

CHAPTER 7

DIRECT SEA-WATER COOLING SYSTEM

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1. Cooling System

1-1 Composition

- (1) A sea water direct cooling system incorporating a rubber impeller pump is employed.
- (2) A thermostat is installed and a bypass circuit is provided to keep the cooling water temperature constant at all times.
This not only prevents overcooling at initial operation, but also improves the combustion performance and increases the durability of moving parts by keeping the temperature constant.
- (3) Anticorrosion zinc is provided at the cylinder and the cylinder head to prevent electrolytic corrosion of the cylinder jacket and cylinder head by the sea water.
- (4) A cooling water temperature sender is installed so that any abnormal rise in cooling water temperature is indicated by the lamp on the instrument panel.
- (5) A scoop strainer is provided at the water intake Kingston cock to remove dirt and vinyl from the water.
- (6) Rubber hoses are used for all interior piping. This eliminates pipe brazing damage due to engine vibration and simplifies the engine's vibration mounting.

1-2 Cooling water route

The cooling water is sucked up by the water pump through a Kingston cock installed on the hull. The water delivered from the water pump branches in two directions at the cylinder intake coupling. Some of the water enters the cylinder jacket and the rest bypasses the cylinder jacket and enters the mixing elbow or the exhaust manifold.

The water that enters the cylinder jacket cools the cylinders and then rises to the cylinder head through the passage between the cylinder and cylinder head and to cool the cylinder head.

The cooling water from the cylinder head, after passing the thermostat, enters the mixing elbow in models 1GM10(C) and 2GM20(C). However, in models 3GM30(C) and 3HM35(C), it first passes to the exhaust manifold to cool the exhaust gas and then enters the mixing elbow.

After that, the water is discharged to the outside of the boat through the rubber hose from the mixing elbow.

The thermostat is closed until the cooling water temperature reaches a fixed temperature (42°C), making the flow go to the cylinder head and then through the bypass circuit.

When the cooling water temperature exceeds 42°C, the thermostat opens, and the cooling water begins to flow through the entire system. At 52°C, the thermostat valve is fully opened and the cooling water temperature is maintained at that level.

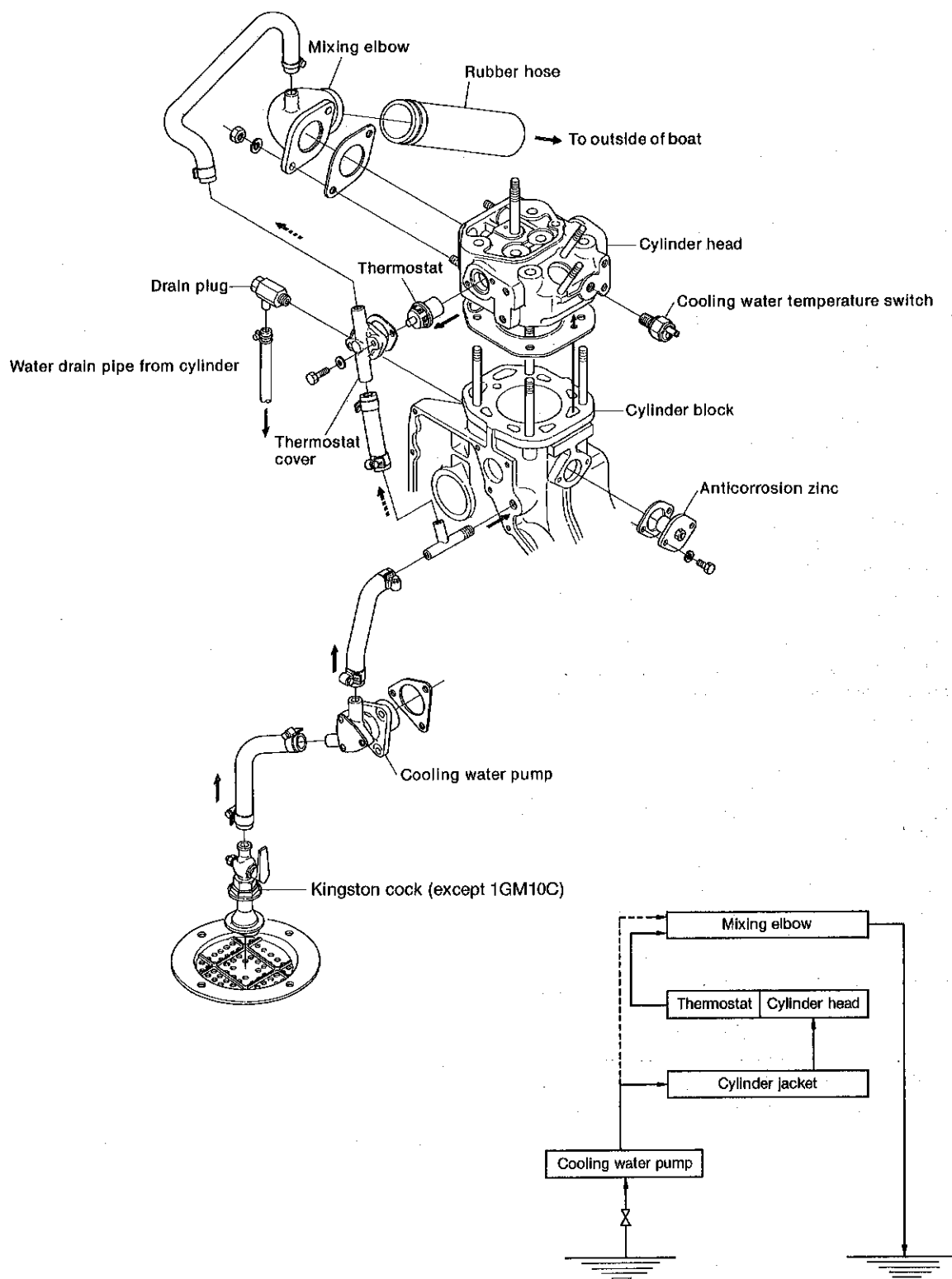
1-3 Piping

To simplify the cooling system piping and eliminate cracking of the brazed parts by vibration, rubber or vinyl hoses connected with hose clips are adapted for this engine.

Therefore, the following items must be distorted when inspecting the cooling system:

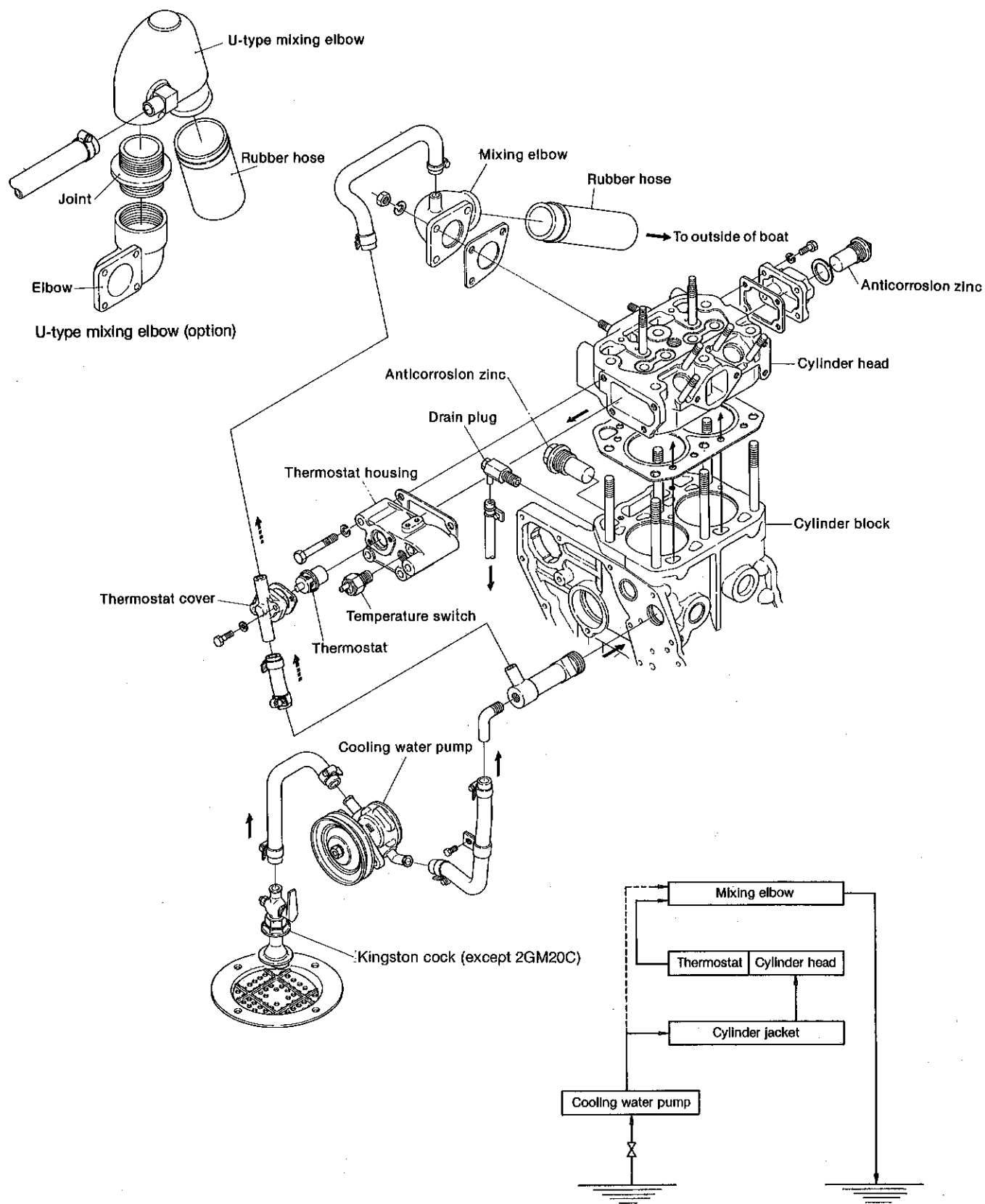
- (1) There must be no extreme bends in the piping.
- (2) The cross section of the piping must not be changed by heavy objects on the piping.
- (3) There must be no fractures or cracks which allow water leakage.
- (4) Piping must not touch high temperature parts, and piping must be securely clamped.
- (5) Hose clips must be securely tightened and there must be no leakage from the insertion sections.

1-2.1 Cooling water passage of engine model 1GM10(C)



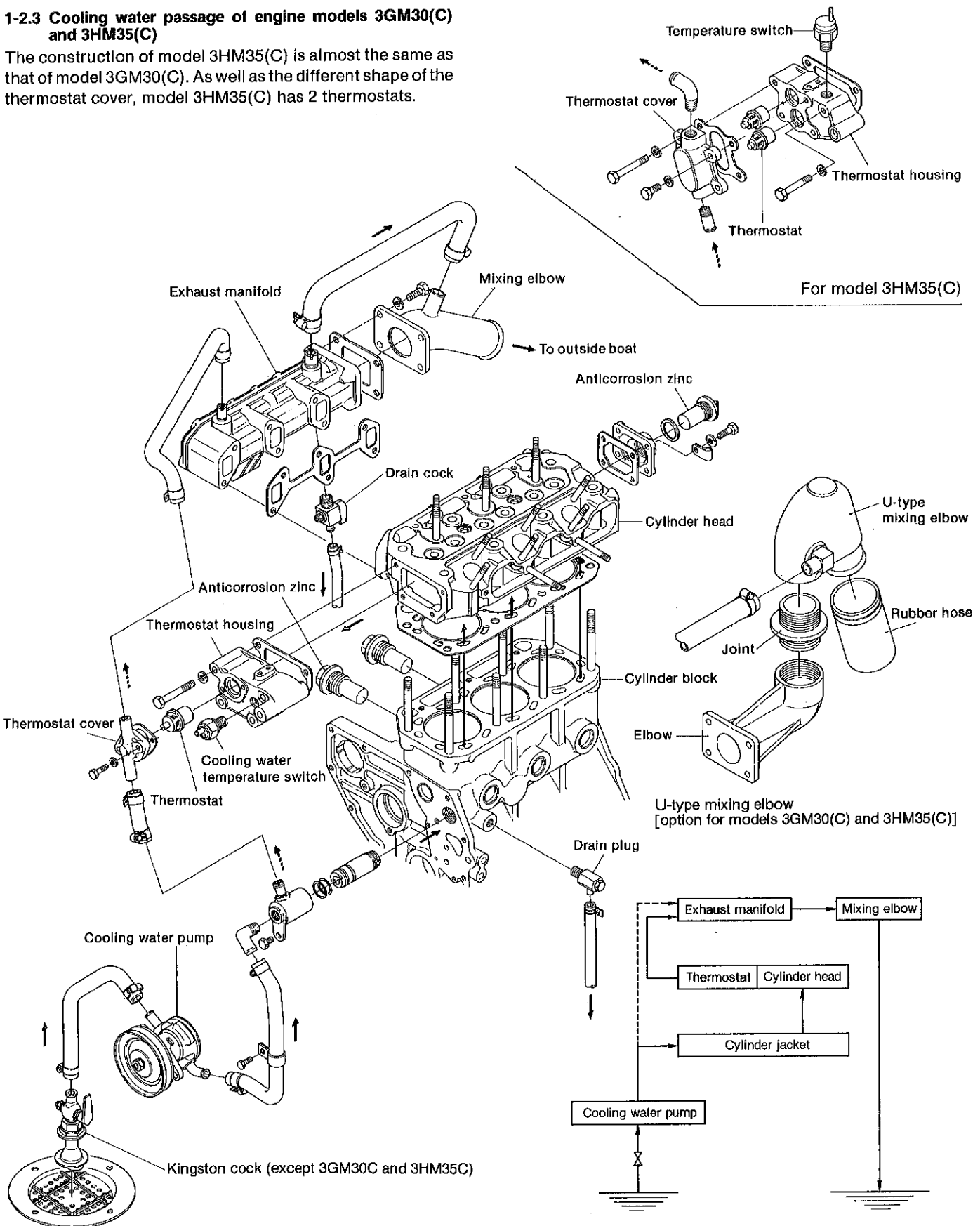
← When the cooling water is at the correct temperature
 ←... When the cooling water temperature is lower than the correct temperature

1-2.2 Cooling water passage of engine model 2GM20(C)



1-2.3 Cooling water passage of engine models 3GM30(C) and 3HM35(C)

The construction of model 3HM35(C) is almost the same as that of model 3GM30(C). As well as the different shape of the thermostat cover, model 3HM35(C) has 2 thermostats.



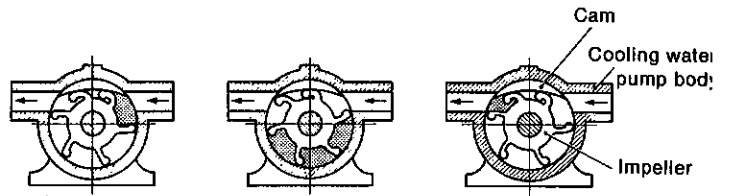
← When the cooling water is at the correct temperature
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2. Water Pump

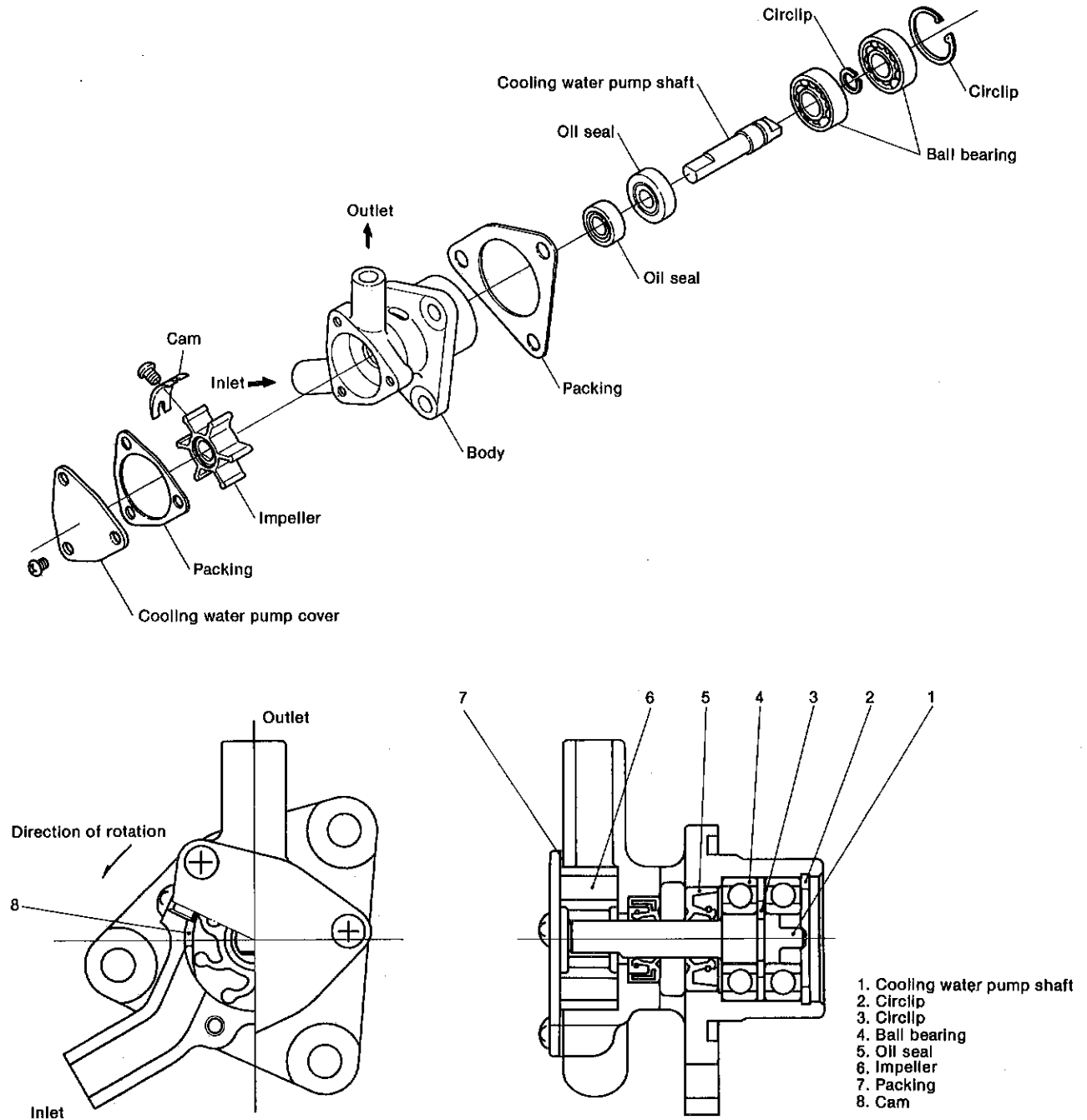
2-1 Construction and operation

The water pump is a rubber impeller type pump. The rubber impeller, which has ample elasticity, is deformed by the off-set plate inside the casing, causing the water to be discharged. This pump is ideal for small, high-speed engines.

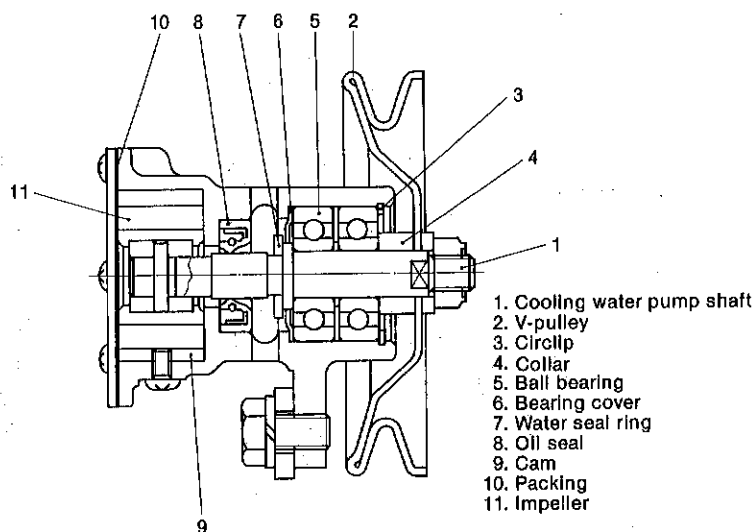
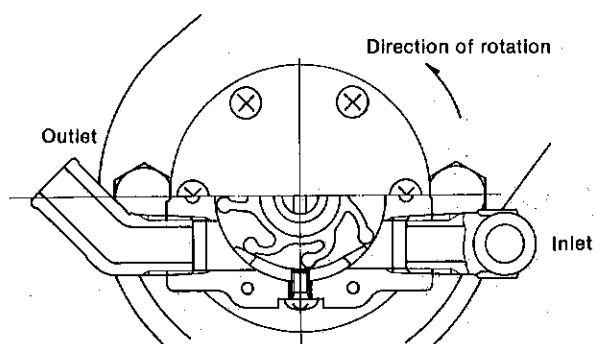
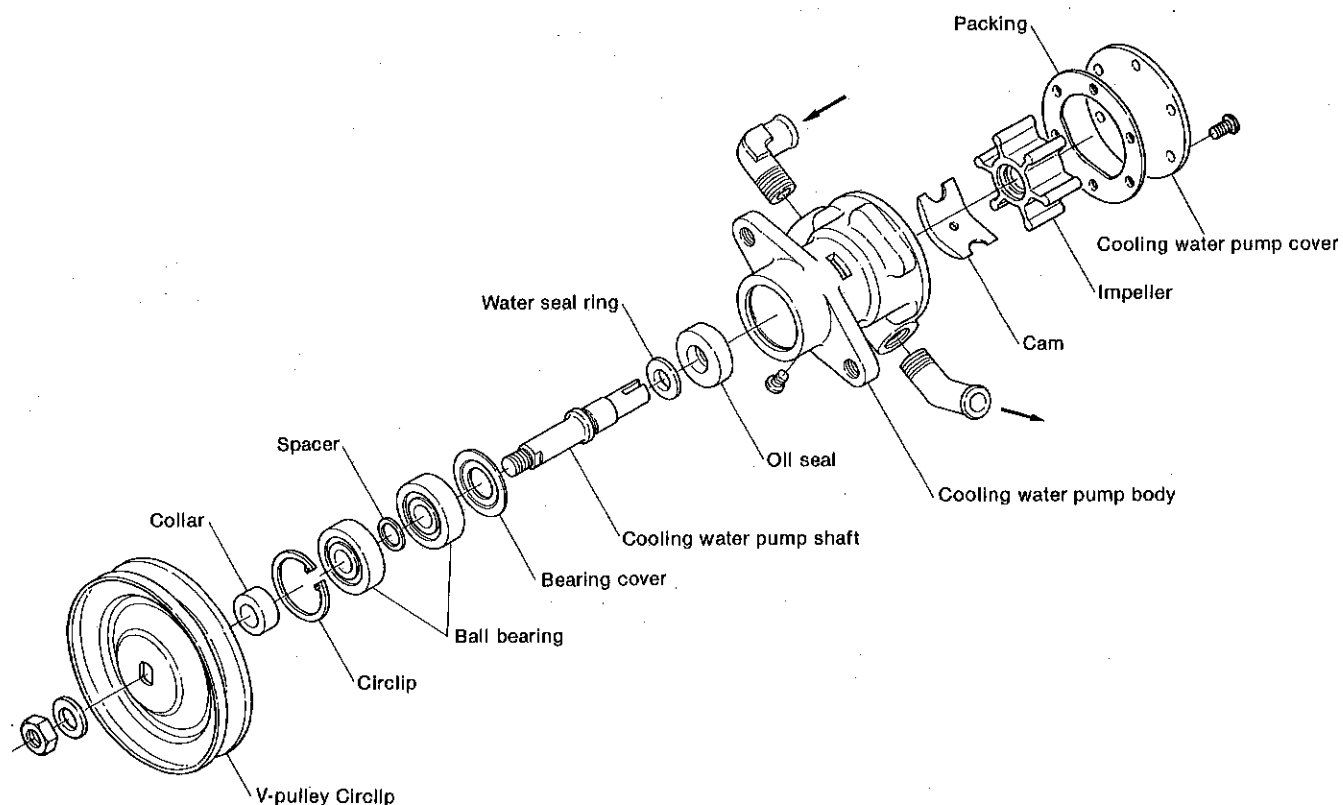
The cooling water pump of engine model 1GM10(C) is driven by connecting the cooling water pump shaft to the slit on the end of the lubricating oil pump drive shaft.



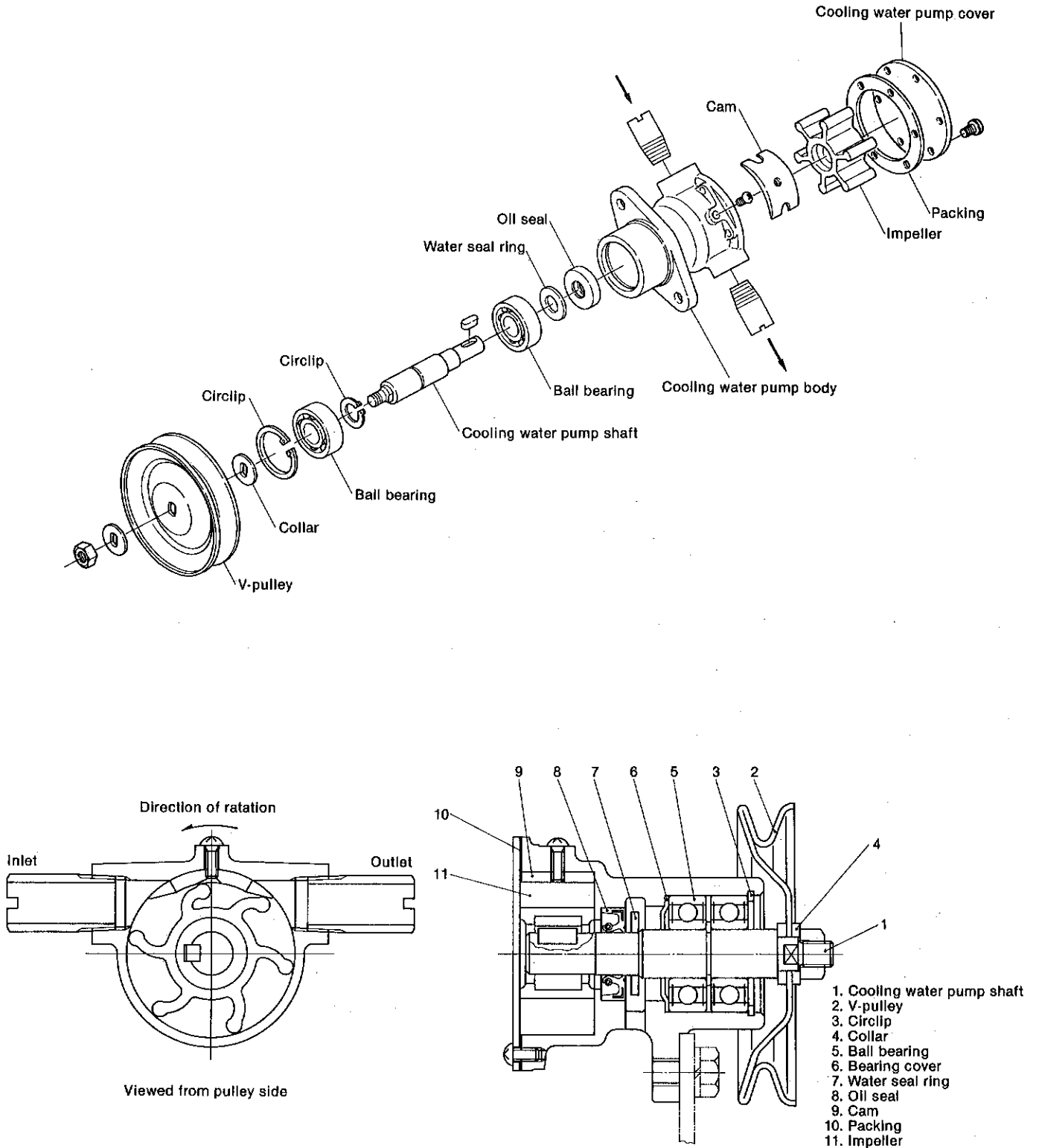
2-1.1 Cooling water pump of engine model 1GM10(C)



2-1.2 Cooling water pump of engine models 2GM20(C) and 3GM30(C)



2-1.3 Cooling water pump of engine model 3HM35(C)



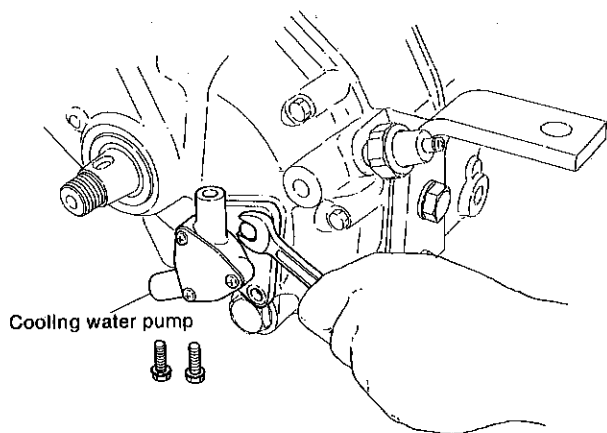
2-1.4 Specifications

	1GM10(C)	2GM20(C), 3GM30(C)	3HM35(C)
Rated speed	2600rpm	2720rpm	2660rpm
Suction head	0.5m (1.64 ft)	1.0m (3.28 ft)	1.0m (3.28 ft)
Total head	3.0m (9.84 ft)	3.0m (9.84 ft)	4.0m (13.12 ft)
Delivery capacity	300 #/h	700 #/h	1500 #/h

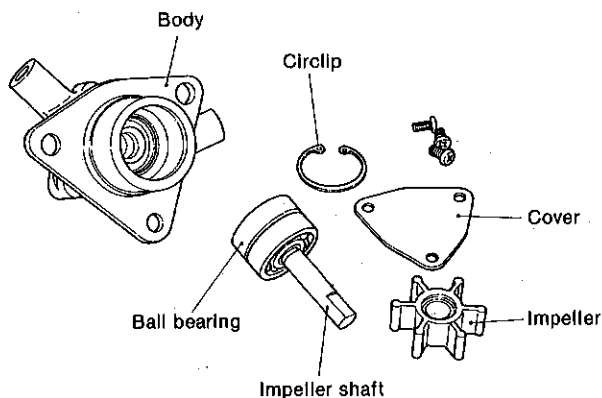
2-2 Disassembly

2-2.1 For model 1GM10(C)

- (1) Loosen the water pump mounting bolts, remove the water pump ass'y from the timing gear case.

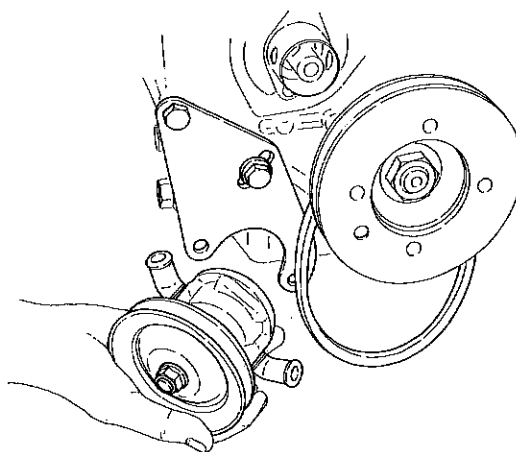


- (2) Remove the cooling water pump cover and packing by removing the 3 screws which secure the cooling water pump cover.
- (3) Pull the water pump impeller.
- (4) Remove the set screw and remove the offset plate.
- (5) Remove the bearing snap ring and remove the impeller shaft and bearing ass'y while tapping the impeller side of the impeller shaft lightly.
- (6) Pull the oil seal from the pump body.
- (7) Pull the ball bearing and spacer from the impeller shaft.

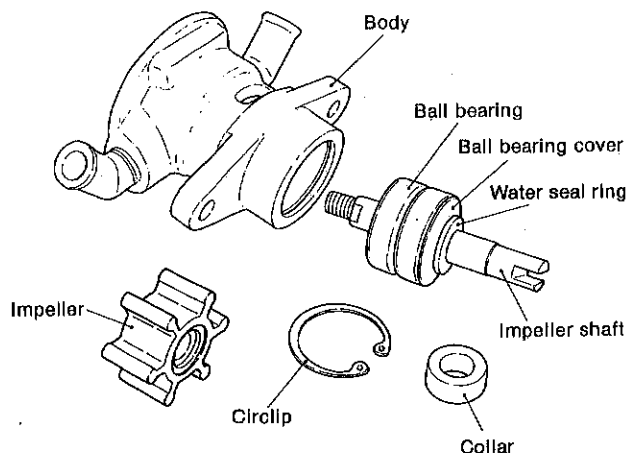


2-2.2 for models 2GM20(C), 3GM30(C) and 3HM35(C)

- (1) After removing the V-belt by loosening the mounting bolts of the cooling water pump bracket, remove the cooling water pump assembly.

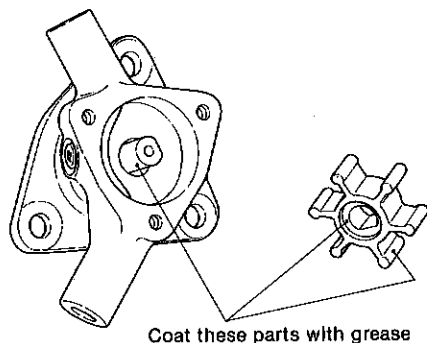


- (2) Remove the cooling water pump bracket.
- (3) Remove the V-pulley mounting bolt and V-pulley.
- (4) Remove the cooling water pump cover fixing screws, and then remove the cooling water pump cover and packing.
- (5) Pull the water pump impeller.
- (6) Remove the set screw and remove the offset plate.
- (7) In engine model 3HM35(C), remove the key from the impeller shaft.
- (8) Remove the bearing snap ring and remove the impeller shaft and bearing ass'y while tapping the impeller side of the impeller shaft lightly.
At the same time, the bearing cover and seal ring can be removed together with the impeller shaft.
- (9) Pull the oil seal from the pump body.
- (10) Pull the ball bearing and spacer from the impeller shaft.



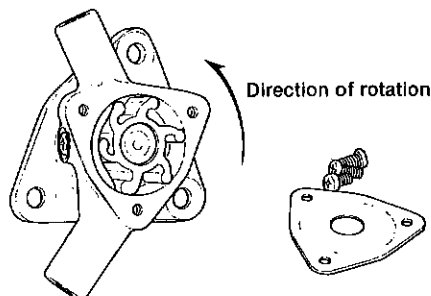
2-3 Reassembly precautions

- (1) Before inserting the rubber impeller into the casing, coat the sliding face, pump shaft and impeller fitting section with grease or Monton X.

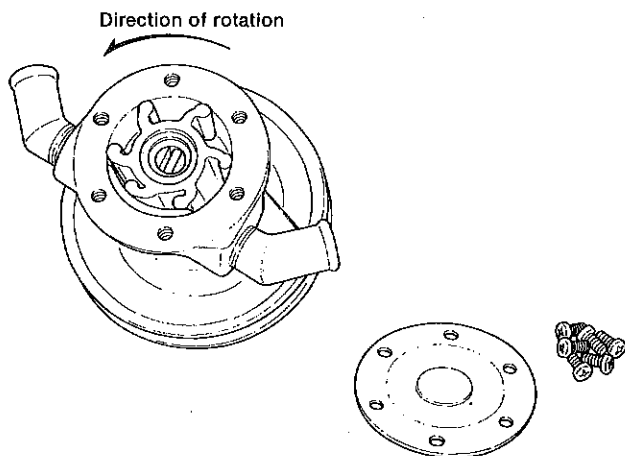


- (2) Be sure that the direction of curving of the impeller is correct.
The impeller is curved in the direction opposite the direction of rotation.

Model 1GM10(C)

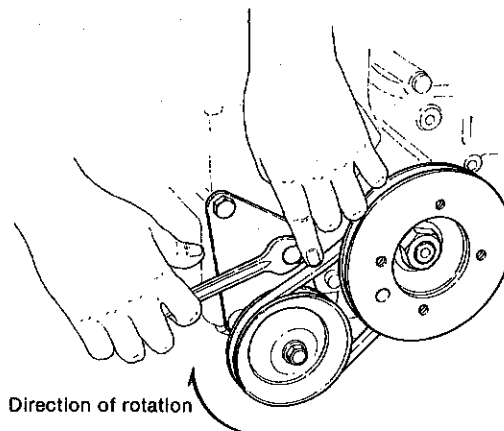


Models 2GM20(C), 3GM30(C) and 3HM35(C)



- (3) Adjust the V-belt tension. [for models 2GM20(C), 3GM30(C) and 3HM35(C)]

If the V-belt tension is slack, the discharge of the cooling water will diminish; if it is too tight, the play of the pump bearings and the wear of the wear plate will be accelerated. Adjust the tension to the specified value. Check the deflection of the V-belt by pressing it in the center with your fingers.



	2GM20(C)	3GM30(C)	3HM35(C)
V-belt tension	To be 5 ~ 7mm (0.1964 ~ 0.2756in.) deflection when pushed by the thumb with a force of 10kg (22.0 lb)		
Type of V-belt	M19in.		
V-belt part No.	104511-78780		

NOTE: Mount the belt in the direction of pump rotation.

- (4) If the sliding surface of the V-belt is cracked, worn or is stained with oil, etc., replace it with a new one.

- (5) Check after assembly

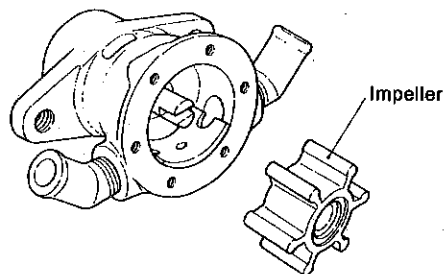
After assembly, attach the belt and run the engine to ascertain whether or not it provides the specified discharge.

2-4 Handling precautions

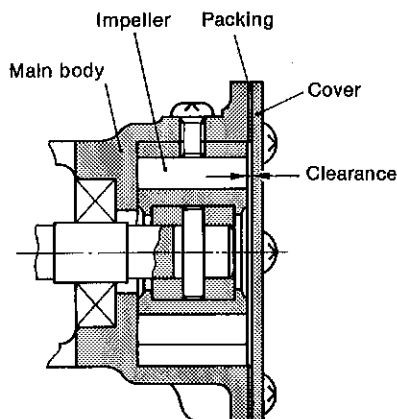
- (1) Never operate the water pump dry as this will damage the rubber impeller.
- (2) Always turn the engine in the correct direction of rotation. Turning the engine in the opposite direction will damage the rubber impeller.
- (3) Inspect the pump after every 1,500 hours of operation and replace if faulty.

2-5 Inspection

- (1) Inspect the rubber impeller for fractures, cracks and other damage, and replace if faulty.



(2) Rubber impeller side wear



1) Model 1GM10(C) mm (in.)

	Maintenance standard	Clearance at assembly	Maximum allowable clearance	Wear limit
Impeller width	12 ±0.1 (0.4685 ~ 0.4764)	0.2 (0.0079)	0.4 (0.0157)	—
Housing width	(without packing) 11.9 (0.4685)			—
Wear plate wear	—			0.2 (0.0079)

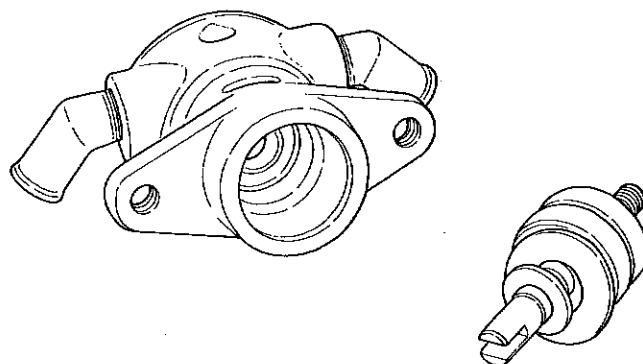
2) Models 2GM20(C) and 3GM30(C) mm (in.)

	Maintenance standard	Clearance at assembly	Maximum allowable clearance	Wear limit
Impeller width	19 ±0.1 (0.744 ~ 0.752)	0.2 (0.0079)	0.4 (0.0157)	—
Housing width	18.9 (0.7441) (without packing) 19.2 (0.7559) (with packing)			—
Wear plate wear	—			0.2 (0.0079)

3) Model 3HM35(C) mm (in.)

	Maintenance standard	Clearance at assembly	Maximum allowable clearance	Wear limit
Impeller width	22.1 ±0.1 (0.8661 ~ 0.8740)	0.2 (0.0079)	0.4 (0.0157)	—
Housing width	(without packing) 22 (0.8661)			—
Wear plate wear	—			0.2 (0.0079)

(3) Water pump impeller shaft oil seal section wear.



mm (in.)

	Maintenance standard	Wear limit
Oil seal section shaft diameter	10.0 (0.3937)	9.9 (0.3898)

If water leakage increases while the engine is running, or if the components are found to be defective when disassembled, replace them.

(4) Inspect the bearing for play and check for seizing at the impeller shaft fitting section. Replace the bearing if there is any play.

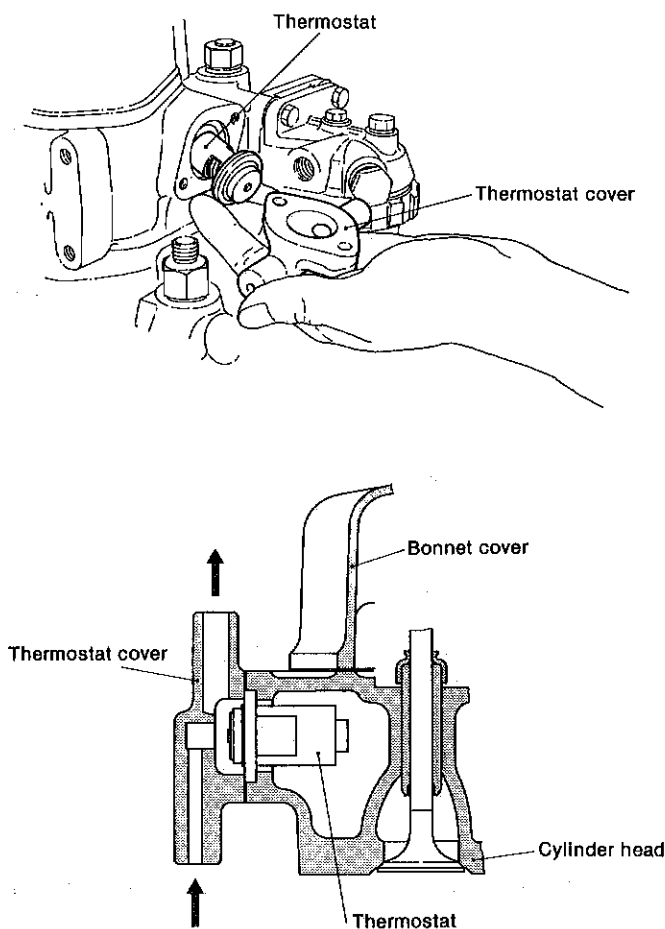
3. Thermostat

3-1 Construction and operation

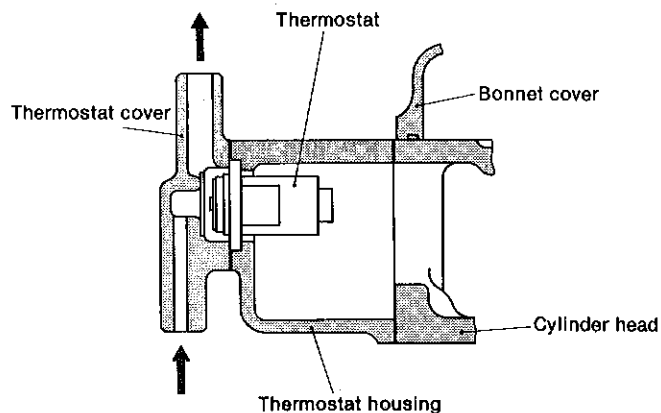
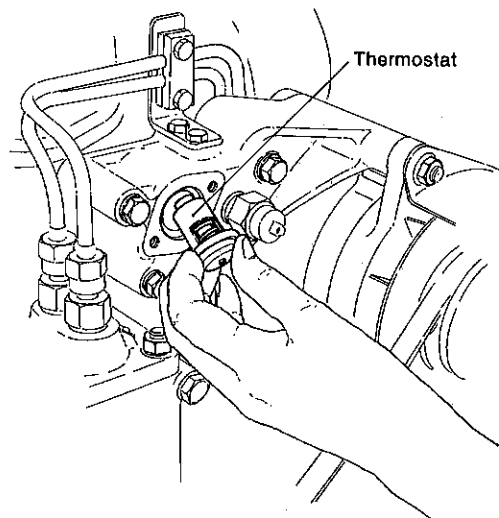
The thermostat remains closed until the cooling water temperature reaches a fixed temperature. Until the cooling water reaches this fixed temperature, it collects at the cylinder head and the water flowing from the water pump is discharged through the bypass circuit. When the cooling water temperature exceeds the fixed temperature, the thermostat opens and the cooling water flows through the main circuit of the cylinder and cylinder head. The thermostat serves to prevent overcooling and improve combustion performance by maintaining the cooling water temperature at the specified level.

In engine model 1GM10(C), the thermostat is mounted on the cylinder head at the gear case end. In engine models 2GM20(C) 3GM30(C) and 3HM35(C), it is mounted on the thermostat housing which is combined with the generator mounting base on the cylinder head at the gear case end.

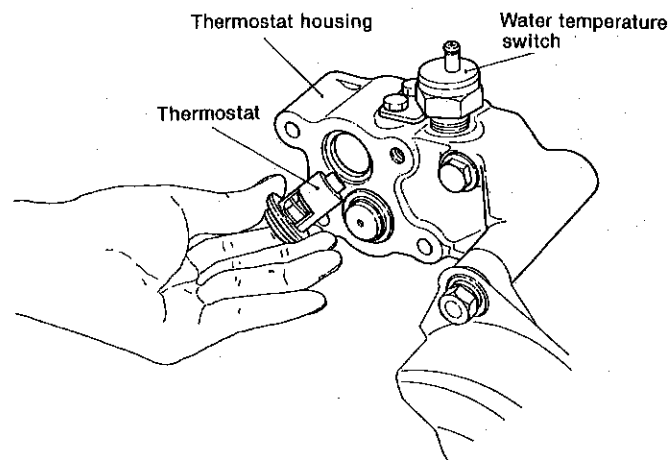
Model 1GM10(C)

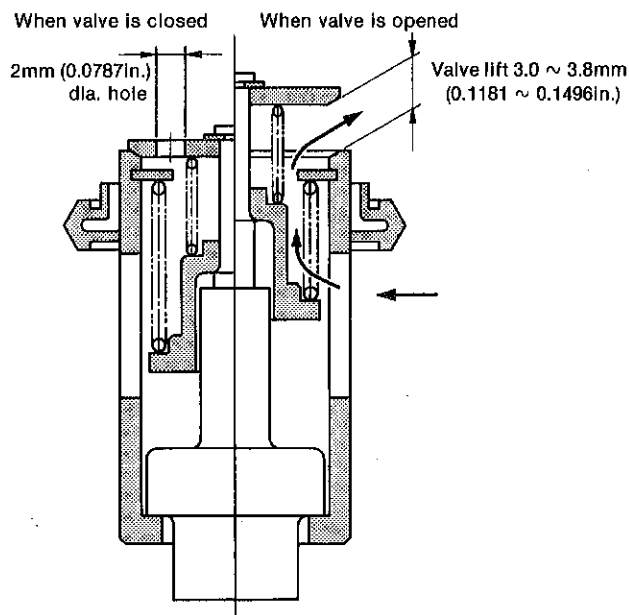
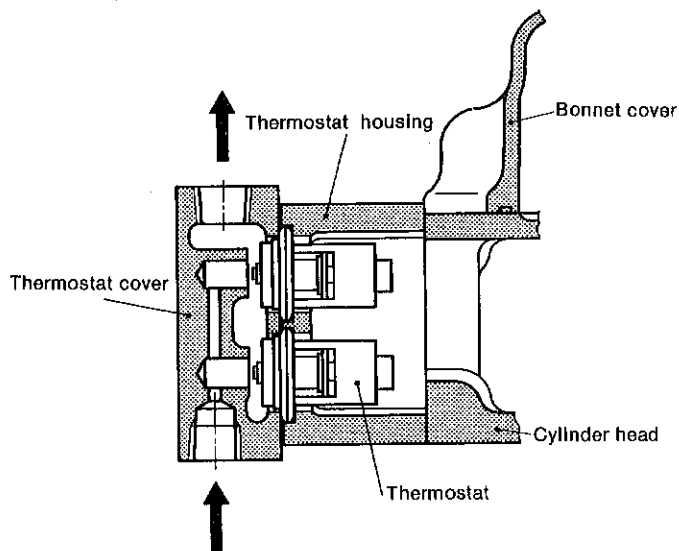


Models 2GM20(C) and 3GM30(C)



Model 3HM35(C)

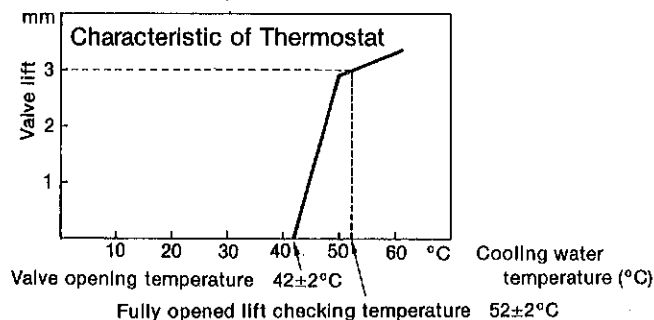




A wax-pellet type thermostat is used for this engine. The "wax-pellet" type is the description given to a quantity of wax in the shape of a small pellet. When the temperature of the cooling water rises, the wax melts and its volume expands. The valve is opened or closed by this variation of volume.

Thermostat operating temperature

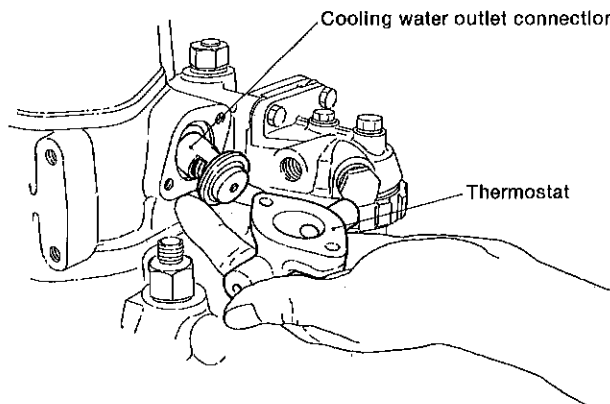
Opening temperature	42 ± 2°C
Full open temperature	52 ± 2°C



When the seawater temperature is below 42°C, the pumped-up seawater is discharged outside directly from the thermostat section, and circulation of the cooling water into the cylinder is stopped until the water temperature rises. When the water temperature reaches 52°C, the thermostat valve is fully opened.

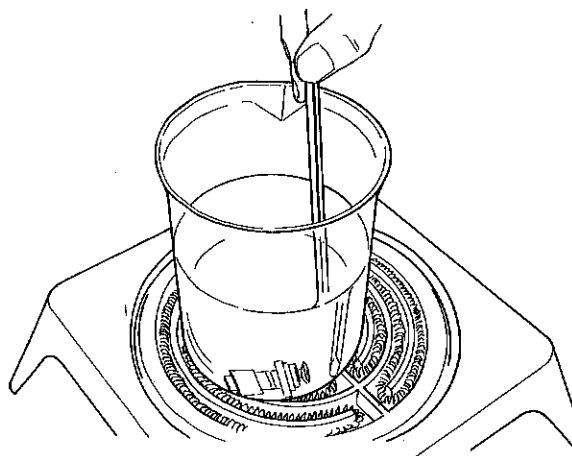
3-2 Inspection

- (1) Remove the water outlet coupling at the top of cylinder body to remove and inspect the thermostat. Remove any dirt or foreign matter that has built up in the thermostat, and check the spring, etc. for damage and corrosion.



- (2) Testing the thermostat

Place the thermostat in a container filled with water. Heat the container with an electric heater. If the thermostat valve begins to open when the water temperature reaches about 42°C and becomes fully open at 52°C, the thermostat may be considered operational. If its behaviour differs much from the above, or if it is found to be broken, replace it.



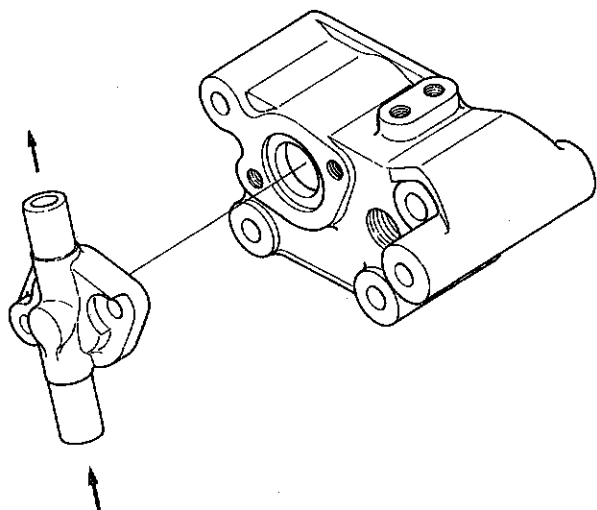
- (3) In general, inspect the thermostat after every 300 hours of operation. However, always inspect it when the cooling water temperature rises abnormally and when white smoke is emitted over a long period of time after the engine starting.
- (4) Replace the thermostat when it has been in use for a year, or after every 2000 hours of operation.

Part No. code of thermostat	105582—49200
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- (5) Attaching the thermostat to the cooling water system.
Before attaching the thermostat to the system, be sure to check its packing and make sure there are no leaks.

3-3 Care must be taken when assembling the thermostat

The thermostat cover must be assembled with the arrow mark kept upward.



4. Anticorrosion Zinc

4-1 Principles

Anticorrosion zinc is installed to prevent electrolytic corrosion by sea water.

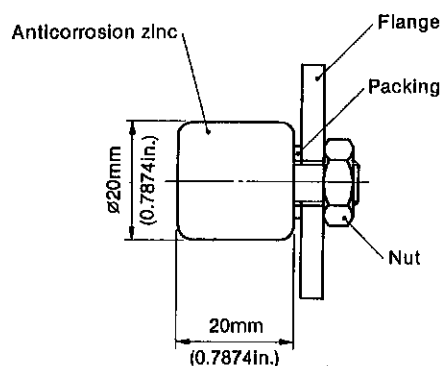
When different metals, i.e., iron and copper, are placed in a highly conductive liquid, such as sea water, the iron gradually rusts. The anticorrosion zinc provides protection

against corrosion by being itself corroded in place of the cylinder, cylinder liners and other iron parts.

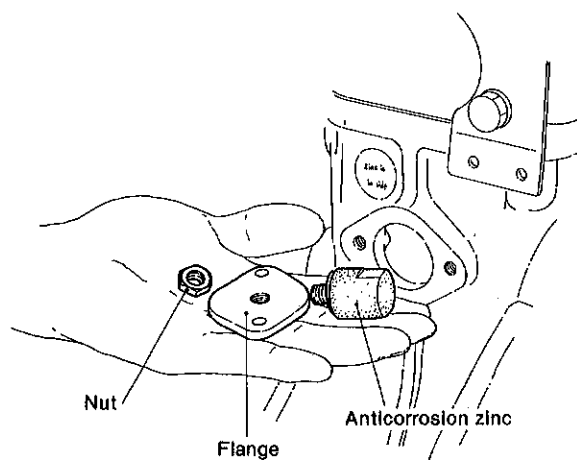
The anticorrosion zinc is to be put in the following positions.

		1GM10(C)	2GM20(C)	3GM30(C), 3HM35(C)
Cylinder block	Set position	At the side of the fuel valve	At exhaust side	At exhaust side
	Number	1	1	2
Cylinder head	Set position	—	At side cover of cylinder head (rear)	At side cover of cylinder head (rear)
	Number	—	1	1
Type·Size		Flange type 20mm dia × 20mm (0.7874 × 0.7874in.)	Plug type 20mm dia × 30mm (0.7874 × 1.9811in.)	
Part No. of anticorrosion zinc		27210—200200	27210—200300	

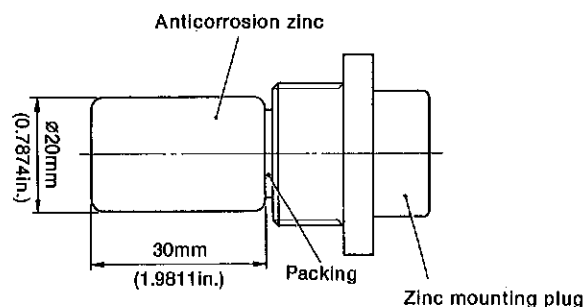
Model 1GM10(C)



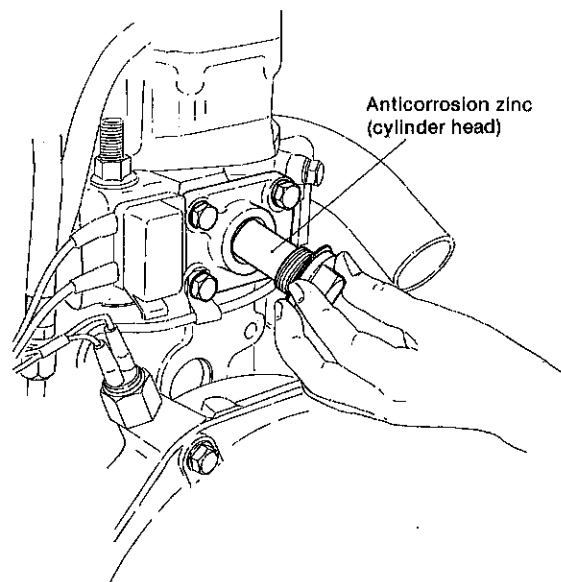
Mounting position for model 1GM10(C)

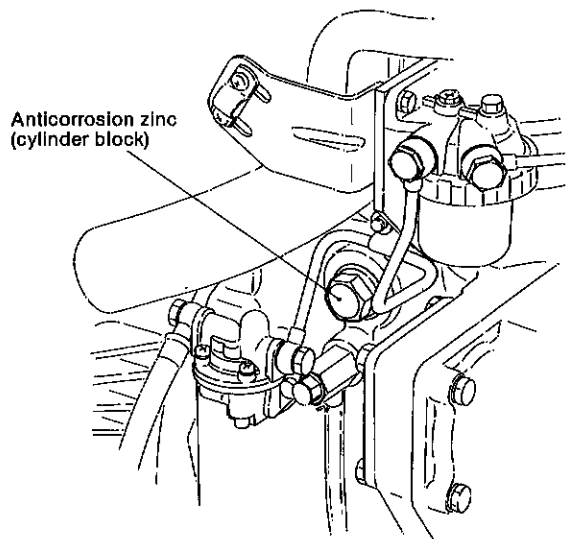


Models 2GM20(C), 3GM30(C) and 3HM35(C)

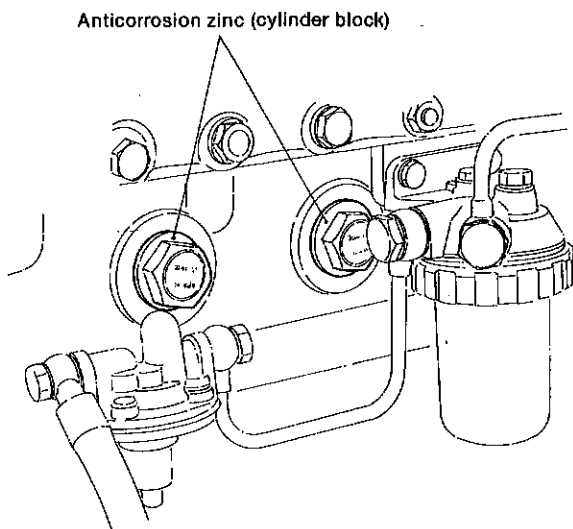
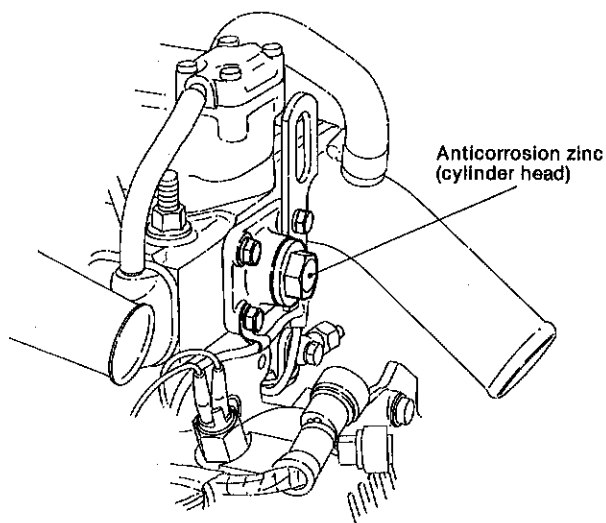


Mounting position for model 2GM20(C)





Mounting position for models 3GM30(C) and 3HM35(C)

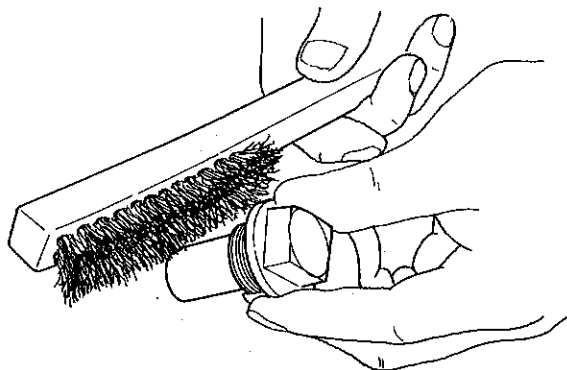


4-2 Inspection

Generally, replace the anticorrosion zinc after every 500 hours of operation. However, since this period depends on the properties of the sea water and operating conditions, periodically inspect the anticorrosion zinc and remove the oxidized film on its surface.

Replace the anticorrosion zinc after 50% corrosion.

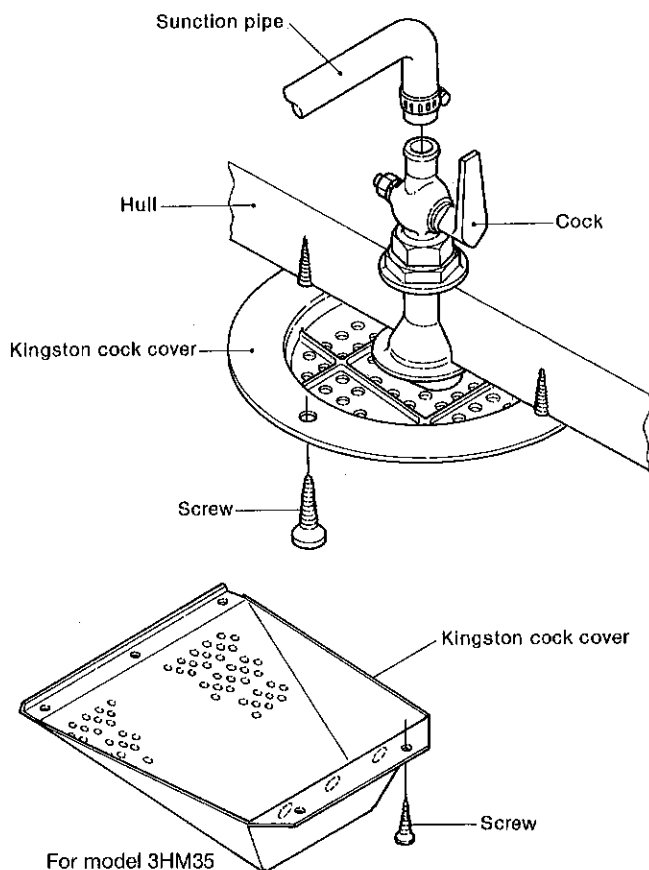
Replace the anticorrosion zinc by pulling the old zinc from the zinc mounting plug and screwing in the new zinc.



5. Kingston Cock (Optional)

5-1 Construction

The Kingston cock, installed on the bottom of the hull, controls the intake of cooling water into the boat. The Kingston cock also serves to filter the water so that mud, sand, and other foreign matter in the water does not enter the water pump. Numerous holes are drilled in the water side of the Kingston cock, and a scoop strainer is installed to prevent the sucking in of vinyl, etc.



5-2 Handling precautions

Caution the user always to close the Kingston cock after each day of use and to confirm that it is open before beginning operation.

If the Kingston cock is left open, water will flow in reverse and the vessel will sink if trouble occurs with the water pump.

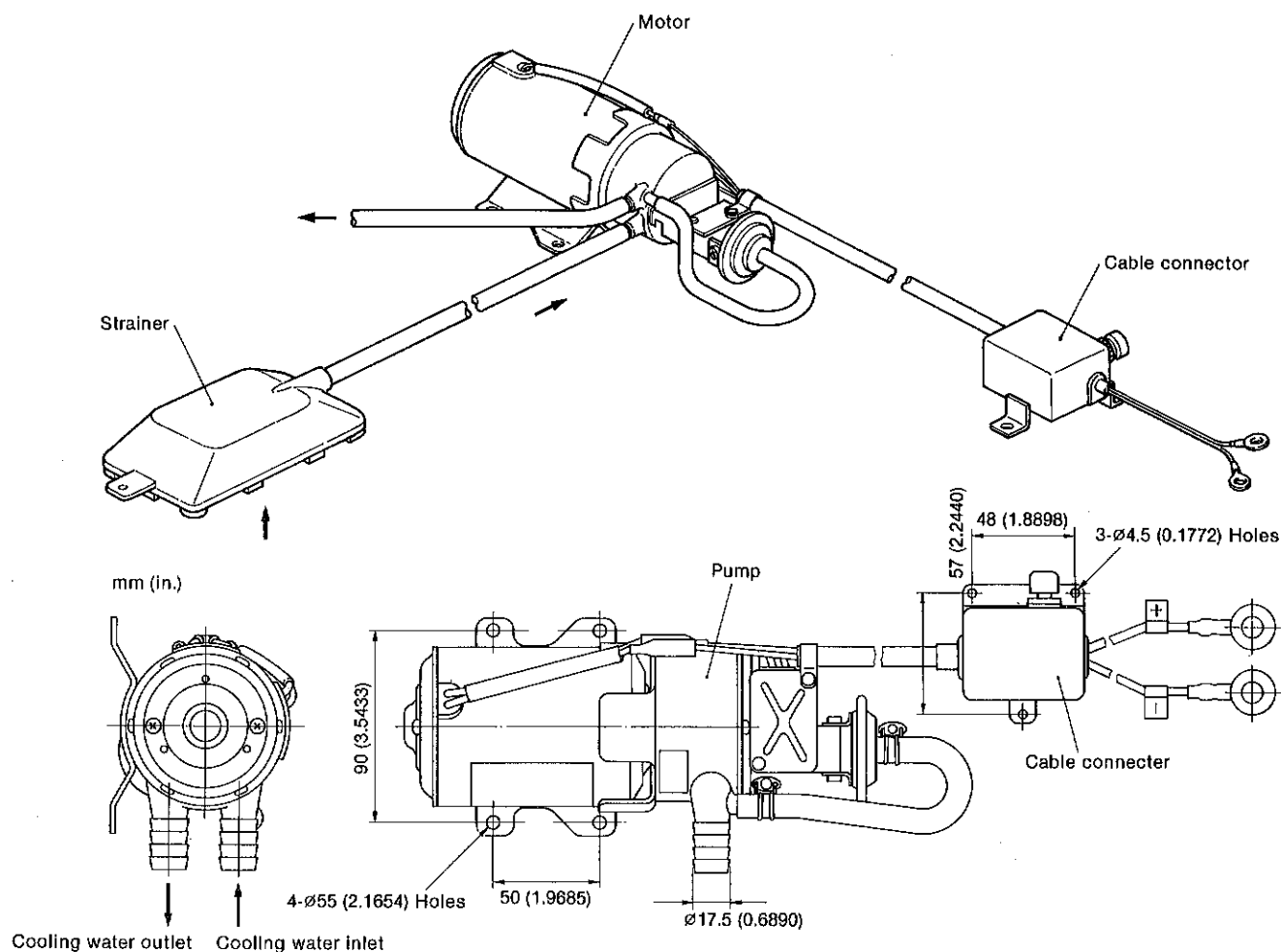
On the other hand, if the engine is operated with the Kingston cock closed, cooling water will not be able to get in, resulting in engine and pump trouble.

5-3 Inspection

When the cooling water volume has dropped and the pump is normal, remove the vessel from the water and check for clogging of the Kingston cock.

Moreover, when water leaks from the cock, disassemble the cock and inspect it for wear, and repair or replace it.

6. Bilge Pump and Bilge Strainer (Optional)



6-1 Bilge pump

6-1.1 Specifications

Code No.	120345-46010 (with strainer)
Model No.	BP190-10
Rating	60 min.
Voltage	12V
Output	90W
Weight	3.0kg (6.6 lb)

6-1.2 Performance of pump (in pure water)

Self-suction performance	Voltage	11.5V
	Max. self-suction lift	1.2m (3.94 ft)
	Self-suction time	4 sec.
Pumping lift performance	Voltage	11.5V
	Current	8A
	Total lift	1m (3.28 ft)
	Lifting volume of water	17 l/min

6-2 Bilge strainer

