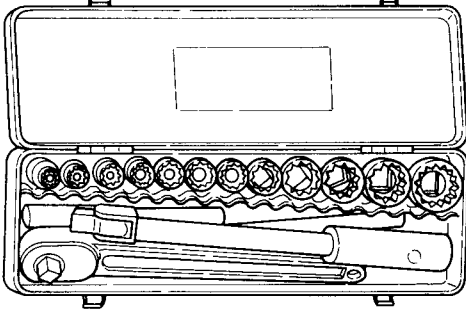
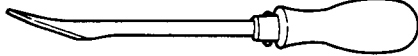
- Sufficiently clean and inspect all parts to be assembled.
- Coat sliding and rotating parts with new engine oil when assembling.
- Replace all gaskets and O-rings.
- Use a liquid packing agent as necessary to prevent oil/water leaks.
- Check oil and thrust clearances, etc. of parts when assembling.
- Make sure you use the correct bolt/nut/washer. Tighten main bolts/nuts to specified torque. Be especially careful not to overtighten the aluminum alloy part mounting bolts.
- Align match mark (if any) when assembling. Make sure that the correct set of parts is used for bearings, pistons, and other parts for which a property fit is used.

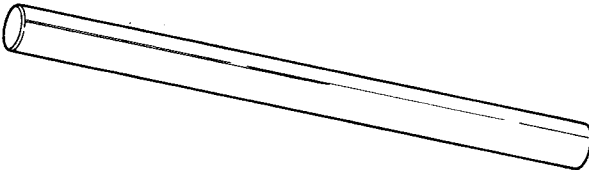
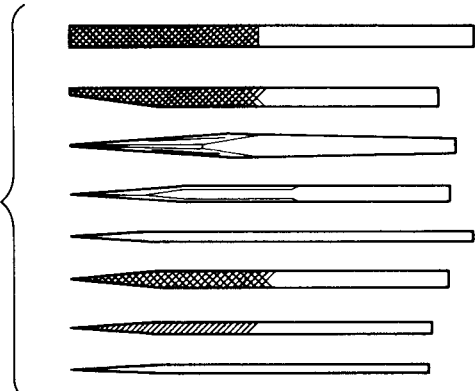

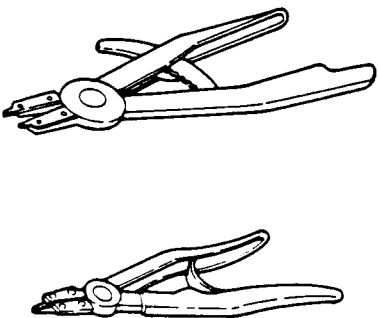
2. Disassembly and Reassembly Tools

The following tools are required when disassembling and reassembling the engine.
 Please use them as instructed.

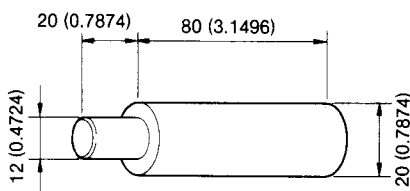
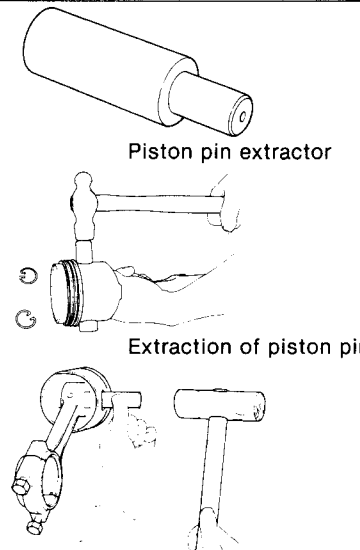
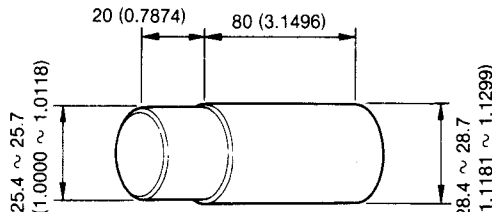
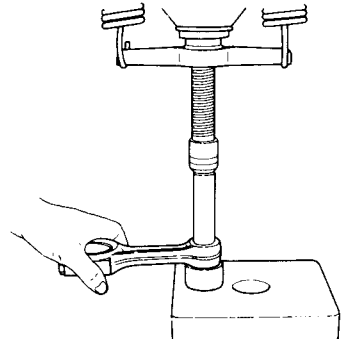
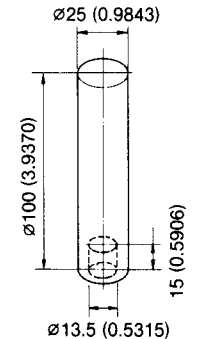
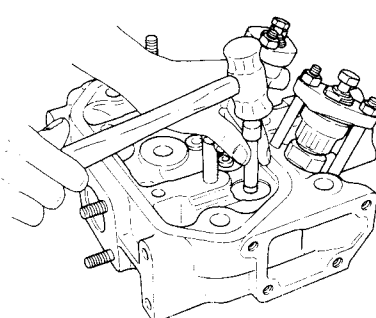
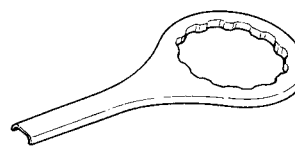
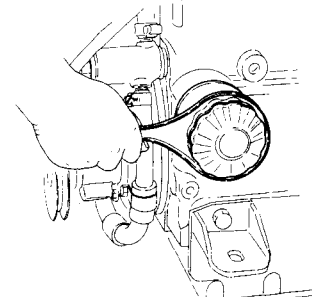
2-1. General Handtools

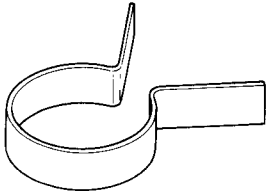
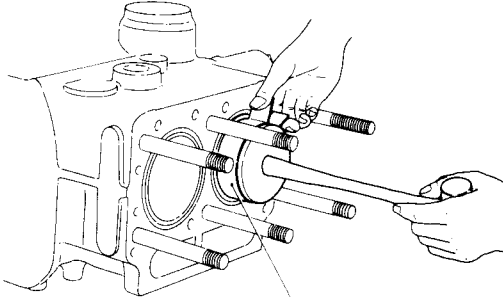
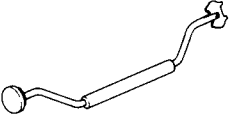
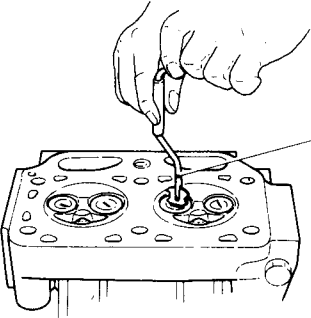

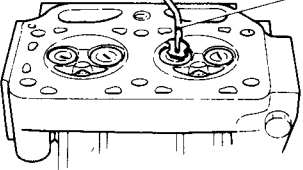

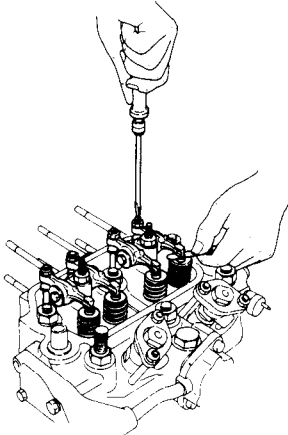
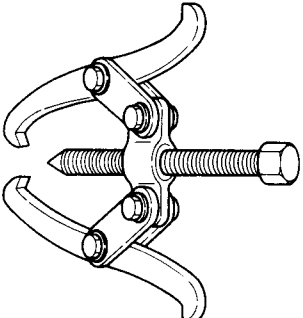
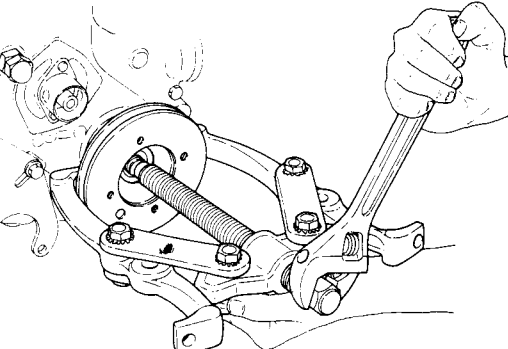
Name of tool	Illustration	Remarks
Wrench		Size: 10 × 13
Wrench		Size: 12 × 14
Wrench		Size: 17 × 19
Wrench		Size: 22 × 24
Screwdriver		
Steel hammer		Local supply

Name of tool	Illustration	Remarks
Copper hammer		Local supply
Mallet		Local supply
Nippers		Local supply
Pliers		Local supply
Offset wrench		Local supply 1 set
Box spanner		Local supply 1 set
Scraper		Local supply

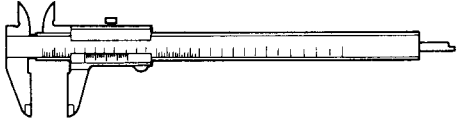
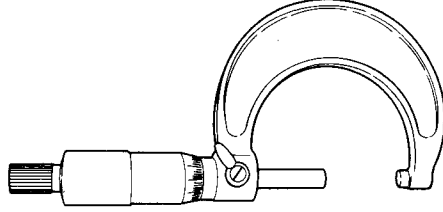
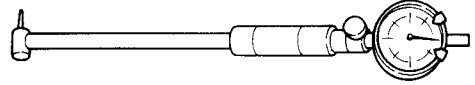
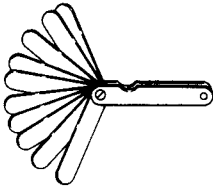
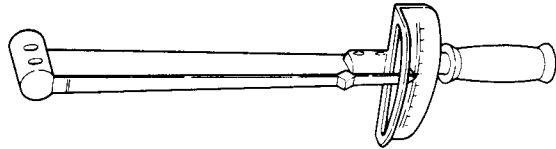
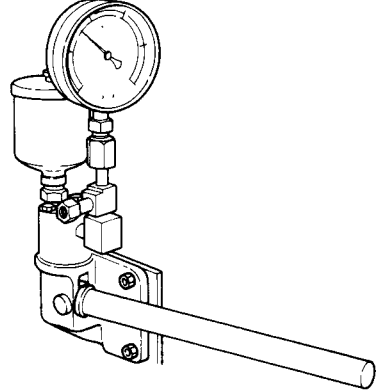
Name of tool	Illustration	Remarks
Lead rod		Local supply
File		Local supply 1 set
Rod spanner for hexagon socket head screws		Local supply Size: 6mm (0.2362in.) 8mm (0.3150in.) 10mm (0.3937in.)
Starling Pliers Hole type Shaft type	 <p data-bbox="868 1186 925 1218">S-0</p> <p data-bbox="868 1396 958 1428">H4 ~ H8</p> <p data-bbox="868 1543 1031 1585">S = Hole type H = Shaft type</p>	Local supply

2-2 Special Handtools

Name of tool	Shape and size	Application
Piston pin insertion/ extraction tool	<p style="text-align: right;">mm (in.)</p>  <p style="text-align: center;">Part No. 128670-92260</p>	 <p style="text-align: center;">Piston pin extractor</p> <p style="text-align: center;">Extraction of piston pin</p> <p style="text-align: center;">Insertion of piston pin</p>
Connecting rod small end bushing insertion/ extraction tool	<p style="text-align: right;">mm (in.)</p> 	 <p style="text-align: center;">Extraction</p>
Intake and exhaust valve insertion/ extraction tool	<p style="text-align: right;">mm (in.)</p> 	
Lubricating oil No.2 filter case remover		

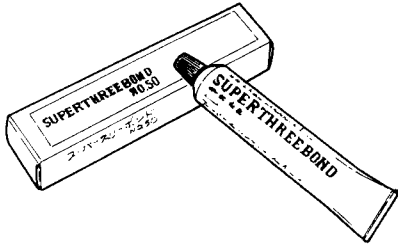
Name of tool	Shape and size	Application
Piston ring compressor		 <p>Piston insertion guide</p>
Valve lapping handle		 <p>Lapping tool</p>
Valve lapping powder		
Feeler gauge		
Pulley puller	 <p>Local supply</p>	 <p>Removing the coupling</p>

2-3 Measuring Instruments

Name of tool	Shape and size	Application
Vernier calipers		0.05mm (0.0020in.), 0 ~ 150mm (0 ~ 5.9055in.)
Micrometer		0.01mm (0.0004in.) 0 ~ 25mm (0 ~ 0.9843in.), 25 ~ 50mm (0.9843 ~ 1.9685in.), 50 ~ 75mm (1.9685 ~ 2.9528in.), 75 ~ 100mm (2.9528 ~ 3.9370in.), 100 ~ 125mm (3.9370 ~ 4.9213in.), 125 ~ 150mm (4.9213 ~ 5.9055in.)
Cylinder gauge		0.01mm (0.0004in.), 18 ~ 35mm (0.7087 ~ 1.3780in.), 35 ~ 60mm (1.3780 ~ 2.3622in.), 50 ~ 100mm (1.9685 ~ 3.9370in.)
Thickness gauge		0.05 ~ 2mm (0.0020 ~ 0.0787in.)
Torque wrench		0 ~ 13kg-m. (0 ~ 94ft-lb)
Nozzle tester		0 ~ 500kg/cm ² (0 ~ 7111.7lb/in. ²)

2-4 Other

Supplementary packing agent

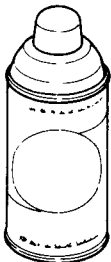


Type	Use
"Three Bond 3B8-005"	White. Since "Three Bond 3B8-005" is a nonorganic solvent, it does not penetrate asbestos sheets made principally or completely of asbestos. Always use it with grey asbestos sheet packing for complete oil tightness. When "Three Bond 3B8-005" is difficult to obtain, use silicon nonsolvent type "Three Bond No. 50."
"Three Bond No. 50"	Grey. Silicon nonsolvent type liquid packing. Semidry type packing agent coated on mating faces to prevent oil and gas leakage. Does not penetrate asbestos sheet and assures complete oil tightness.
"Three Bond No. 1"	Reddish brown. Paste type wet viscous liquid packing. Ideal for mating faces which are removed but reinstalled. Particularly used to prevent water leakage and to prevent seizing of bolts and nuts.

The surface to be coated must be thoroughly cleaned with thinner or benzene and completely dry. Moreover, coating must be thin and uniform.

Products of Three Bond Co., Ltd.

Paint



Color spray

Only Metallic Ecole Silver is used on this engine.

Wipe the surface to be painted with thinner or benzene, shake the spray can well, push the button at the top of the can and spray the paint onto the surface from a distance of 30 ~ 40 cm.

Paint

Type

White paint
(Mixed oil paint)

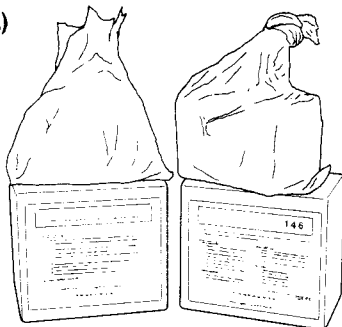
Usage point

Cylinder liner
insertion hole

Use

Paint parts that contact with the cylinder body when inserting the cylinder liner to prevent rusting and water leakage.

Yanmar cleaner (Ref.)



Cooling passage cleaner is mixed by adding one part "Unicon 146" to about 16 parts water (specific gravity ratio). To use, drain the water from the cooling system, fill the system with cleaner, allowing it to stand overnight (10 ~ 15 hours). Then drain out the cleaner, refill the system with water, and operate the engine for at least one hour.

NEJI LOCK SUPER 203M: a locking agent for screws (Ref.)



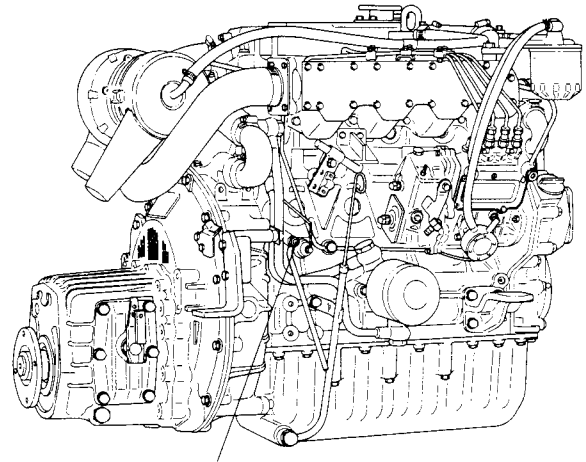
For coating on screws and bolts to prevent loosening, rusting, and leaking. To use, wipe off all oil and water on the threads of studs, coat the threads with screw lock, tighten the stud bolt, and allow them to stand until the screw lock hardens. Use screw lock on the oil intake pipe threads, oil pressure switch threads, fuel injection timing shim faces, and front axle bracket mounting bolts.

3. Disassembly and Reassembly

3-1 Disassembly

For engines mounted in an engine room, remove the piping and wiring connecting them to the ship.

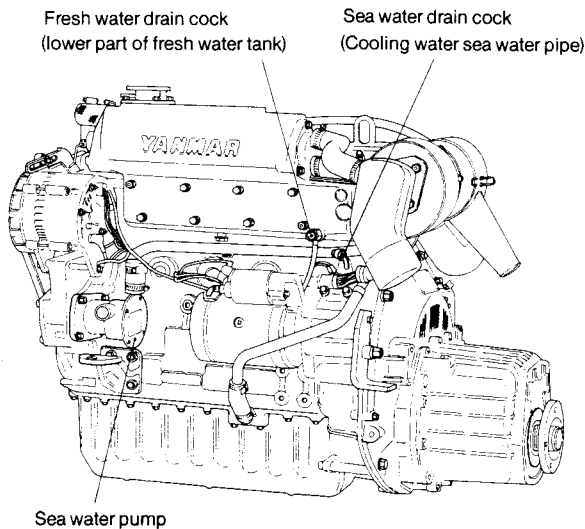
- (1) Remove the remote control cable (from engine and marine gearbox).
- (2) Unplug the extension cord for the instrument panel from the engine.
- (3) Remove the wiring between the starting motor and the battery.
- (4) Remove the exhaust rubber hose from the mixing elbow.
- (5) Remove the fresh water sub-tank rubber hose from the filler cap.
- (6) Remove the cooling water (sea water) pump sea water intake hose (after making sure the Kingston cock is closed).
- (7) Remove the fuel oil intake rubber hose from the fuel feed pump.
- (8) Remove the body fit (reamer) bolts and disassemble the propeller shaft coupling and thrust shaft coupling.
- (9) If a driven coupling is mounted to the front drive coupling, disassemble.
- (10) Remove the flexible mount nut, lift the engine, and remove it from the engine base.
 (Leave the flexible mount attached to the engine base.)



Fresh water drain cock (cylinder block)

3-1.1 Drain cooling water

- (1) Open the sea water drain cock between the sea water pump and lube oil cooler to drain the sea water.
- (2) Open the cylinder body drain cock to drain the fresh water from the cylinder head and cylinder body.
- (3) Open the fresh water drain cock on the lower part of the fresh water tank to drain the fresh water.



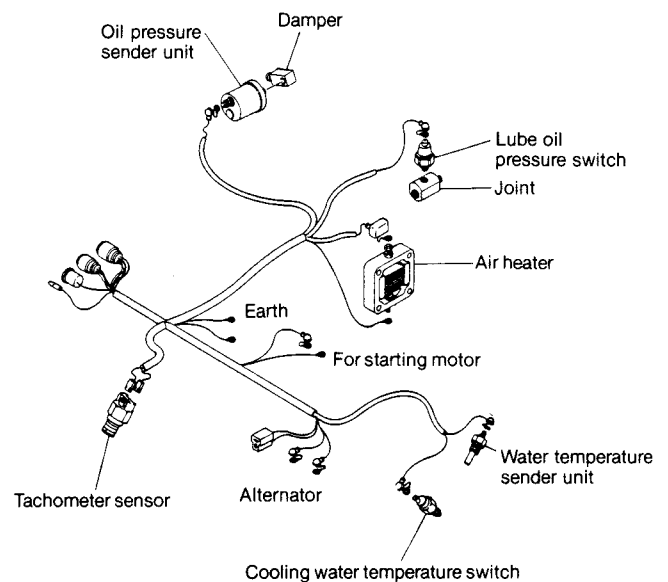
3-1.2 Drain lube oil

- (1) Remove the pipe coupling bolt which holds the lube oil dip stick guide, and drain the lube oil from the engine.
- (2) Remove the drain plug on the lower part of the crank case control side, and drain the lube oil from the marine gearbox.

NOTE: If a lube oil supply/discharge pump is used for the engine, the intake hose is placed in the dip stick guide, and for the clutch side (gearbox) it is placed in the oil hole on top of the case.

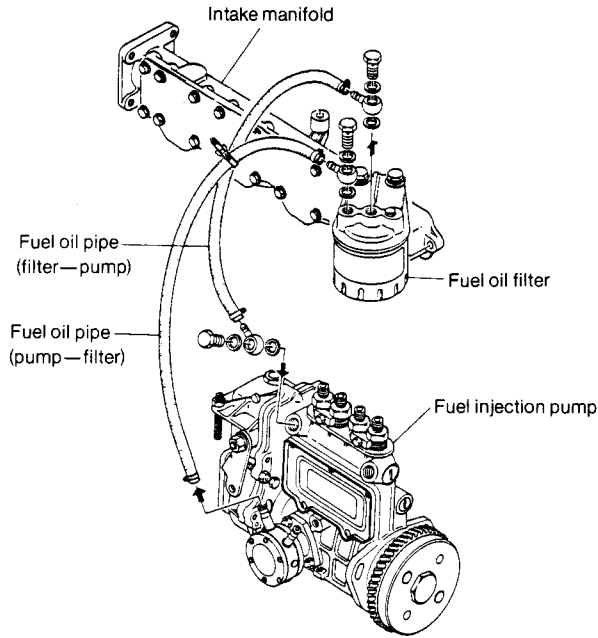
3-1.3 Removing (electrical) wiring

Remove the wiring from the engine.



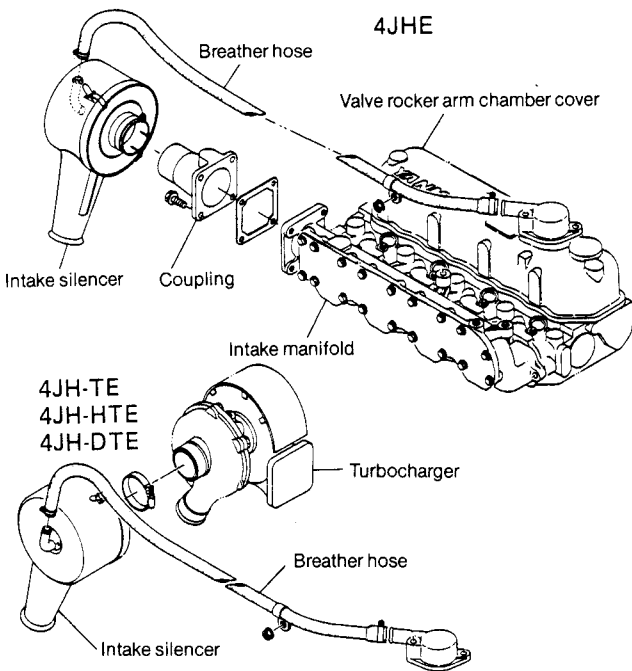
3-1.4 Removing the fuel oil filter & fuel oil pipe

- (1) Remove the fuel oil pipe (fuel oil filter—fuel feed pump, fuel oil filter—fuel injection pump).
- (2) Remove the fuel oil filter (with bracket) from the intake manifold.



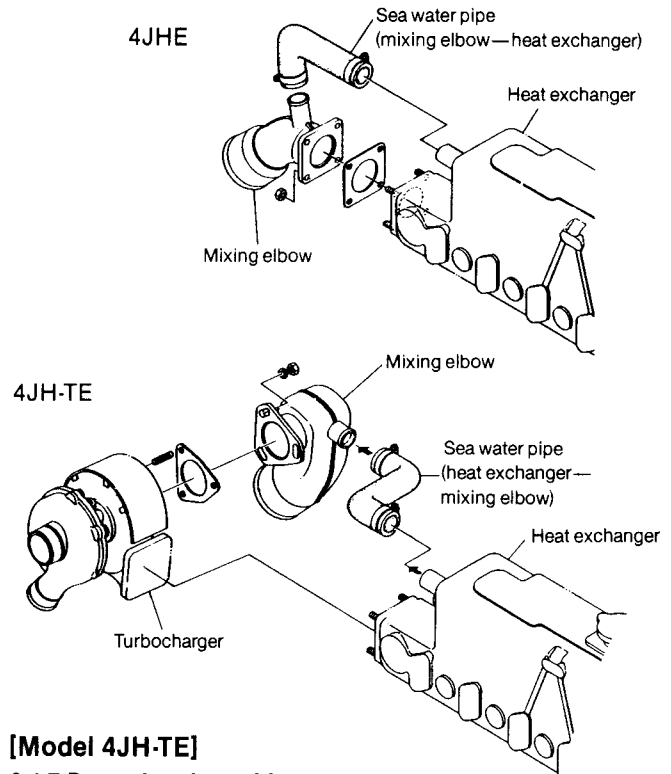
3-1.5 Removing the intake silencer

- (1) Remove the breather hose attached to the intake silencer—valve rocker arm chamber cover.
- (2) Remove the intake silencer
 4JHE: from the intake manifold intake coupling
 4JHE, 4JH-HTE, 4JH-DTE: from the blower side of the turbocharger



3-1.6 Removing the mixing elbow

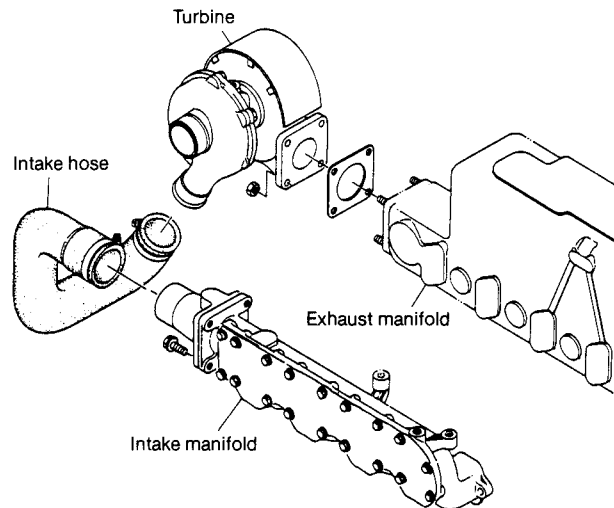
- (1) Remove cooling water (sea water) pipe rubber hose (heat exchanger—mixing elbow).
- (2) Remove the mixing elbow
 4JHE: from exhaust manifold outlet
 4JH-TE: from turbocharger outlet

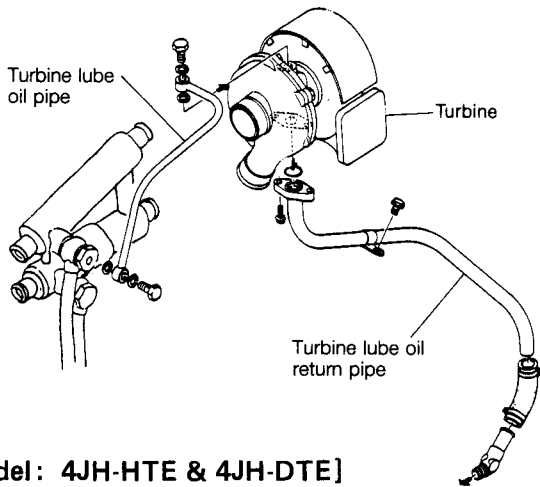


[Model 4JH-TE]

3-1.7 Removing the turbine

- (1) Remove the intake rubber hose (turbine—intake manifold).
- (2) Remove the oil pan side rubber hose for the turbine lube oil return pipe from the oil pan, and the vibration stop from the flywheel housing.
- (3) Remove the turbine lube oil pipe (lube oil cooler—turbine).
- (4) Remove the turbine from the exhaust manifold.





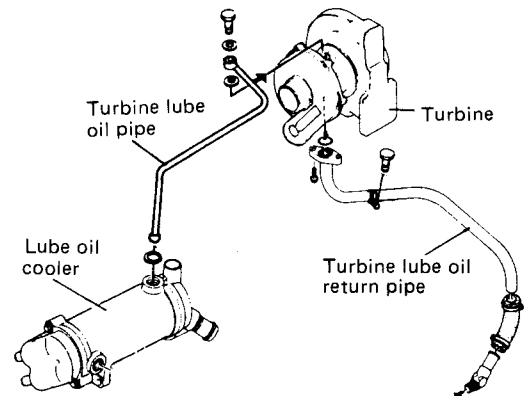
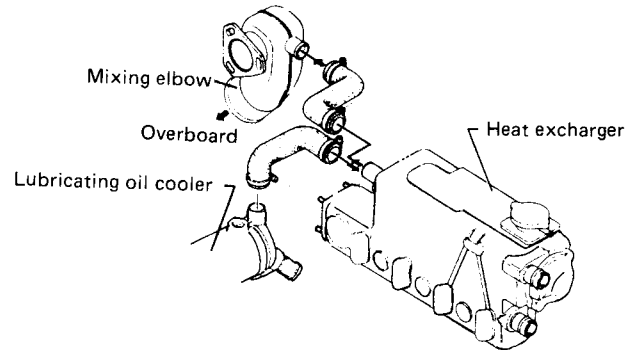
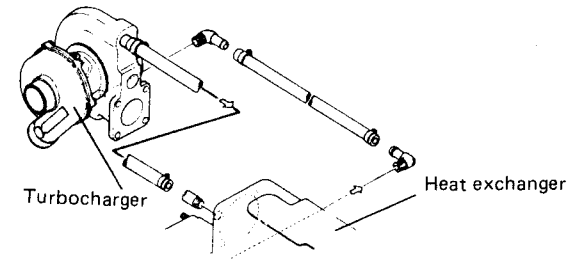
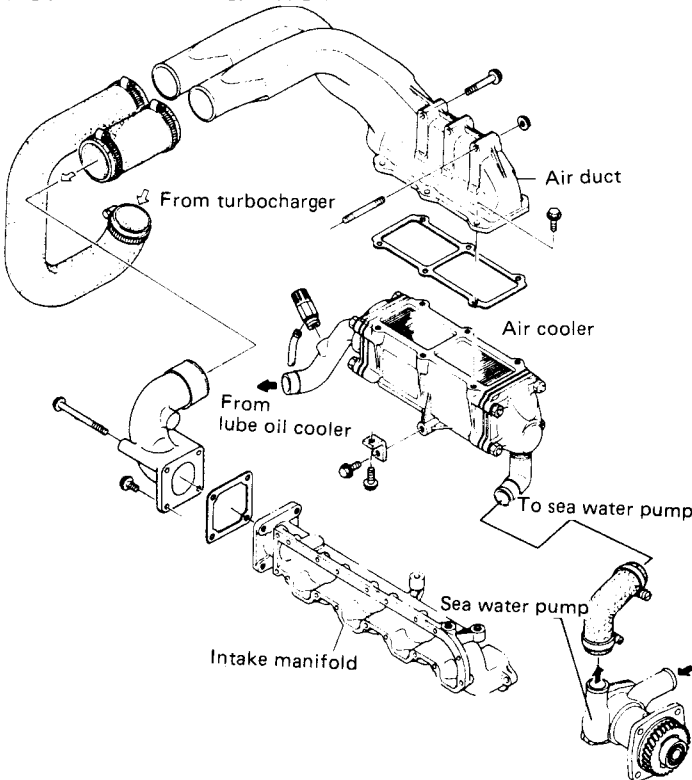
- Removing the mixing elbow and the turbocharger.**
- (1) Remove the fresh water hoses.
(Turbocharger — heat exchanger)
 - (2) Remove the lube oil pipes.
(Lube oil cooler—Turbocharger—Lube oil pump)
 - (3) Remove the sea water hose.
(Mixing elbow — heat exchanger)
 - (4) Remove the mixing elbow from turbocharger.
 - (5) Remove the air duct rubber hose.
(Air duct — Turbocharger)
 - (6) Remove the turbocharger from exhaust manifold.

[Model: 4JH-HTE & 4JH-DTE]

Removing the air cooler

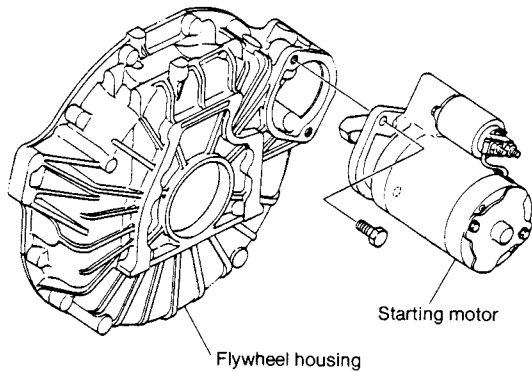
- (1) Remove the intake rubber hoses.
(Air duct-intake manifold, and turbocharger)
- (2) Remove the sea-water rubber hoses.
(Sea water pump — Air cooler — Lube oil cooler)
- (3) Remove the air cooler from the heat exchanger, and cylinder block.

MODEL: 4JH-HTE & 4JH-DTE



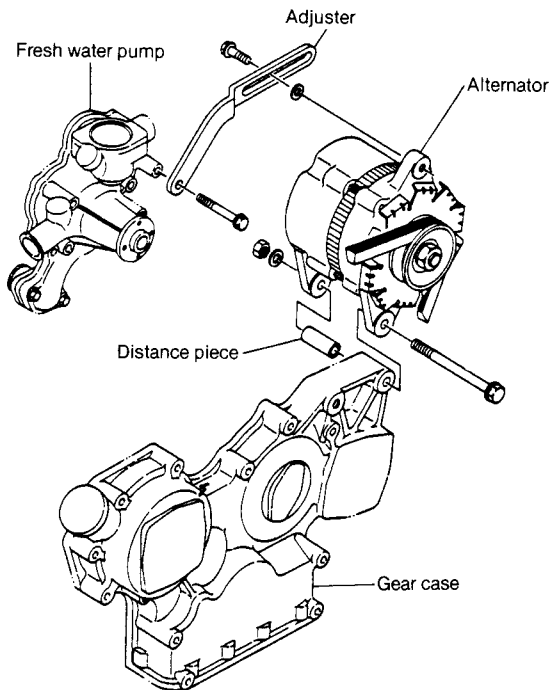
3-1.8 Removing the starting motor

Remove the starting motor from the flywheel housing.



3-1.9 Removing the alternator

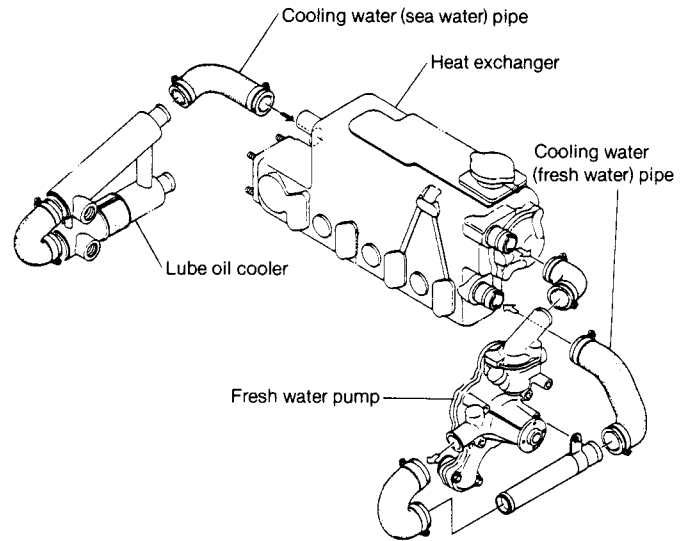
- (1) Loosen the alternator adjuster bolt and remove the V-belt.
- (2) Remove the adjuster from the fresh water pump, and remove the alternator from the gear case (with distance piece).



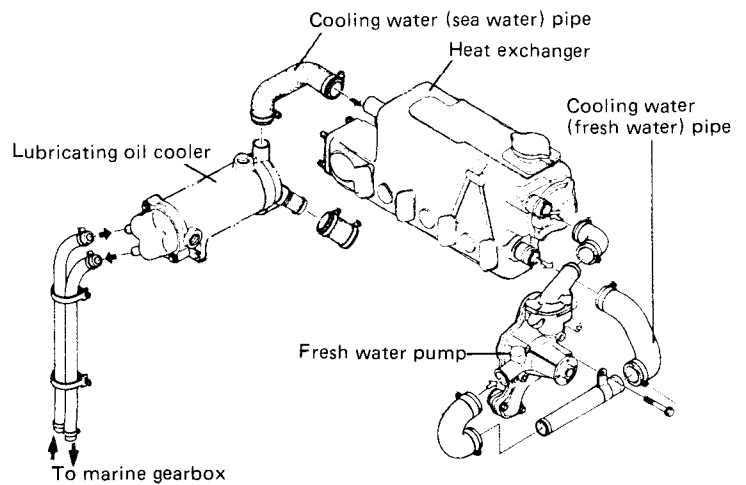
3-1.10 Removing the cooling water pipe

- (1) Remove the cooling water (sea water) pipe (lube oil cooler — heat exchanger).
- (2) Remove the cooling water (fresh water) pipe (heat exchanger — fresh water pump, fresh water pump — fresh water tank).
- (3) Remove the cooling water pipe (lube oil cooler — marine gearbox)

[Model: 4JHE, 4JH-TE]

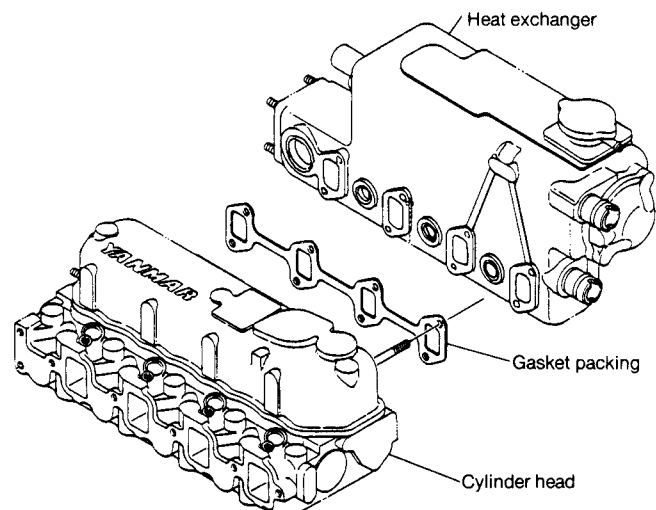


[Model: 4JH-HTE, 4JH-DTE]

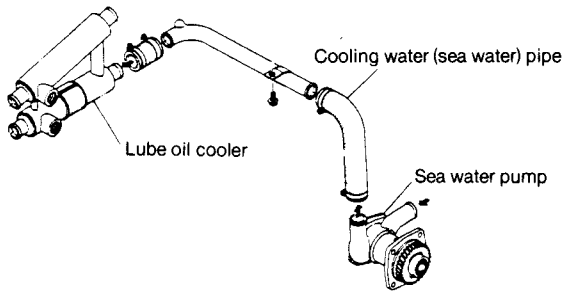


3-1.11 Removing the heat exchanger (exhaust manifold, fresh water tank unit)

Remove the heat exchanger and gasket packing.

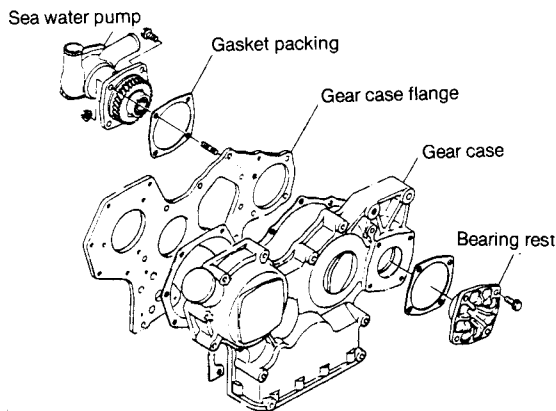


3-1.12 Removing the cooling water (sea water) pipe (sea water pump—lube oil cooler).



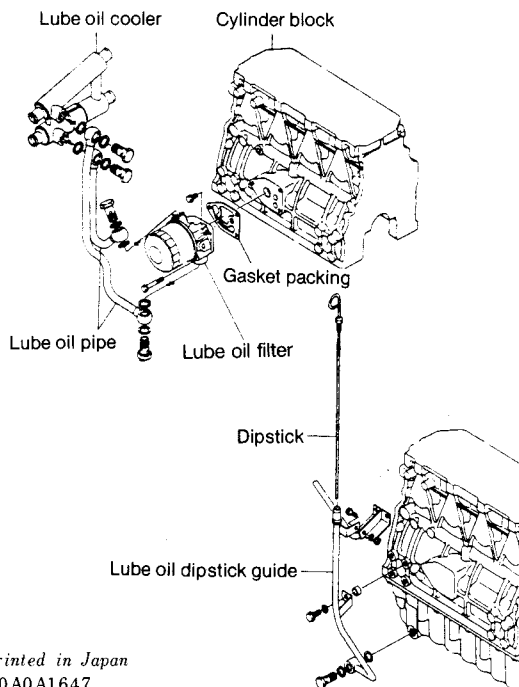
3-1.13 Removing the sea water pump

- (1) Pull out the bearing mounts, receptacles from the sea water pump mounting side and from the opposite side of the gear case.
- (2) Remove the sea water pump.



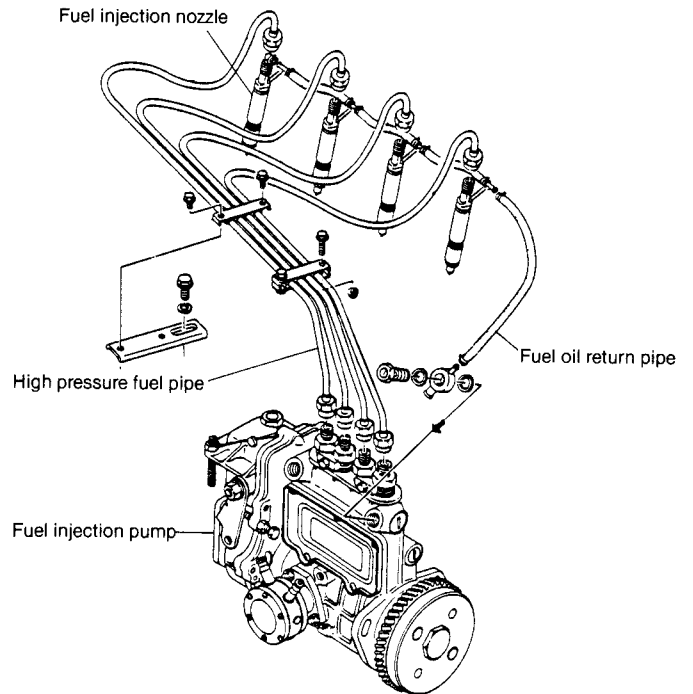
3-1.14 Removing the lube oil filter

- (1) Remove the lube oil pipe (lube oil cooler—filter bracket—lube oil cooler).
- (2) Remove the filter bracket (with lube oil filter element) from the cylinder block.
- (3) Remove the lube oil pipe (cylinder block—fuel injection pump).
- (4) Remove the lube oil dipstick and guide.



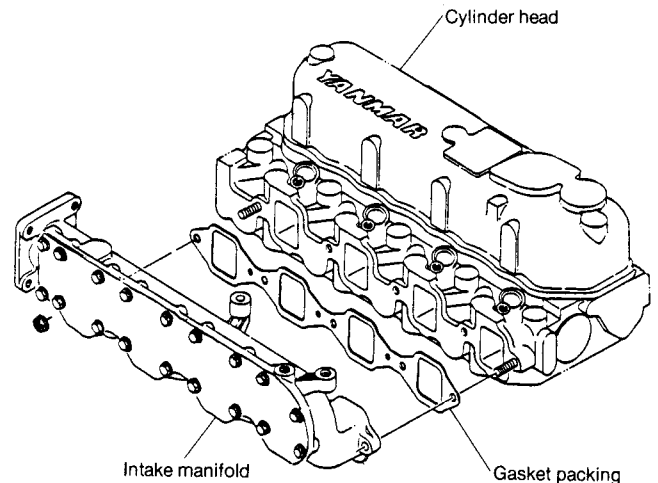
3-1.15 Removing the high pressure fuel pipe

- (1) Remove the high pressure fuel pipe vibration stop from the intake manifold.
- (2) Loosen the box nuts on both ends of the high pressure fuel pipe and remove the high pressure fuel pipe.
- (3) Remove the fuel oil return pipe (fuel injection nozzle—fuel injection pump).



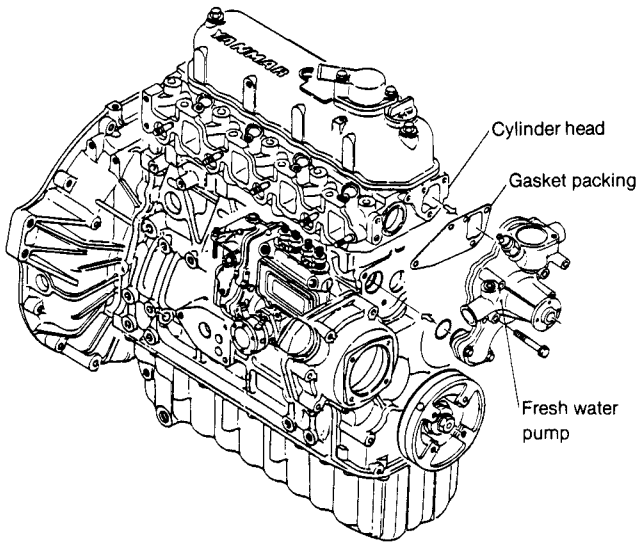
3-1.16 Removing the intake manifold

- (1) Remove the governor speed remote control bracket.
- (2) Remove the intake manifold and gasket packing.



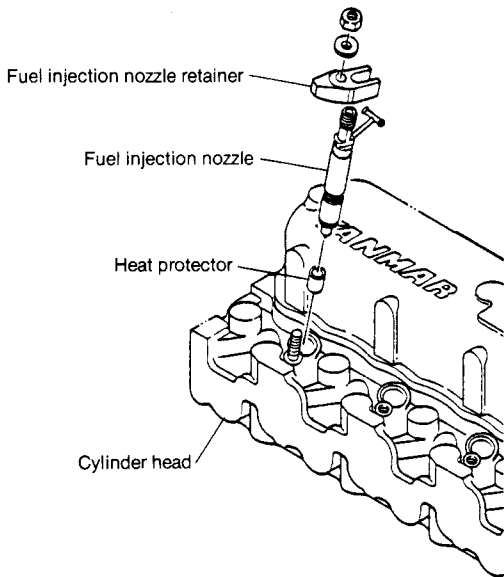
3-1.17 Removing the fresh water pump

Remove the fresh water pump, gasket packing and O-ring.



3-1.18 Removing the fuel injection nozzles

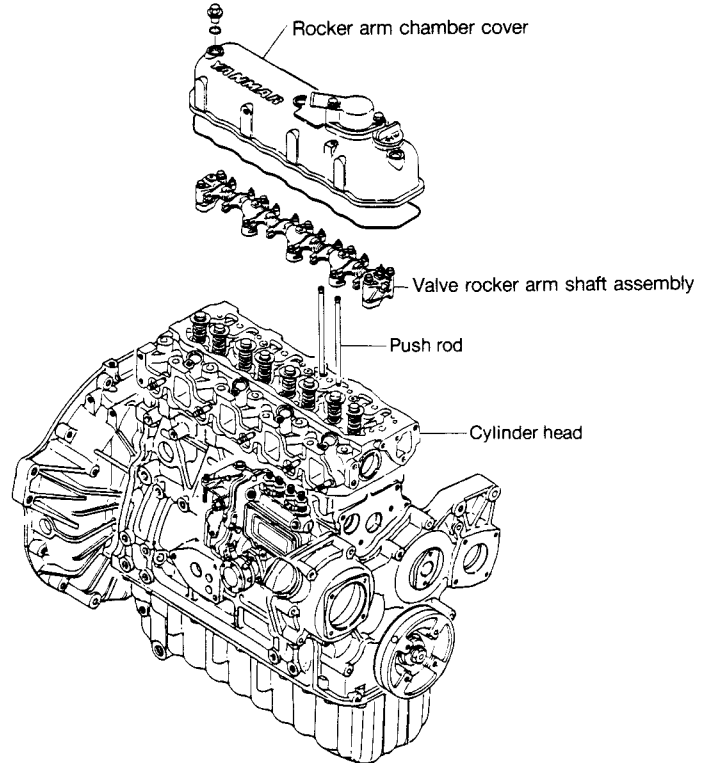
Remove the fuel injection nozzle retainer nut, and pull out the fuel injection nozzle retainer and fuel injection nozzle.



NOTE: If the heat protector stays in the cylinder head, make a note of the cylinder no. and be sure to remove it when you disassemble the cylinder head.

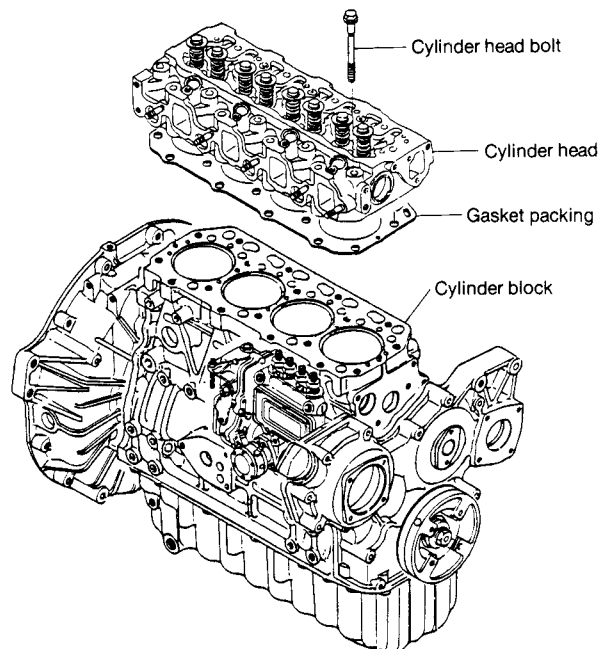
3-1.19 Removing the valve elbow shaft assembly

- (1) Remove the valve elbow chamber cover.
- (2) Remove the valve elbow shaft support mounting bolts(s), and remove the entire valve elbow shaft assembly.
- (3) Pull out the push rods.



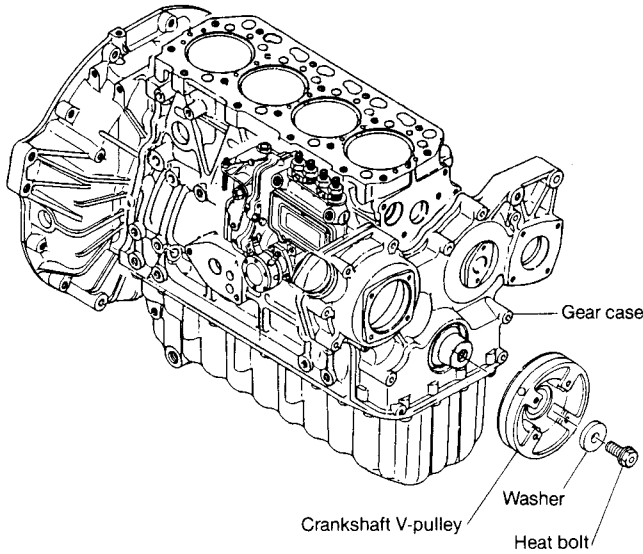
3-1.20 Removing the cylinder head

- (1) Remove the cylinder head bolts with a torque wrench, and remove the cylinder head.
- (2) Remove the cylinder gasket packing.



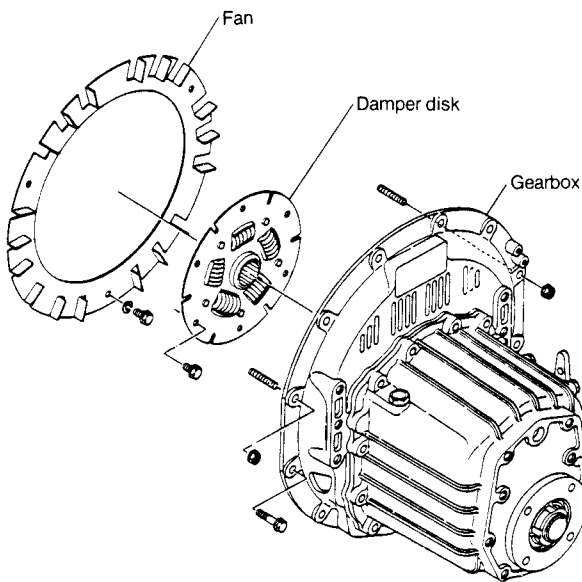
3-1.21 Removing the crankshaft V-pulley

Remove the hex bolts holding the crankshaft V-pulley, and remove the crankshaft V-pulley with an extraction tool.



3-1.22 Removing the marine gearbox

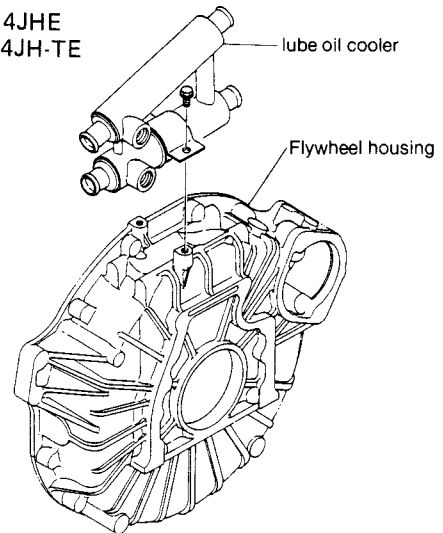
- (1) Remove the hex bolts from the clutch case flange, and remove the gearbox assembly.
- (2) Remove the damper disk from the flywheel.
- (3) Remove the fan from the flywheel.



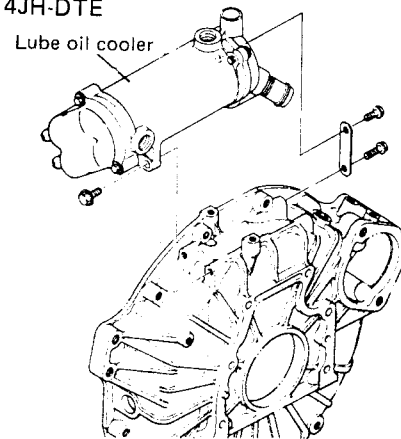
3-1.23 Removing the lube oil cooler

Remove the lube oil cooler from the upper part of the flywheel housing.

MODEL: 4JHE
4JH-TE

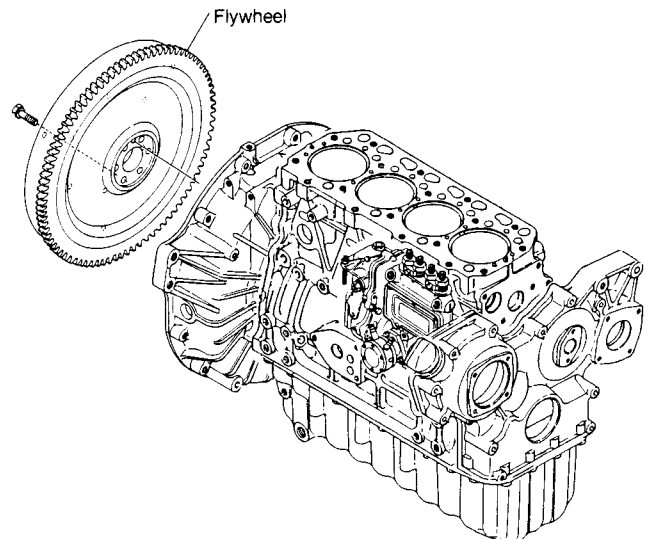


MODEL: 4JH-HTE
4JH-DTE



3-1.24 Removing the flywheel

Remove the flywheel mounting bolts and then the flywheel.



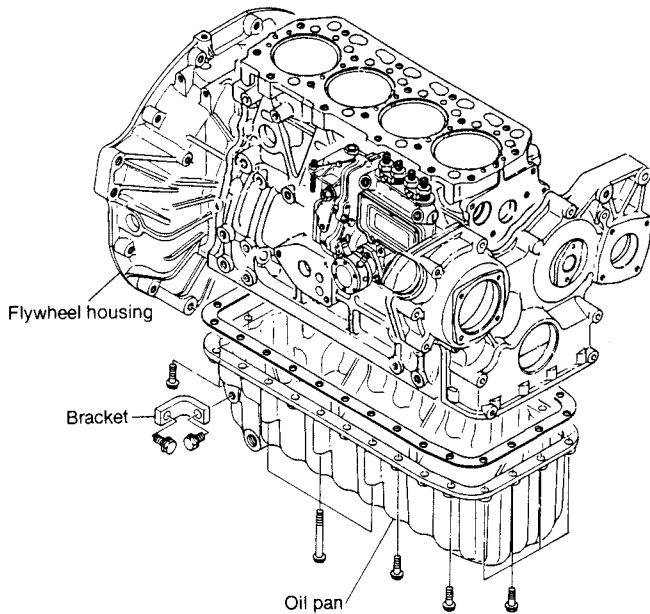
NOTE: Be careful not to scratch the ring gear.

3-1.25 Turning the engine over

- (1) Place a wood block of appropriate size on the floor, and stand up the engine on the flywheel housing.
- (2) Remove the engine mounting feet.

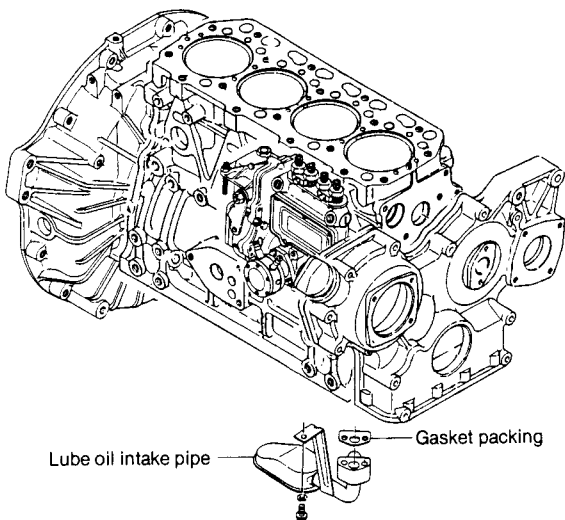
3-1.26 Removing the oil pan

- (1) Remove the bracket holding the oil pan and clutch housing.
- (2) Remove the oil pan and gasket packing.



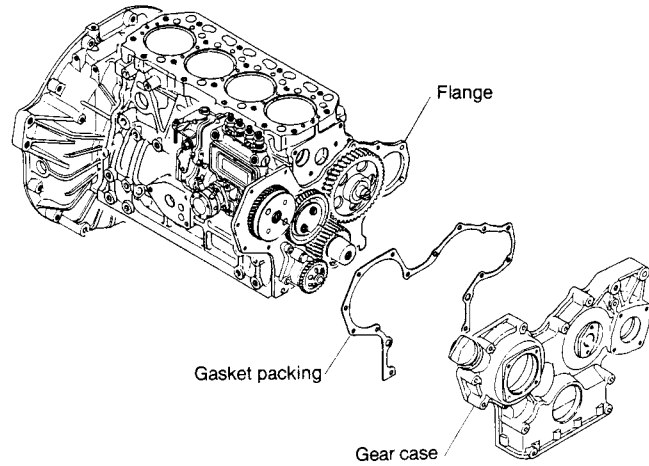
3-1.27 Removing the lube oil intake pipe

Remove the lube oil intake pipe and gasket packing.



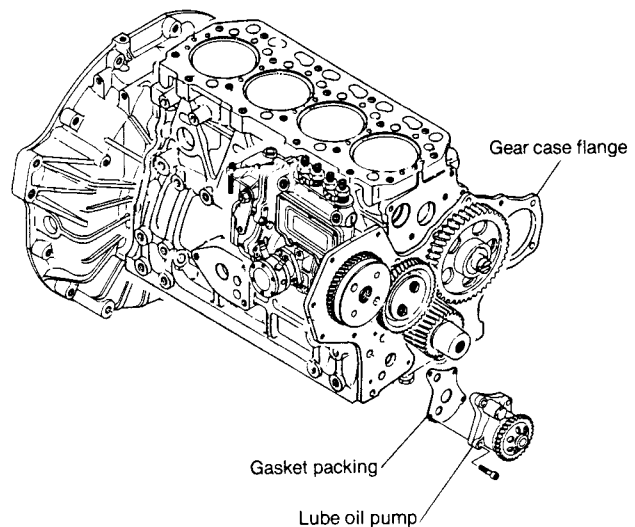
3-1.28 Removing the gear case

Remove the gear case mounting bolts, and remove the gear case from the cylinder block.



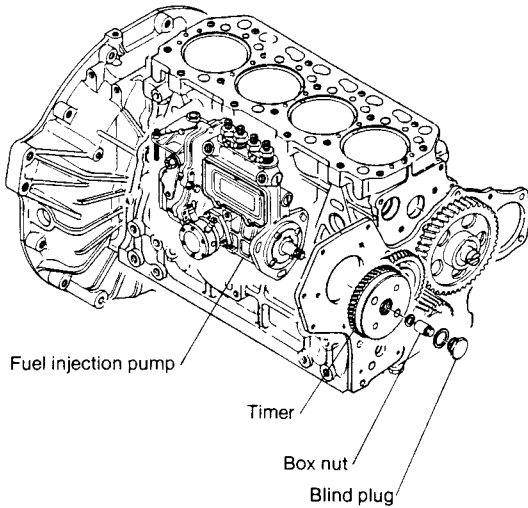
3-1.29 Removing the lube oil pump

Remove the lube oil pump and gasket packing from the gear case flange.



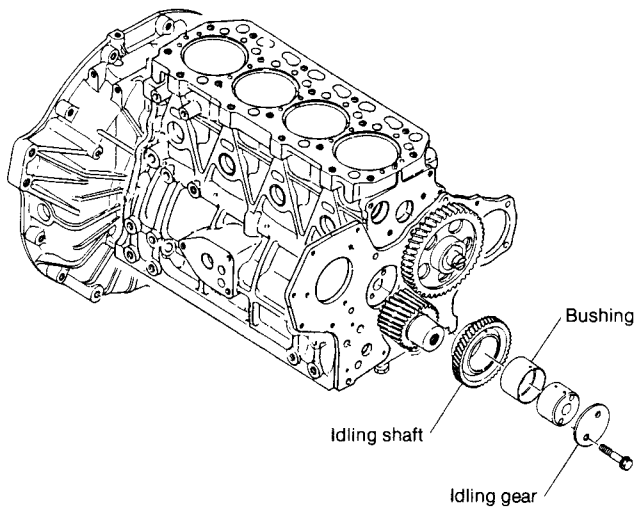
3-1.30 Remove the fuel injection pump

- (1) Remove the blind plug mounted to the hub of the automatic advancing timer.
- (2) Remove the box nut, and pull out the fuel oil pump drive gear/automatic advancing timer assembly with an extraction tool.
- (3) Remove the fuel injection pump and O-ring from the gear case flange.



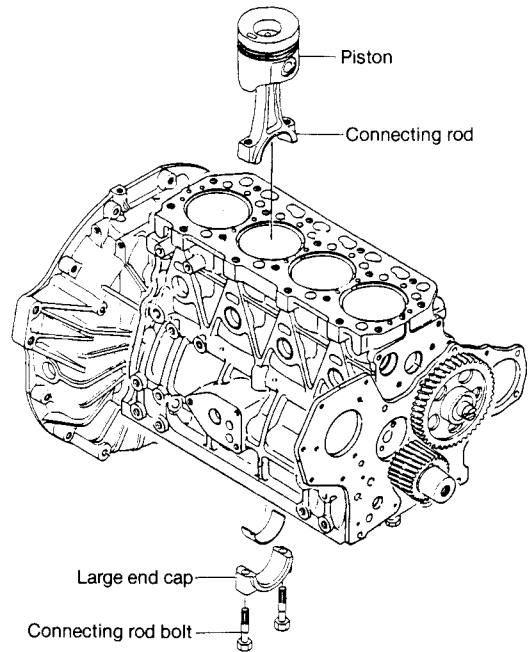
3-1.31 Removing the idling gear

Remove the two hex bolts holding the idling shaft, and pull out the idling gear and idling shaft.



3-1.32 Removing the pistons and connecting rods

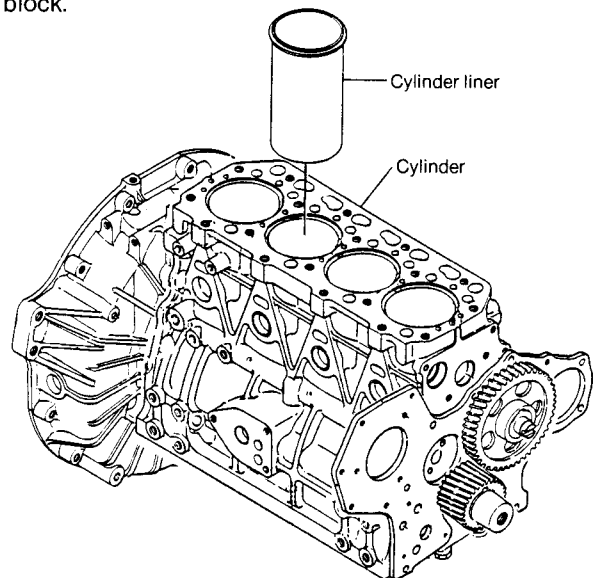
- (1) Remove the connecting rod bolt and the large end cap.
- (2) Push the connecting rod from the bottom and pull out the piston connecting rod assembly.



NOTE: Place a tool against the piston cooling nozzle to make sure the nozzle position does not change and it doesn't get scratches.

3-1.33 Removing the cylinder liner

Remove the cylinder liner from the top of the cylinder block.



NOTE: If it is difficult to pull out the liner, tap the bottom of the liner with a plastic hammer.

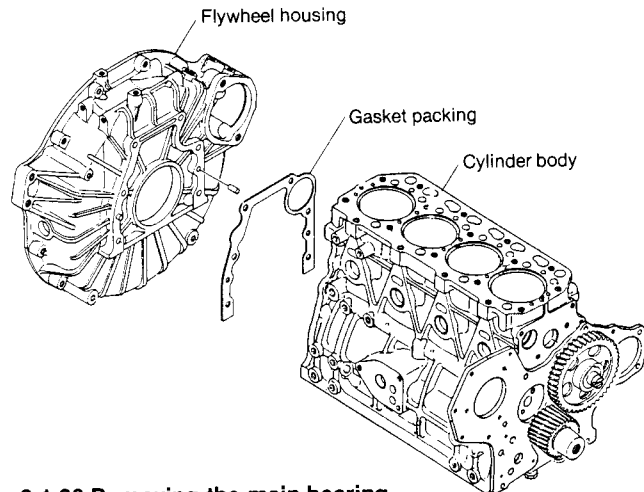
3-1.34 Turning the engine over

Place a wood block of suitable size on the floor and turn the engine over, with the cylinder head mounting surface facing down.

NOTE: Make sure that the cylinder head positioning pins on the cylinder block do not come in contact with the wood block.

3-1.35 Removing the flywheel housing

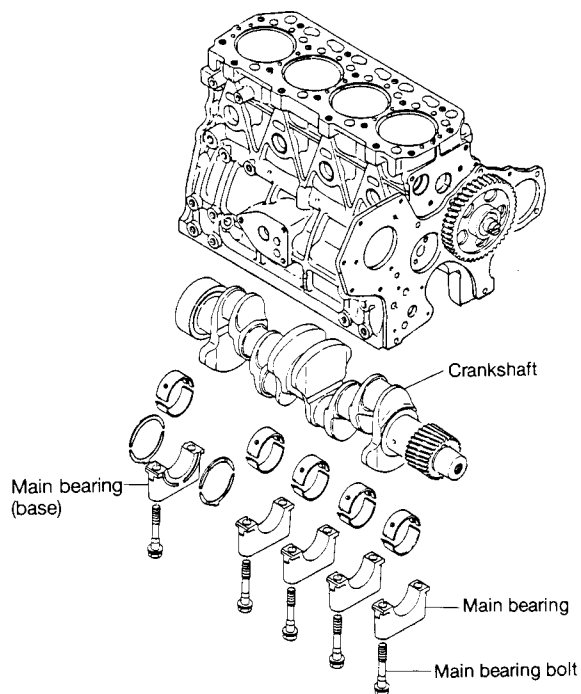
Remove the flywheel housing from the cylinder block.



3-1.36 Removing the main bearing

- (1) Remove the main bearing bolts.
- (2) Remove the main bearing cap and lower main bearing metal.

NOTE: The thrust metal (lower) is mounted to the standard main bearing cap. Be sure to differentiate between mounting surfaces.



3-1.37 Removing the crankshaft

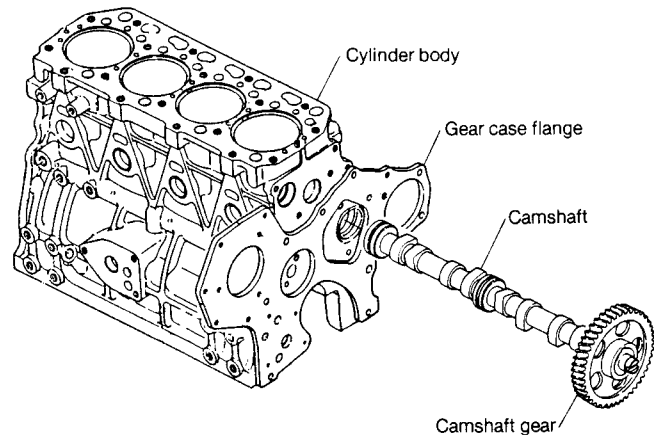
- (1) Remove the crankshaft

NOTE: 1. The thrust metal (upper) is mounted to the standard main bearing. However, in some cases the thrust metal (upper) may be mounted to the crankshaft.
2. Remove the main bearing metal (upper) from the cylinder block.

3-1.38 Removing the camshaft

- (1) Loosen the thrust rest mounting bolts out of the holes in the camshaft gear, and remove.
- (2) Pull out the camshaft gear and camshaft assembly from the cylinder block.

NOTE: The camshaft gear and camshaft are shrunk fit. They must be heated to 180—200°C to disassemble.

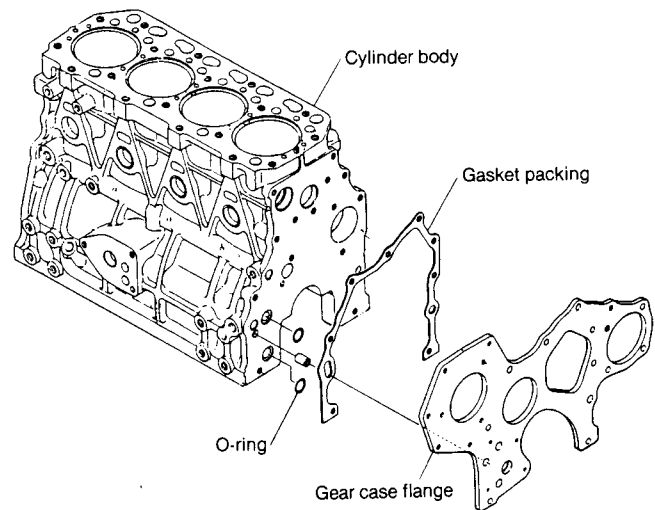


3-1.39 Removing the tappets

Remove the tappets from the tappet holes in the cylinder block.

3-1.40 Removing the gear case flange

- (1) Remove the gear case flange from the cylinder block.
- (2) Remove the two O-rings from the lube oil passage.



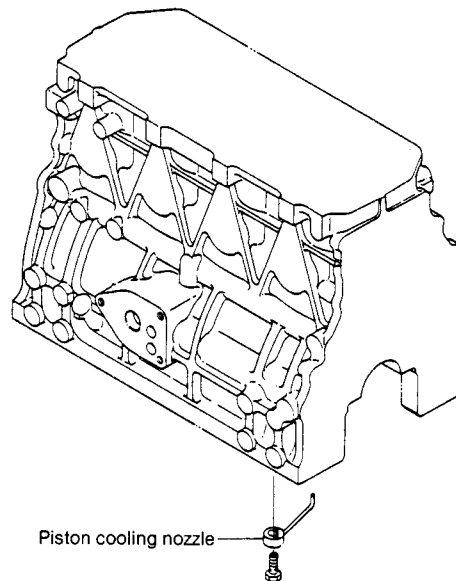
3-1.41 Removing the piston cooling nozzle

Remove the piston cooling nozzle mounting nut and then the piston cooling nozzle from the cylinder block.

3-2 Reassembly

3-2.1 Mounting the piston cooling nozzle

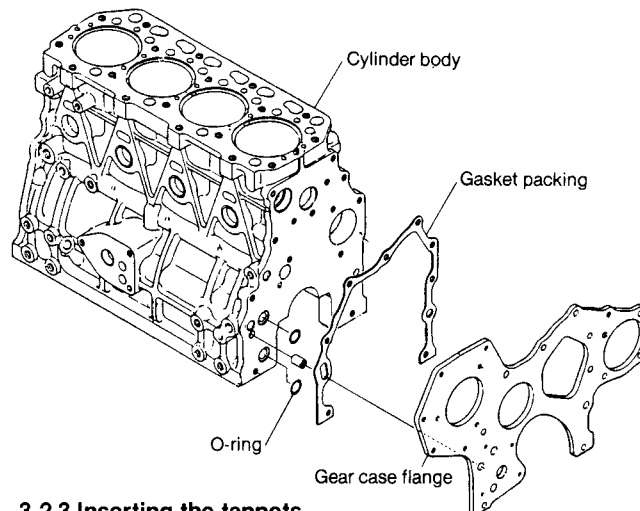
Turn the cylinder block upside down and place it on appropriate wood blocks. Mount the piston cooling nozzles.



3-2.2 Mounting the gear case flange

Mount the gear case flange, gasket packing and lube oil line O-ring onto the cylinder block.

NOTE: 1. When mounting the gear case flange, match up the two cylinder block pipe knock pins.
2. Be sure to coat the cylinder block lube oil line O-ring with grease when assembling, so that it does not get out of place.



3-2.3 Inserting the tappets

Coat the inside of the cylinder block tappet holes and the outside circumference of the tappets with engine oil, and insert the tappets in the cylinder block.

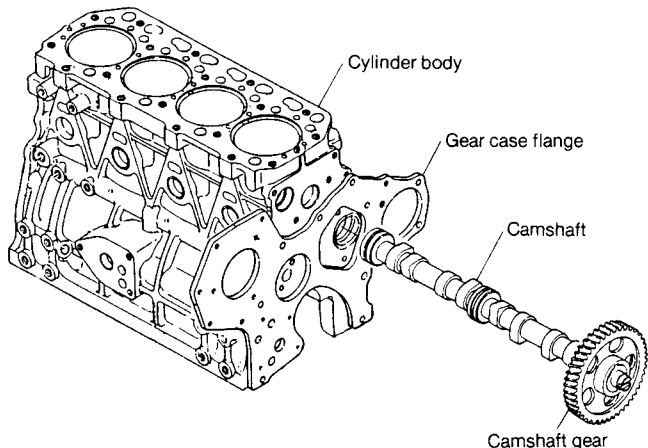
NOTE: Separate the tappets to make sure that they are reassembled in the same cylinder, intake/exhaust manifold as they came from.

3-2.4 Mounting the camshaft

- (1) If the camshaft and camshaft gear have been disassembled, shrink fit the camshaft and camshaft gear [heat the camshaft gear to 180—200°C (356—392°F) in the hot oil and press fit].

NOTE: When mounting the camshaft and camshaft gear, be sure not to forget assembly of the thrust rest. Also make sure they are assembled with the correct orientation.

- (2) Coat the cylinder block camshaft bearings and camshaft with engine oil, insert the camshaft in the cylinder block, and mount the thrust rest with the bolt.



- (3) Measure the camshaft side gap.

	mm (in.)
Camshaft side gap	0.05 ~ 0.25 (0.0020 ~ 0.0098in.)

- (4) Make sure that the camshaft rotates smoothly.

3-2.5 Mounting the crankshaft

- (1) The crankshaft and crankshaft gear are shrink fitted. If the crankshaft and crankshaft gear have been disassembled, they have to be shrink fitted [heat the crank shaft gear to 180°—200°C (356—392°F) in the hot oil and press fit].

- (2) Coat the cylinder block crank journal holes and upper part of the main bearing metal with oil and fit the upper main bearing metal onto the cylinder block.

NOTE: 1. Be sure not to confuse the upper and lower main bearing metals. The upper metal has an oil groove.

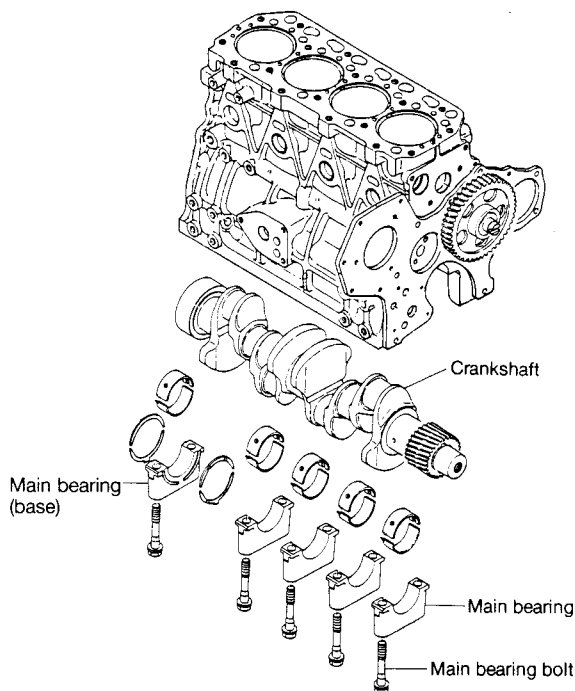
2. When mounting the thrust metal, fit it so that the surface with the oil groove slit faces outwards, (crankshaft side).

- (3) Coat the crank pin and crank journal with engine oil and place them on top of the main bearing metal.

NOTE: 1. Align the crankshaft gear and camshaft gear with the "A" match mark.

2. Position so that the crankshaft gear is on the gear case side.

3. Be careful not to let the thrust metal drop.



3-2.6 Mounting the main bearing metal with engine oil, and mounting the main bearing cap.

NOTE: 1. The lower main bearing metal does not have an oil groove.

2. The standard bearing thrust metal is fitted with the oil groove slit facing outwards.

- (2) Coat the main bearing cap bolt washer contact surface and threads with engine oil, place them on the crankshaft journal, and tighten the main bearing bolts to the specified torque.

	kg-m (ft-lb)
Main bearing bolt tightening torque	9.5 ~ 10.5 (68.7 ~ 75.9)

NOTE: 1. The main bearing cap should be fitted with the arrow near the embossed letters "FW" on the cap pointing towards the flywheel.

2. Make sure you have the correct cylinder alignment no.

- (3) Measure the crankshaft side clearance.

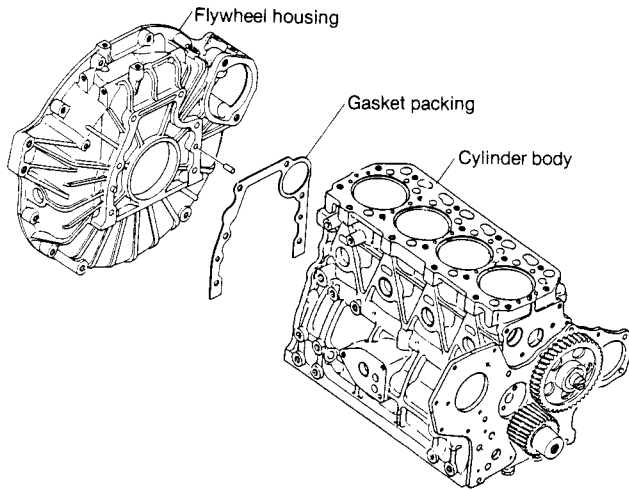
	mm (in.)
Crankshaft side clearance	0.090 ~ 0.271 (0.0035 ~ 0.0107)

- (4) Make sure that the crankshaft rotates smoothly and easily.

3-2.7 Mounting the flywheel housing

- (1) Press fit the oil seal in the flywheel housing, and coat the lip of the oil seal with engine oil.
- (2) Mount the flywheel housing and gasket packing, matching them up with the cylinder block positioning pins.

NOTE: Trim the gasket packing if it protrudes onto the oil pan mounting surface.

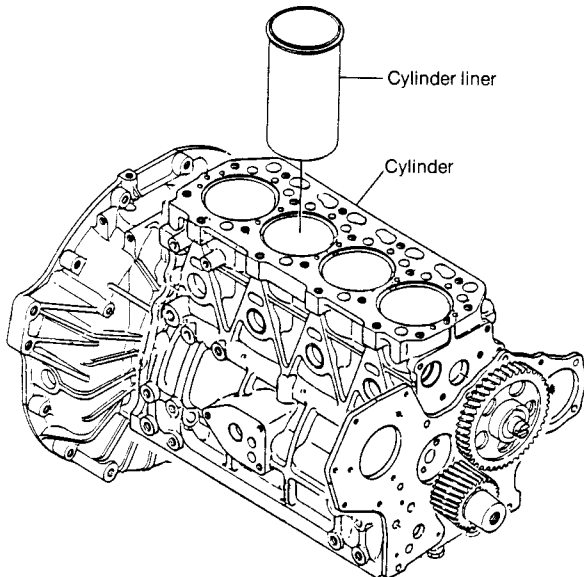


3-2.8 Stand up the cylinder block

On wood blocks, with the flywheel housing facing down. Take care that the gearbox mounting surface does not get scratched.

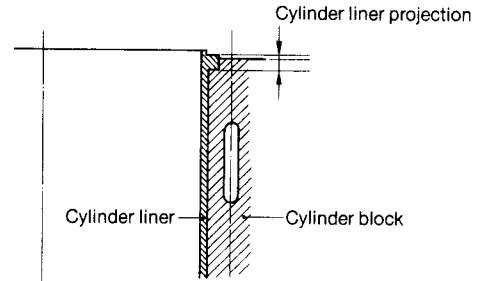
3-2.9 Inserting the cylinder liners

- (1) Thoroughly clean the cylinder block mounting holes and contact surfaces.
- (2) After thoroughly cleaning the outside of the cylinder liner, carefully insert it in to the cylinder block by hand (do not force).



- NOTE:** 1. Make sure that each liner is put back into its original cylinder.
 2. Do not turn over the engine (with the cylinder head mounting surface facing down) after the liners have been inserted.

(3) Measuring cylinder liner projection



mm (in.)	
Cylinder liner projection	0.03 ~ 0.09 (0.0012 ~ 0.0035)

(4) Measuring cylinder liner inner dia.

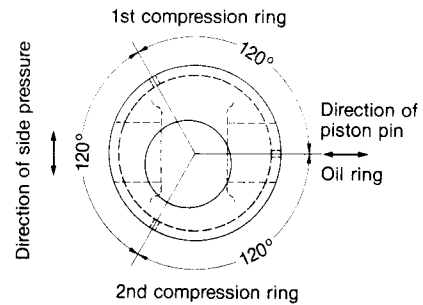
Cylinder liner distortion after insertion	0.03mm or less (0.0012in. or less)
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3-2.10 Mounting the piston and connecting rod

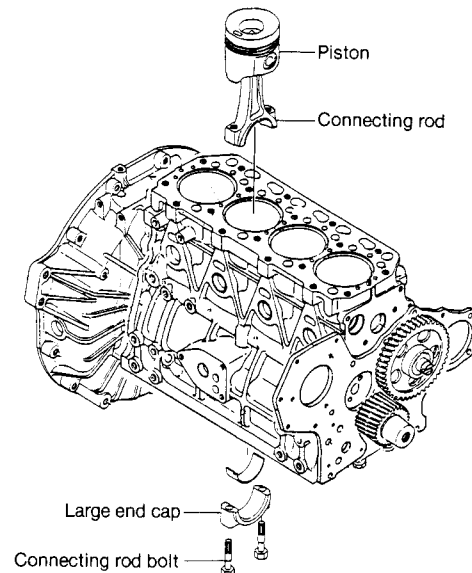
- (1) Reassemble the piston and connecting rod.

NOTE: When reassembling the piston and connecting rod, make sure that the parts are assembled with the correct orientation.

- (2) Each ring opening (piston/oil rings) should be staggered at gaps of 120°.



- (3) Coat the outside of the piston and the inside of the connecting rod crank pin metal with engine oil and insert the piston with the piston insertion tool.



- NOTE:** 1. Insert the piston so that the match mark on the large end of the connecting rod faces the fuel feed pump, and the manufacturer's mark on the stem points toward the flywheel.
 2. After inserting the piston, make sure the combustion chamber hollow is facing the fuel feed pump, looking from the top of the piston.

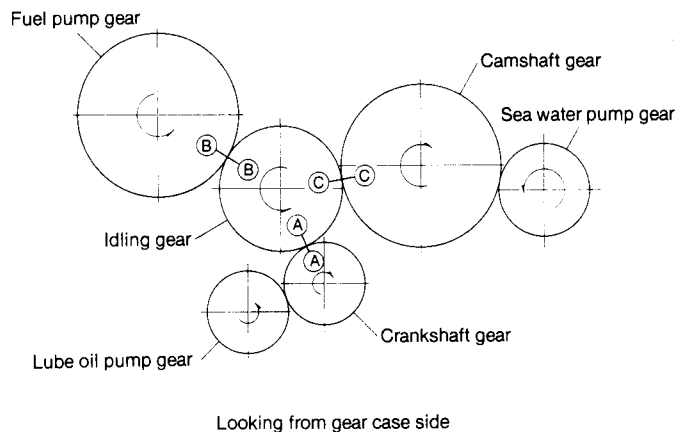
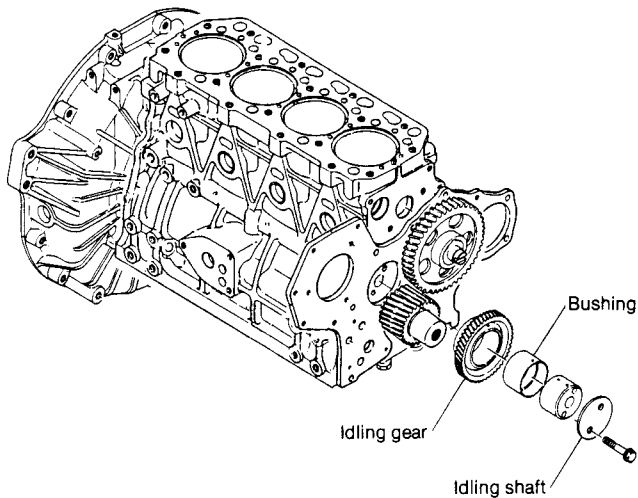
- (4) Align the large end match mark, mount the cap, and tighten the connecting rod bolts.

	kg-m (ft-lb)
Connecting rod bolt tightening torque	4.5 ~ 5.0 (32.5 ~ 36.2)

NOTE: If a torque wrench is not available, match up with the mark made before disassembly.

3-2.11 Mounting the idling gear

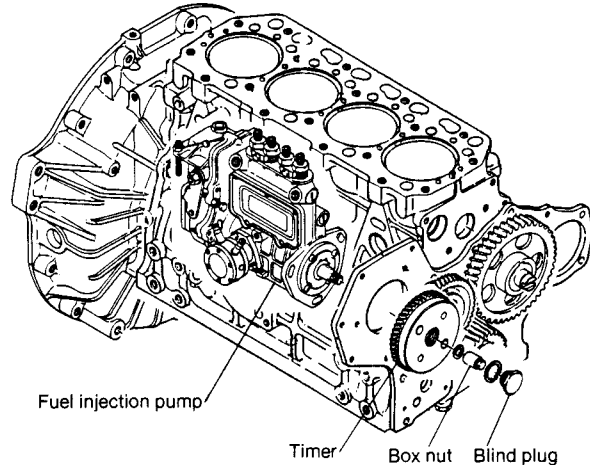
- Fit the idling gear so that the side of the idling shaft with two oil holes faces up.
- Align the "A" and "C" camshaft gear and crankshaft gear match marks, match up with idling shaft retaining plate, and tighten the bolts.
- Measure the idling gear, camshaft gear and crankshaft gear backlash.



3-2.12 Mounting the fuel injection pump

Lightly fit the fuel injection pump on the gear case.

- NOTE:** 1. Be careful not to scratch the O-ring between the fuel injection pump and gear case flange.
 2. Tighten the fuel injection pump all the way after adjusting injection timing.



3-2.13 Mounting the fuel feed pump drive gear and automatic advancing timer.

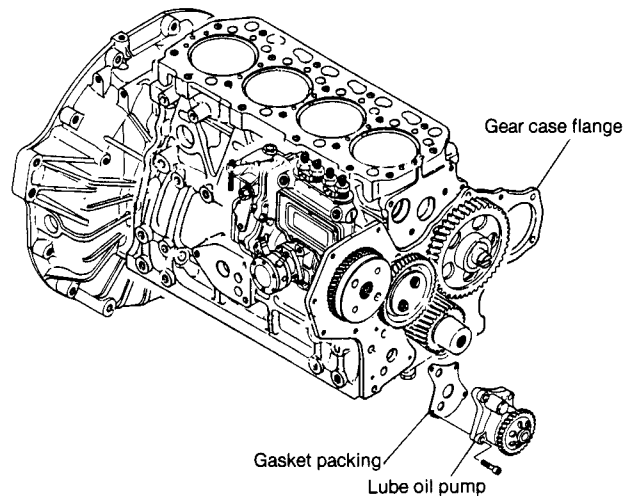
- When the drive gear and automatic advancing timer have been disassembled, coat all sliding parts in both assemblies with grease.
- Align the "B" match marks on the fuel pump drive gear and idling gear.
- Tighten all box nuts holding the fuel feed pump to the specified torque.

	kg-m (ft-lb)
Box nut tightening torque	6 ~ 7 (43.4 ~ 50.6)

- Grease parts around the box nuts (lithium grease) and tighten the blind plug.
- Measure the backlash of the fuel feed pump drive gear.

3-2.14 Mounting the lube oil pump

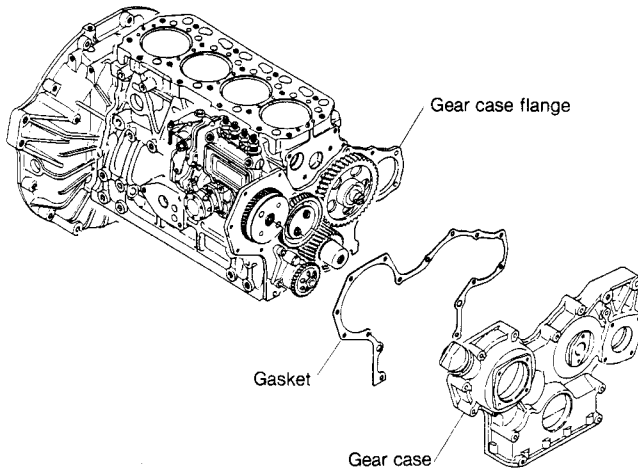
- Mount the lube oil pump on the gear case flange.
- Measure the backlash of the lube oil pump drive gear.



3-2.15 Mounting the gear case

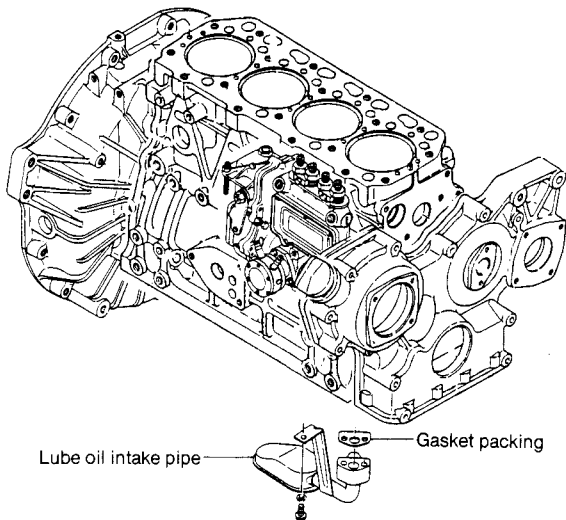
- (1) Coat the inside and outside of the oil seals with engine oil, and press fit them into the gear case.
- (2) Position the two pipe knock pins, and tighten the bolts holding the gear case and gasket packing.

NOTE: Trim the gasket packing if it protrudes onto the oil pan mounting surface.



3-2.16 Mounting the lube oil intake pipe

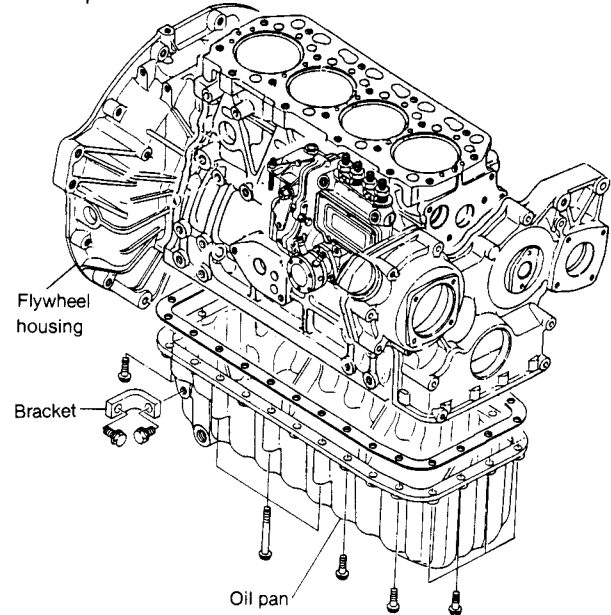
Mount the lube oil intake pipe on the bottom of the cylinder block, using new packing.



	kg-m (ft-lb)
lube oil intake pipe tightening torque	2.6 (18.8)

3-2.17 Mounting the oil pan

- (1) Coat with three bond (3B-1114) the surfaces of the gear case, gear case flange and flywheel that contact with the cylinder block.
- (2) Tighten the gasket packing/oil pan bolts.
- (3) Mount the bracket that connects the flywheel with the oil pan.

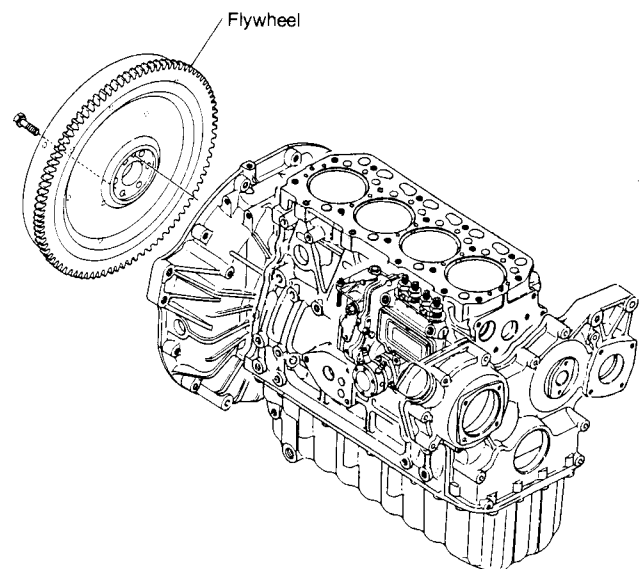


3-2.18 Mounting the engine mounting feet and turning the engine upright.

Place suitable wood blocks below the oil pan and turn the engine upright.

3-2.19 Mounting the flywheel

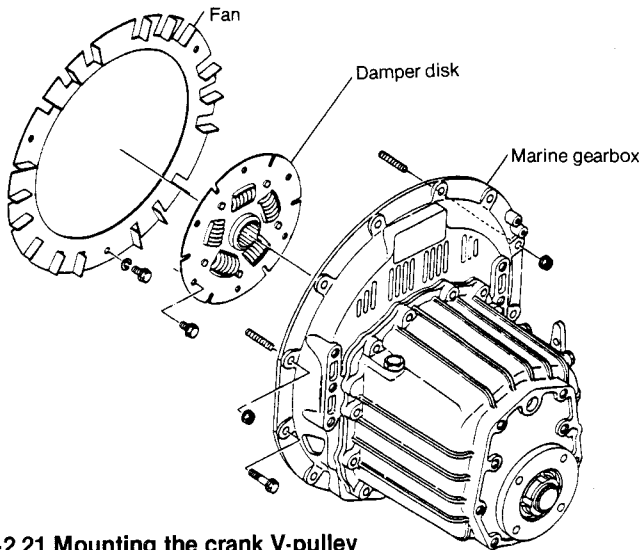
- (1) Coat the flywheel mounting bolt threads with engine oil.
- (2) Align the positioning pins, and tighten the flywheel bolts to the specified torque.



	kg-m (ft-lb)
Flywheel mounting bolt tightening torque	7.0 ~ 8.0 (50.6 ~ 57.9)

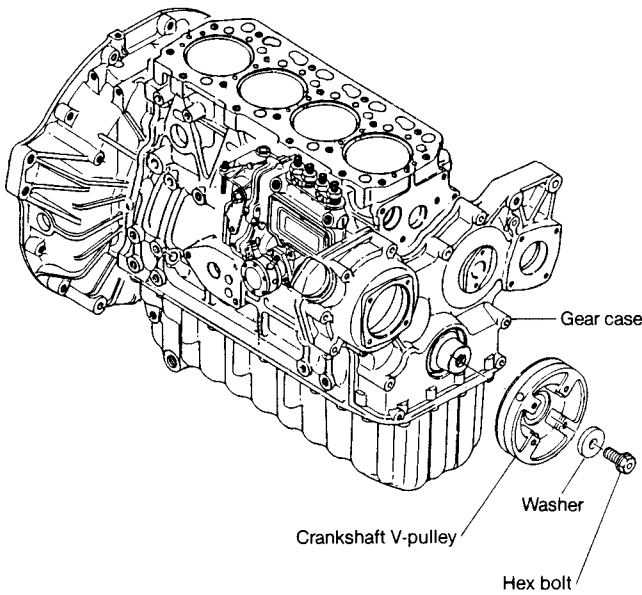
3-2.20 Mounting the marine gearbox

- (1) Mount the fan and damper disk to the flywheel.
- (2) Align the damper disk with the input shaft spline and insert. Tighten the flywheel housing and flange.



3-2.21 Mounting the crank V-pulley

- (1) Coat the oil seal and the section of the shaft with which it comes in contact with oil.
- (2) Tighten to the specified torque.



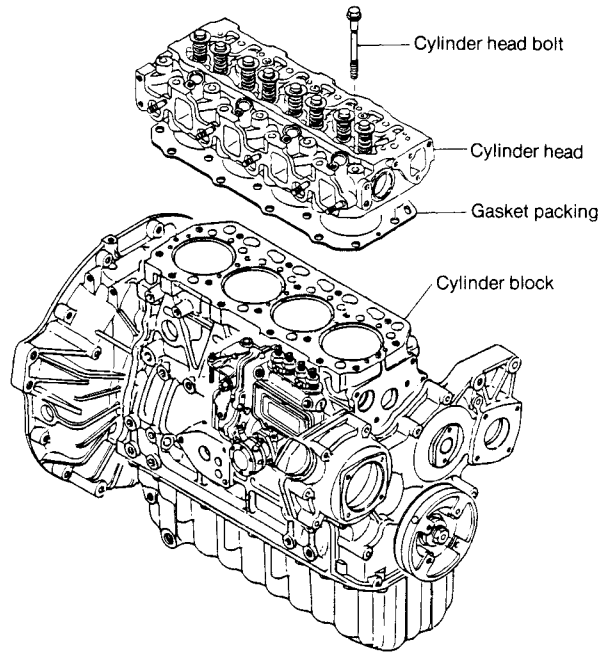
	kg-m (ft-lb)
V-pulley tightening torque	11.5 ~ 12.5 (83.2 ~ 90.4)

3-2.22 Mounting the cylinder head

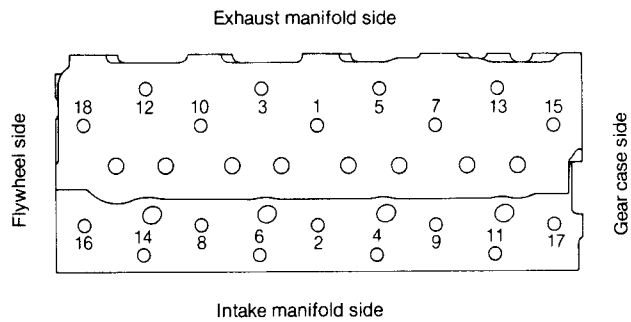
- (1) Fit the gasket packing against the cylinder block, aligning it with the cylinder block positioning pins.

NOTE: The side on which the engine model is inscribed should face up (cylinder head side).

- (2) Lift the cylinder head horizontally and mount, aligning with the cylinder head gasket.
- (3) Coat the mounting bolt washers and threads with engine oil, and lightly tighten the bolts in the specified order. Then tighten completely, in the same order.



Tightening order



	kg-m (ft-lb)	
	Partial	Complete
Cylinder bolt tightening torque	3.5 ~ 4.5 (25.3 ~ 32.5)	7.5 ~ 8.5 (54.2 ~ 61.5)

- (4) Measure the top clearance.

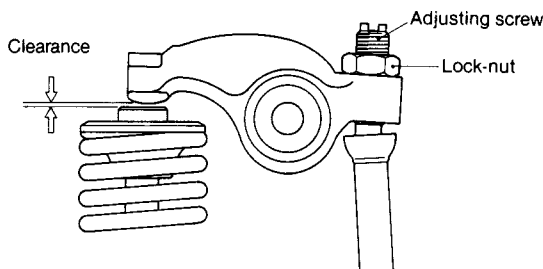
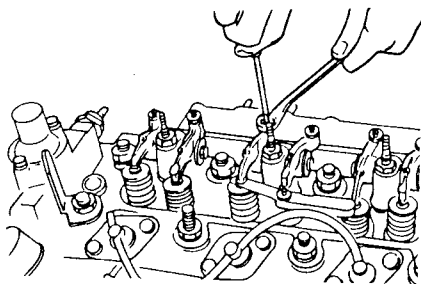
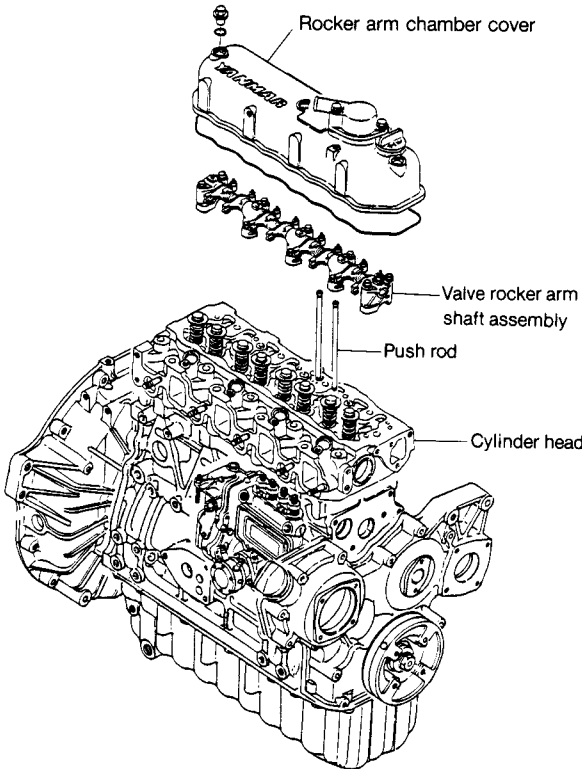
	mm (in.)
Top clearance	0.71 ~ 0.89 (0.0279 ~ 0.0350)

3-2.23 Mounting the valve rocker arm shaft assembly pushrod

- (1) Fit the pushrod to the tappet.
- (2) Mount the valve rocker arm shaft assembly.

kg-m (ft-lb)	
Valve rocker arm shaft support tightening torque	2.4 ~ 2.8 (17.4 ~ 20.4)

- (3) Adjust valve clearance.

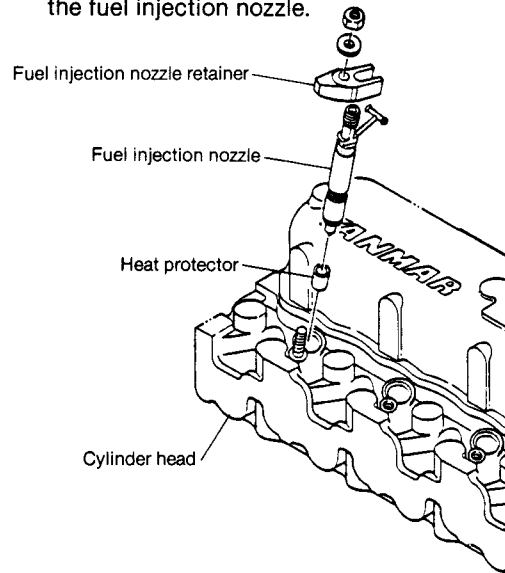


mm (in.)	
Intake/discharge valve clearance	0.2 (0.0079)

- (4) Coat the valve rocker arm and valve spring with engine oil, and mount the valve rocker arm chamber cover.

3-2.24 Mounting the fuel injection nozzle

- (1) Mount the injection nozzle tip heat protector, and then the fuel injection nozzle.

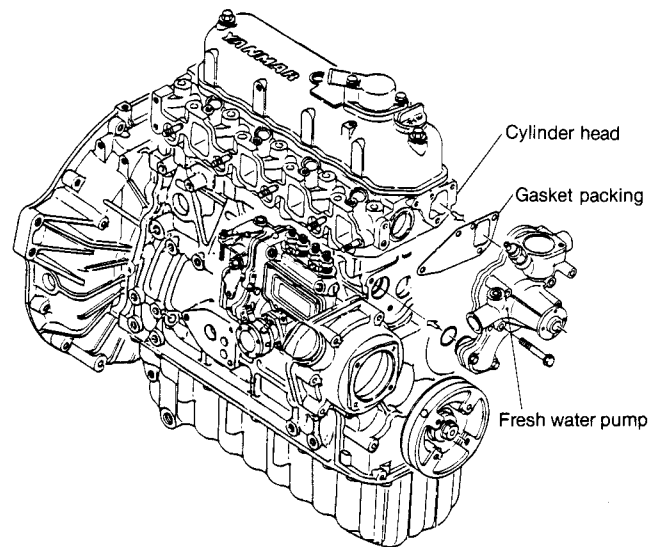


- (2) Tighten the fuel injection nozzle retainer nut to the specified torque.

kg-m (ft-lb)	
Fuel injection nozzle retainer tightening torque	2.0 ~ 3.0 (14.5 ~ 21.7)

3-2.25 Mounting the fresh water pump

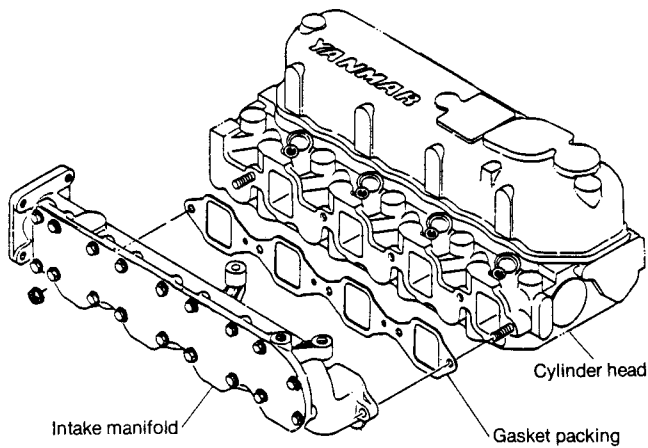
- (1) Thoroughly coat both sides of the packing with adhesive.
- (2) Replace the O-ring for the connecting pipe which is inserted in the cylinder block, and tighten the fresh water pump to the specified torque.



kg-m (ft-lb)	
Fresh water pump tightening torque	0.7 ~ 1.1 (5.0 ~ 8.0)

3-2.26 Mounting the intake manifold

- (1) Thoroughly clean the inside of the intake manifold, and mount the gasket packing and intake manifold.
- (2) Mount the governor remote control bracket.

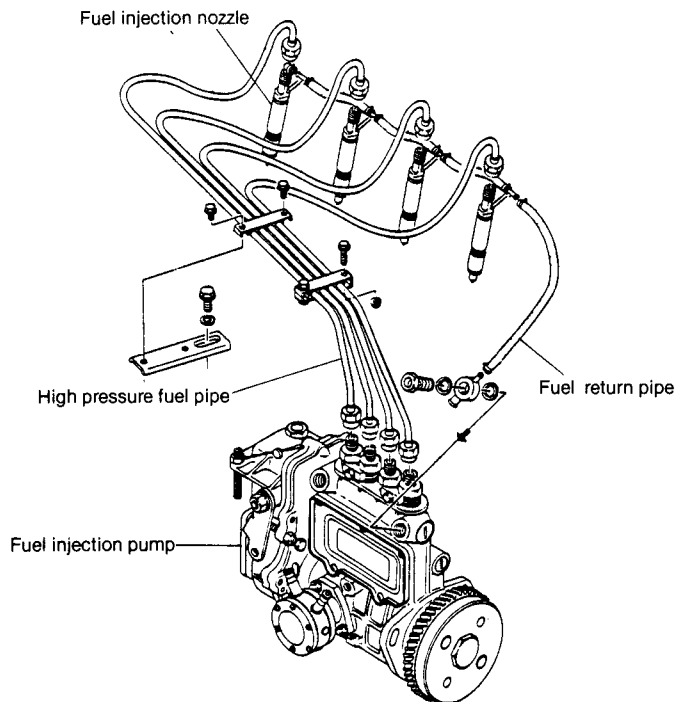


3-2.27 Mounting the high pressure fuel pipe and fuel oil return pipe

- (1) Mount the high pressure fuel pipe and then the high pressure fuel pipe vibration stop.

NOTE: Lightly tighten the box nuts on both ends of the high pressure fuel pipe. Completely tighten after adjusting the injection timing.

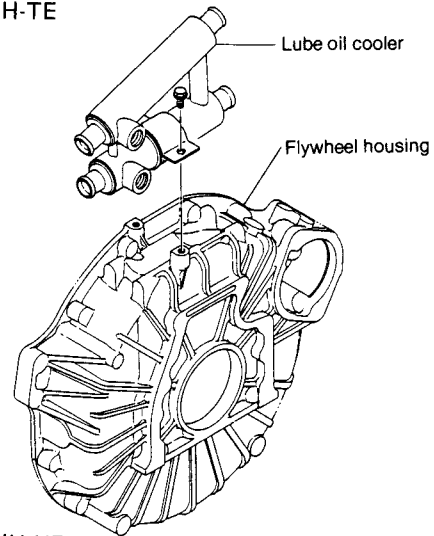
- (2) Mount the fuel oil return pipe with the hose clamp (fuel injection nozzle—fuel injection pump)



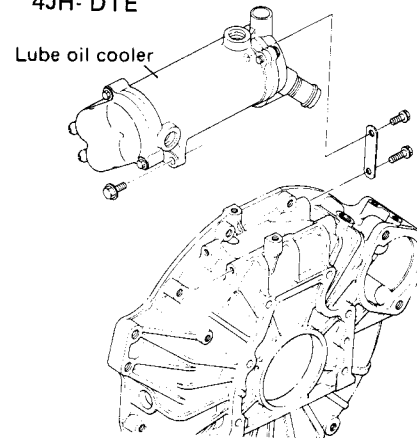
3-2.28 Mounting the lube oil cooler

Mount the lube oil cooler to the top of the flywheel housing with the bracket.

MODEL: 4JHE
4JH-TE

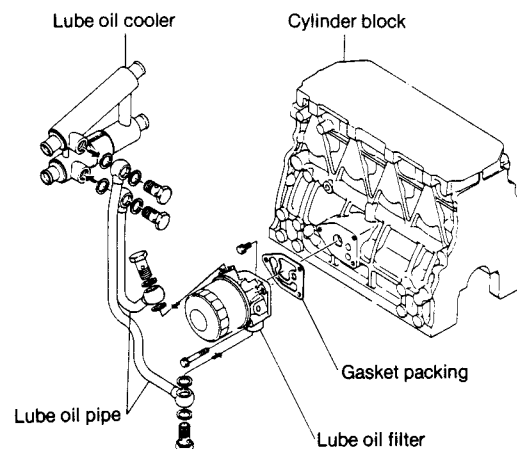


MODEL: 4JH-HTE
4JH-DTE



3-2.29 Mounting the lube oil filter

- (1) Mount the filter bracket and packing on the cylinder block.
- (2) Mount the filter element with the filter remover mounting tool.

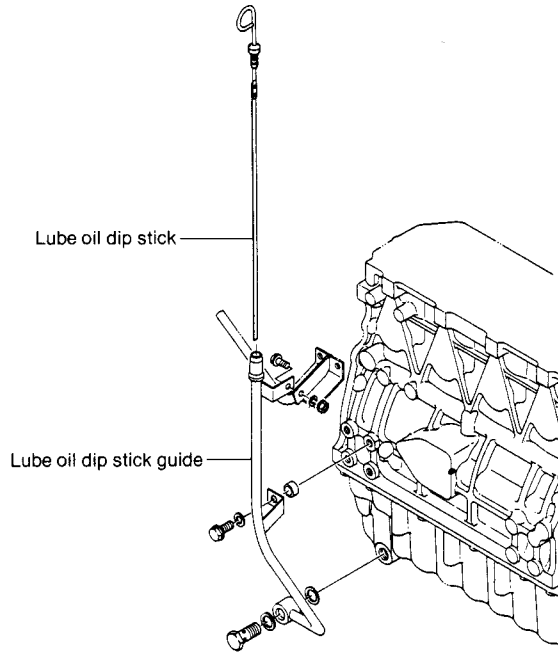


3-2.30 Mounting the lube oil pipe

- (1) Mount the lube oil pipe (filter—lube oil cooler, lube oil cooler—filter).
- (2) Mount the lube oil pipe (cylinder block—fuel injection pump).

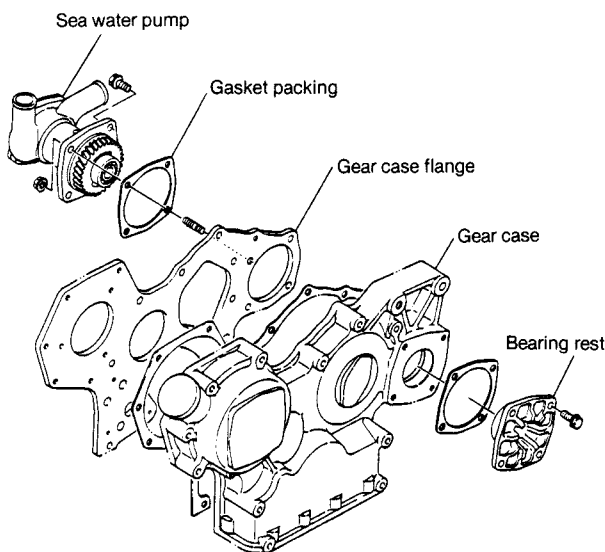
3-2.31 Mounting the dipstick guide

Mount the dipstick and dipstick guide.



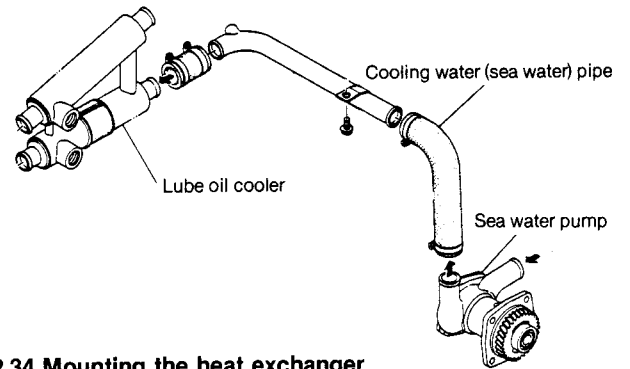
3-2.32 Mounting the sea water pump

- (1) Mount the sea water pump assembly to the gear case flange.
- (2) Lightly tap the gear case side bearing rest with a wood hammer, and tighten the mounting bolts.



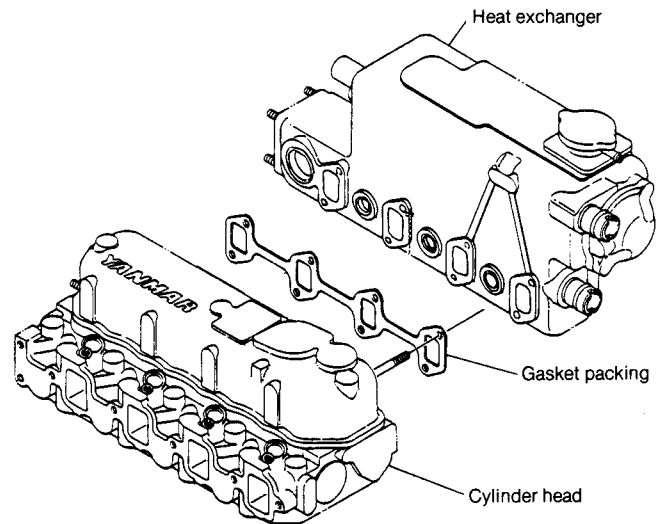
3-2.33 Mounting the cooling sea water pipe

Mount the cooling water pipe with the hose clamp (sea water pump—lube oil cooler).



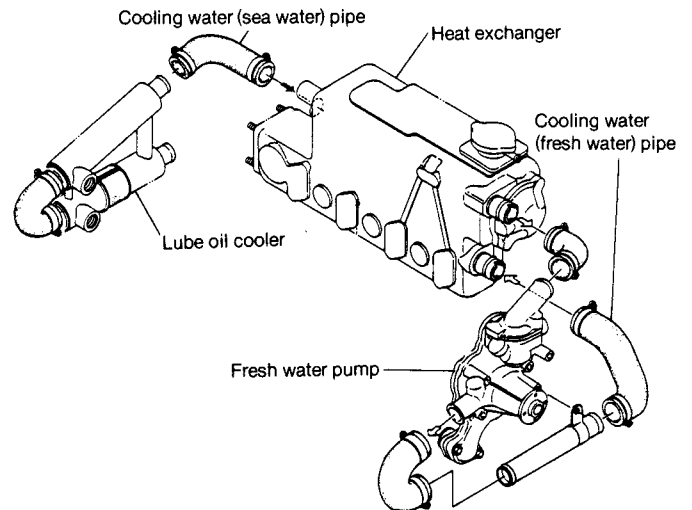
3-2.34 Mounting the heat exchanger (exhaust manifold, fresh water tank unit).

Mount the gasket packing and exhaust manifold.

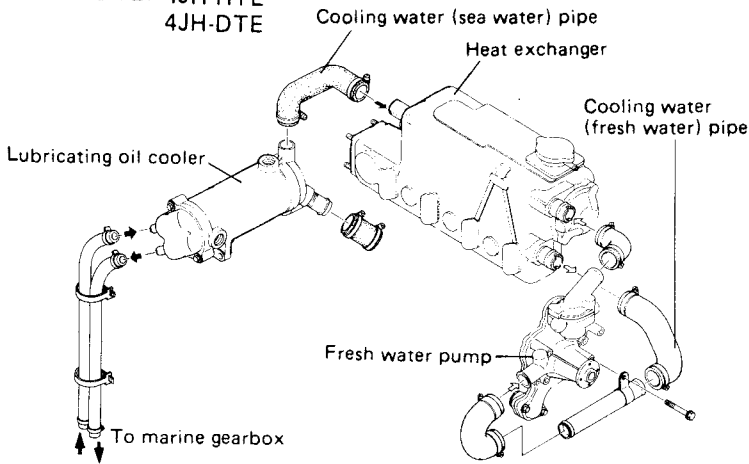


3-2.35 Mounting the cooling water pipe

- (1) Mount the cooling fresh water pipe with the hose clamp (fresh water tank — fresh water pump, fresh water pump—heat exchanger).
- (2) Mount the cooling sea water pipe with the hose clamp (lube oil cooler — heat exchanger).
- (3) Mount the cooling sea water pipe with the hose clamp (lube oil cooler — marine gearbox).

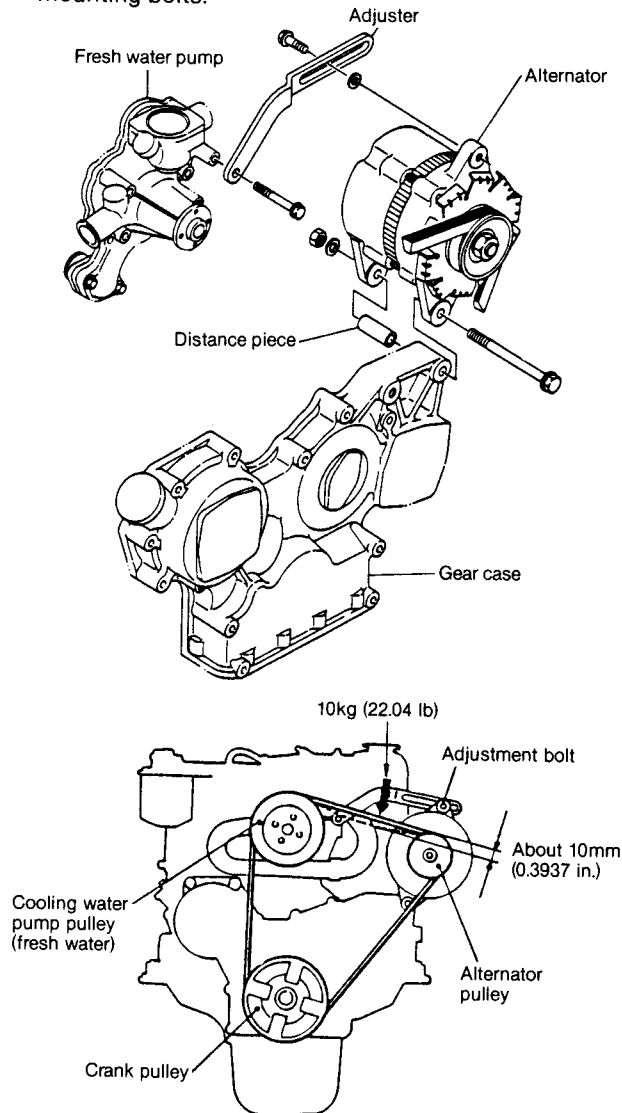


MODEL: 4JH-HTE
4JH-DTE



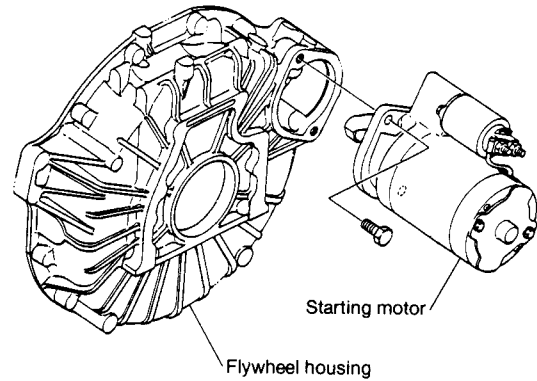
3-2.36 Mounting the alternator

- (1) Mount the adjuster on the fresh water pump, the distance piece on the gear case, and then the alternator.
- (2) Adjust V-belt tension with the adjuster, and tighten the mounting bolts.



3-2.37 Mounting the starting motor

Fit the starting motor in the flywheel housing.



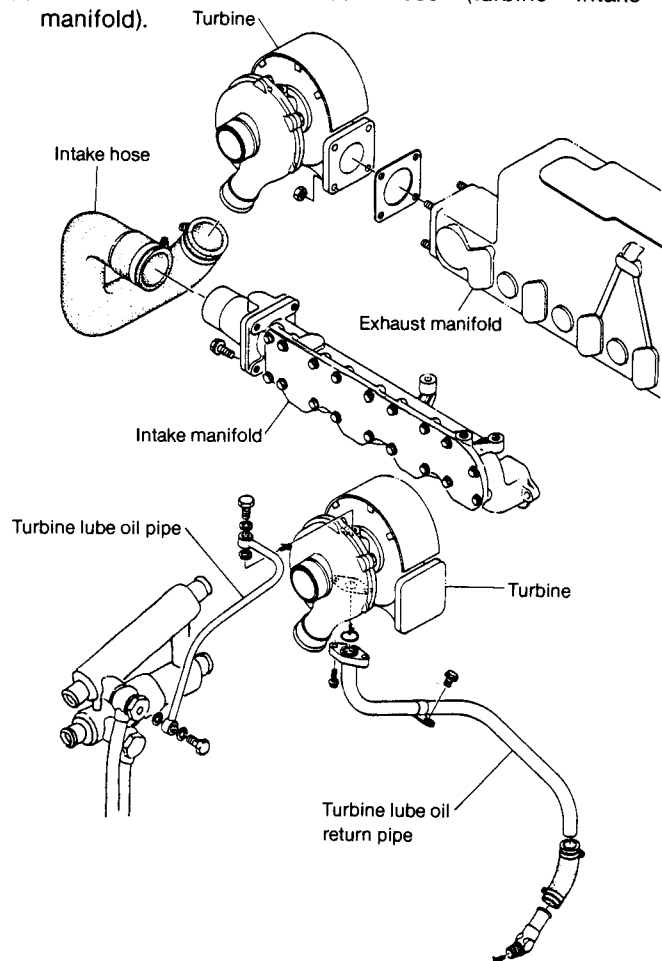
[Model 4JH-TE]

3-2.38 Mounting the turbine

- (1) Mount the turbine on the exhaust manifold.

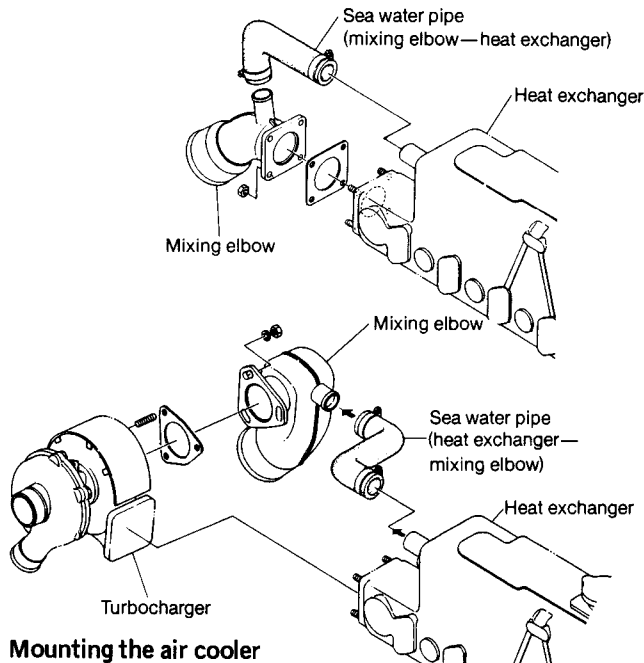
NOTE: First make sure to tighten the turbine lube oil return pipe.

- (2) Mount the lube oil pipe (lube oil cooler—turbine).
- (3) Insert the rubber hose at the end of the lube oil return pipe (turbine—oil pan) into the elbow on the oil pan, and mount with the hose grip.
- (4) Mount the intake rubber hose (turbine—intake manifold).



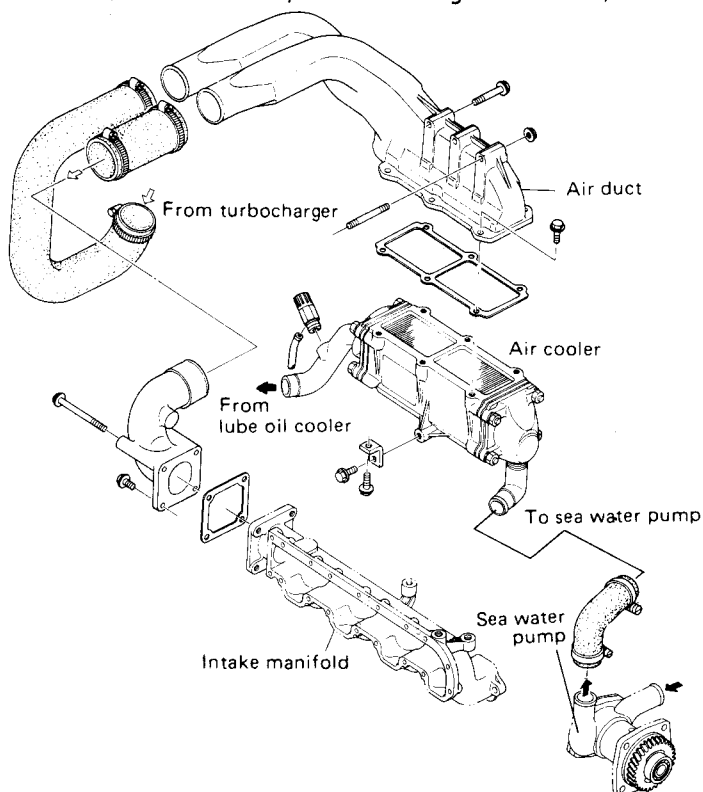
3-2.39 Mounting the mixing elbow

- (1) Mount the mixing elbow on the exhaust manifold outlet for model 4JHE, and on the turbocharger outlet for model 4JE-TE.
- (2) Mount the cooling sea water pipe rubber hose with the hose grip (heat exchanger—mixing elbow).



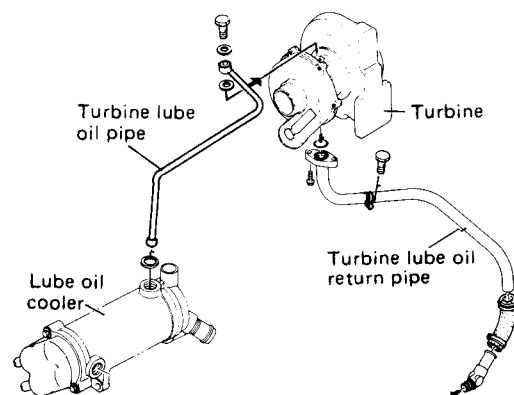
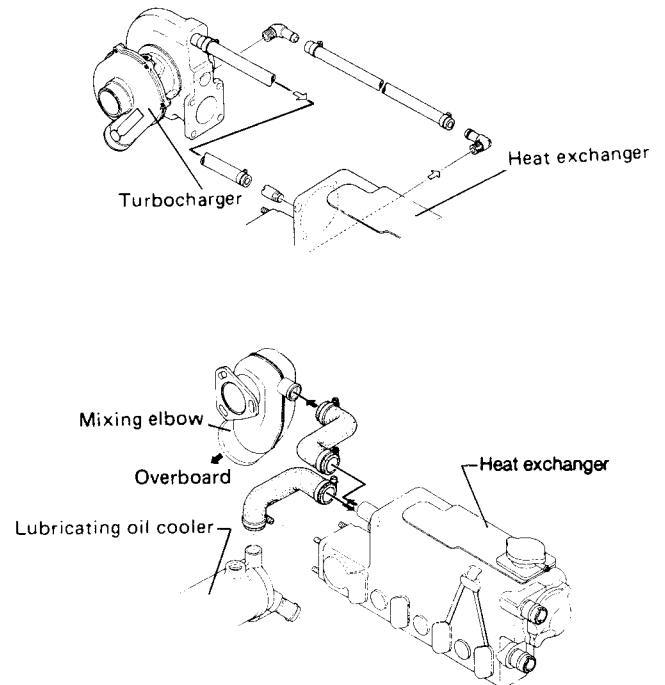
Mounting the air cooler

- (1) Mount the air cooler on the heat exchanger, and cylinder block.
- (2) Mount the sea-water rubber hoses. (Lube oil cooler — Air cooler — Sea water pump)
- (3) Mount the intake rubber hoses (Intake manifold, and turbocharger — Air duct)



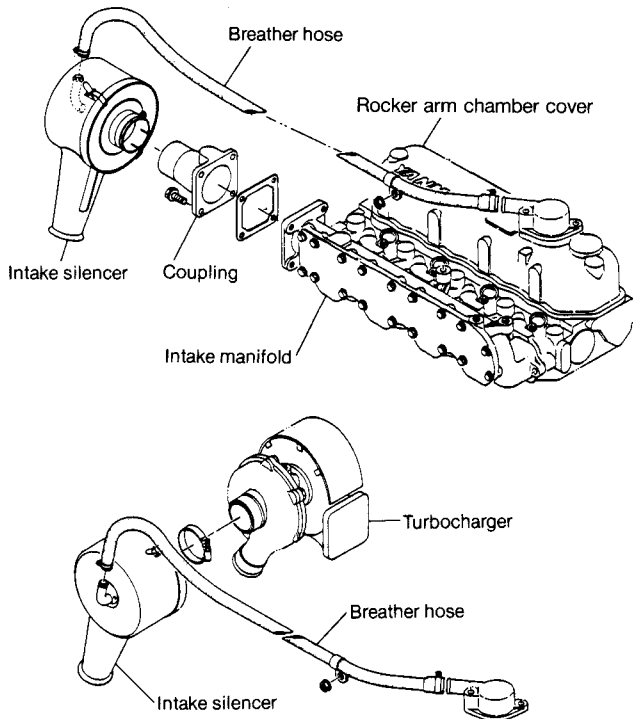
Mounting the mixing elbow and the turbocharger

- (1) Mount the turbocharger on the exhaust manifold.
- (2) Mount the air duct rubber hose. (Turbocharger — Air duct)
- (3) Mount the mixing elbow on the turbocharger.
- (4) Mount the sea water hose. (Heat exchanger — Mixing elbow)
- (5) Mount the lube oil pipes. (Lube oil pump — Turbocharger — Lube oil cooler)
- (6) Mount the fresh water hoses. (Heat exchanger — Turbocharger)



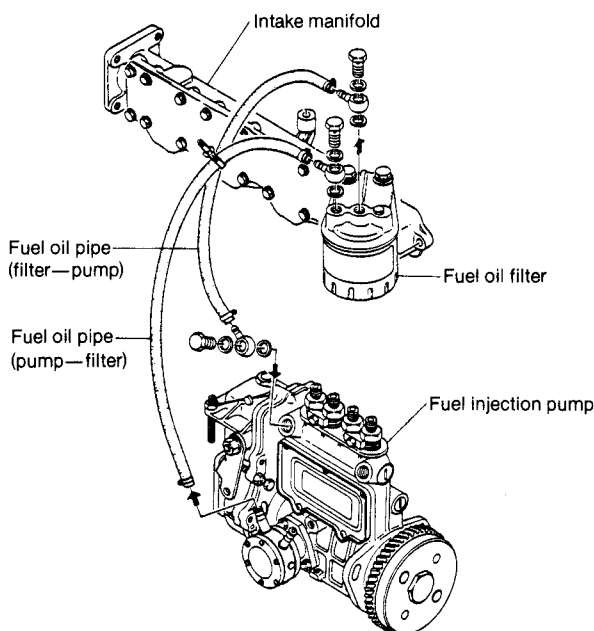
3-2.40 Mounting the intake silencer

- (1) Mount the intake silencer on the intake manifold inlet coupling for model 4JHE, and on the turbocharger blower side for model 4JH-TE.
- (2) Mount the breather hose with the hoe clamp (intake silencer—valve rocker arm chamber cover).



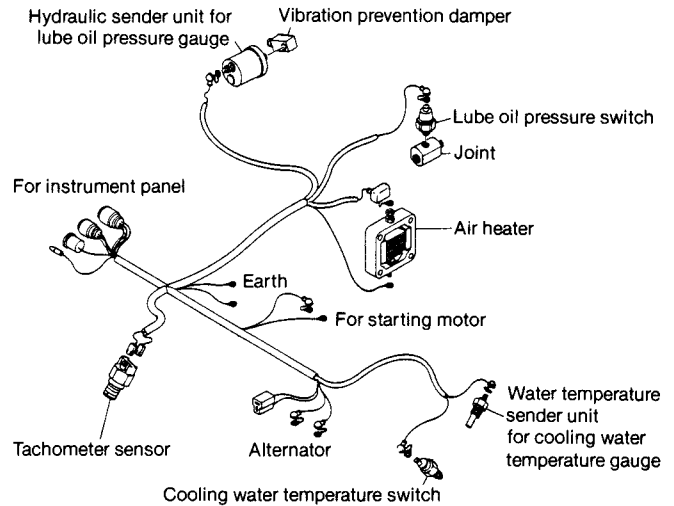
3-2.41 Mounting the fuel filter and fuel oil pipe

- (1) Mount the fuel filter.
- (2) Mount the fuel oil pipe (fuel feed pump—fuel filter, fuel filter—fuel injection pump).



3-2.42 Electrical Wiring

Connect the wiring to the proper terminals, observing the color coding to make sure the connections are correct.



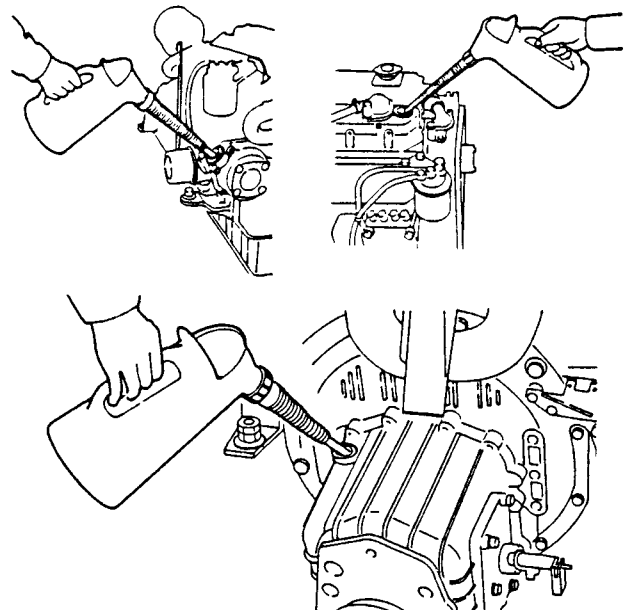
3-2.43 Installation in the ship and completion of the piping and wiring

Mount the engine in the ship after all engine assembly has been completed. Connect the cooling water, fuel oil and other piping on the ship and the exhaust hoses. Connect the battery, instrument panel, remote control and other wiring.

3-2.44 Filling with lube oil

Fill the engine with lube oil from the supply port on top of the gear case and the marine gearbox supply port on top of the clutch case.

		ℓ (in. ³)
Lube oil capacity	Engine	6.5 (396.63)
	Gearbox	1.2 (73.22)



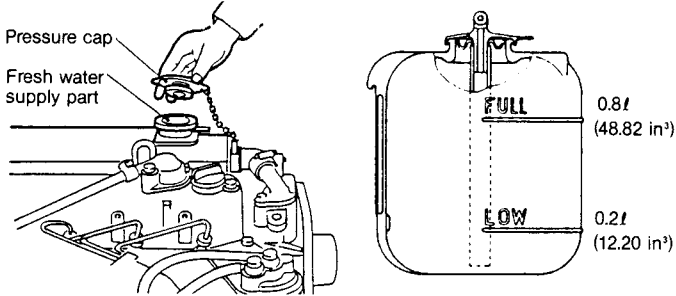
3-2.45 Filling with cooling water

(1) Open the fresh water tank cap and fill with water.

l (in. ³)	
Fresh water tank capacity	6.0 (366.12)

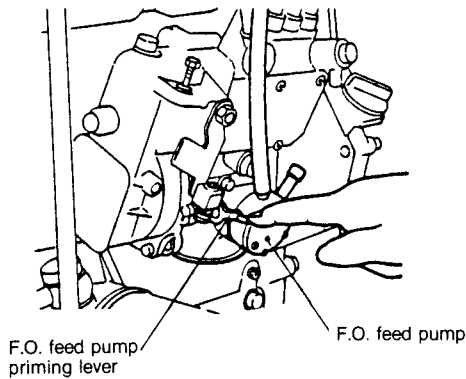
(2) Fill with water until the level in the sub-tank is between the full and low marks.

l (in. ³)		
Sub-tank capacity	Full	Low
	0.8 (48.82)	0.2 (12.20)

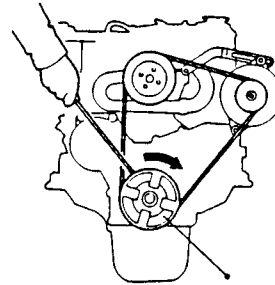
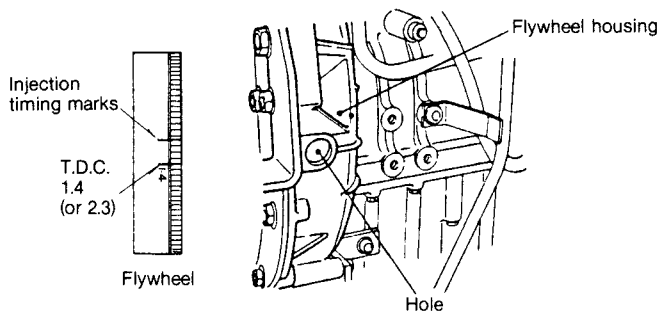


3-2.46 Check fuel injection timing

(1) Open the fuel tank cock and shift the fuel feed pump priming lever for air bleeding.

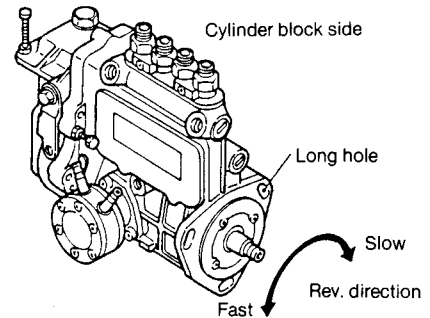


(2) Check injection timing by turning the flywheel and looking through the inspection hole in the flywheel housing.



(3) If injection timing is off, change the mounting position using the long hole in the injection pump mounting flange. Turning the fuel feed pump towards the cylinder block slows timing down, while movement in the other direction makes it faster.

Fuel injection timing (FID)	4JH-E	E/#00101 ~ 00574, b.TDC 8 ~ 10° E/#00575 and after, b.TDC 11 ~ 13°
	4JH-TE 4JH-HTE 4JH-DTE	b.TDC 11 ~ 13°



4. Bolt/nut tightening torque

Engine

Description	Thread dia. × pitch mm	Tightening torque kg-m (ft-lb)	Wrench mm (in.)
Cylinder head bolts	M10 × 1.25	7.5 ~ 8.5 (54.24 ~ 61.48)	14 (0.5512)
Connecting rod bolts	M9 × 1.0	4.5 ~ 5.0 (32.54 ~ 36.16)	13 (0.5118)
Flywheel bolts	M10 × 1.25	7.0 ~ 8.0 (50.63 ~ 57.86)	17 (0.6693)
Crankshaft V-pulley bolts	M14 × 1.5	11.5 ~ 12.5 (83.17 ~ 90.41)	22 (0.8661)
Main bearing bolts	M12 × 1.5	9.5 ~ 10.5 (68.71 ~ 75.94)	17 (0.6693)
Fuel pump automatic timer box nuts	M12 × 1.75	6.0 ~ 7.0 (43.39 ~ 50.63)	13 (0.5112)

Turbocharger (RHB52)

Description	Thread dia. × pitch mm	Tightening torque kg-m (ft-lb)	Wrench mm (in.)
Turbine chamber bolts	M6	10.0 ~ 11.0 (72.33 ~ 79.56)	10 (0.3937)
Blower chamber bolts	M5	3.5 ~ 4.5 (25.31 ~ 32.54)	8 (0.3150)
Thrust metal bolts	M3	0.7 ~ 0.9 (5.06 ~ 6.50)	—
Seal plate screws	M3	0.7 ~ 0.8 (5.06 ~ 5.78)	—
Blower blade nuts	M5	1.8 ~ 2.2 (13.01 ~ 15.91)	8 (0.3150)

5. Test running

5-1. Preliminary Precautions

Before making a test run, make sure of the following points.

- (1) Warm the engine up.
- (2) Remove any precipitation from the F.O. filter, water separator, and F.O. tank.
- (3) Use only lube oil recommended by Yanmar.
- (4) Be sure to add Yanmar anti-rust agent to fresh cooling water.
- (5) During cold weather, add Yanmar anti-freeze to the cooling water.
- (6) Provide good ventilation in the engine room

5-2 Check Points and Precautions During Running

Step	Item	Instructions	Precautions
1	Checks before operation	<ol style="list-style-type: none"> 1) Make sure that the Kingston Cock is open. 2) Make sure there is enough lube oil and (fresh) cooling water. 3) Operate the remote control handle and check if the devices connected to the engine side work properly. 	<ol style="list-style-type: none"> 3) Lamp should go off when engine is running.
2	No load operation; warm up operation	<ol style="list-style-type: none"> 1) Glow plug is provided to aid engine starts. When the lube oil temperature is raised to allow the engine to start, the pilot lamp goes off. 2) When the engine is started, check the following: <ul style="list-style-type: none"> • there is no water and no oil leakage. • gas does not leak when the engine is started. • there are no abnormal indications on the instrument panel. • there is no abnormality in cooling water discharge, engine vibrations, or engine sounds. 3) To warm up the engine, operate at low revolutions for about 5 minutes, then raise the revolutions to the rated rpms and then to max. rpms. 	<ol style="list-style-type: none"> 1) Even if one glow plug should break, the remaining plug works. 2) <ul style="list-style-type: none"> • Fix leaks if any. • Check the intake/exhaust valves, F.O. injection valve, and cylinder head. 3) Do not raise the engine revolutions abruptly.
3	Cruising (load) operation	<ol style="list-style-type: none"> 1) Do not operate the engine at full load yet, but raise the rpms gradually for about 10 minutes until they reach rated rpms. 2) Make sure that exhaust color and temperature are normal. 3) Check the instrument panel and see if the water temperature and oil pressure are normal. 	
4	Stopping the engine	<ol style="list-style-type: none"> 1) Before stopping the engine, operate it at 650—700 rpms for about 5 minutes. 2) Raise engine rpms to 1,800 just before stopping the engine and idle the engine for about 3—4 seconds. 	<ol style="list-style-type: none"> 1) Stopping the engine suddenly during high speed operation increases the temperature of engine parts. 2) This procedure prevents carbon from being deposited on the valve seats, etc.
5	Checks after stopping the engine	<ol style="list-style-type: none"> 1) Check again for water and oil leaks. 2) Make sure that no nuts and bolts are loose. 3) Close the Kingston and fuel cocks. 4) When the temperature is expected to fall below freezing, drain the cooling water (sea water). 5) Turn off the battery switch. 	<ol style="list-style-type: none"> 1) Check the oil seal area. 2) Especially the engine installation bolts. 4) Drain from the sea water pump.