YANMAR
SERVICE MANUAL

MARINE DIESEL ENGINE

MODELS

1GM (10L)
2GM (F)(L)
3GM (D)(F)(L)
3HM (F)(L)

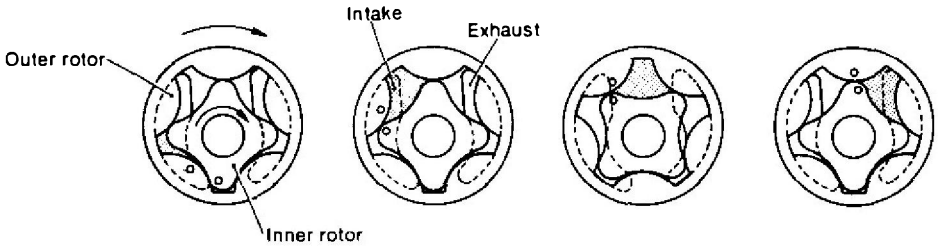
1-4 Table of capacity for lubricating oil system

			1GM	2GM	3GM(D)	3HM
Lubricating oil pump	Pump speed	rpm	2600	3600		3400
	Discharge volume	ℓ/min ℓ/h	3.9 234	12.5 760		12 720
	Discharge pressure	kg/cm² (lb/in.²)	3.5 ±0.5 (42.67 ~ 56.89)			
Lubricating oil filter	Filter capacity					
	Discharge pressure	kg/cm² (lb/in.²)	1 (14.22)			
Oil pressure regulator valve	Standard pressure	kg/cm² (lb/in.²)	3.5 ±0.5 (42.67 ~ 56.89)			
	Full open pressure (Max)	kg/cm² (lb/in.²)	4 (56.89)			
Lubricating oil pressure alarm switch	ON	kg/cm² (lb/in.²)	0.2 ±0.1 (1.422 ~ 4.266)			0.5±0.1 (5.689 ~ 8.534)
Lubricating oil tank	Crankcase oil capacity, Total (effective)	ℓ	1.3 (0.6)	2.0 (1.3)	2.7 (1.8)	5.5 (3.0)

2. Oil Pump

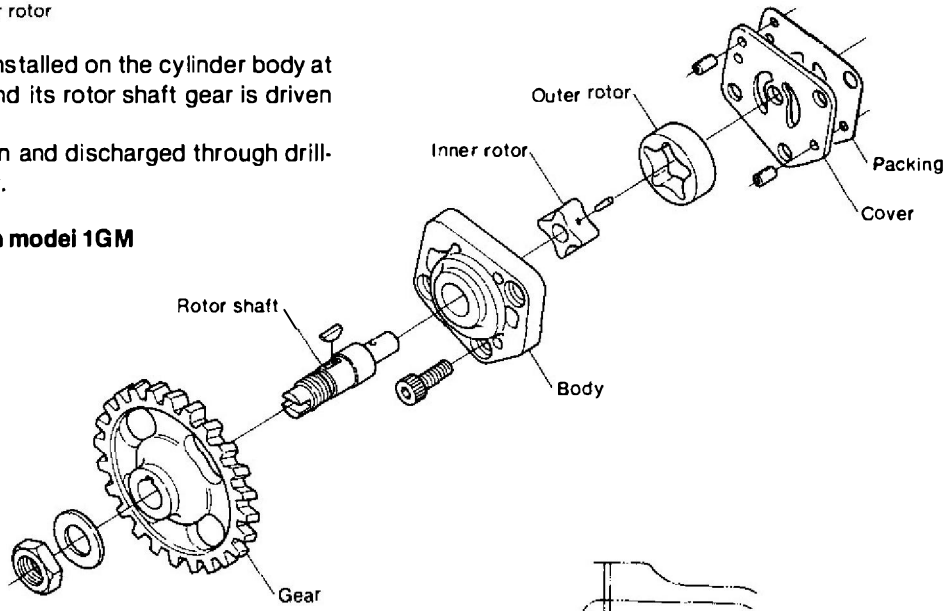
2-1 Construction

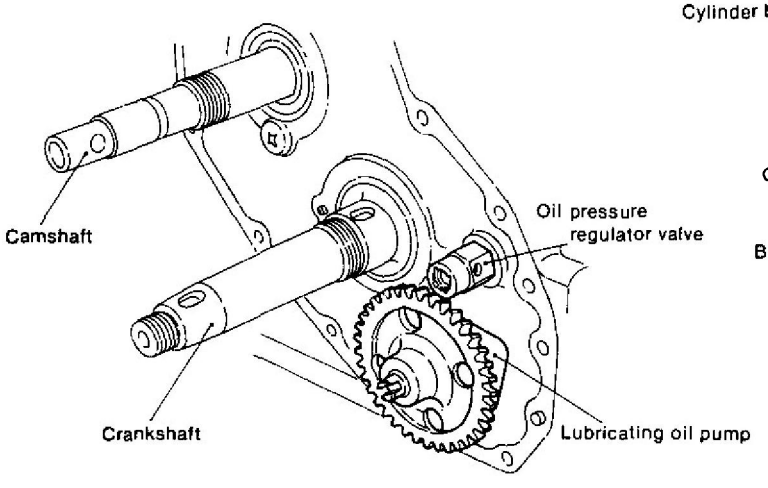
The oil pump is a compact, low pressure variation trochoid pump comprising a trochoid curve inner rotor and outer rotor. Pumping pressure is provided by the change in volume between the two rotors caused by rotation of the rotor shaft.

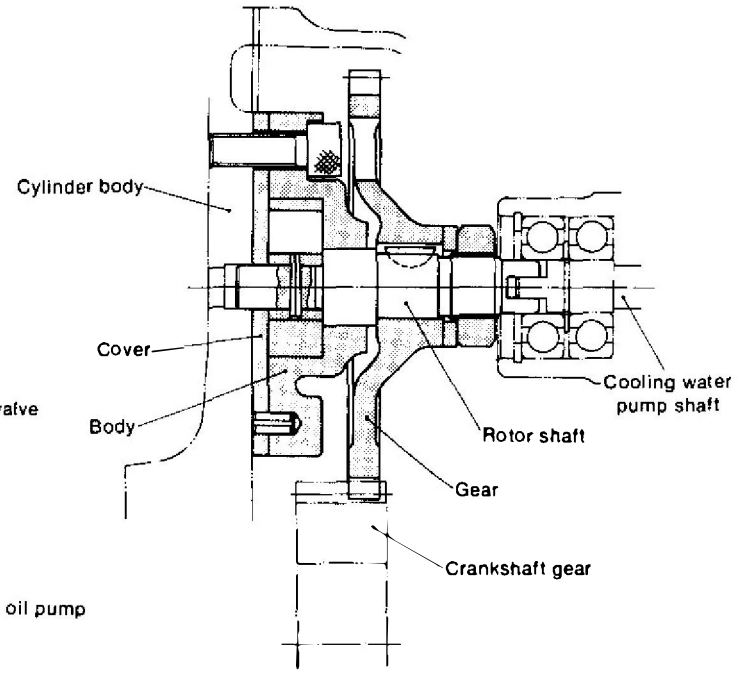


The lubricating oil pump is installed on the cylinder body at the timing gear case end, and its rotor shaft gear is driven by the crankshaft gear.
The lubricating oil is drawn in and discharged through drilled holes in the cylinder body.

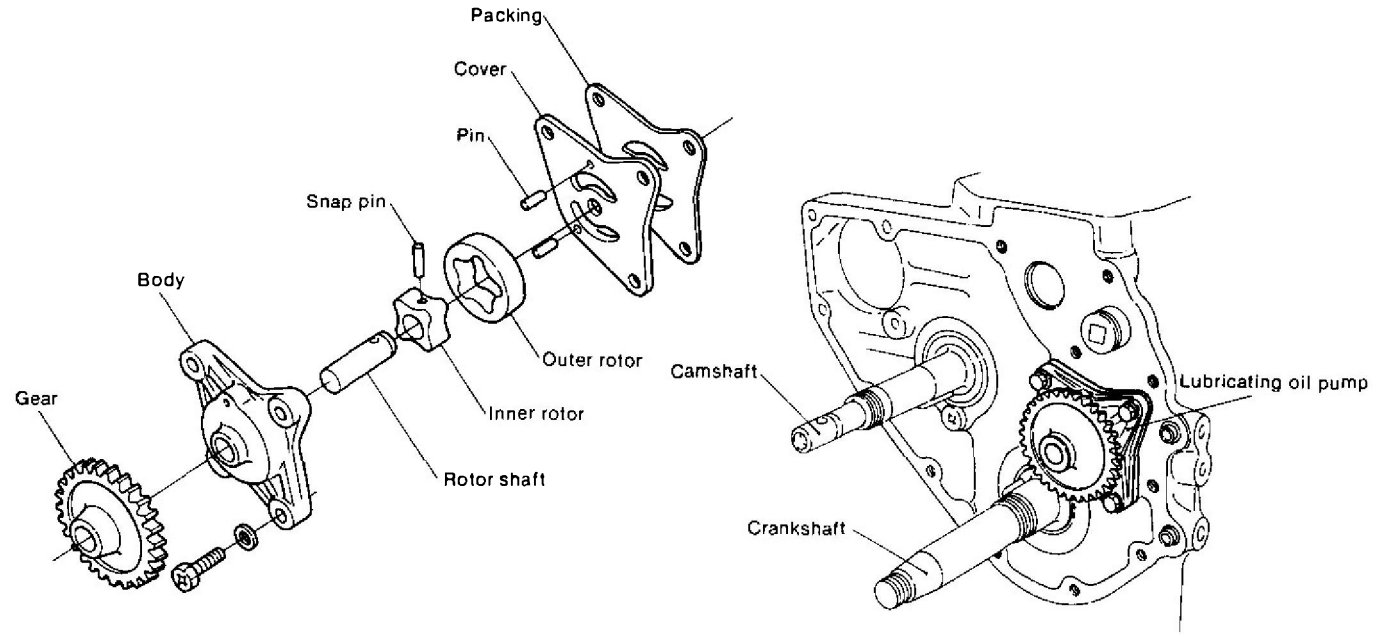
2-1.1 Lubricating oil pump on model 1GM

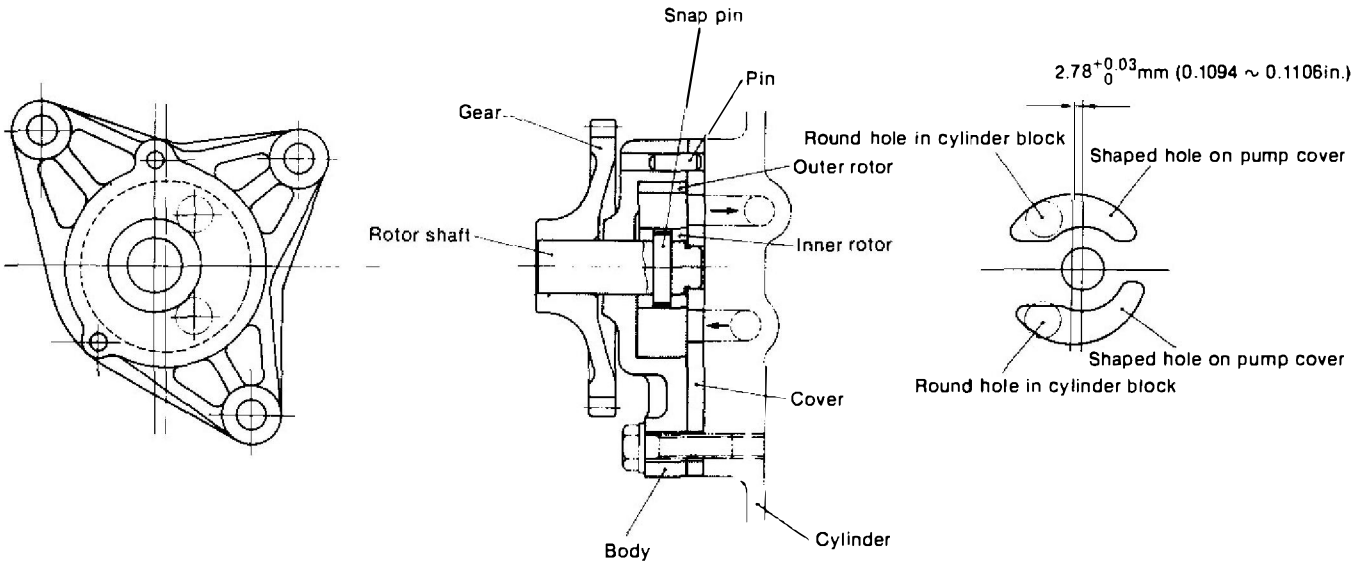






2-1.2 Lubricating oil pump on models 2GM, 3GM(D) and 3HM





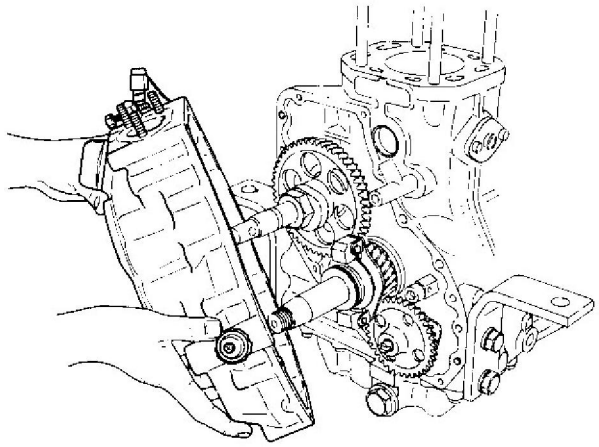
2-1.3 Specifications of lubrication oil pump

	1GM	2GM, 3GM(D)	3HM
Engine speed	3600 rpm	3600 rpm	3400 rpm
Pump speed	2600 rpm	3600 rpm	3400 rpm
Discharge volume	3.9 ℓ/min 234 ℓ/h	12.5 ℓ/min 760 ℓ/h	12 ℓ/min 720 ℓ/h
Discharge pressure	3.5 ±0.5 kg/cm² (42.67 ~ 56.89 lb/in.²)	3.5 ±0.5 kg/cm² (42.67 ~ 56.89 lb/in.²)	3.5 ±0.5 kg/cm² (42.67 ~ 56.89 lb/in.²)

2-2 Disassembly

2-2.1 Model 1GM

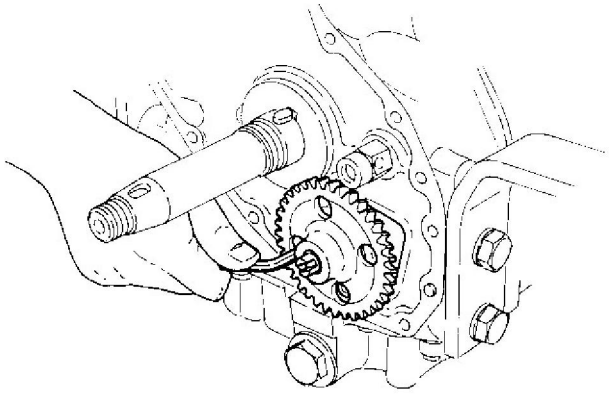
(1) Remove the timing gear case



(1') Remove gear case
(2) Withdraw the governor sleeve and thrust bearing, and also take out the governor weight support after removing the hexagonal nut.

NOTE: The lubricating oil pump drive gear cannot be removed without removing the governor weight support.

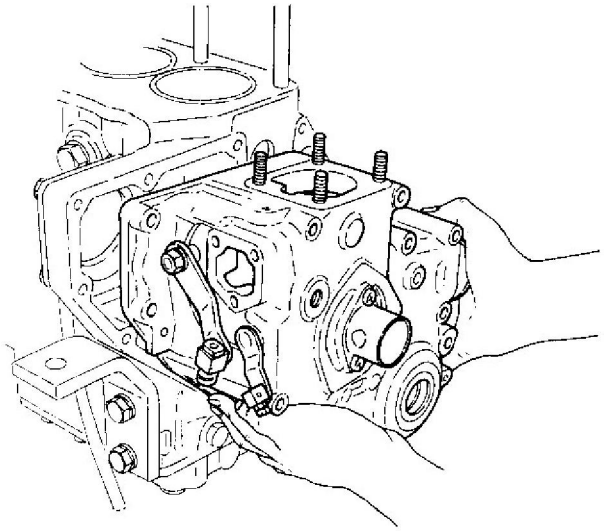
(3) Remove the hexagonal nut of the lubricating oil pump rotor shaft, then remove the pump drive gear.
(4) Remove the pump body from the cylinder by removing the fixing bolt with a hexagonal bar spanner.
(4') Loosening bolt with a hexagonal bar spanner.



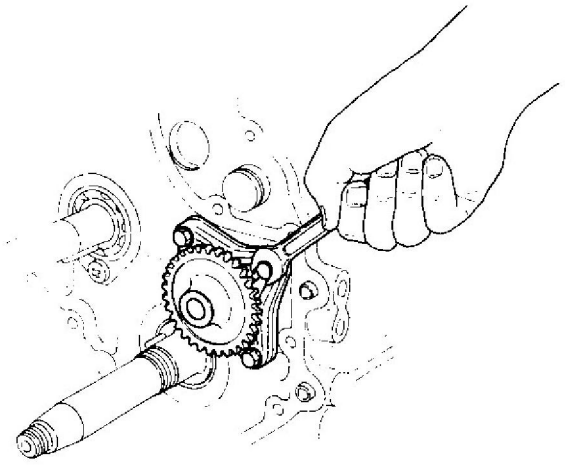
(5) Remove the pump cover.
(6) Take out the outer rotor and the assembly of inner rotor and rotor shaft.

2-2.2 Models 2GM, 3GM(D) and 3HM

(1) Remove the timing gear case.



(2) Remove the lubricating oil pump driving gear and pump assembly.



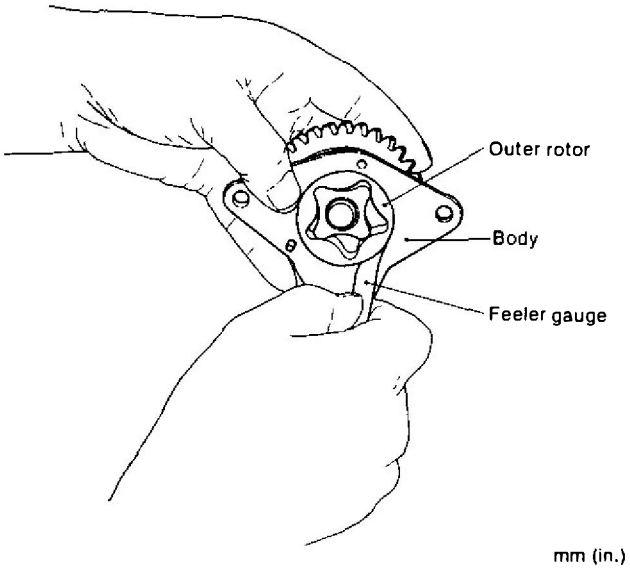
NOTE: Do not separate the lubricating pump gear from the rotor shaft. If removed, it cannot be used again. When any part is unusable, replace it as a complete assembly.

2-3 Inspection

When the discharge pressure of the oil pump is extremely low, check the oil level. If it is within the prescribed range, the oil pump must be inspected.

(1) Outer rotor and pump body clearance

Measure the clearance by inserting a feeler gauge between the outside of the outer rotor and the pump body casing. If the clearance exceeds the wear limit, replace the outer rotor and pump body as a set.

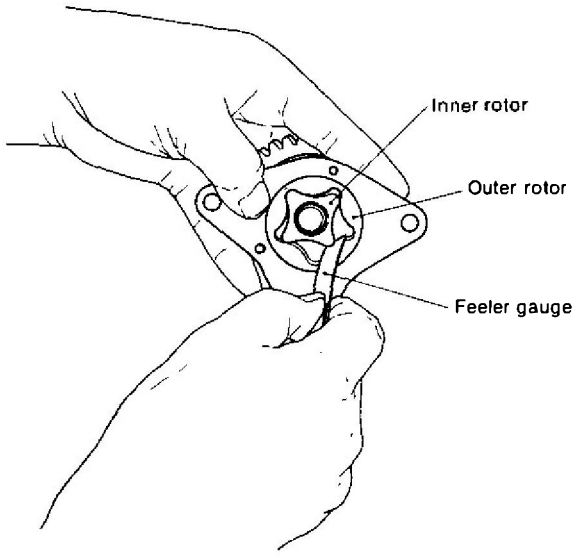


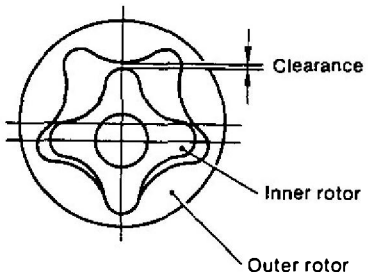
mm (in.)

Maintenance standard	0.050 ~ 0.105 (0.00197 ~ 0.00413)
Wear limit	0.15 (0.00591)

(2) Outer rotor and inner rotor clearance

Fit one of the teeth of the inner rotor to one of the grooves of the outer rotor and measure the clearance at the point where the teeth of both rotors are aligned. Replace the inner rotor and outer rotor ass'y if the wear limit is exceeded.





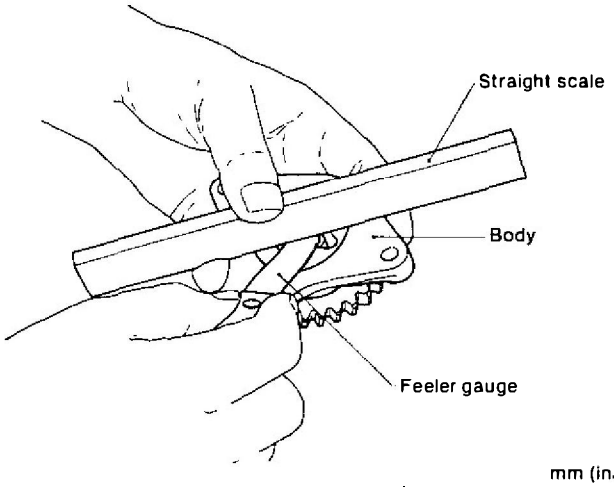
mm (in.)

Maintenance standard	0.050 ~ 0.105 (0.00197 ~ 0.00413)
Wear limit	0.15 (0.00591)

(3) Pump body and inner rotor, outer rotor side clearance

Install the inner rotor and outer rotor into the pump body casing so that they fit snugly.

Check the clearance by placing a ruler against the end of the body and inserting a feeler gauge between the ruler and the end of the rotor. Replace as a set if the wear limit is exceeded.



mm (in.)

	1GM	2GM, 3GM(D), 3HM
Maintenance standard	0.03 ~ 0.08 (0.0012 ~ 0.0031)	0.03 ~ 0.07 (0.0012 ~ 0.0031)
Wear limit	0.13 (0.0051)	0.13 (0.0051)

(4) Rotor shaft and body clearance

Measure the outside diameter of the rotor shaft and the inside diameter of the body shaft hole, and replace the rotor shaft and body as an ass'y if the clearance exceeds the wear limit.

mm (in.)

	1GM		
	Maintenance standard	Clearance when assembled	Maximum allowable clearance
Rotor shaft outside diameter	ø14 (0.5512)	0.015~0.050 (0.0006~0.0020)	0.2 (0.0079)
Rotor shaft hole inside diameter	ø14 (0.5512)		

3. Oil Filter

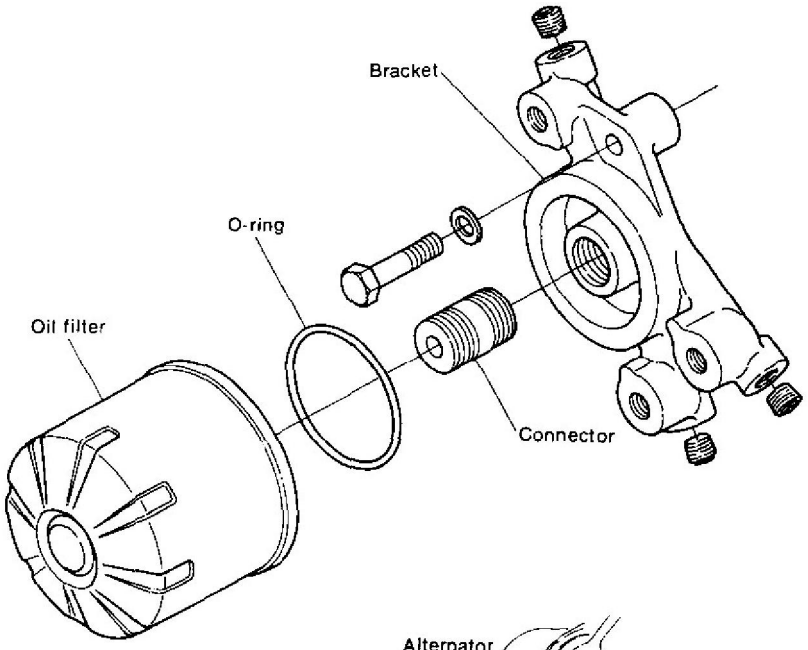
3-1 Construction

The oil filter removes the dirt and metal particles from the lubricating oil to minimize wear of moving parts. The construction of the oil filter is shown below.

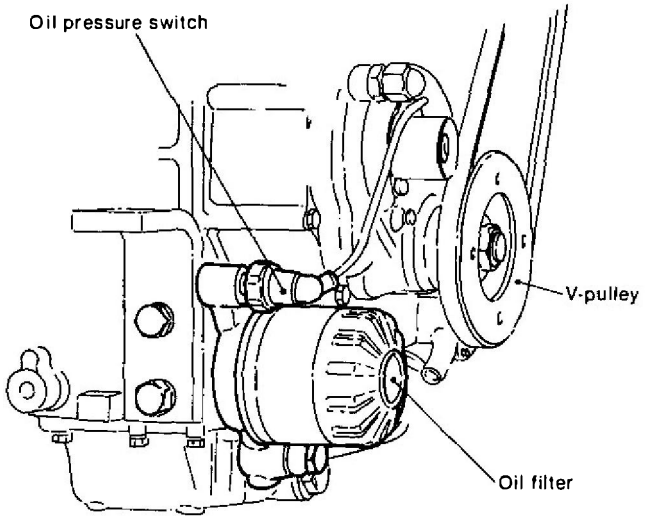
The lubricating oil from the oil pump is passed through the filter paper and distributed to each part as shown by arrow A in the figure.

After extended use, the filter paper will become clogged and its filter performance will drop. When the pressure loss caused by the filter paper exceeds 1 kg/cm² (14.22 lb/in.²), the bypass valve inside the filter opens and the lubricating oil is sent to each part automatically as an emergency measure, without passing through the filter, as shown by arrow B.

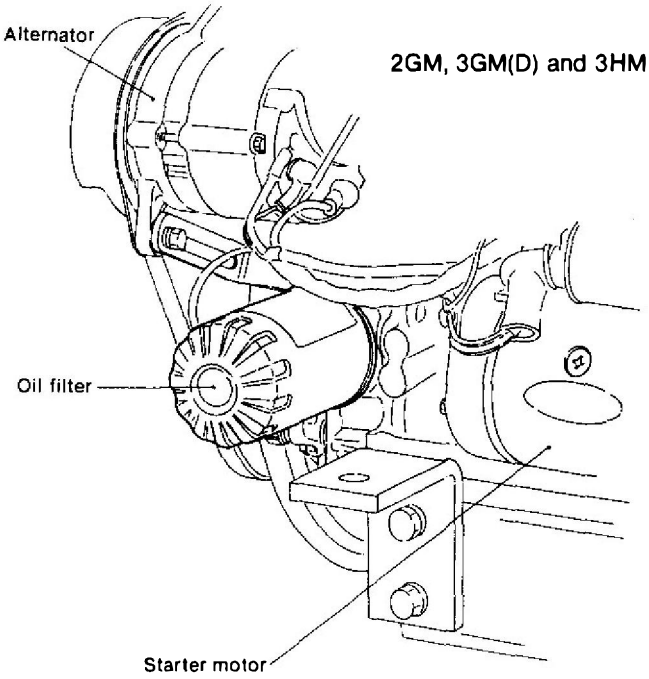
The oil filter is located at the fitted position of the oil pressure regulator valve on the side surface of the gear case together with the oil pressure valve for engine models 2GM, 3GM(D) and 3HM. However, in the case of engine model 1GM, the filter alone is fitted on its mounting base at the gear case end, cylinder end surface. The oil pressure regulator valve is installed separately on the end surface of the cylinder, in the gear case.



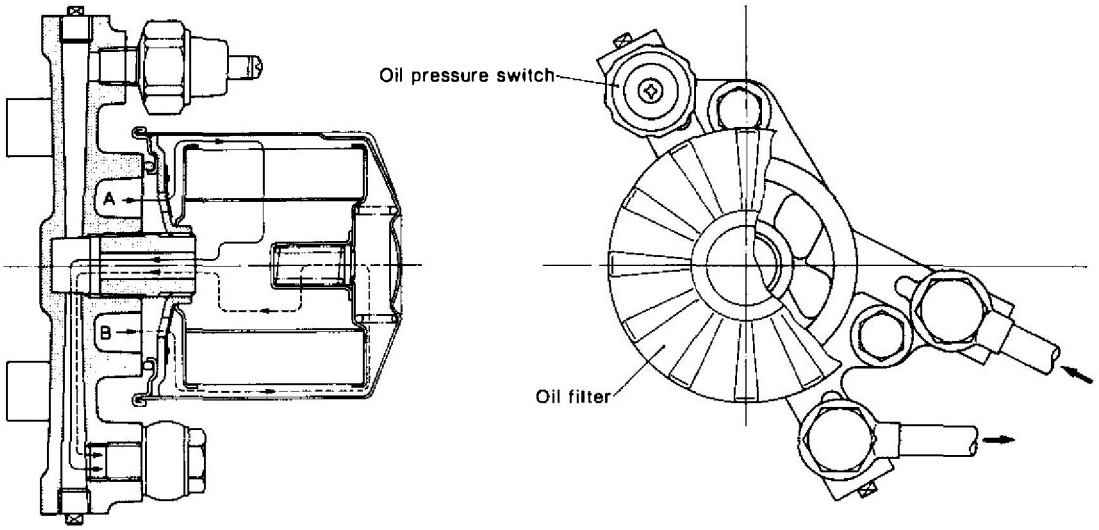
1GM



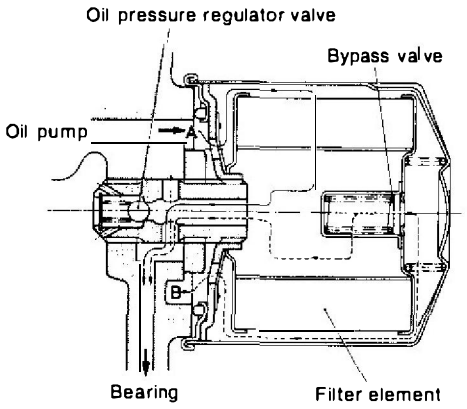
2GM, 3GM(D) and 3HM



1GM



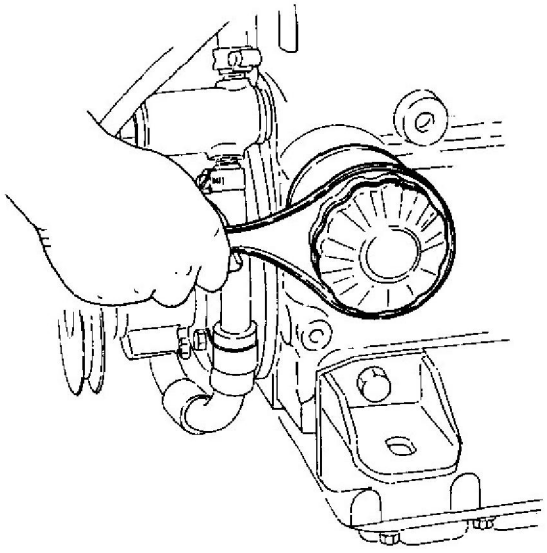
2GM, 3GM(D) and 3HM



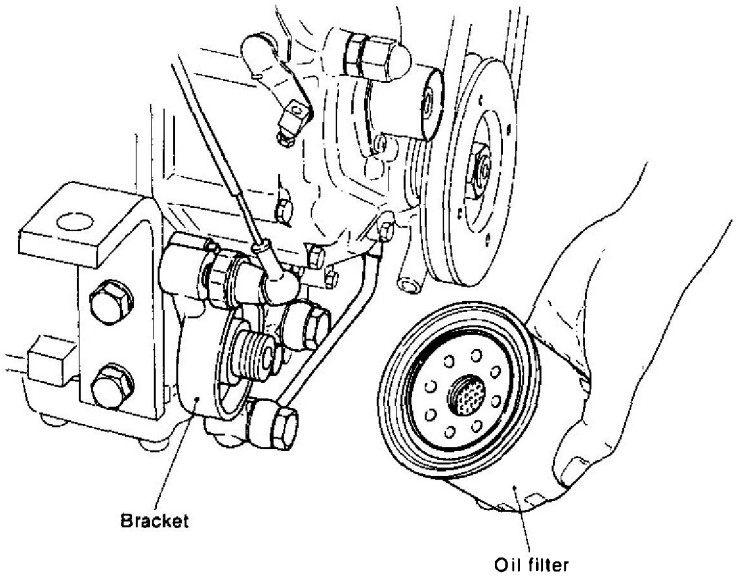
3-2 Replacement

When the oil filter has been used for an extended period, the filter paper will become clogged, unfiltered lubricating oil will be sent directly to each part from the bypass circuit, and wear of moving parts will be accelerated. Therefore, it is important that the filter be periodically replaced.
Because this oil filter is a cartridge type, it is replaced as a complete unit.

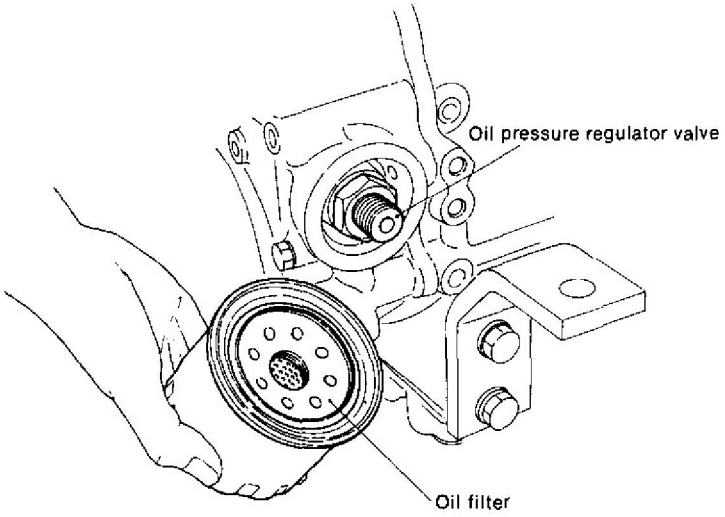
Oil filter replacement period	Every 300 hours of engine operation



1GM



2GM, 3GM(D) and 3HM



3-2.1 Replacing the oil filter

(1) Clean the oil filter mounting face on the cylinder block.
(2) Before installing the new filter, coat the rubber packing with a thin coat of lubricating oil.
(3) Turn the filter gently until it contacts the rubber packing of the seal surface, then tighten another 2/3 turn.
(4) After installation, run the engine and check the packing face for oil leakage.

3-2.2 In case of oil leakage

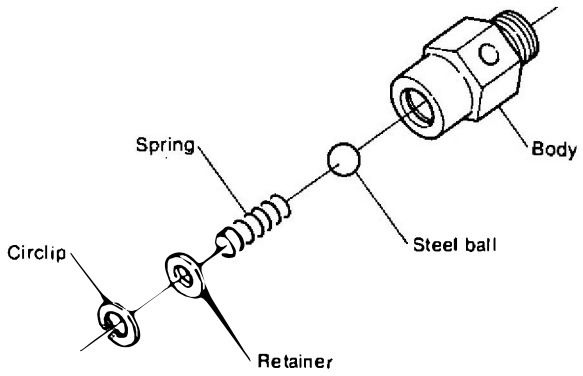
If there is oil leakage, remove the oil filter and replace the packing. At the same time, inspect the cylinder block mounting face and repair the face with an oil stone if it is scored.

4. Oil Pressure Regulator Valve

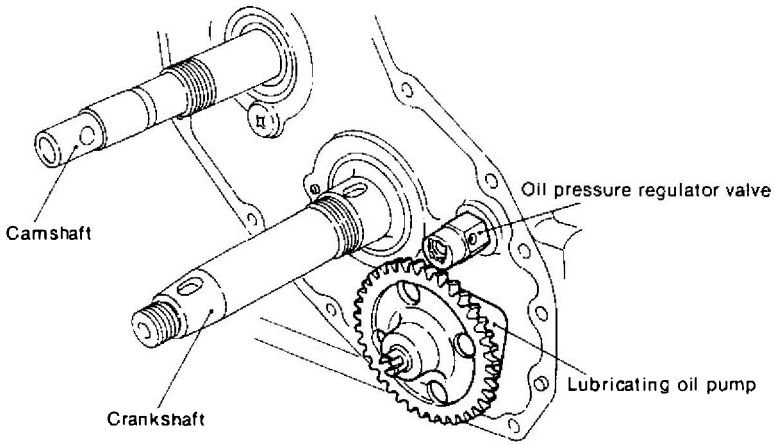
4-1 Construction

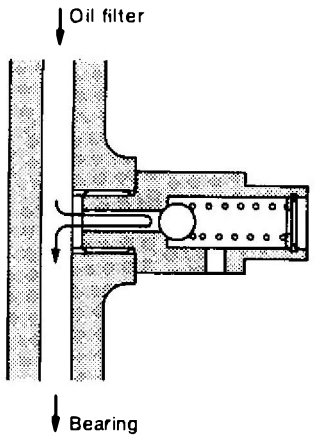
The oil pressure regulator valve serves to adjust the pressure of the lubricating oil to the prescribed pressure during operation. When the pressure of the lubricating oil from the oil filter exceeds the force of the spring, the metal ball is pushed away from the valve seat and the lubricating oil flows to the oil pan through the gap between the ball and seat. The spring's force is adjusted with a shim.
In engine model 1GM, the oil pressure regulator valve is located at the end surface of the cylinder in the gear case and the pressure is regulated at the intermediate section of the oil passageway between the lubricating oil main gallery and the main bearing at the gear end.
The regulator valve is located in the mounting position of the lubricating oil filter at the timing gear case for engine models 2GM, 3GM(D) and 3HM.

4-1.1 Model 1GM



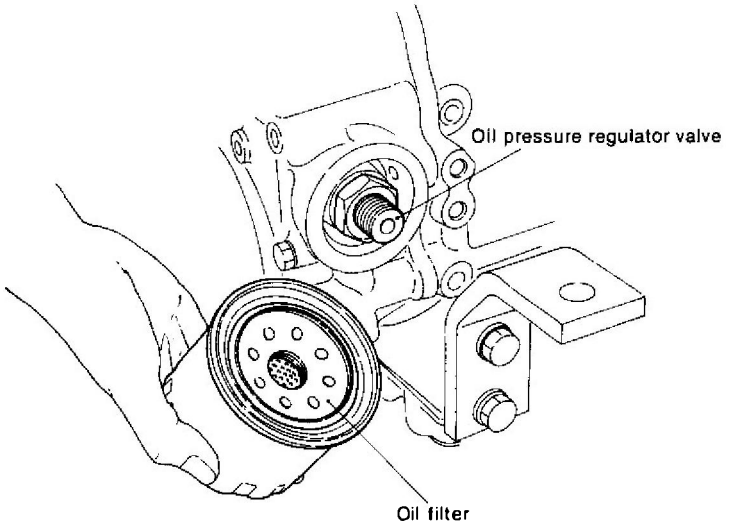
Mounting position for model 1GM

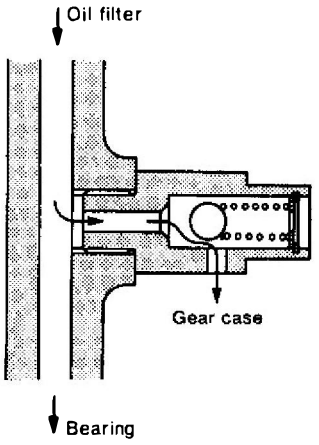




When the pressure is lower than the regulated pressure

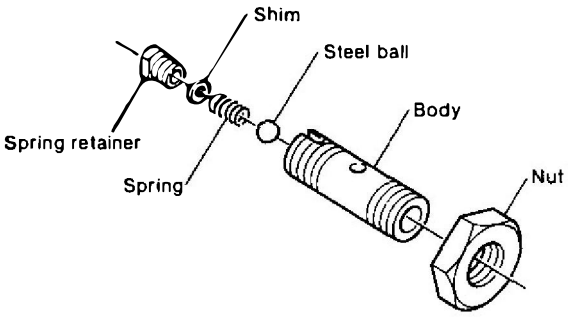
Mounting position for model 2GM

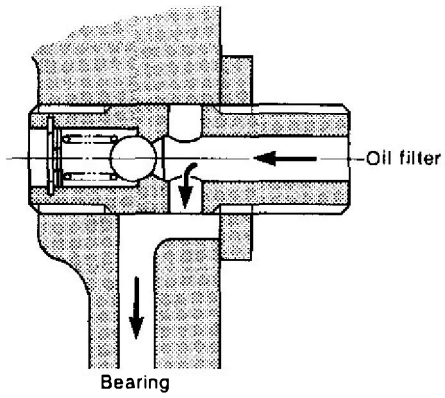




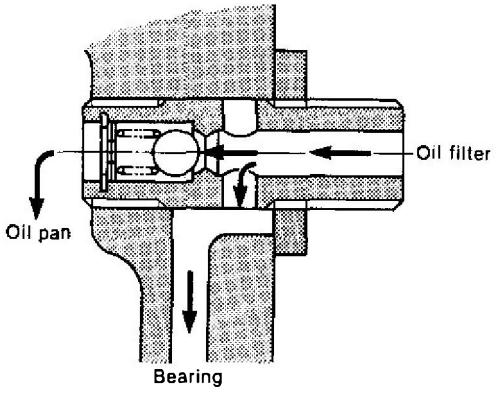
When the pressure is higher that the regulated pressure

4-1.2 Models 2GM, 3GM(D)and 3HM





When the pressure is lower that the regulated pessure



When the pressure is higher that the regulated pressure

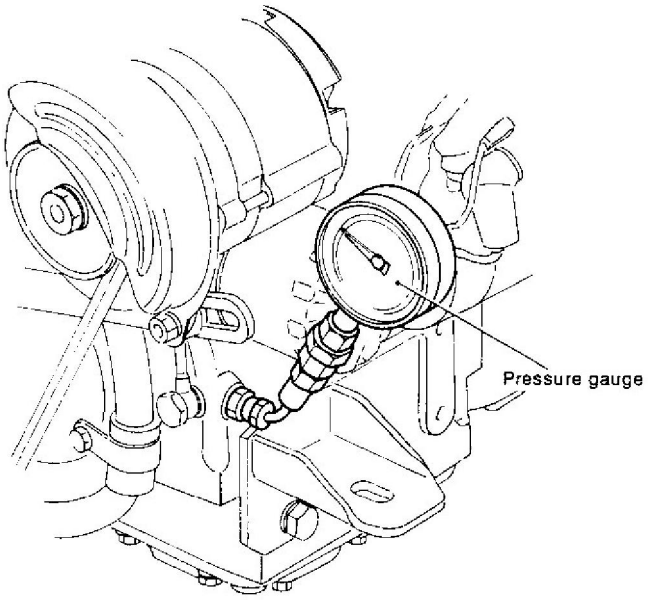
4-1.3 Specifications

	1GM	2GM,3GM(D),3HM
Standard pressure	3.5 ±0.5 kg/cm² (42.67 ~ 56.89 lb/in.²)	3.5 ±0.5 kg/cm² (42.67 ~ 56.89 lb/in.²)

As the lubricating oil pressure regulator valve has been calked during manufacture so that it cannot be dismantled, replace it as a unit if any replacement becomes necessary.

5. Oil Pressure Measurement

The lubricating oil pressure is monitored by a pilot lamp, but it must also be measured using a pressure gauge. Connect the oil pressure gauge to the pilot lamp unit for primary pressure and to the lubricating oil pipe connector forsecondary pressure, as shown in figure.
Secondary oil pressure is especially important. Idle the engine at medium speed when measuring the oil pressure. Also check whether the oil pressure rises smoothly and to the standard value.



kg/cm² (lb/in.²)

	1GM, 2GM, 3GM(D)		3HM	
	850 rpm	3600 rpm	850 rpm	3400 rpm
Secondary pressure standard value	0.5 (7.11)	3.5 ±0.5 (42.67~56.89)	0.5 (7.11)	3.5 ±0.5 (42.67~56.89)

If the oil pressure is lower than the standard value, probable causes are:
(1) Clearance of lubricated bearings in the lubricating oil circuit is too large (Shaft or bearing is worn).
(2) Excessive oil escaping from rocker arm support.
Therefore, inspection and repair of the bearings and rocker arm support are required.

CHAPTER 7

COOLING SYSTEM

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 an abnormal rise in the cooling water temperature is indicated at 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.

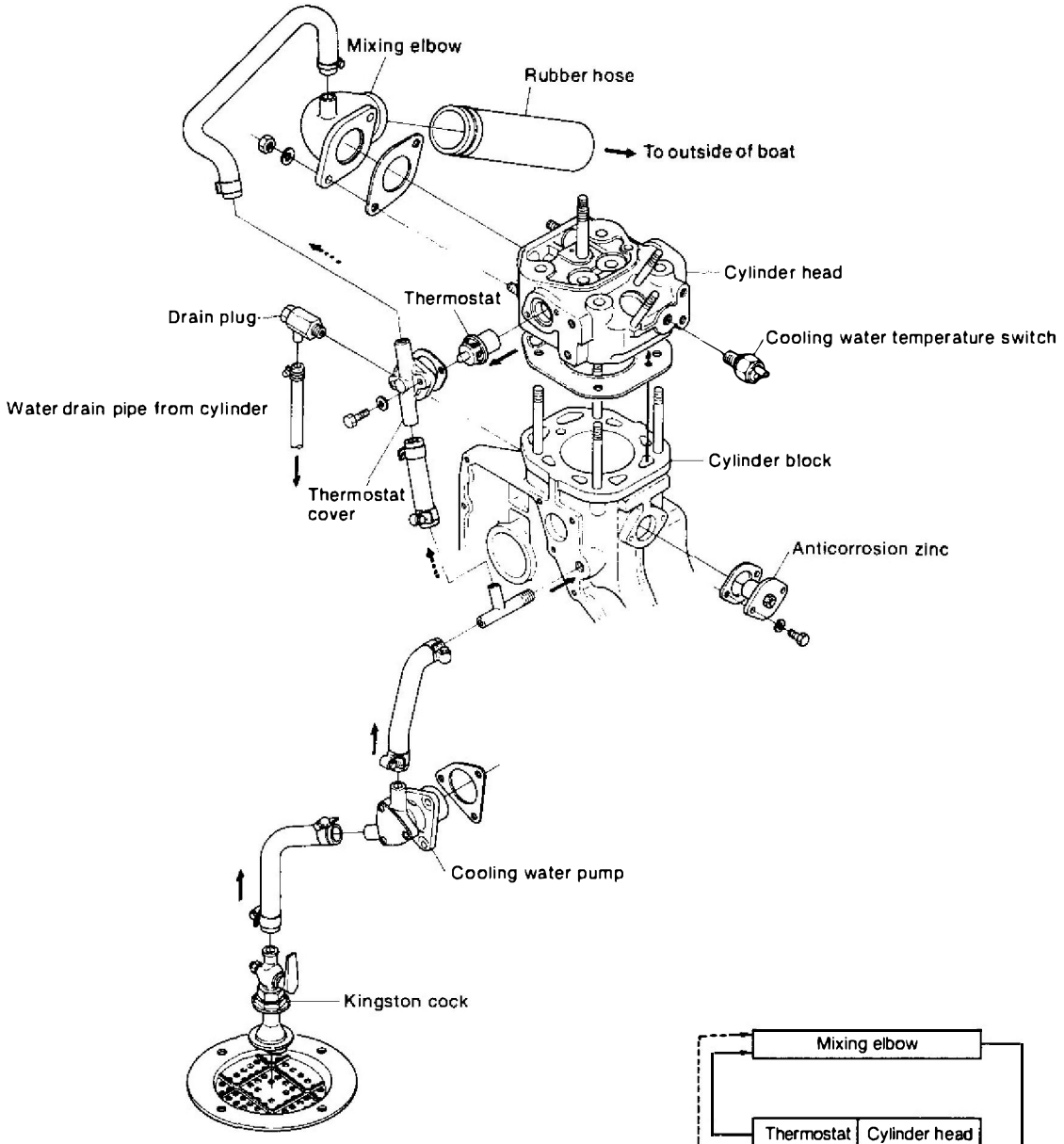
1-2 Cooling water route

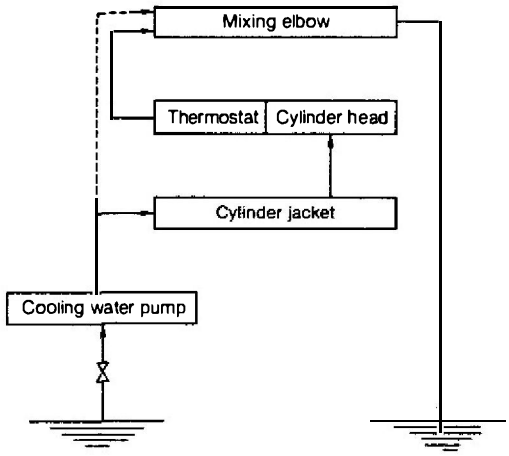
The cooling water is sucked up by the water pump through a Kingston cock installed on the hull. The water delivered from the water pump is branched in two directions at the cylinder intake coupling: one part of the water enters the cylinder jacket and the other bypasses the cylinder jacket and enters the mixing elbow (1GM, 2GM) or the exhaust manifold (3GM(D), 3HM).
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 cools the cylinder head.
The cooling water from the cylinder head, after passing the thermostat, enters the mixing elbow in models 1GM and 2GM. However, in models 3GM(D) and 3HM, it first passes to the exhaust manifold to cool 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 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 opened fully 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 checked 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.

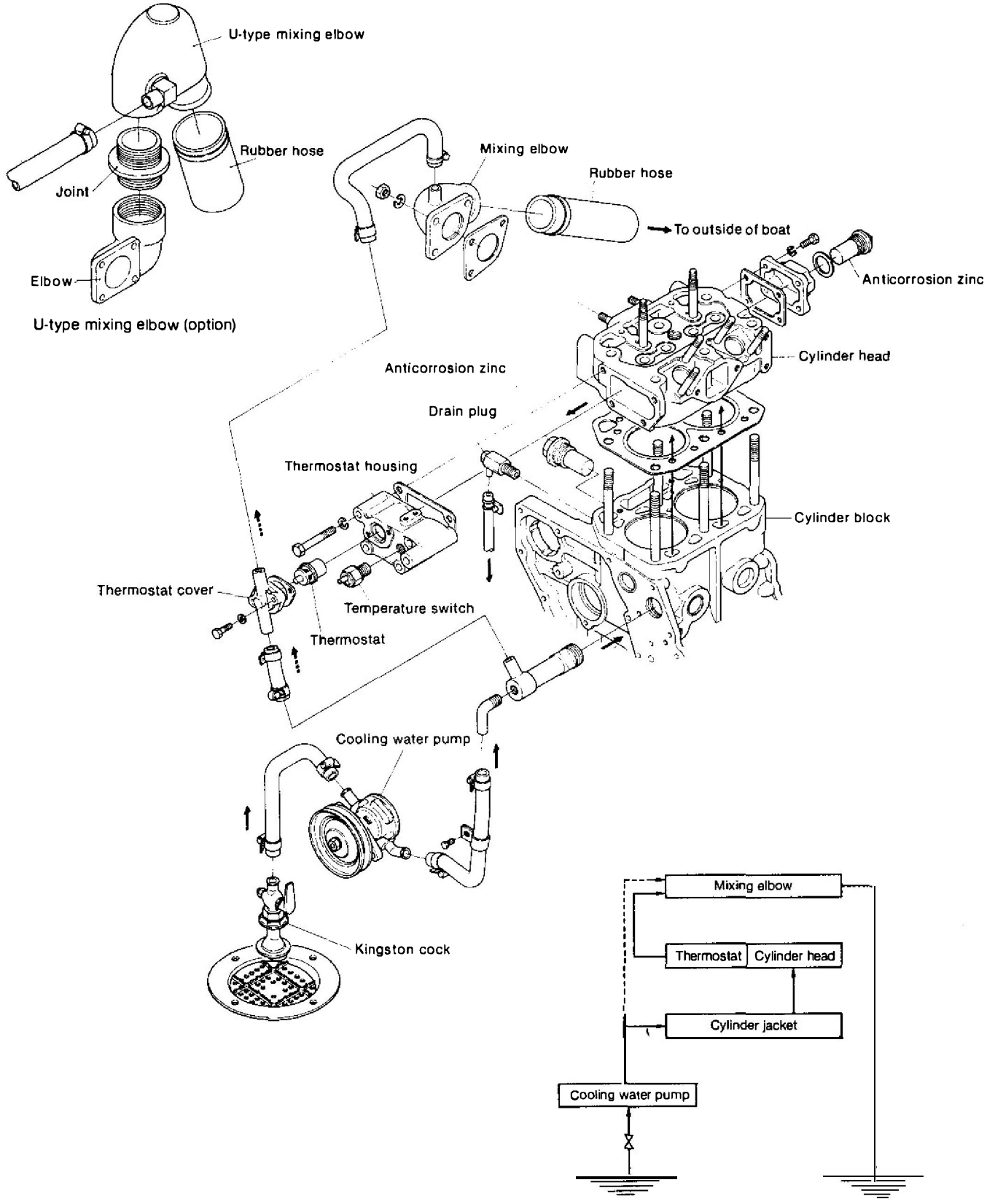
1-2.1 Cooling water passage of engine model 1GM





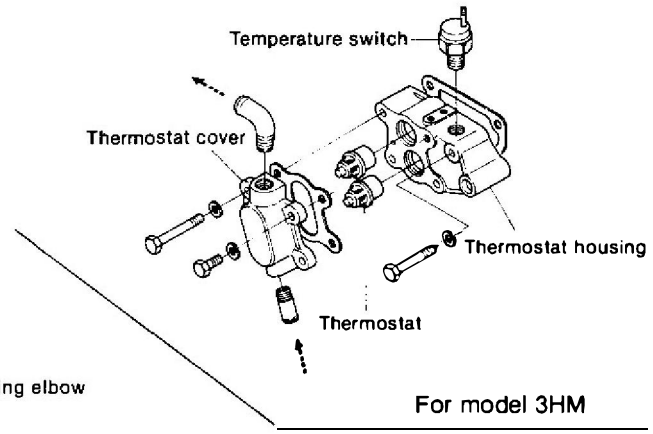
When the cooling water is at the correct temperature
When the cooling water temperature is lower than the correct temperature

1-2.2 Cooling water passage of engine model 2GM

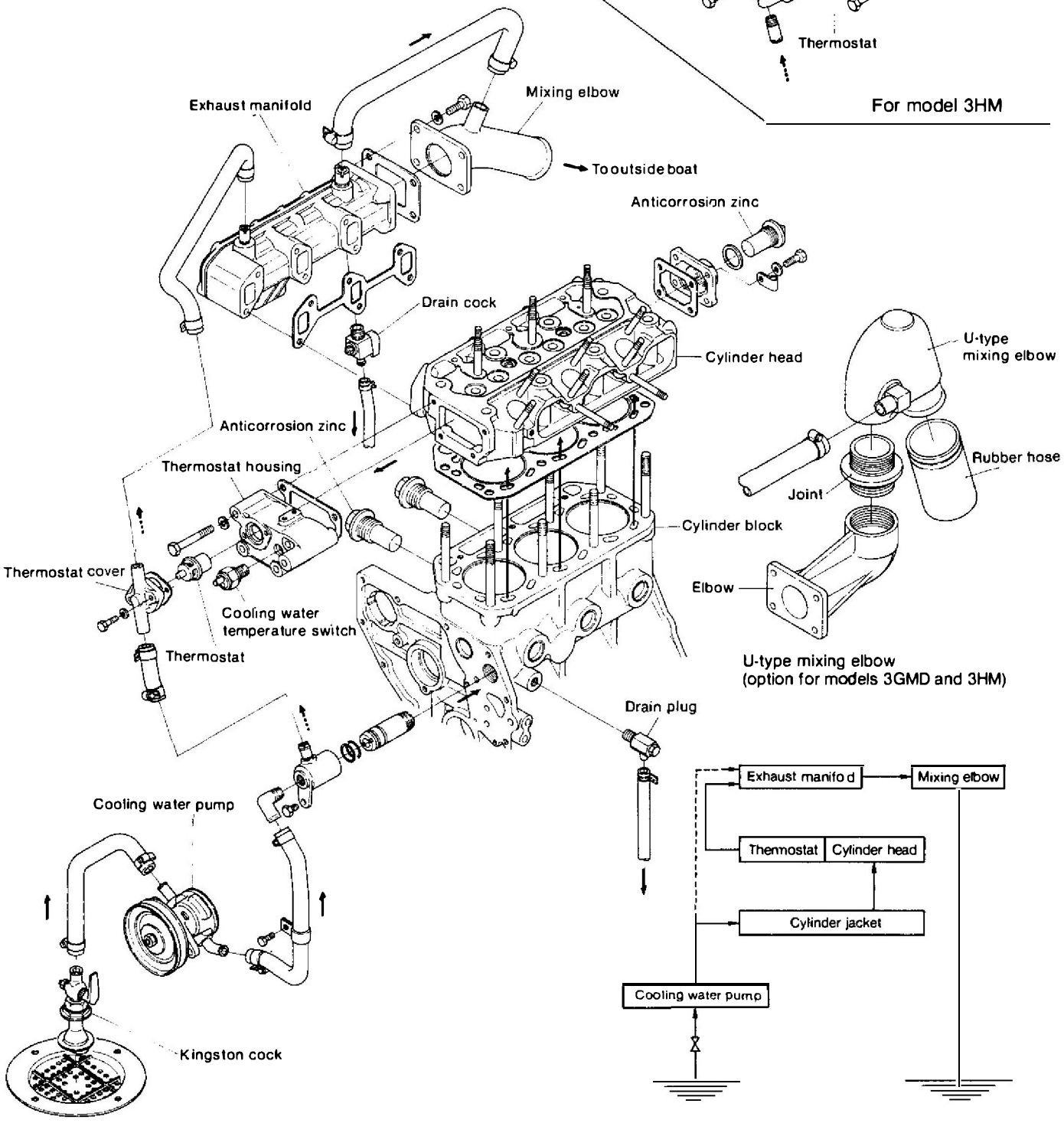


1-2.3 Cooling water passage of engine models 3GM(D) and 3HM

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



For model 3HM



U-type mixing elbow
(option for models 3GMD and 3HM)

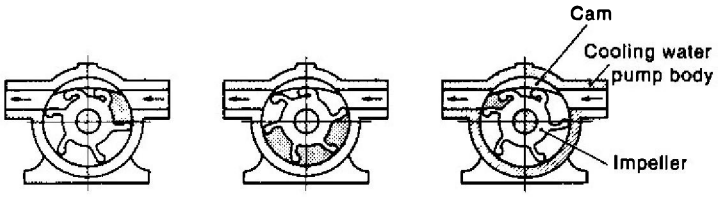
← When the cooling water is at the correct temperature
←··· When the cooling water temperature is lower than the correct temperature

2. Water Pump

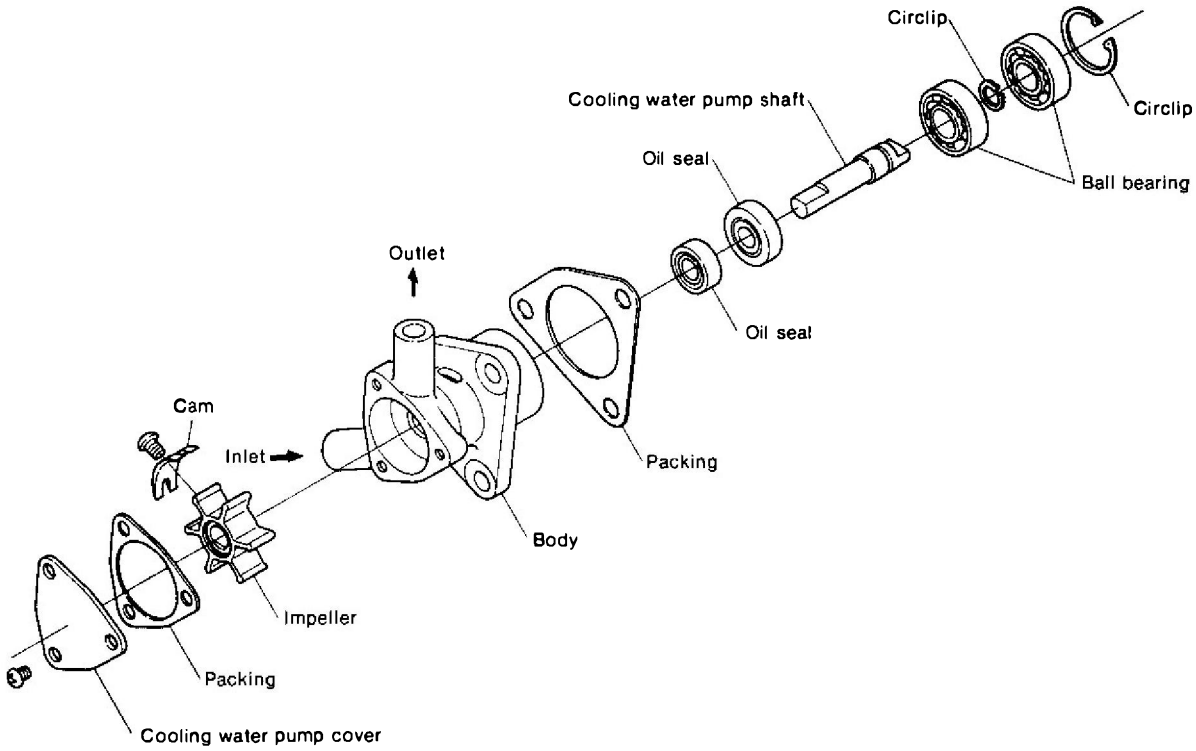
2-1 Construction and operation

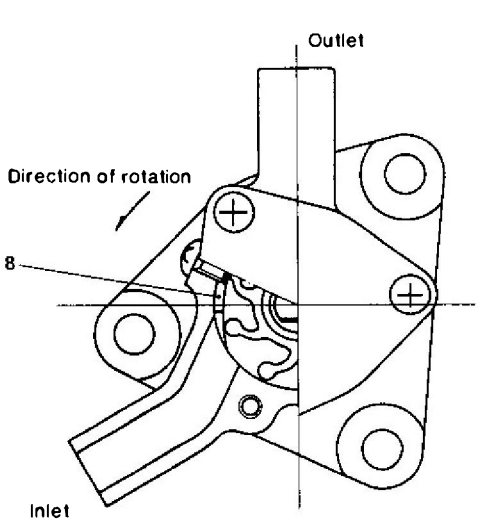
The water pump is a rubber impeller type pump. The rubber impeller, which has ample elasticity, is deformed by the off-set plate inside the casing, causing the water to be discharged. This pump is ideal for small, high-speed engines.

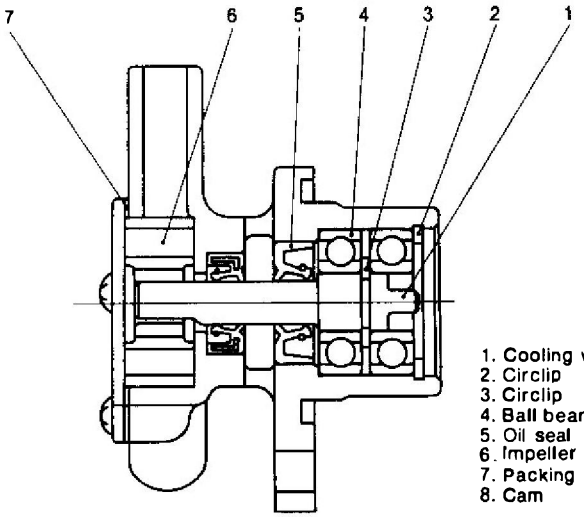
The cooling water pump of engine model 1GM is driven by connecting the cooling water pump shaft to the slit on the end of the lubricating oil pump drive shaft.



2-1.1 Cooling water pump of engine model 1GM

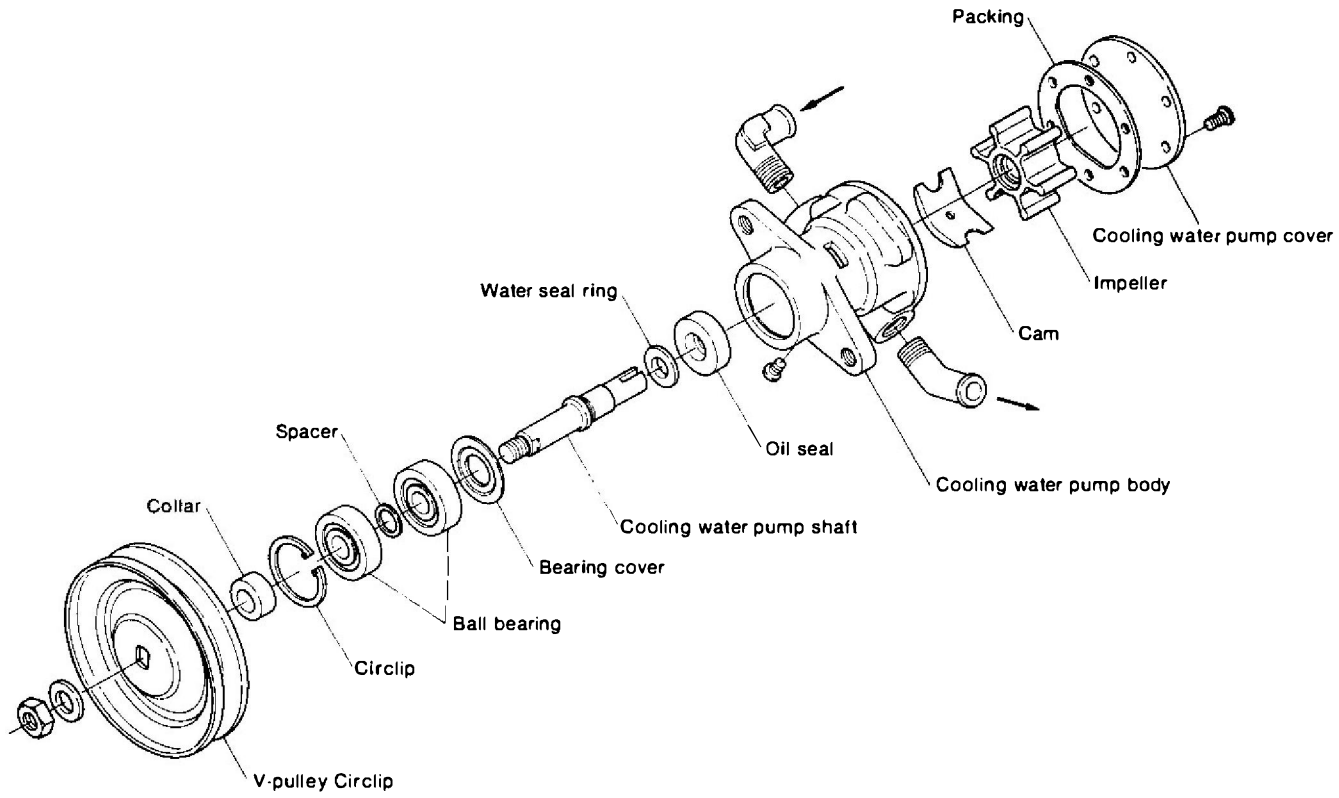






1. Cooling water pump shaft
2. Circlip
3. Circlip
4. Ball bearing
5. Oil seal
6. Impeller
7. Packing
8. Cam

2-1.2 Cooling water pump of engine models 2GM and 3GM(D)



10 8 7 6

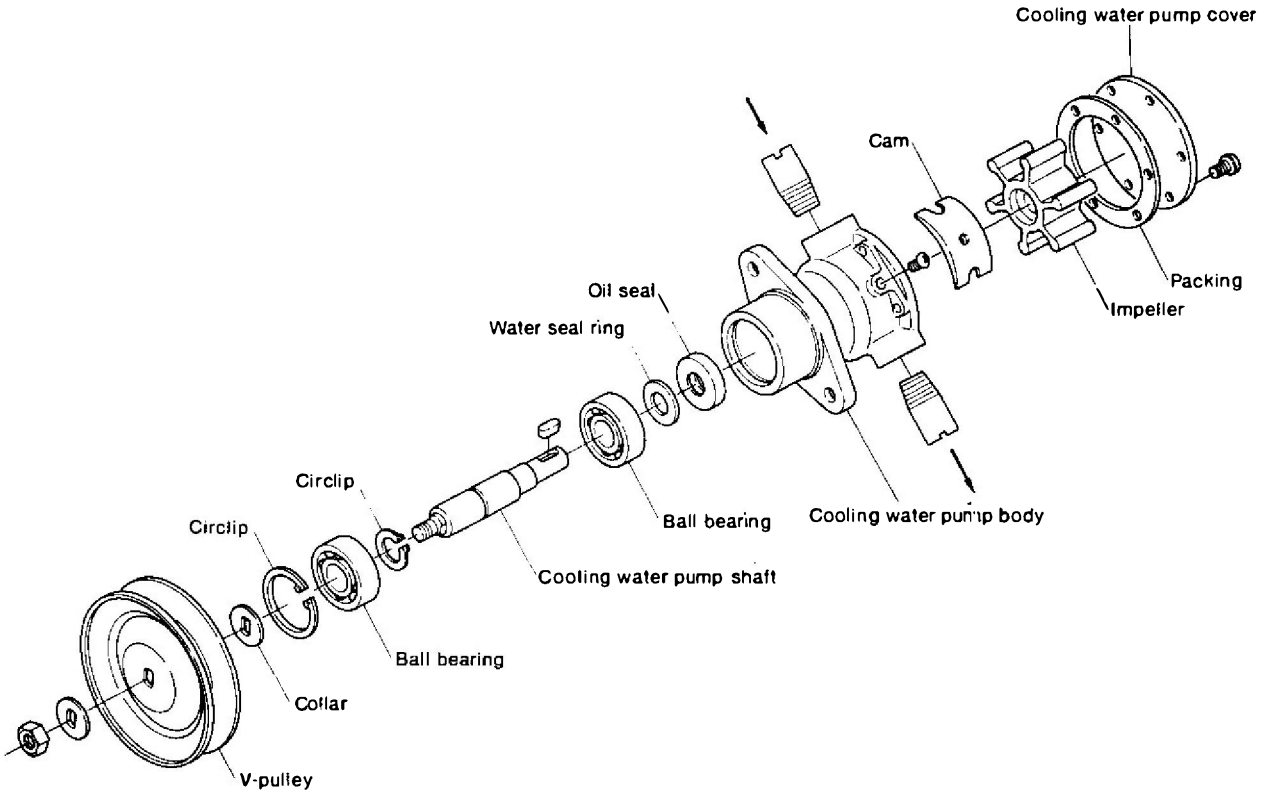
Direction of rotation

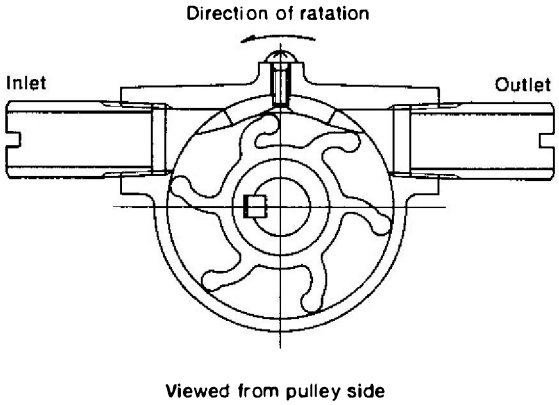
4

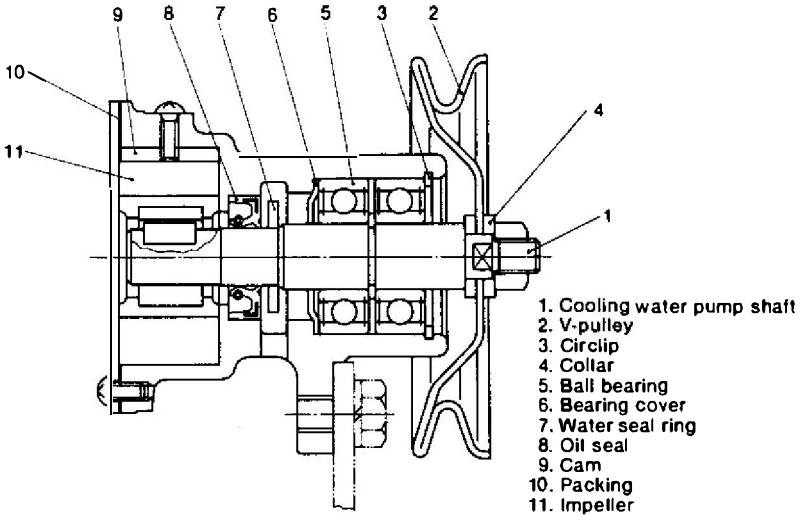
Inlet

1. Cooling water pump shaft
2. V-pulley
3. Circlip
4. Collar
5. Ball bearing
6. Bearing cover
7. Water seal ring
8. Oil seal
9. Cam
10. Packing
11. Impeller

2-1.3 Cooling water pump of engine model 3HM







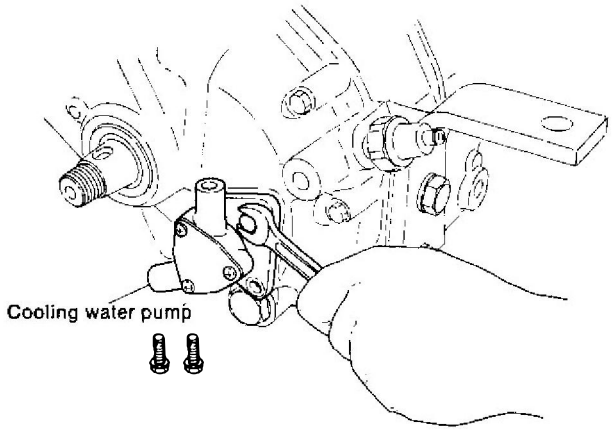
2-1.4 Specifications

	1GM	2GM, 3GM(D)	3HM
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 ℓ/h	700 ℓ/h	1500 ℓ/h

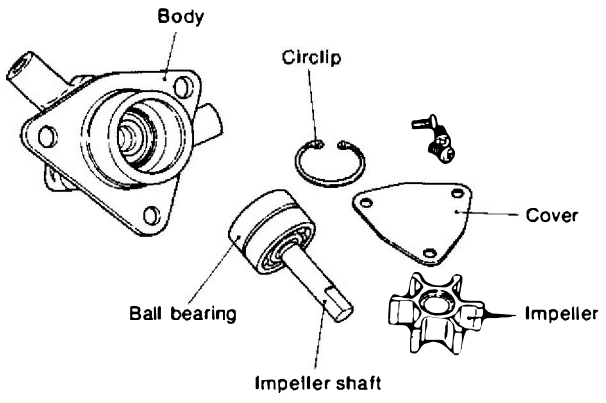
2-2 Disassembly

2-2.1 For model 1GM

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

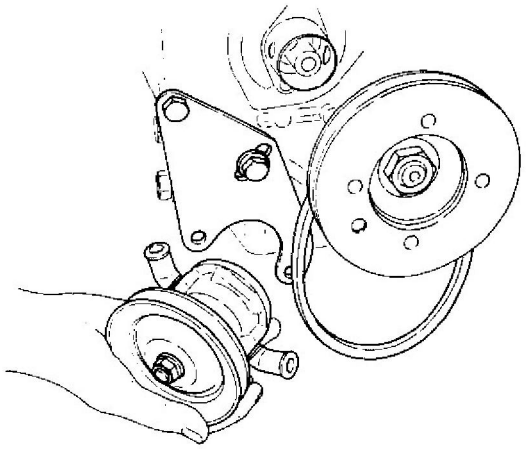


(2) Remove the cooling water pump cover and packing by removing the 3 screws which secure the cooling water pump cover.
(3) Pull the water pump impeller.
(4) Remove the set screw and remove the offset plate.
(5) Remove the bearing snap ring and remove the impeller shaft and bearing ass'y while tapping 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.

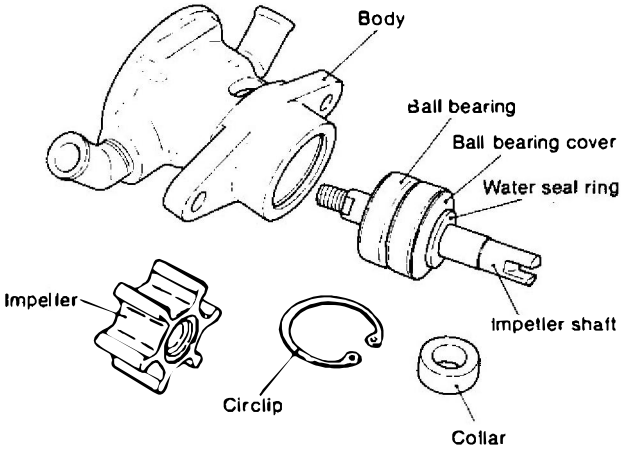


2-2.2 For models 2GM, 3GM(D) and 3HM

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

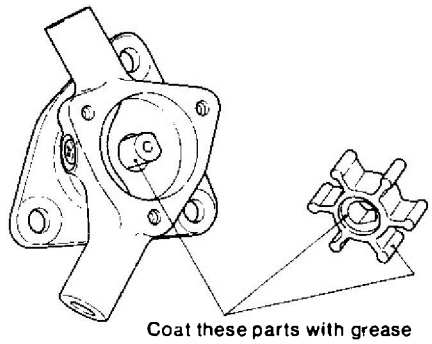


(2) Remove the cooling water pump bracket.
(3) Remove the V-pulley mounting bolt and V-pulley.
(4) Remove the cooling water pump cover fixing screws, and then remove the cooling water pump cover and packing.
(5) Pull the water pump impeller.
(6) Remove the set screw and remove the offset plate.
(7) In engine model 3HM, 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.



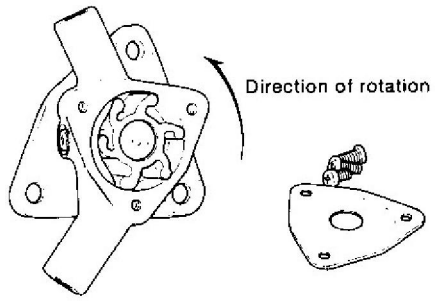
2-3 Reassembly precautions

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

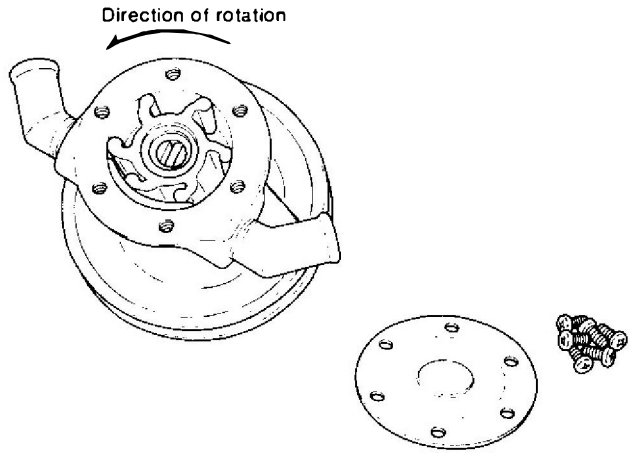


(2) Be sure that the direction of curving of the impeller is correct.
The impeller is curved in the direction opposite the direction of rotation.

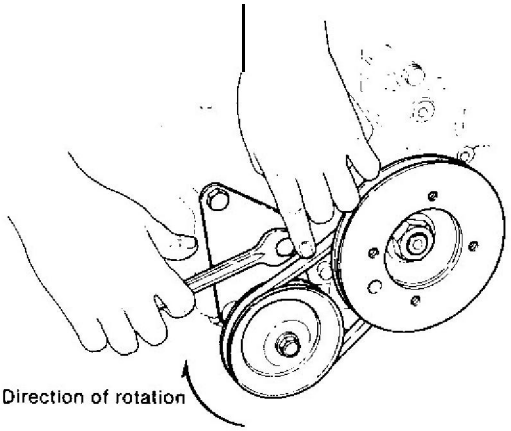
Model 1GM



Models 2GM, 3GM(D) and 3HM



(3) Adjust the V-belt tension. (for models 2GM, 3GM(D) and 3HM)
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.



	2GM	3GM(D)	3HM
V-belt tension	To be 5 ~ 7mm (0.1964 ~ 0.2756in.) deflection when pushed with 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 or 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

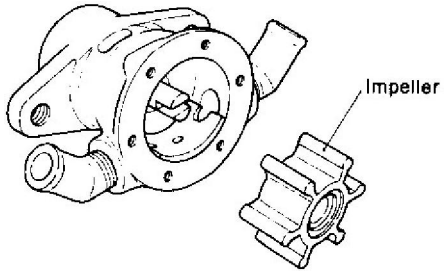
(1) Never operate the water pump dry as this will damage the rubber impeller.

(2) Always turn the engine in the correct direction of rotation as turning the engine in the opposite direction will damage the rubber impeller.

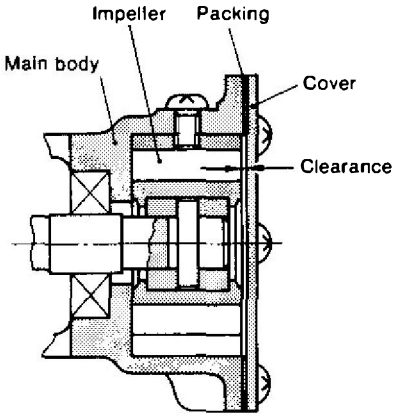
(3) Inspect the pump after every 1,500 hours of operation and replace if faulty.

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 1GM

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 2GM and 3GM(D)

mm (in.)

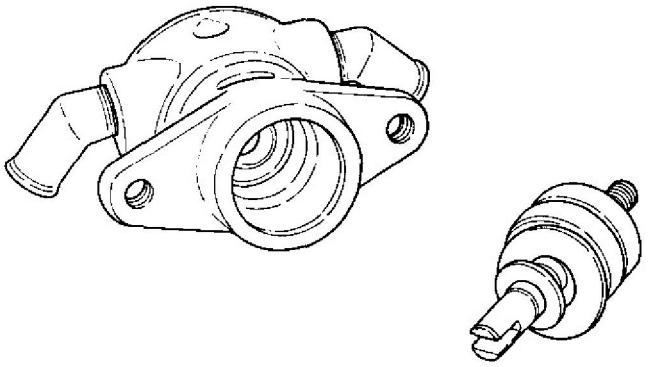
	Maintenance standard	Clearance at assembly	Maximum allowable clearance	Wear limit
Impeller width	19 ±0.1 (0.744 ~ 0.752)	0.2 (0.0079)	0.4 (0.0157)	—
Housing width	18.9 (0.7441) (without packing) 19.2 (0.7559) (with packing)			—
Wear plate wear	—			0.2 (0.0079)

3) Model 3HM

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.

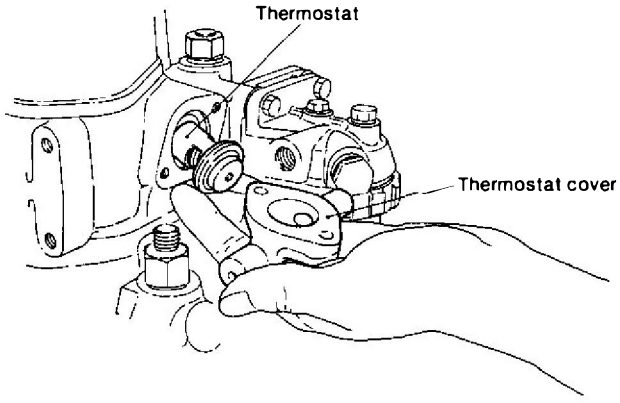
3. Thermostat

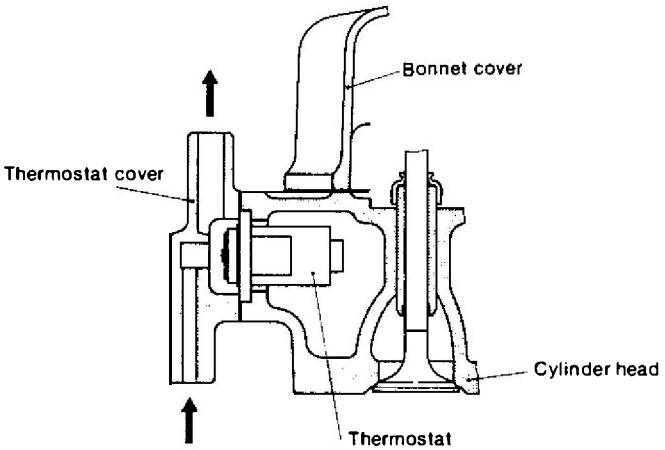
3-1 Construction and operation

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 a 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 a specified level.

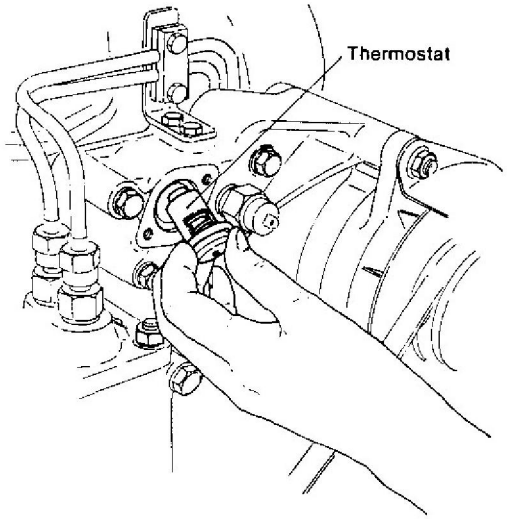
In engine model 1GM, the thermostat is mounted on the cylinder head at the gear case end. In engine models 2GM, 3GM(D) and 3HM, it is mounted on the thermostat housing which is combined with the generator mounting base on the cylinder head at the gear case end.

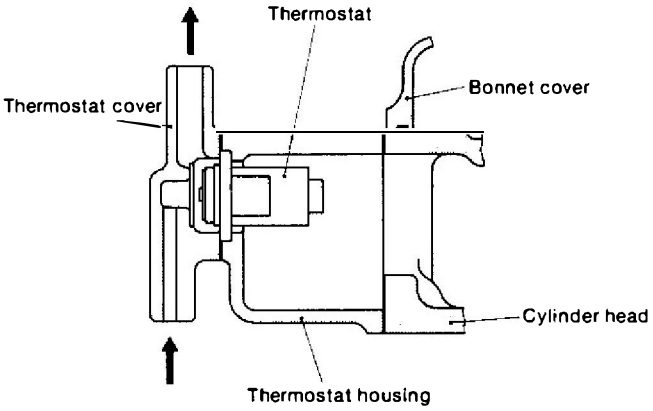
Model 1GM



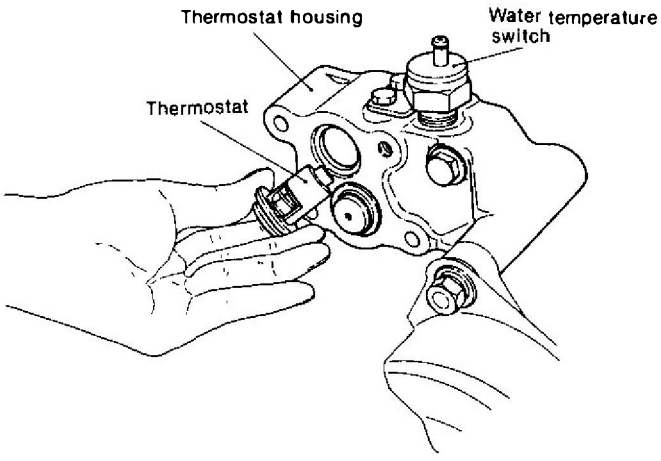


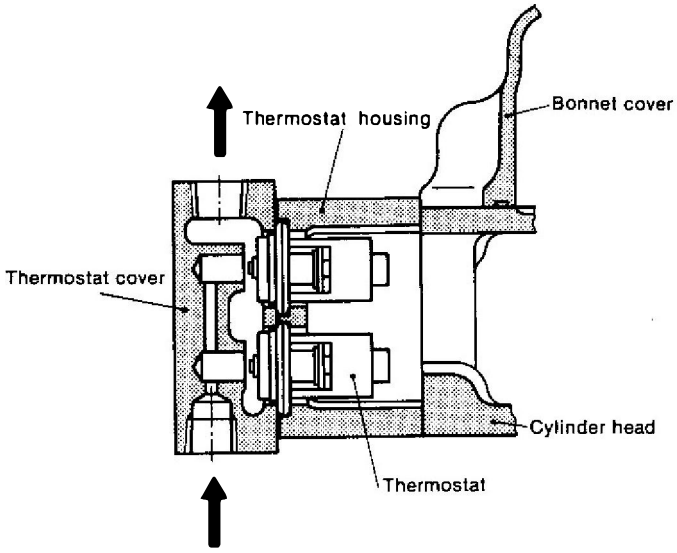
Models 2GM and 3GM(D)

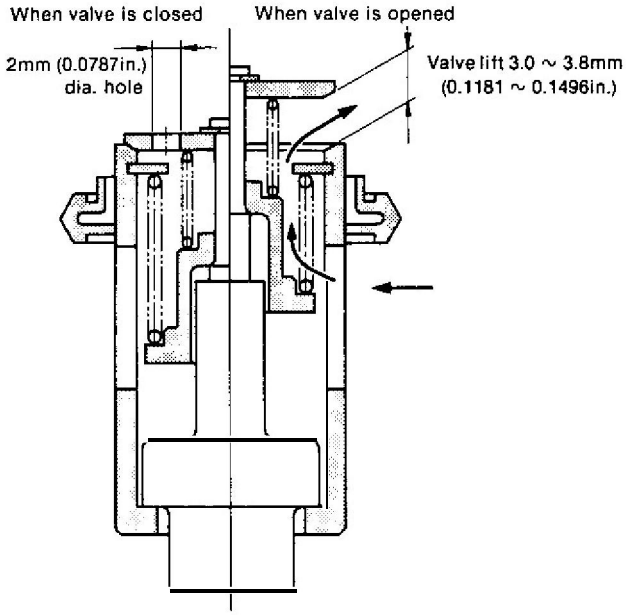




Model 3HM



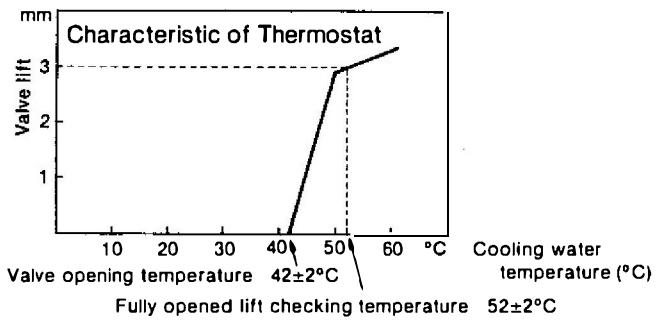




A wax-pellet type thermostat is used for this engine. The "wax-pellet" type is the description given to a quantity of wax in the shape of a small pellet. When the temperature of the cooling water rises, the wax melts and its volume expands. The valve is opened or closed by this variation of volume.

Thermostat operating temperature

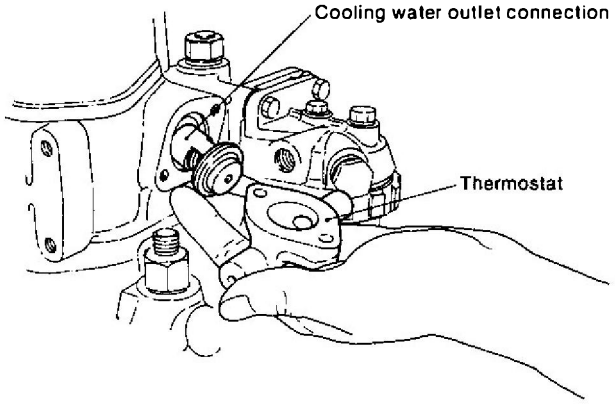
Opening temperature	42 ±2°C
Full open temperature	52 ±2°C



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 opened fully.

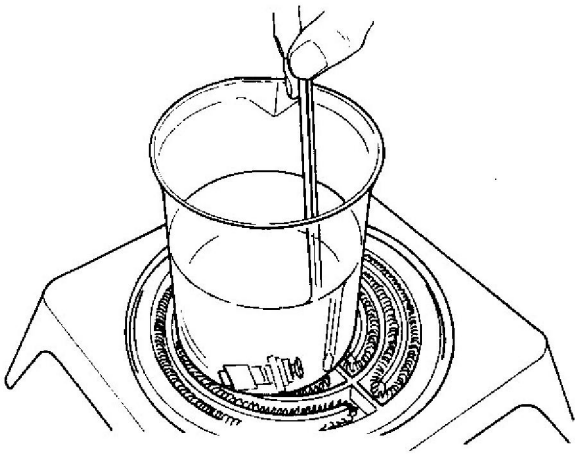
3-2 Inspection

(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 all right. 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 has risen abnormally and when white smoke is emitted for a long period of time after the engine starts.

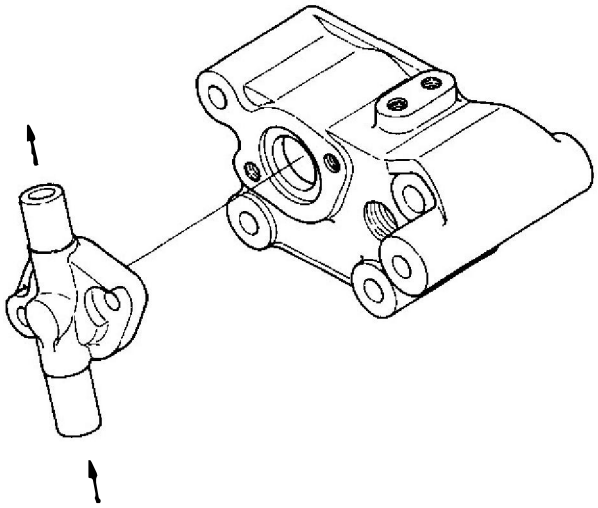
(4) Replace the thermostat when it has been in use for a year, or after every 2000 hours of operation.

Part No. code of thermostat	105582—49200

(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.



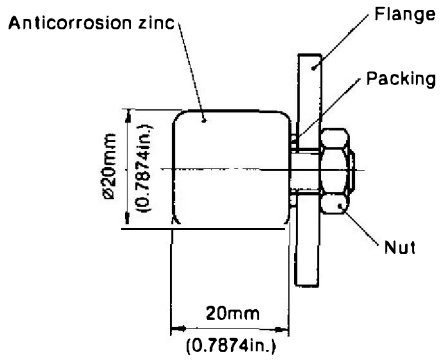
4. Anticorrosion Zinc

4-1 Principles

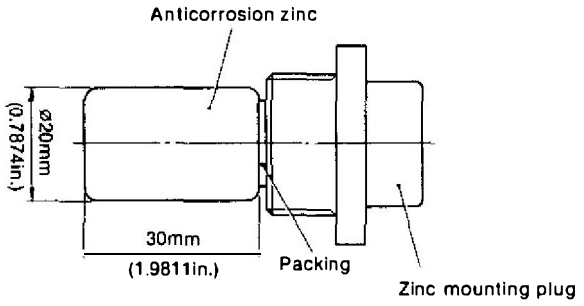
Anticorrosion zinc is installed to prevent electrolytic corrosion by sea water.
When different metals, i.e., iron and copper, are placed in an highly conductive liquid, such as sea water, the iron gradually rusts. The anticorrosion zinc provides protection against corrosion by corroding in place of the cylinder, cylinder liners and other iron parts.
The anticorrosion zinc is to be put in the following positions.

		1GM	2GM	3GM(D), 3HM
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	

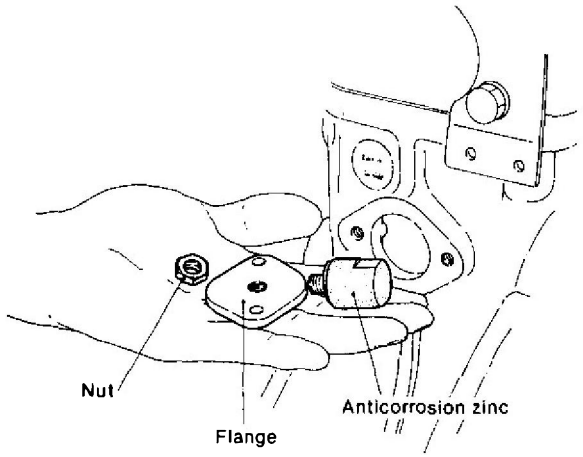
Model 1GM



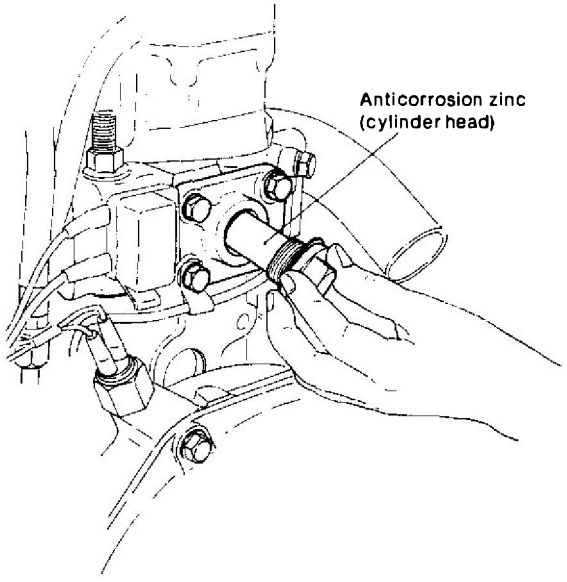
Model 2GM, 3GM(D) and 3HM

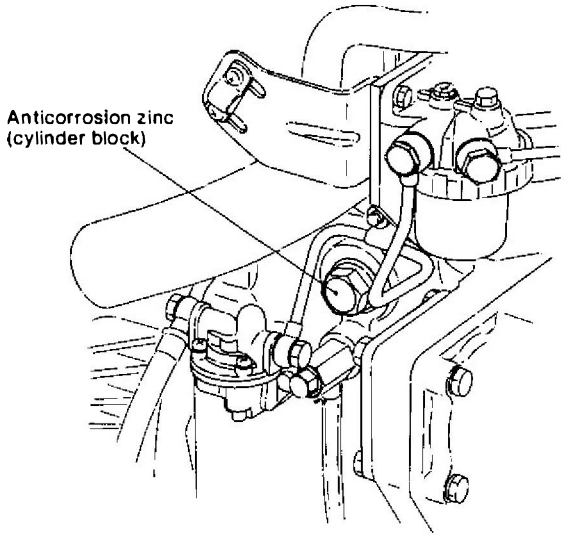


Mounting position for model 1GM

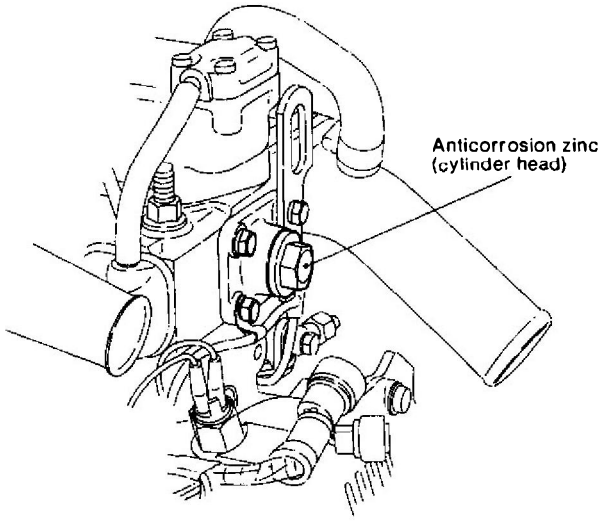


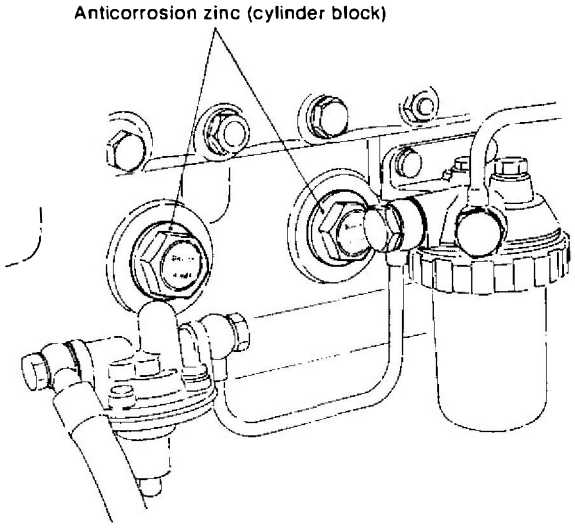
Mounting position for model 2GM





Mounting position for models 3GM(D) and 3HM



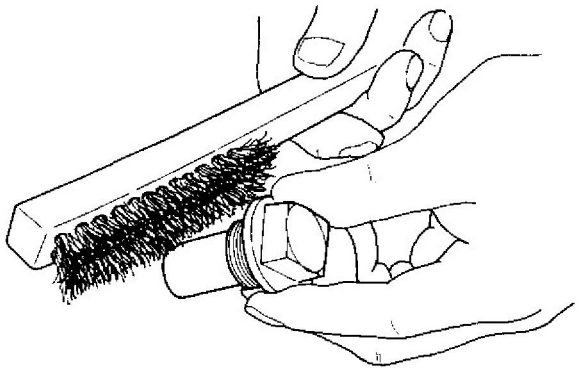


4-2 Inspection

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.

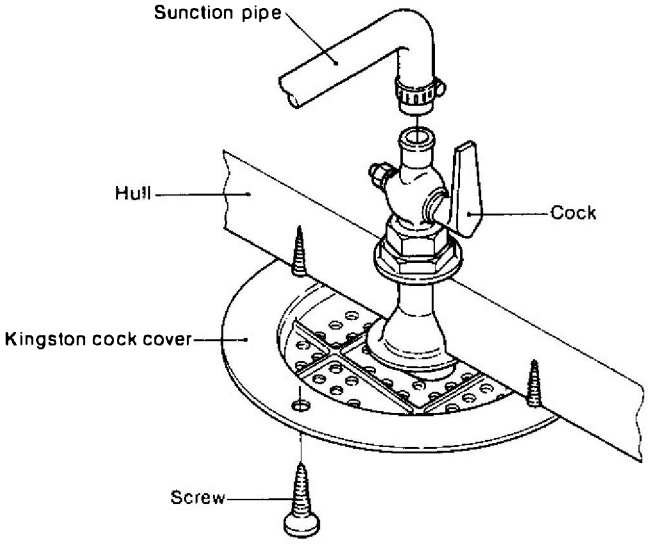
Replace the anticorrosion zinc by pulling the old zinc from the zinc mounting plug and screwing in the new zinc.

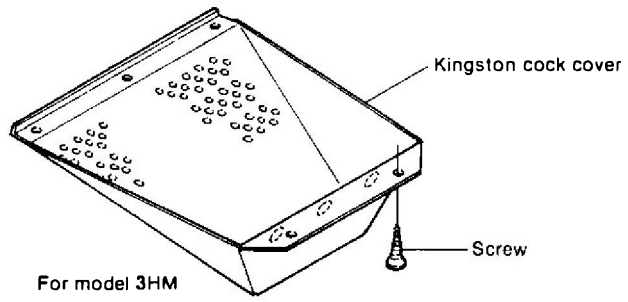


5. Kingston Cock (Optional)

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 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.





For model 3HM

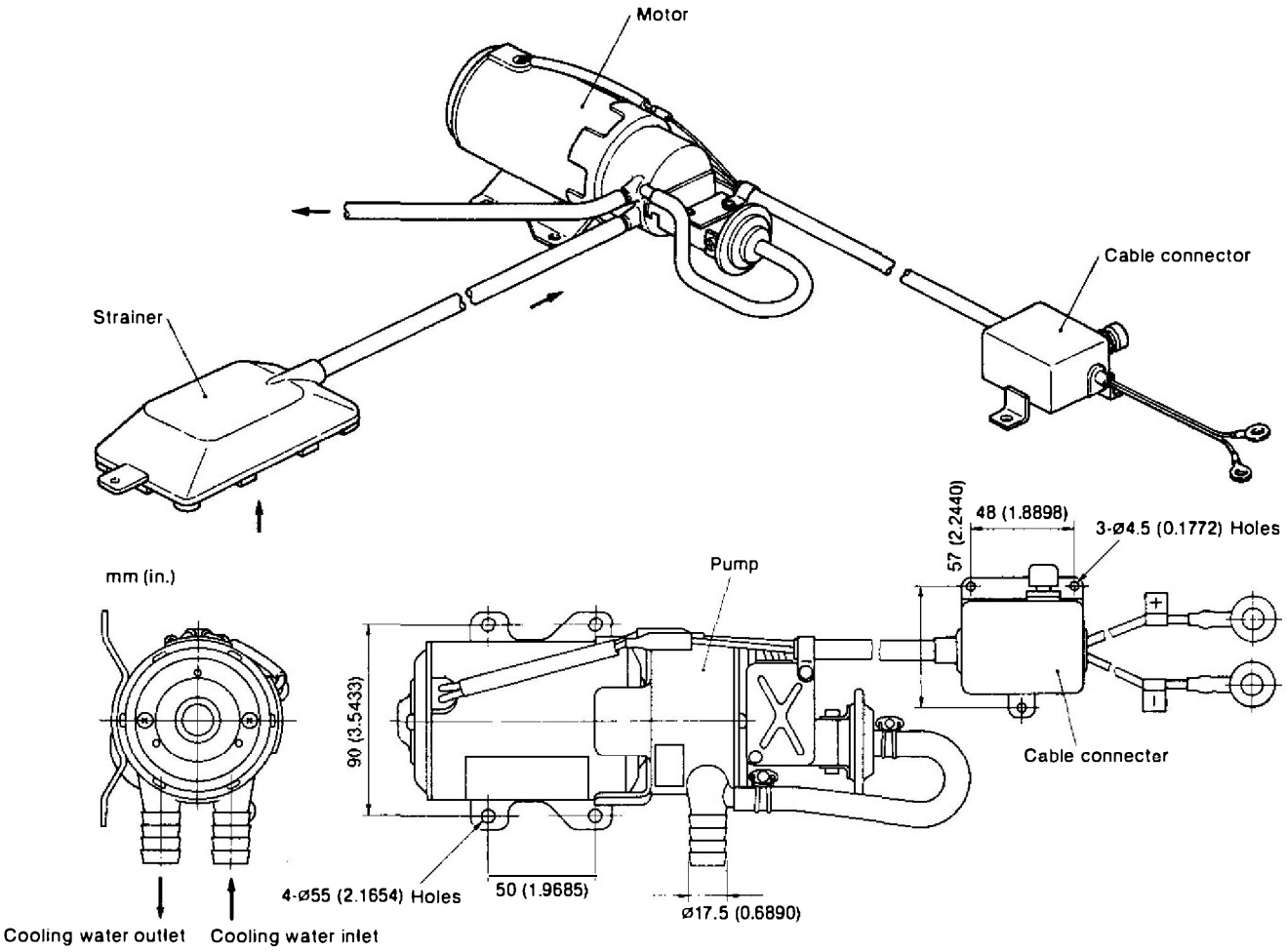
5-2 Handling precautions

Caution the user to always 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.
Moreover, 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

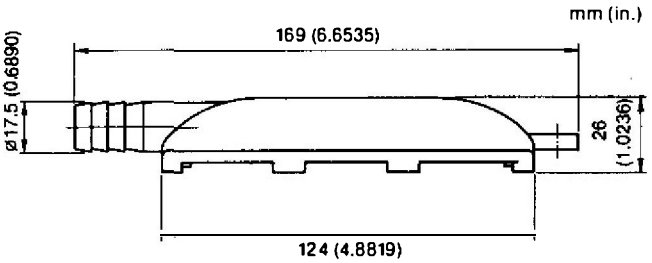
6-1.1 Specifications

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



CHAPTER 8

REDUCTION AND REVERSING GEAR

[A] For engine models 1GM, 2GM and 3GMD

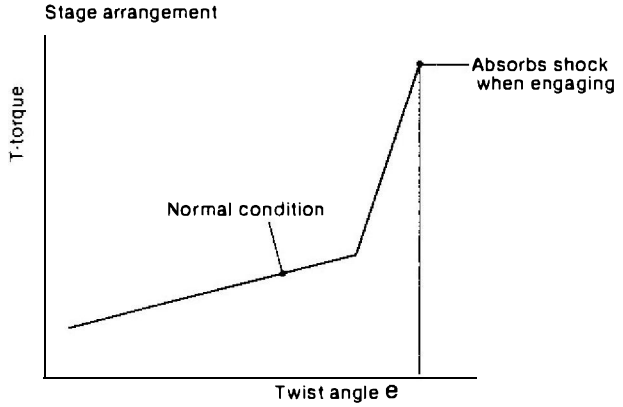
1. Construction

1-1 Construction

This clutch is a cone-type, mechanically operating clutch. When the drive cone (which is connected to the output shaft by the lead spline) is moved forward or backward, its taper contacts the large gear and transfers power to the output shaft.

The construction is simple when compared with other types of clutches, and it serves to reduce the number of components, making for a lighter, more compact unit which can be operated smoothly. Although it is small, the power transmission efficiency is high even under a heavy load. Its durability is high and it is reliable as high grade materials are used for the shaft and gear, and a taper roller bearing is incorporated. Power transmission is smooth as connection with the engine is made through the damper disc.

- The drive cone is made from special aluminum bronze which has both higher wear-resistance and durability. The drive cone is connected with the output shaft through the thread spline. The taper angle, diameter of the drive cone, twist angle, and diameter of the thread spline, are designed to give the greatest efficiency, thus ensuring that the drive cone can be readily engaged or disengaged.
- Helical gears are used for greater strength. The intermediate shaft is supported at 2 points to reduce deflection and gear noise.
- The clutch case, mounting flange and side cover are made from an aluminum alloy of special composition to reduce weight. It is also anticorrosive against seawater.
- As the damper disc is fitted to the output shaft, power can be transmitted smoothly. For the damper disc, springs of different strengths are used so that two stages of torque and twist angle are applied. That is, in the first stage, only the weak spring is used, and the strong spring comes into action for a torque higher than a predetermined value. This prevents gear noise due to torsional vibration as well as absorbing shock when engaging.



- The oil level dipstick hole doubles as a breather in addition to being the oil supply port. There is a small clearance between the dipstick and the inside of the dipstick tube which functions as a breather.
- The engagement between the cone and the large gear can be maintained even when the load on the propeller is zero. This is done by the action of the notch and spring joint on the operation lever in the operation device.
  The operation device can still be used without adjusting the remote operation device when the cone is internally worn, because it is compensated for by the spring joint.
- In order to reduce friction on the operation lever shaft, a needle bearing is used to allow smooth operation.

1-2 Specifications

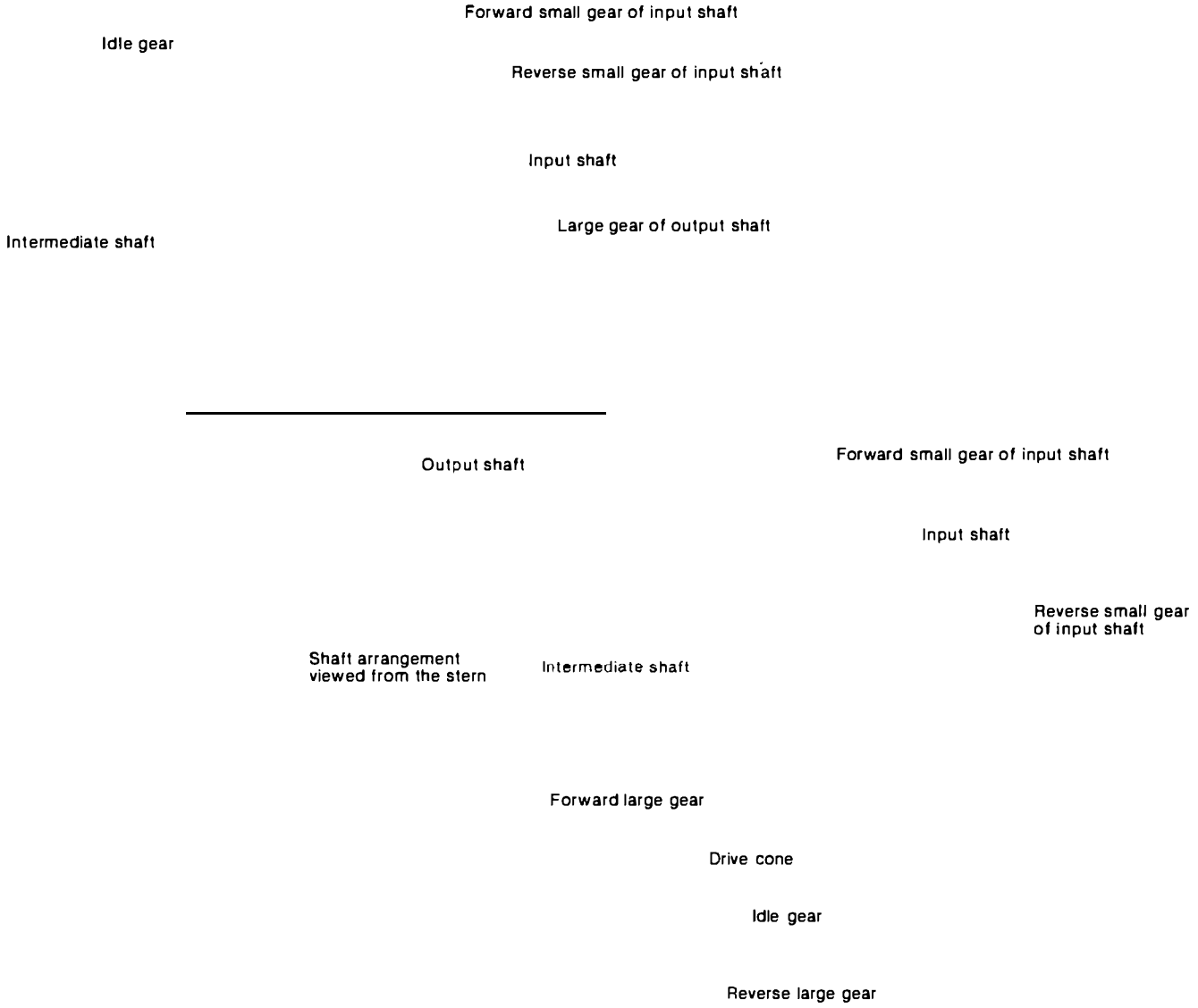
Model			KM2-A			KM3-A		
For engine models			1GM, 2GM			3GMD		
Clutch			Constant mesh gear with servo cone clutch (wet type)					
Reduction ratio	Forward		2.21	2.62	3.22	2.36	2.61	3.20
	Reverse		3.06	3.06	3.06	3.16	3.16	3.16
Propeller shaft rpm (Forward) rpm			1540	1298	1055	1441	1303	1062
Direction of rotation	Input shaft		Counter-clockwise, viewed from stern					
	Output shaft	Forward	Clockwise, viewed from stern					
		Reverse	Counter-clockwise, viewed from stern					
Remote control	Control head		Single lever control					
	Cable		Morse, 33-C					
	Clamp		YANMAR made, standard accessory					
	Spring joint		YANMAR made, standard accessory					
Output shaft coupling	Outer diameter		ø100mm (3.93")					
	Pitch circle diameter		ø78mm (3.07")					
	Connecting bolt holes		4—ø10.5mm (4—ø0.41")					
Position of shift lever			Left side, viewed from stern					
Lubricating oil			SAE #10W-30, CC class					
Lubricating oil capacity			0.25ℓ			0.3ℓ		
Dry weight			9.3kg (20.5 lbs)			10.8kg (23.0 lbs)		

Models KM2A and KM3A reduction and reverse gear boxes, shafts and gears are the same except for the following items:

- No. of gear teeth (derives different gear ratios).
- Distance between bearings for input and output shafts.
- Clutch case, mounting flange.

1-3 Power transmission system

1-3.1 Arrangement of shafts and gears



1-3.2 Reduction ratio

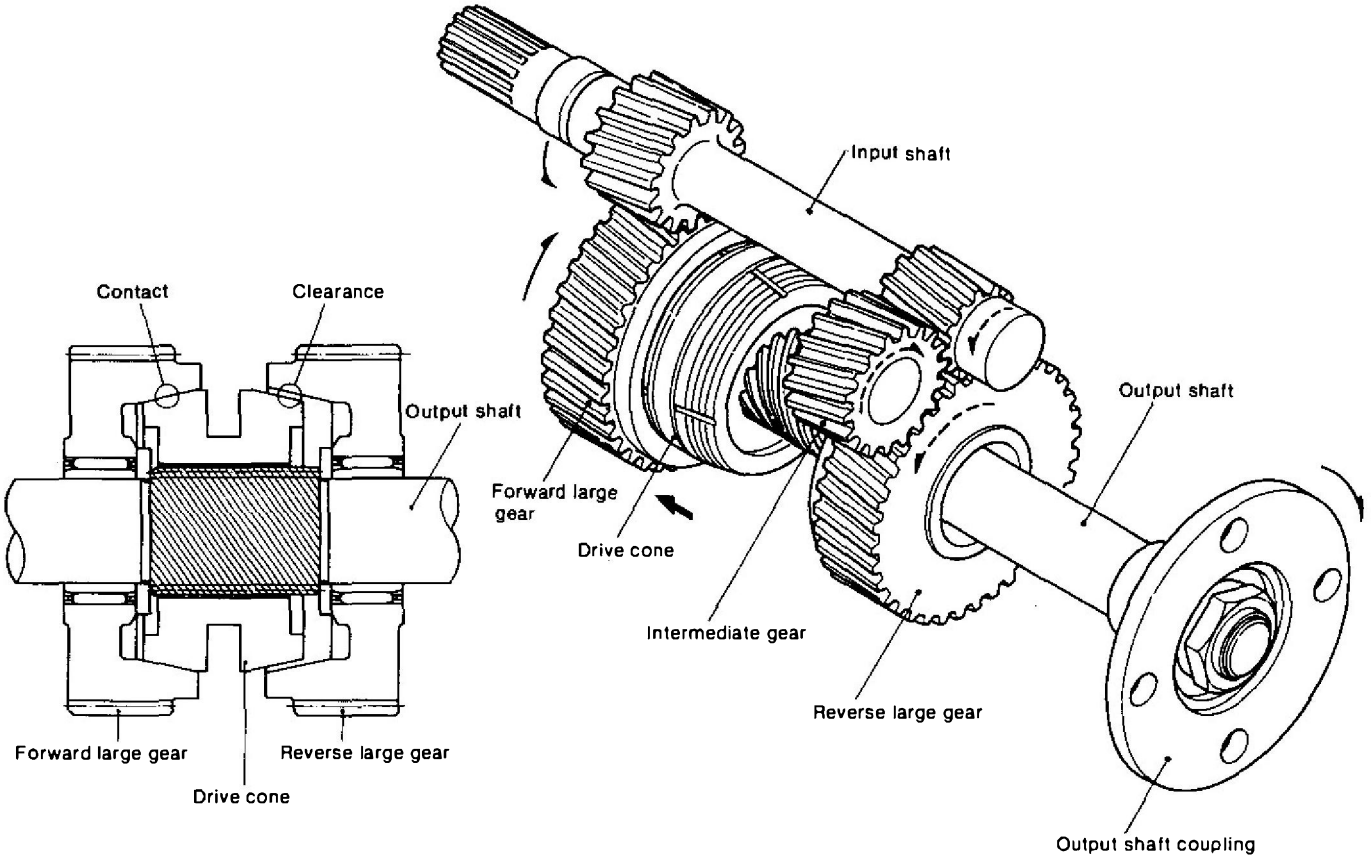
Forward

Model	No. of teeth of forward small gear Zif	No. of teeth of forward large gear Zof	Reduction ratio Zof/Zif
KM2-A	24	53	53/24 = 2.21
	21	55	55/21 = 2.62
	18		58/18 = 3.22
KM3-A	25	59	59/25 = 2.36
	23		60/23 = 2.61
		64	64/20 = 3.20

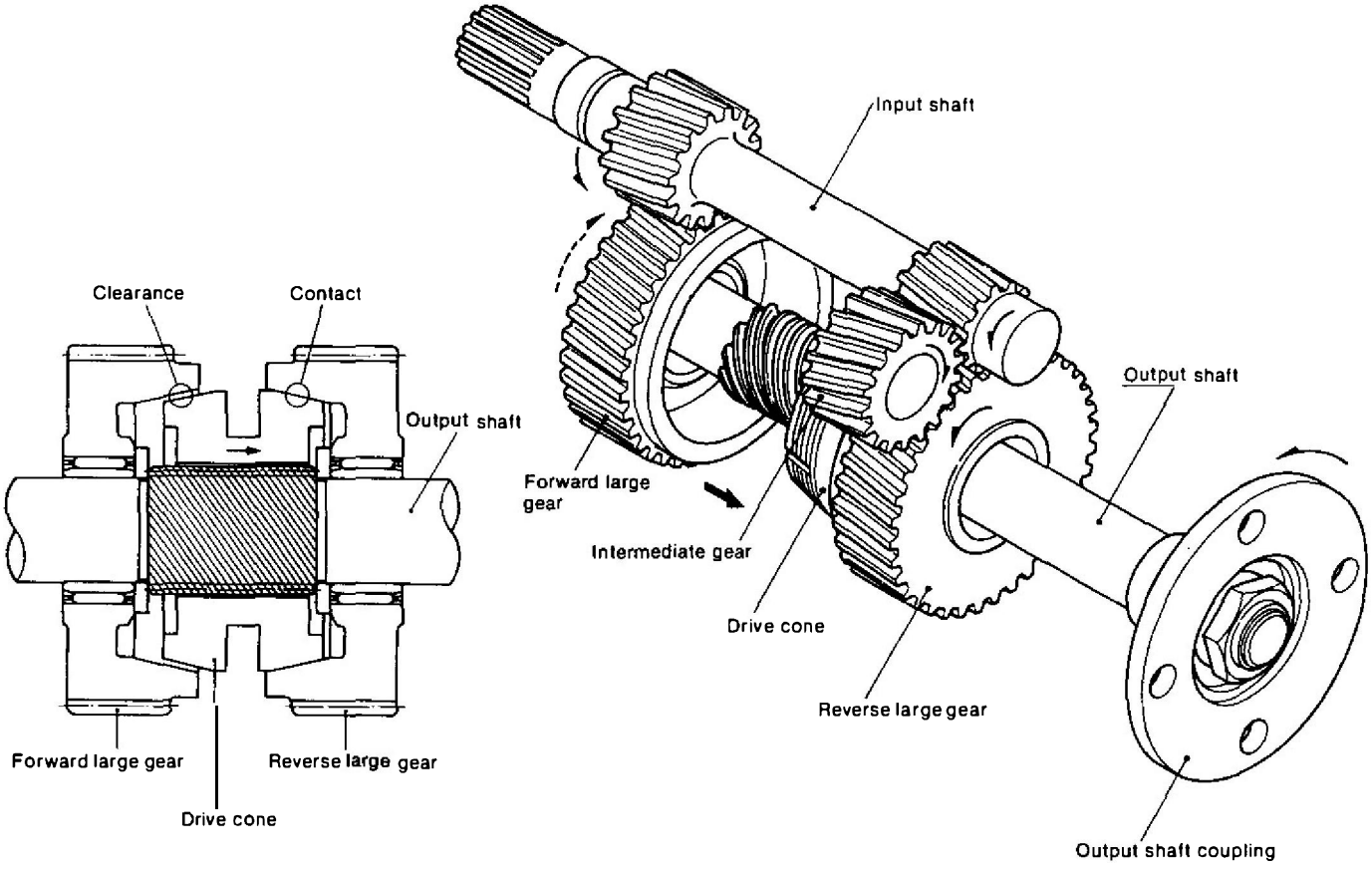
Reverse

Model	No. of teeth of reverse small gear Zir	No. of teeth of intermediate shaft gear Zi	No. of teeth of reverse large gear Zdr	Reduction ratio Zi/Zir·Zdr/Zi
KM2-A	18		55	55/18 = 3.06
KM3-A	19		60	60/19 = 3.16

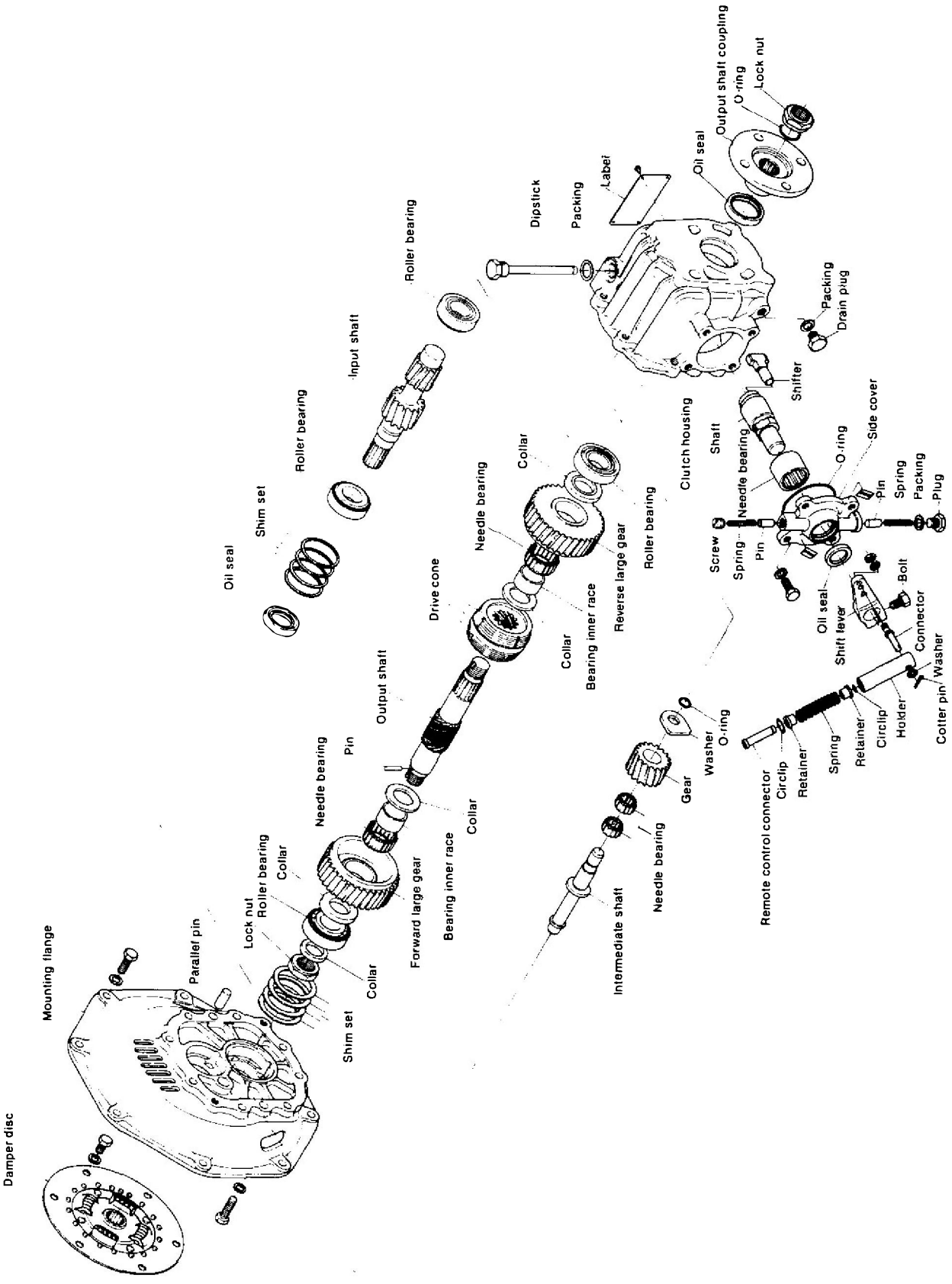
1-3.3 Power transmission routine—Forward

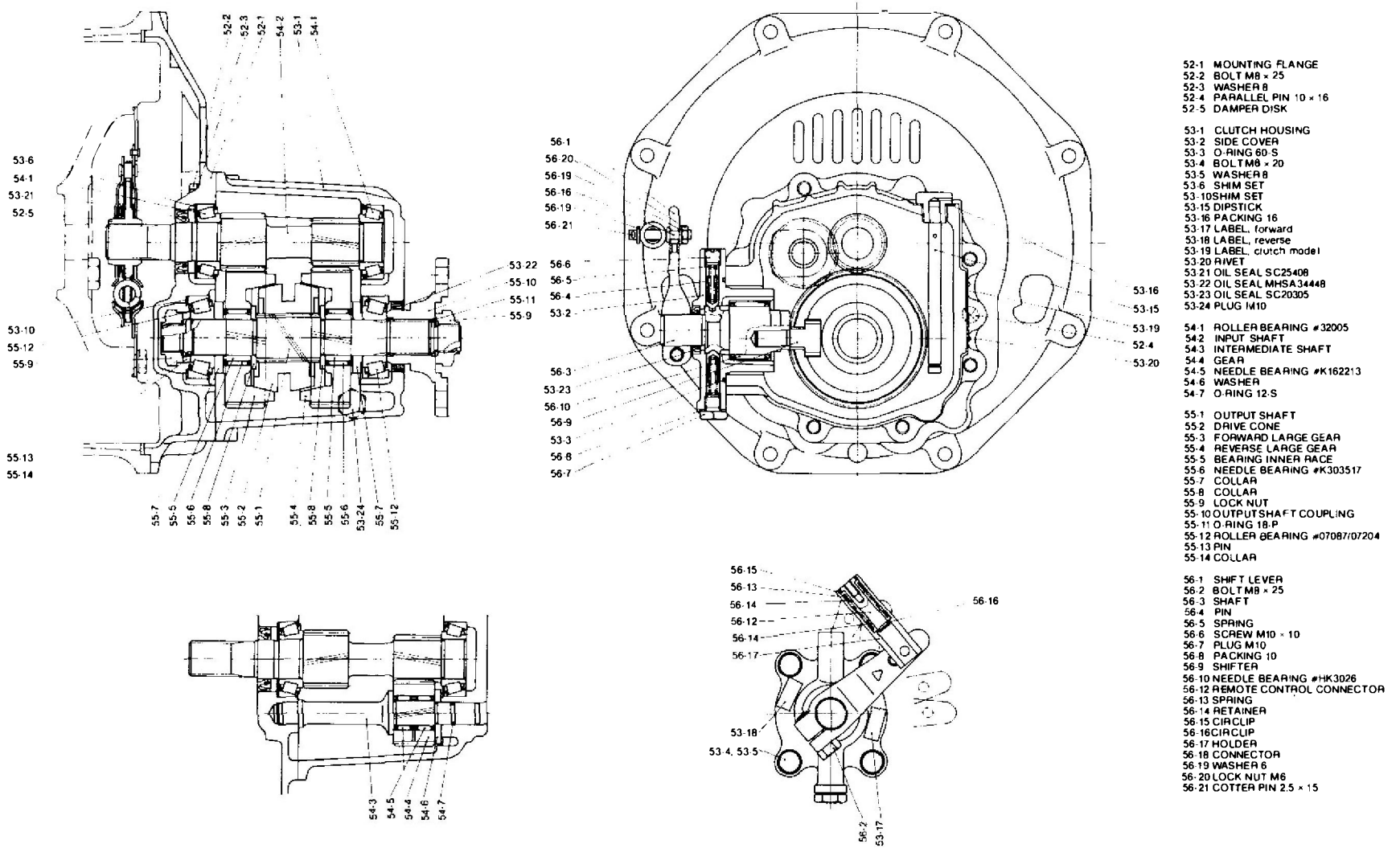


1-3.4 Power transmission routine—Reverse



1-4 Drawing


Output shaft coupling
O-ring
Lock nut
Oil seal
Label
Dipstick
Packing
Roller bearing
Input shaft
Packing
Drain plug
Shifter
Clutch housing
Shaft
Needle bearing
O-ring
Side cover
Pin
Spring
Packing
Plug
Screw
Spring
Pin
Oil seal
Shift lever
Bolt
Connector
Washer
Cotter pin
Holder
Circlip
Retainer
Spring
Retainer
Circlip
Remote control connector
O-ring
Washer
Gear
Needle bearing
Intermediate shaft
Roller bearing
Reverse large gear
Bearing inner race
Collar
Needle bearing
Collar
Drive cone
Oil seal
Shim set
Roller bearing
Output shaft
Pin
Needle bearing
Collar
Roller bearing
Lock nut
Parallel pin
Forward large gear
Bearing inner race
Collar
Shim set
Collar
Mounting flange
Damper disc



52-1 MOUNTING FLANGE
52-2 BOLT M8 × 25
52-3 WASHER 8
52-4 PARALLEL PIN 10 × 16
52-5 DAMPER DISK

53-1 CLUTCH HOUSING
53-2 SIDE COVER
53-3 O-RING 60-S
53-4 BOLT M8 × 20
53-5 WASHER 8
53-6 SHIM SET
53-10 SHIM SET
53-15 DIPSTICK
53-16 PACKING 16
53-17 LABEL, forward
53-18 LABEL, reverse
53-19 LABEL, clutch model
53-20 RIVET
53-21 OIL SEAL SC25408
53-22 OIL SEAL MHSA34448
53-23 OIL SEAL SC20305
53-24 PLUG M10

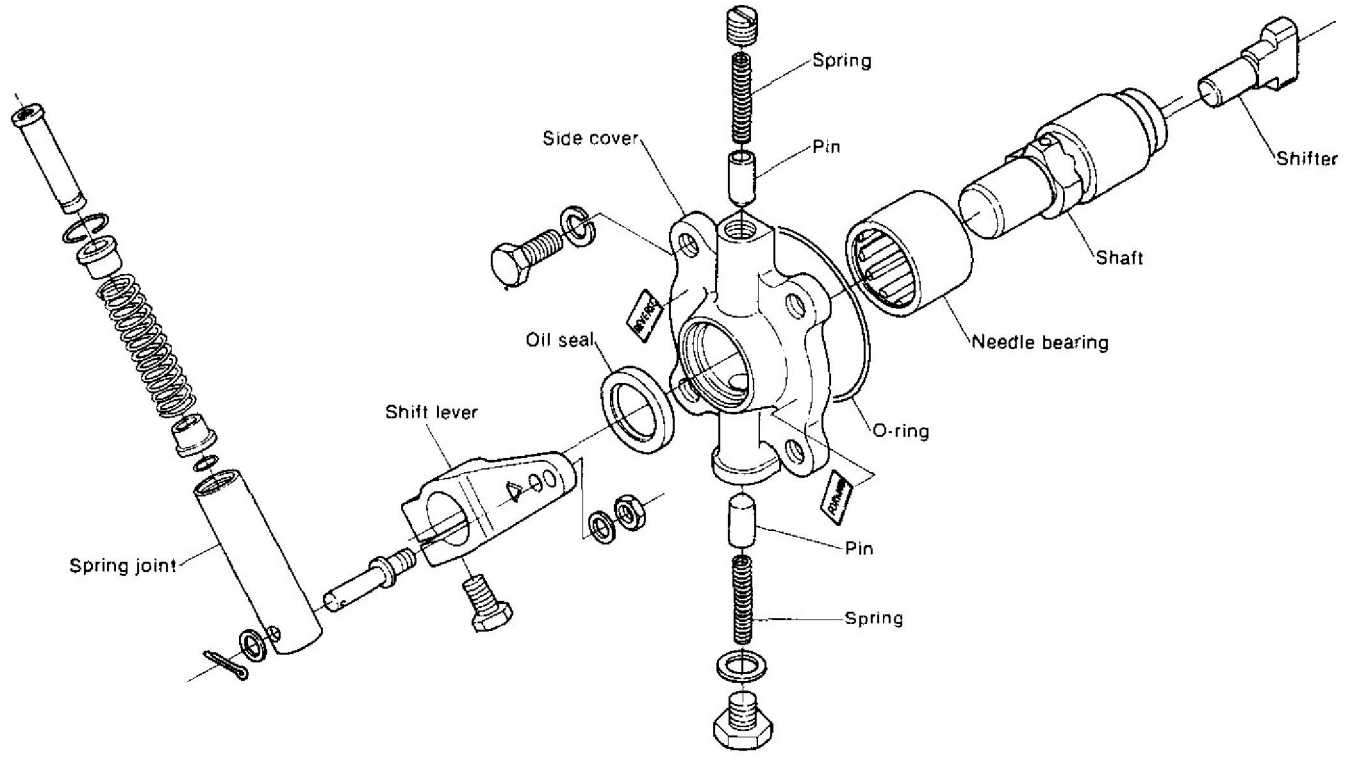
54-1 ROLLER BEARING #32005
54-2 INPUT SHAFT
54-3 INTERMEDIATE SHAFT
54-4 GEAR
54-5 NEEDLE BEARING #K162213
54-6 WASHER
54-7 O-RING 12-S

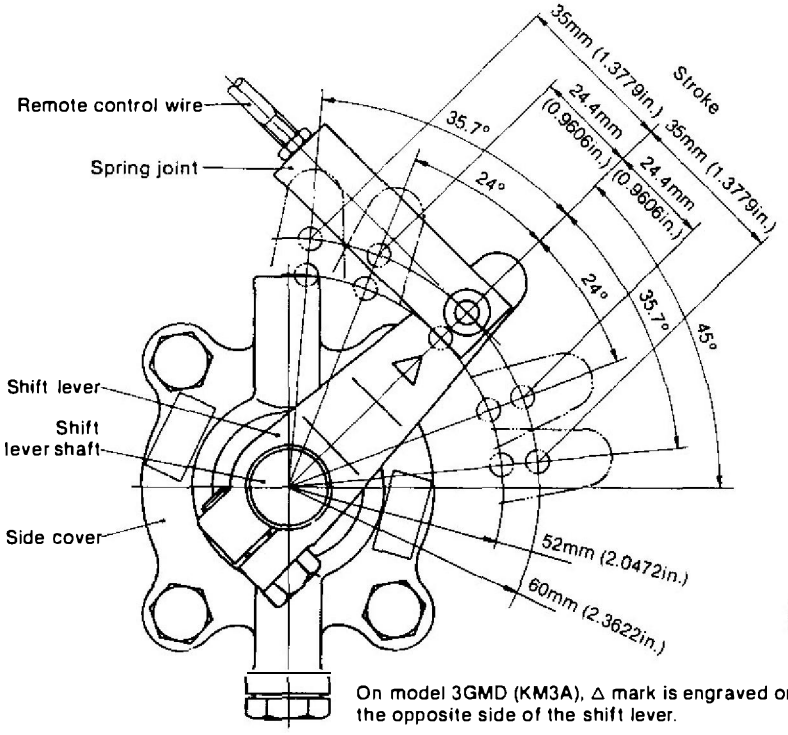
55-1 OUTPUT SHAFT
55-2 DRIVE CONE
55-3 FORWARD LARGE GEAR
55-4 REVERSE LARGE GEAR
55-5 BEARING INNER RACE
55-6 NEEDLE BEARING #K303517
55-7 COLLAR
55-8 COLLAR
55-9 LOCK NUT
55-10 OUTPUT SHAFT COUPLING
55-11 O-RING 18-P
55-12 ROLLER BEARING #07087/07204
55-13 PIN
55-14 COLLAR

56-1 SHIFT LEVER
56-2 BOLT M8 × 25
56-3 SHAFT
56-4 PIN
56-5 SPRING
56-6 SCREW M10 × 10
56-7 PLUG M10
56-8 PACKING 10
56-9 SHIFTER
56-10 NEEDLE BEARING #HK3026
56-12 REMOTE CONTROL CONNECTOR
56-13 SPRING
56-14 RETAINER
56-15 CIRCLIP
56-16 CIRCLIP
56-17 HOLDER
56-18 CONNECTOR
56-19 WASHER 6
56-20 LOCK NUT M6
56-21 COTTER PIN 2.5 × 15

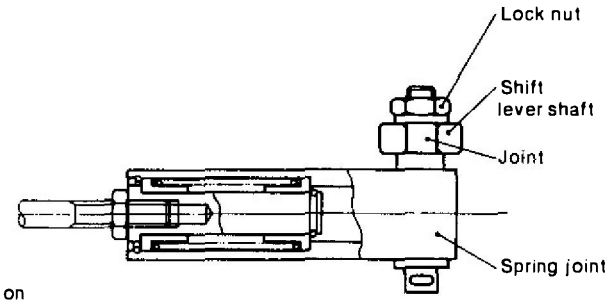
2. Shifting Device

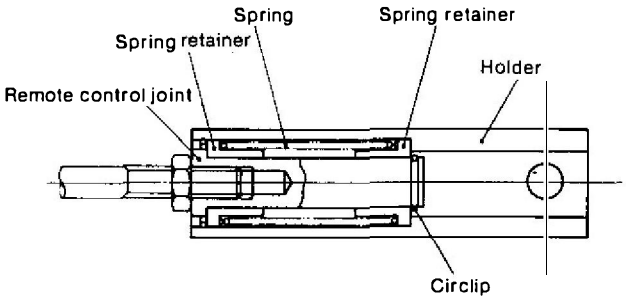
2-1 Construction of shifting device

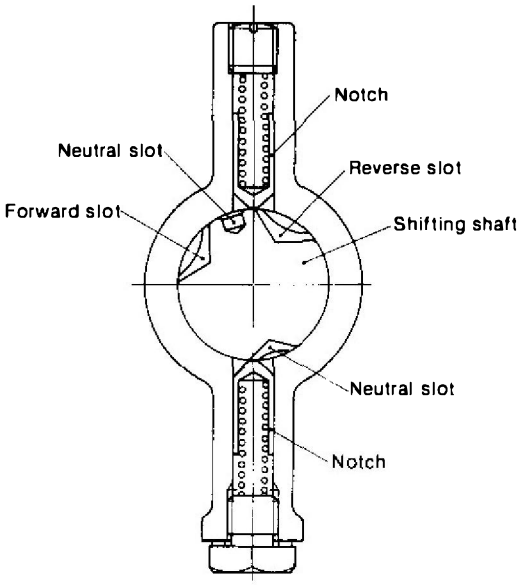




On model 3GMD (KM3A), △ mark is engraved on the opposite side of the shift lever.





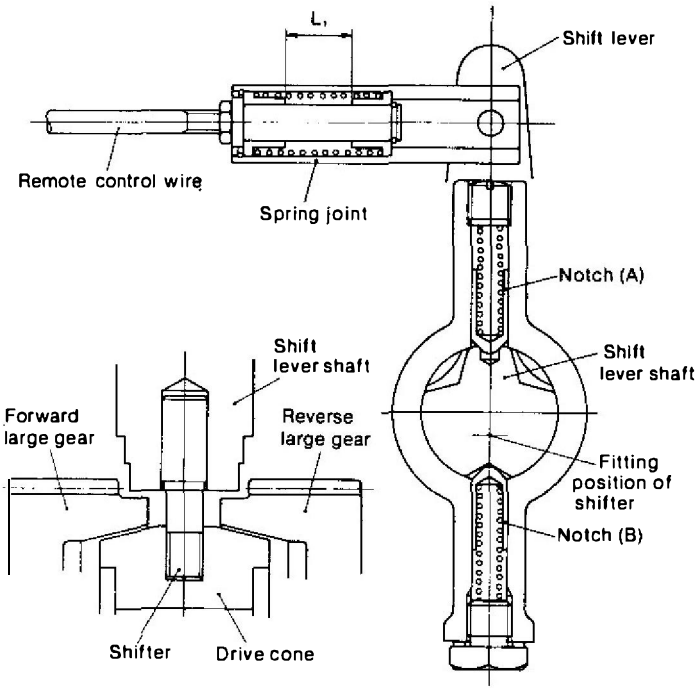


The shift lever shaft is supported by the side cover in which it rotates. Around the shift lever shaft, there are slots which engage the notch in order to control transmission of rotary power either forward or reverse, or to keep it in neutral. The notch engages each slot by the force of the notch spring.
The shifter is set at the end of the shift lever shaft eccentric to the shaft center line and the angular movement of the shift shaft (i.e. rotation). The shifter is moved forward or backward along the line of the output shaft and this in turn moves the drive cone forward or backward.
The spring joint contains a spring and 2 spring retainers in the holder, and the remote control joint is connected to the spring retainers so that it can slide a fixed distance. By pushing or pulling the remote control joint with the holder fixed, the remote control joint moves to a position where the two spring retainers touch.

2-2 Action of the shifting device

2-2.1 Changing from neutral to forward

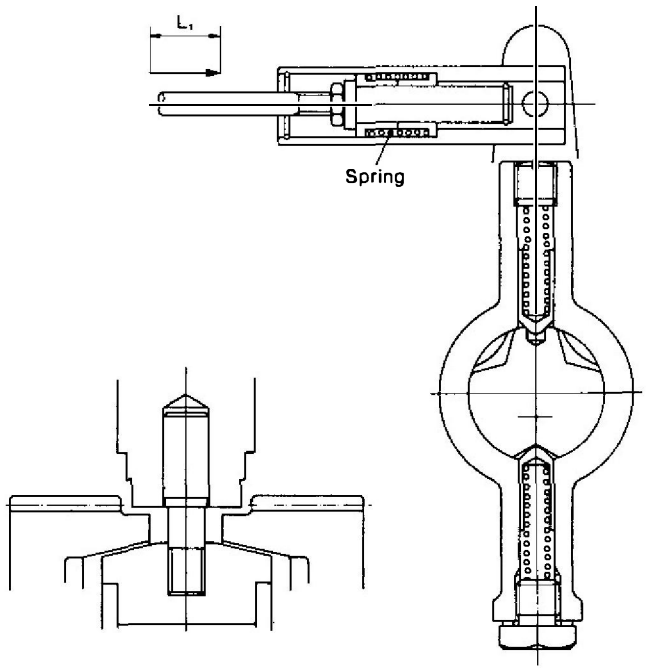
The relationship between the spring joint and the notch is as shown in the following figure, and the two spring retainers are the maximum distance apart.



Neutral position

The shift lever is kept securely in the neutral position by notches (A) and (B).

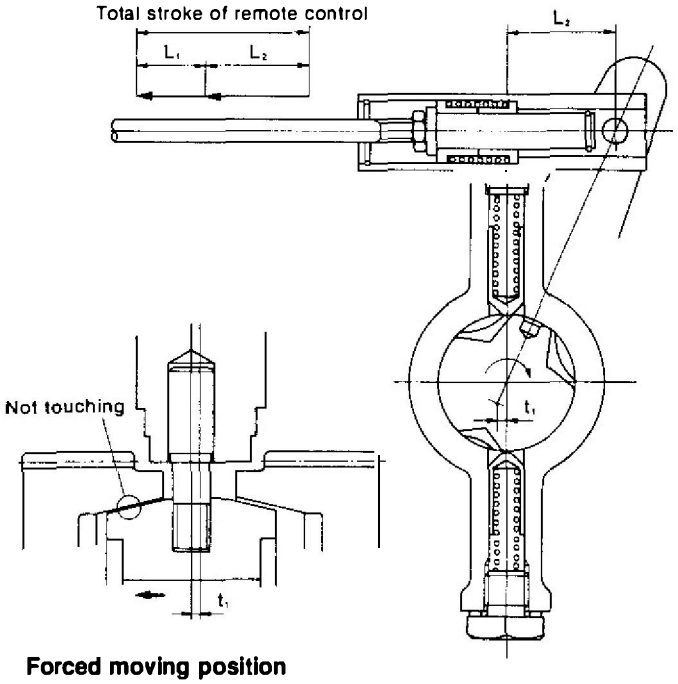
Changing the power transmitting direction to forward is explained below.
The remote control joint forward, when pushed forward moves the spring retainers. The spring is compressed until the two spring retainers touch.



L_1 position of remote operation stroke

The spring in the spring joint is compressed, but the shift lever does not move.

By pushing the remote control joint the holder moves, and the shift lever and the shift lever shaft also move to disengage the notch from the neutral position.



Forced moving position

When the shift lever is forcibly moved through distance L_2 the shifter moves distance t_1. In this position, the drive cone has not yet made contact. However, notches (A) and (B) are disengaged from the neutral notch slot, and notch (A) is positioned on the tapered surface.

The shift lever shaft is turned by the movement of the remote control joint. When the notch touches the tapered part of the forward setting slot, it is pushed by the notch spring force and turns the shift lever forward. At the same time, as the remote control joint is fixed by the two retainers of the spring joint being in contact with each other, the holder is moved by the spring reaction so that the shift lever is pushed forward.

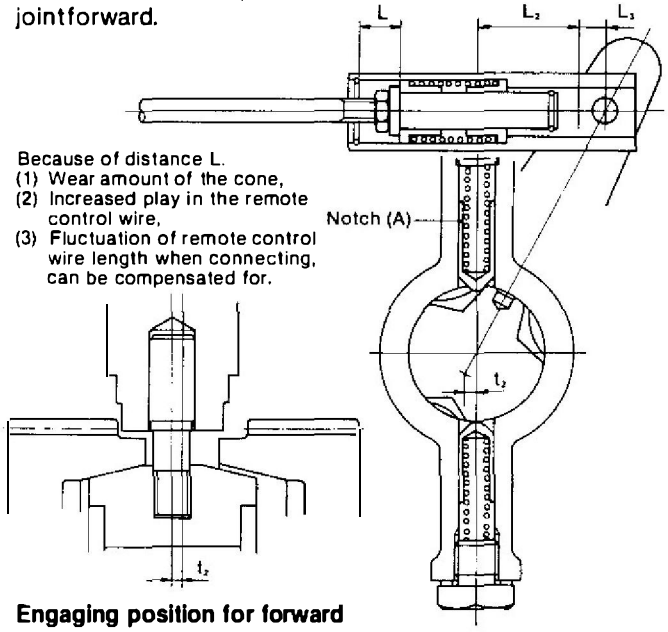
By the actions of the notch spring and spring joint, the shifter maintains pressure on the drive cone.

Engaging position for forward

By means of the shift lever shaft turning force which is caused by the spring in the joint and the notch (A), the shifter is moved distance L_3 and engagement is complete. Pressure is maintained on the drive cone after engagement.

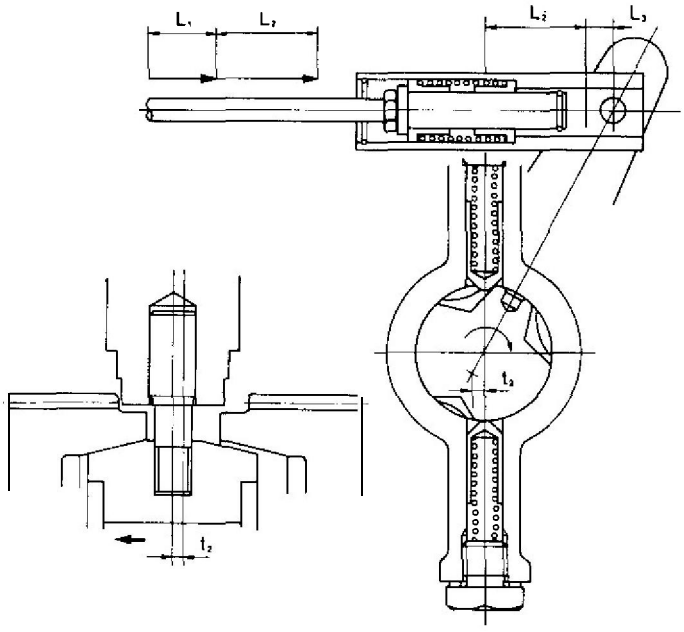
2-2.2 Engagement from forward to neutral

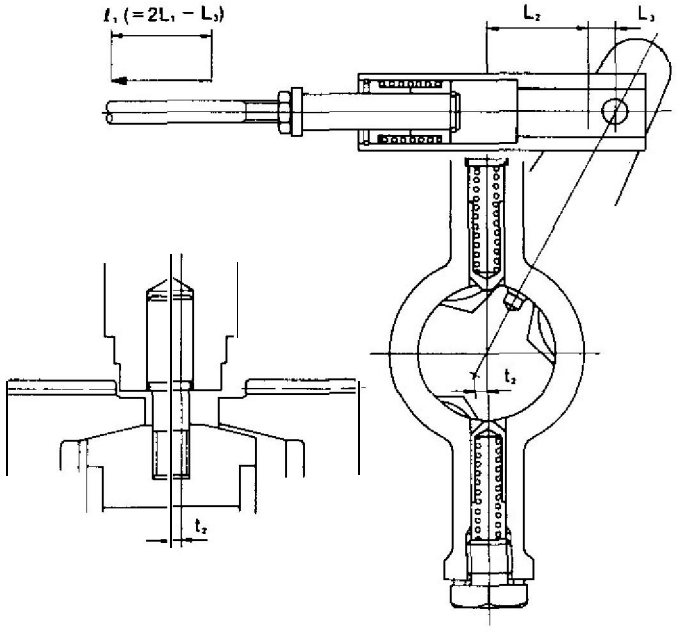
Engagement for reverse is the same as for forward, that is, return to the neutral position and move the remote control joint forward.



Engaging position for forward

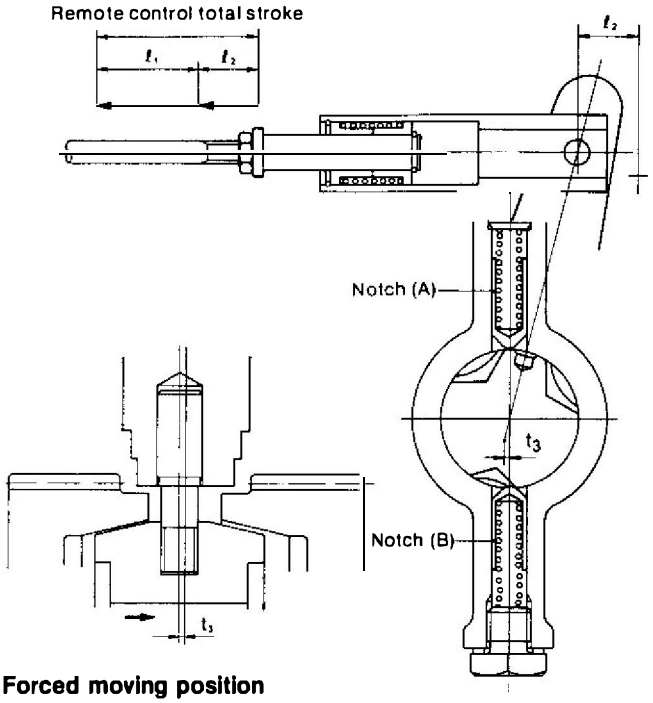
The drive cone, which is moved by the spring in the joint and notch (A), is kept under force until distance L becomes zero even when the cone is worn.





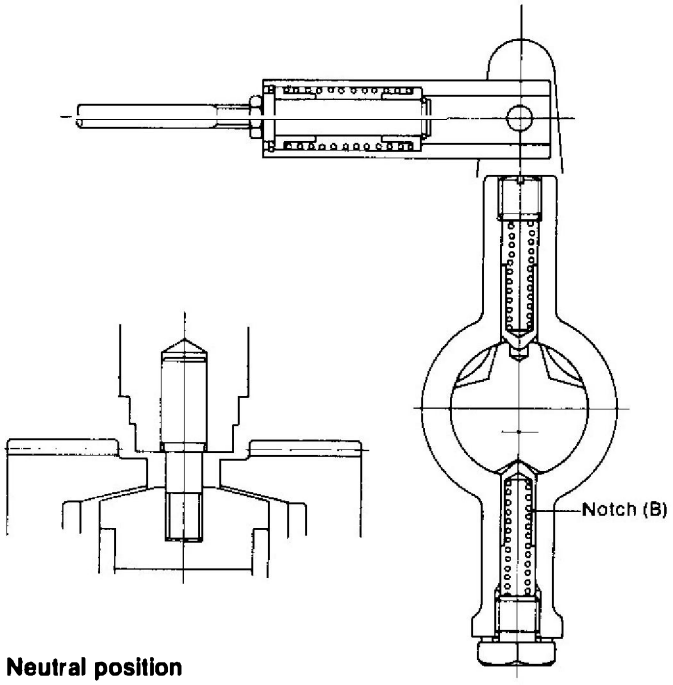
Position of remote control stroke l_1

The shift lever does not move although the spring in the joint is compressed. The cone is kept in contact due to the transmission of torque when idling.



Forced moving position

The shift lever is forcibly moved through distance l_2, overcoming light friction due to the transmitting torque and the drive cone separates. Notch (A) disengages and notch (B) engages.



Neutral position

The shift lever is returned to neutral by the turning force generated on the shift lever shaft by the spring in the joint and notch (B).

2-3 Clutch shifting force

(reference value) [Engine at 1000rpm]

Shifting Position / Shifting Direction	Shift lever position at 60mm	Remote control handle position at 170mm (cable length, 5m)
Engaging stroke	Approx. 3kg (6.6 lbs)	3 ~ 4kg (6.6 ~ 8.8 lbs)
Disengaging stroke	—	6 ~ 8kg (13.2 ~ 17.6 lbs)

Disengaging stroke:

(1) At the initial stage of usage, the stroke may be heavier than the above value, but the stroke gets light when adopted.

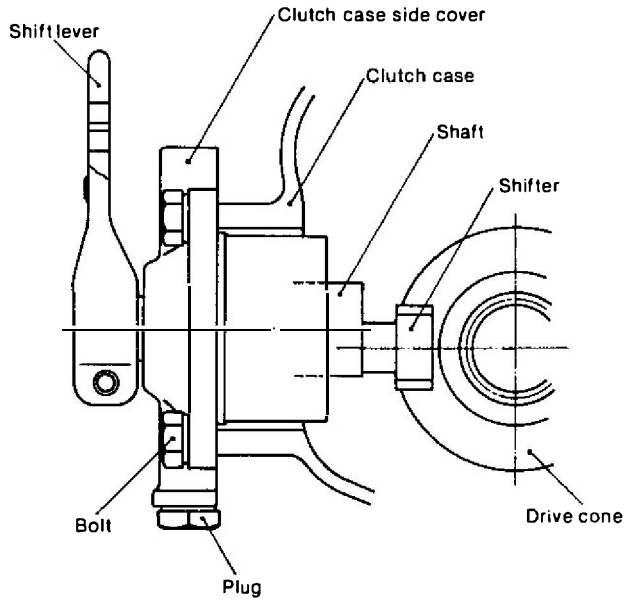
(2) Varies according to the idling speed of the engine. The lower the rotation becomes, the lighter the stroke becomes.

(3) The more the remote control cable get long, the more the cable has the bending positions; the smaller the bending radius becomes, the disengaging stroke gets heavier.
[33-C minimum bending radius 203.2mm (8")]

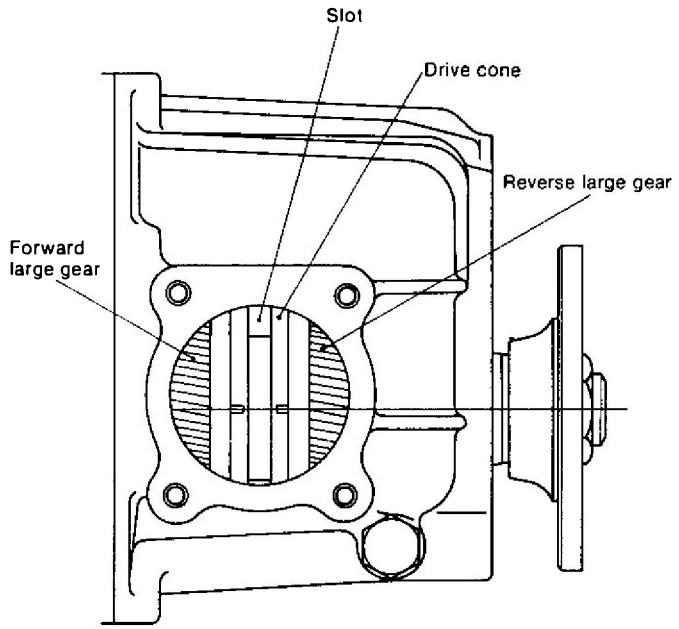
(4) When the spring joint is attached to the shift lever at 52mm distance from the center of the lever shaft, the disengaging stroke will get heavier by 15% comparing to the case where the spring joint being attached at 60mm distance.

2-4 Adjustment

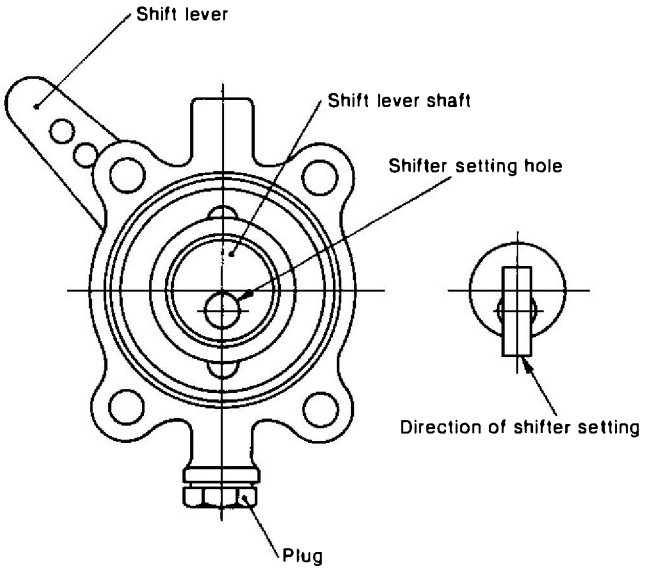
When the clutch side cover is removed, give the following adjustments at the time of the reassembly.



(1) Shift the slot in the drive cone so that it comes to the center of the two large gears.

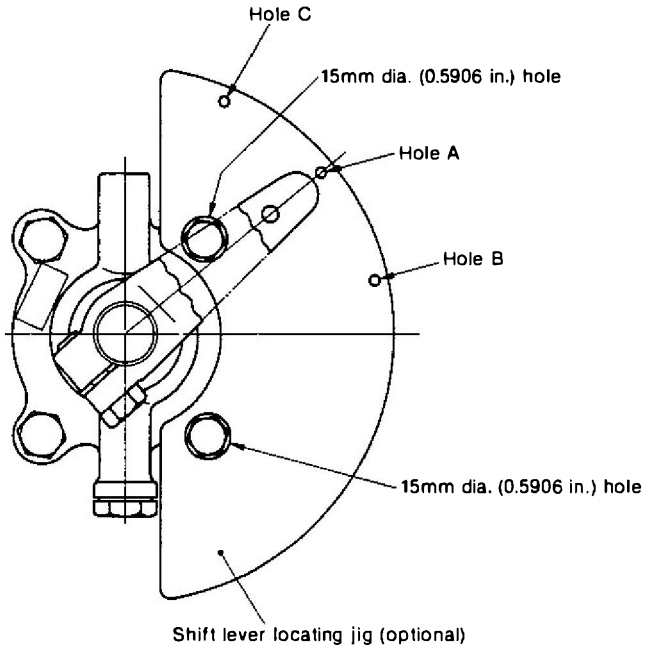


(2) Set the shift lever at neutral position. (Note that the shift lever can be rotated 360° when it is removed from case. The neutral position is the position where the shifter comes downwards when the plug is below.

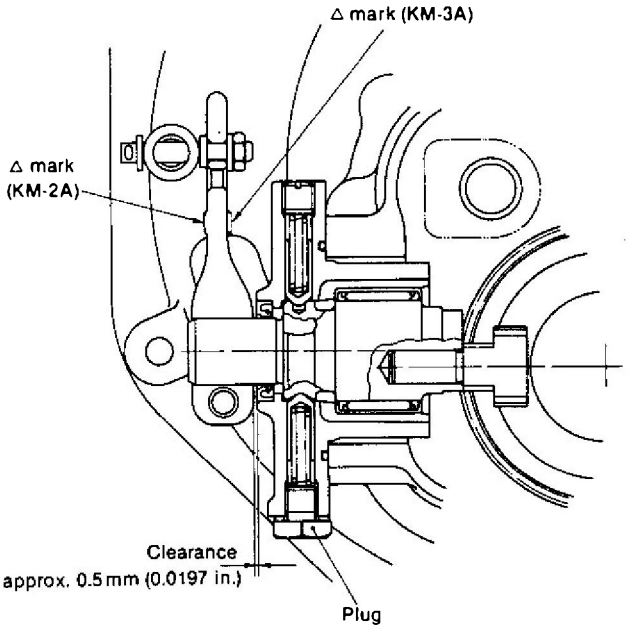


(3) Put the shifter of the side cover at bottom, and set the shifter to the ditch in the drive cone at the center of the forward and reverse gears. Do not move the drive cone from the center of the two gears at the time of the reassembly. (Note that 2mm clearance in diameters are provided in the holes of the side cover, and the gear case. This is for adjusting the difference in the engaging, and disengaging strokes.)

(4) Fit the shift lever locating jig into the holes of the side cover through the 15mm dia. holes as shown.



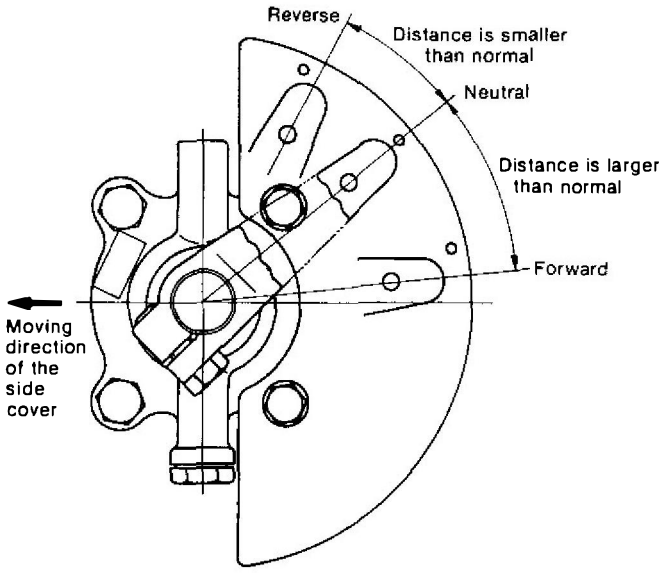
(5) Put the shift lever in neutral and check that the tip of the lever is aligned with hole A of the jig. If not, loosen the fixing bolt on the shift lever, align it, then tighten the bolt. Take care to leave approximately 0.5mm (0.0197in.) clearance between the shift lever and the side cover.



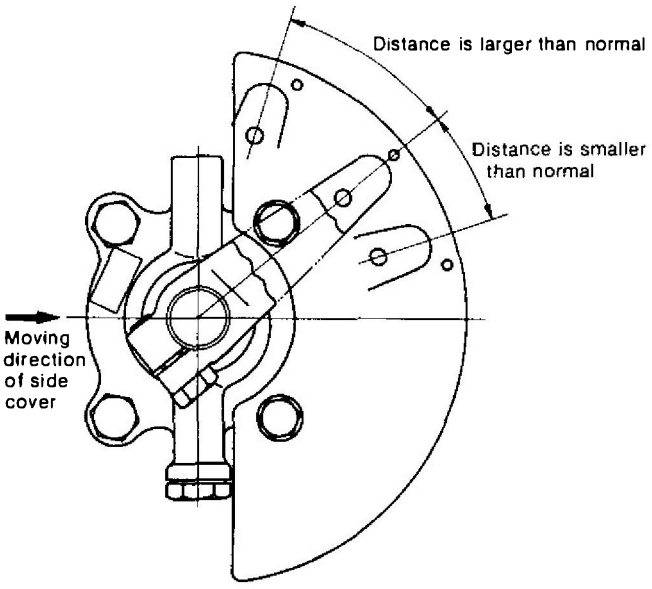
(6) Move the shift lever forward or reverse, and check visually the respective distances between the tip of the shift lever and holes B and C, also check the difference between these distances.

(7) When these two distances are not equal, slightly loosen the four setting bolts of the side cover so that it can be moved a little in the shaft direction.

(8) When the distance is larger than normal in the forward setting, move the side cover slightly to the engine side.

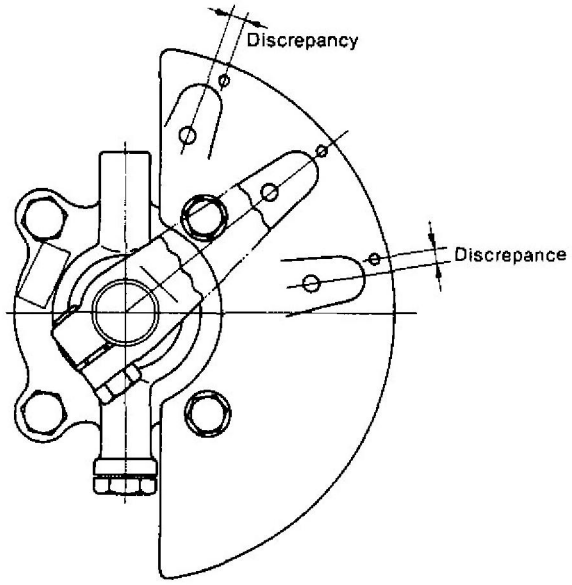


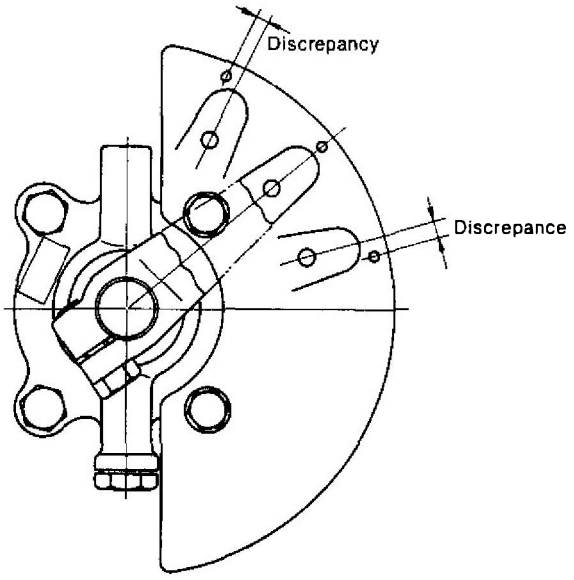
(9) When the distance is larger than normal in the reverse setting, move the side cover slightly to the propeller side.



(10) When the distances are equal between neutral and forward and neutral and reverse tighten the setting bolts of side cover.

(11) Although these distances may be equal both for forward and reverse, there might be some discrepancy between holes B and C due to difference in machining. However, if the discrepancy is the same for forward and reverse there is no problem.



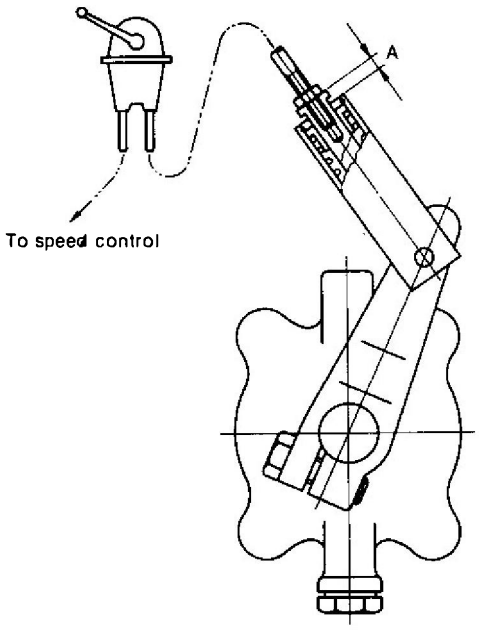


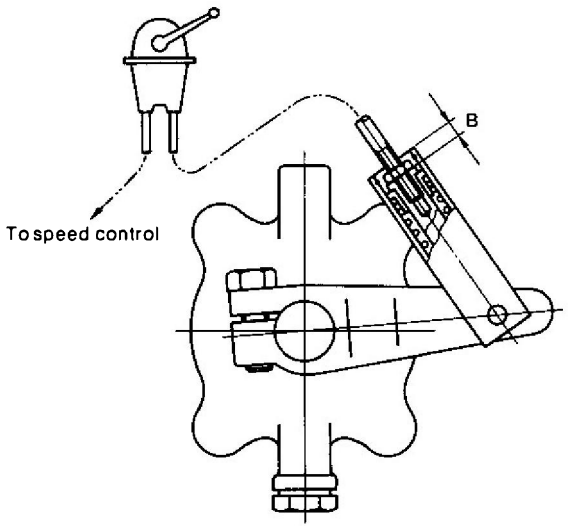
(12) Install the spring joint on the shift lever.
(Only when it is dismantled in the boat).

NOTE: When the shift device is removed in the boat, the engine must always be stopped.

2-5 Inspect the following points (to be inspected every 2-3 months)

(1) Looseness at the connection of the spring joint and the remote control cable.
(2) Looseness of the attaching nut of the spring joint and the shift lever.
(3) To make sure that the value of A, and B is not "Zero" at the engaging position of the remote control lever. If the value is "Zero", untighten the bolt of the side cover, and adjust according to the steps described in 2-4.
When the cone for forwards side gets worn, the value of B is decreased, and for reverse side, the value of A is decreased. When the play in the remote control system is increased, both values of A, and B are decreased.





2-6 Cautions

(1) Always stop the engine when conducting attaching, adjusting, and inspecting.
(2) When conducting inspection immediately after stopping the engine, do not touch the clutch. The oil temperature is often raised to around 90°C (194°F).
(3) Half-clutch operation is not possible with this design and construction. Do not use with the shift lever halfway to the engaged position.
(4) Set the idling engine speed at between 750 and 800 rpm.
NOTE: The dual (Two) lever remote control device cannot be used.

3. Inspection and Servicing

3-1 Clutch case

(1) Check the clutch case with a test hammer for cracking.
Perform a color check when required.
If the case is cracked, replace it.
(2) Check for staining on the inside surface of the bearing section.
Also, measure the inside diameter of the case.
Replace the case if it is worn beyond the wear limit.

3-2 Bearing

(1) Rusting and damage.
If the bearing is rusted or the taper roller retainer is damaged, replace the bearing.
(2) Make sure that the bearings rotate smoothly.
If rotation is not smooth,if there is any binding, or if an abnormal sound is evident, replace the bearing.

3-3 Gear

Check the surface and tooth face conditions and backlash of each gear. Replace any defective part.
(1) Tooth surface wear.
Check the tooth surface for pitching, abnormal wear, dents, and cracks. Repair lightly damaged gears and replace heavily damaged gears.
(2) Tooth surface contact.
Check the tooth surface contact. The amount of tooth surface contact between the tooth crest and tooth flank must be at least 70% of the tooth width.
(3) Backlash.
Measure the backlash of each gear, and replace the gear when it is worn beyond the wear limit.

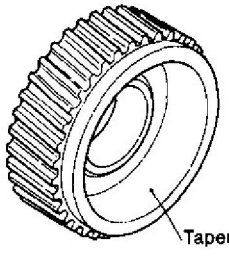
mm (in.)

	Maintenance standard	Wear limit
Input shaft forward gear and output shaft forward gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Input shaft reverse gear and intermediate gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)
Intermediate gear and output shaft reverse gear	0.06 ~ 0.12 (0.0024 ~ 0.0047)	0.2 (0.0079)

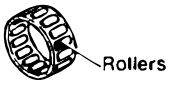
(The same dimensions apply to both KM2-A and KM3-A)

3-4 Forward and reverse large gears

(1) Contact surface with drive cone.
Visually inspect the tapered surface of the forward and reverse large gears where they make contact with the drive cone to check if any abnormal condition or sign of overheating exists.
If any defect is found, replace the gear.

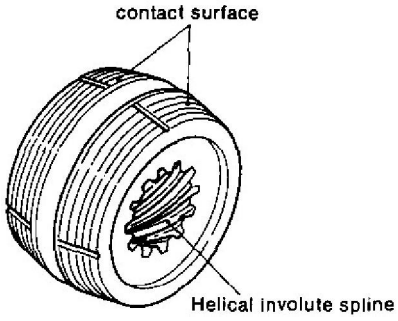


(2) Forward/reverse gear needle bearing.
When an abnormal sound is produced at the needle bearing, visually inspect the rollers; replace the bearing if the rollers are faulty.

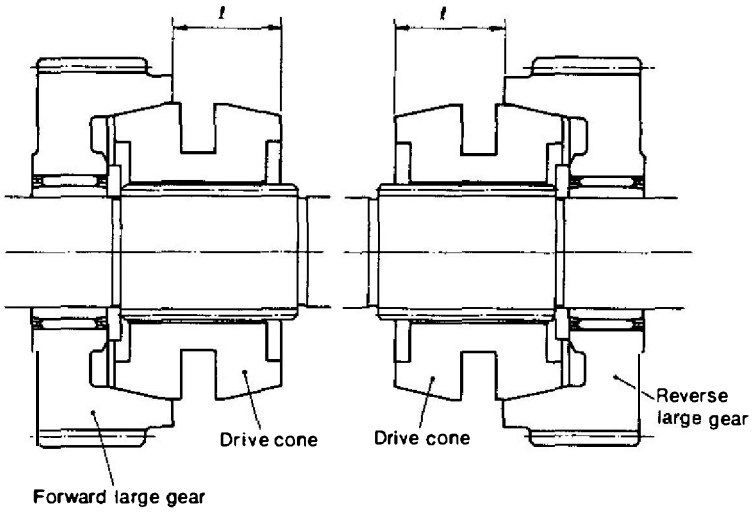


3-5 Drive cone

(1) Visually inspect the surface that comes into contact with the circumferential triangular slot to check for signs of scoring, overheating or wear. If deep scoring or signs of overheating are found, replace the cone.



(2) Check the helical involute spline for any abnormal condition on the tooth surface, and repair or replace the part should any be found.
(3) Measure the amount of wear on the tapered contact surface of the drive cone, and replace the cone when the wear amount exceeds the specified limit.

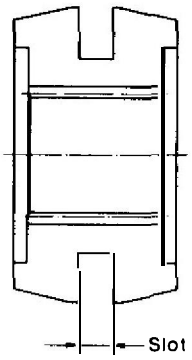


mm (in.)

		Standard dimensions	Limited dimensions
Dimensions *t*	KM2-A	24.4 ~ 24.7 (0.9606 ~ 0.9724)	24.1 (0.9488)
	KM3-A	29.9 ~ 30.2 (1.1772 ~ 1.1890)	29.6 (1.1654)

NOTE: When dismantled, the forward or reverse direction of the drive cone must be clearly identified.

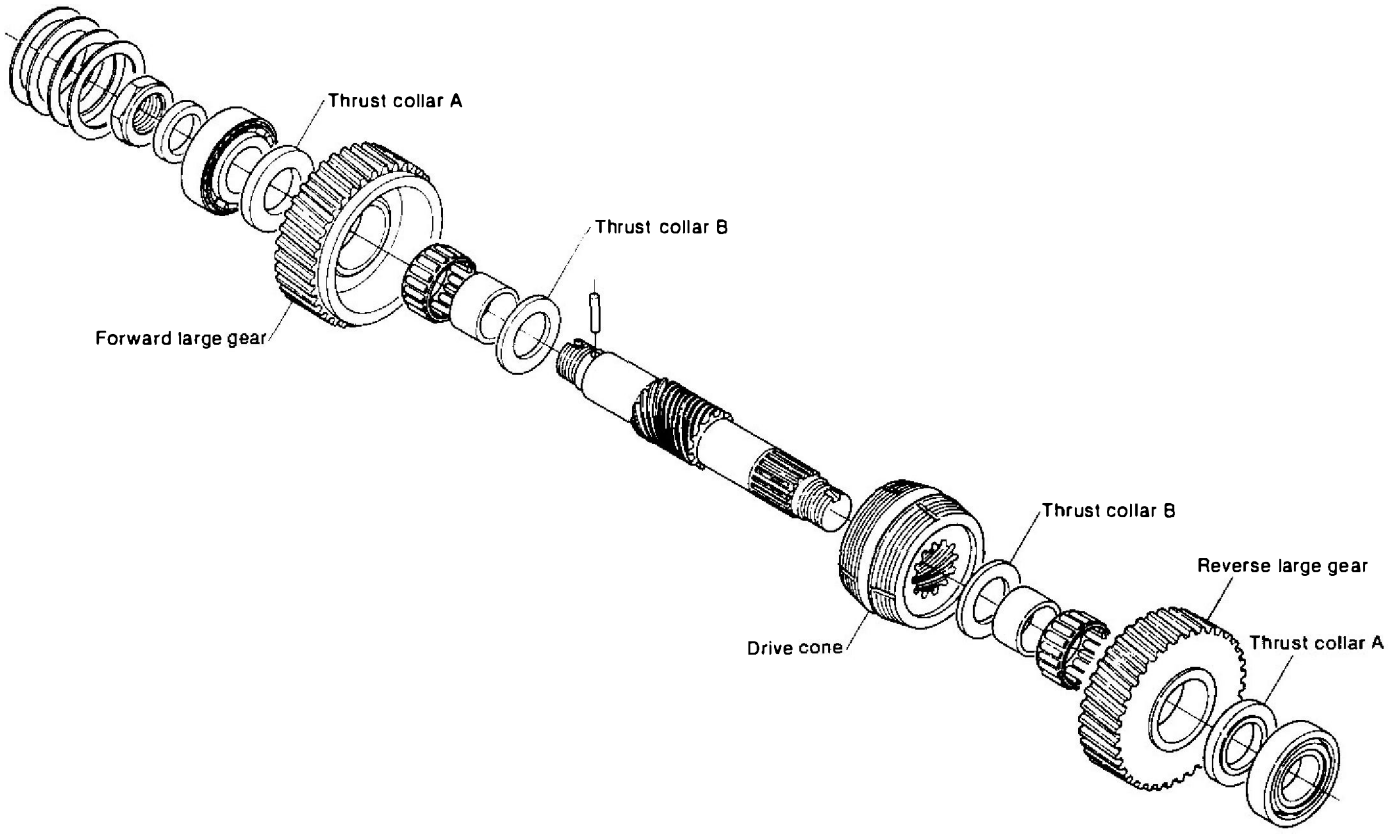
(4) Measure the dimension of the slot width of the drive cone, and replace the cone when the dimension is over the specified limit.



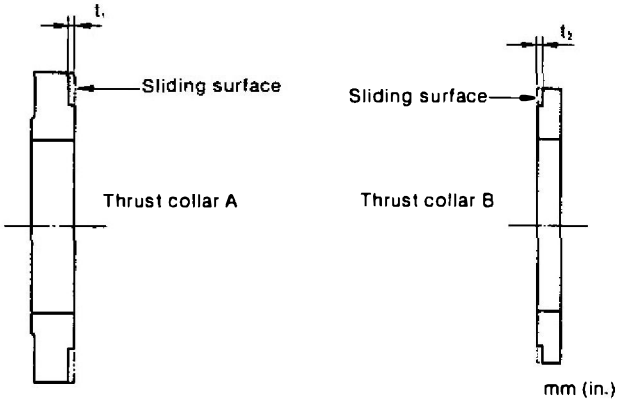
mm (in.)

	Standard dimensions	Standard clearance	Allowable clearance	Limited clearance
Slot width of drive cone	$8^{+0.1}_{0}$ (0.3150 ~ 0.3189)	0.15 ~ 0.3 (0.0059 ~ 0.0118)	0.6 (0.0236)	8.3 (0.3268)
Shifter width	$8^{-0.15}_{-0.20}$ (0.3071 ~ 0.3090)			7.7 (0.3031)

3-6 Thrust collar



(1) Visually inspect the sliding surface of thrust collar A or B to check for signs of overheating, scoring, or cracks. Replace the collar if any abnormal condition is found.
(2) Measure the thickness of thrust collar A or B, and replace it when the dimension exceeds the specified limit.



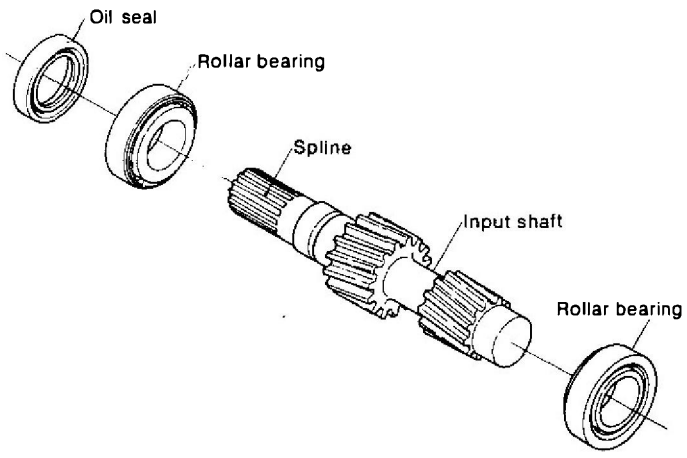
mm (in.)

Stepped wear	Limit for use
Thrust collar A, t_1	0.05 (0.0020)
Thrust collar B, t_2	0.20 (0.0079)

3-7 Oil seal of output shaft

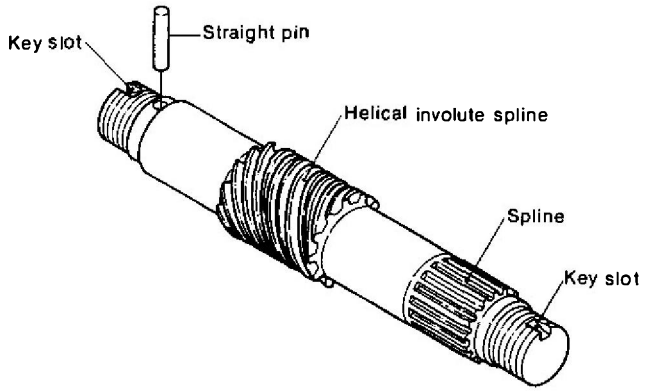
Visually inspect the oil seal of the output shaft to check if there is any damage or oil leakage; replace the seal when any abnormal condition is found.

3-8 Input shaft



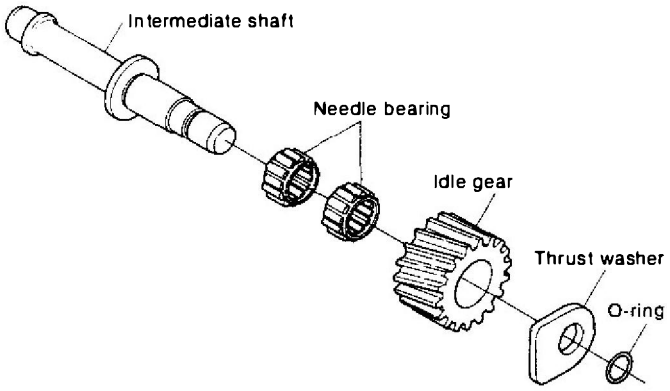
(1) Spline part.
Whenever uneven wear and/or scratches are found, replace with a new part.
(2) Surface of oil seal.
If the sealing surface of the oil seal is worn or scratched, replace.

3-9 Output shaft



(1) Visually inspect the spline and the helical involute spline, and repair or replace a part when any abnormal condition is found on its surface.

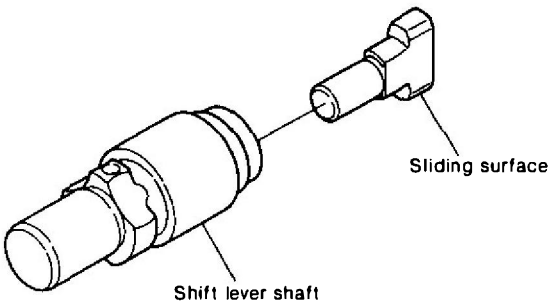
3-10 Intermediate shaft



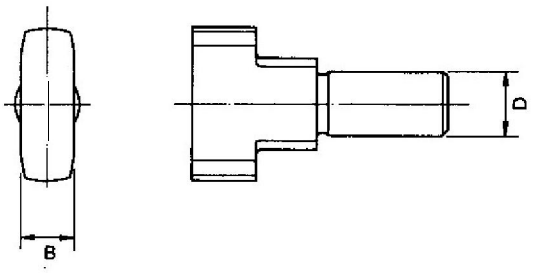
(1) Needle bearing dimensions, staining.
Check the surface of the roller to see whether the needle bearing sticks or is damaged. Replace if necessary.

3-11 Shifting device

3-11.1 Shifter



(1) Visually inspect the surface in contact with the drive cone, and replace the shifter when signs of overheating, damage or wear are found.
(2) Measure the width of the shifter, and replace it when the wear exceeds the specified limit. Also measure the diameter of the shifter shaft, and replace it when the wear exceeds the specified limit.

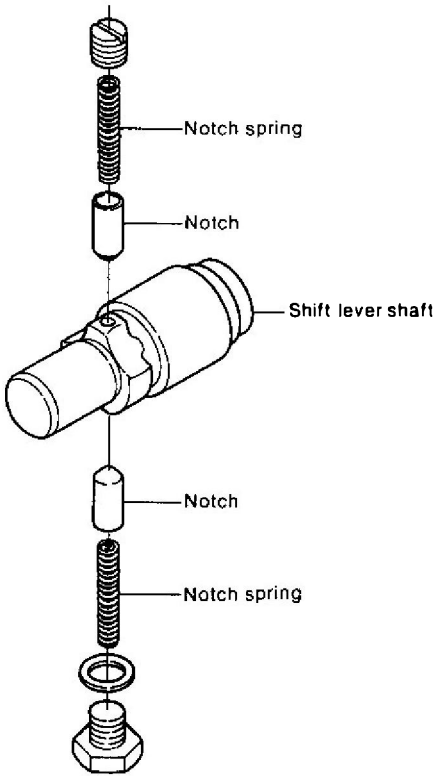


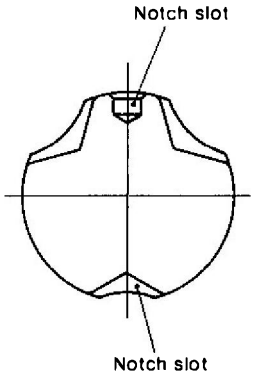
mm (in.)

	Standard dimensions	Clearance	Allowable clearance	Specified limit
Slot width of drive cone	$8^{+0.1}_{0}$ (0.3150 ~ 0.3189)	0.15 ~ 0.3 (0.0059 ~ 0.0118)	0.6 (0.0236)	8.3 (0.3268)
Shifter width	$8^{-0.15}_{-0.20}$ (0.3070 ~ 0.3091)			7.7 (0.3031)
Shifter shaft diameter	$10^{-0.005}_{-0.014}$ (0.3931 ~ 0.3935)	0.005 ~ 0.029 (0.0002 ~ 0.0011)	0.05 (0.0020)	9.95 (0.3917)
Shift lever shaft diameter	$10^{+0.015}_{0}$ (0.3937 ~ 0.3943)			10.05 (0.3957)

3-11.2 Notch slot of shift lever shaft

Visually inspect the notch slot of the shift lever shaft to check for any abnormal wear or crack; replace any defective part that is found.





3-11.3 Notch

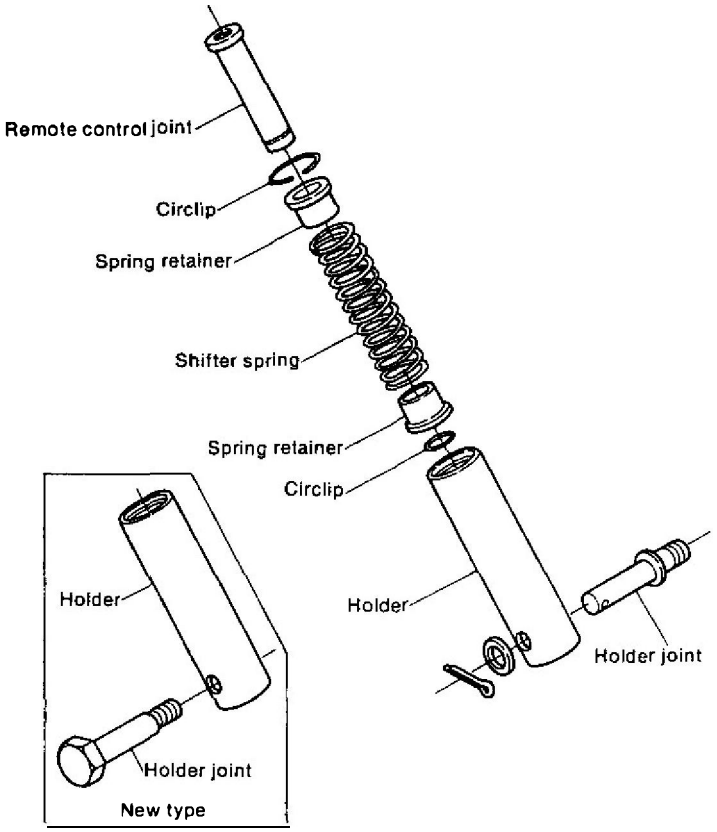
Visually inspect the tip of the notch to check for wear, damage or deformation. Replace the notch if it is found to be defective in any way.

3-11.4 Notch spring

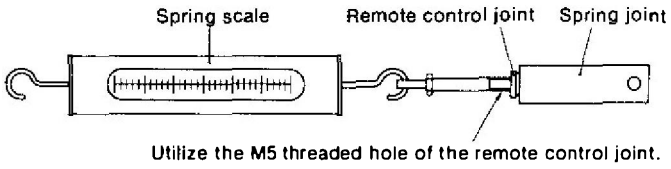
Visually inspect the notch spring to check for any damage, corrosion or permanent set; replace the spring when it is found to be defective.

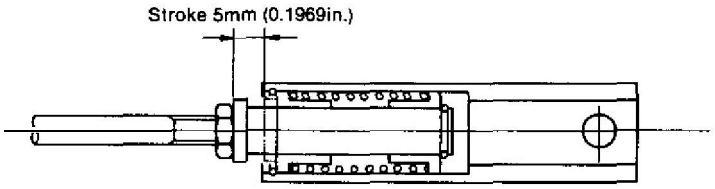
Free length	34mm (1.3386in.)
Spring coefficient	0.459kg (0.992 lb)
Set length	25.5mm (1.0039in.)
Set load	3.90kg (8.598 lb)

3-12 Spring joint



(1) Check each part for abnormal play, and replace if play is excessive.
(2) When the movement of each part is not smooth, measure the tension and replace as a complete unit when it exceeds the specified limit.

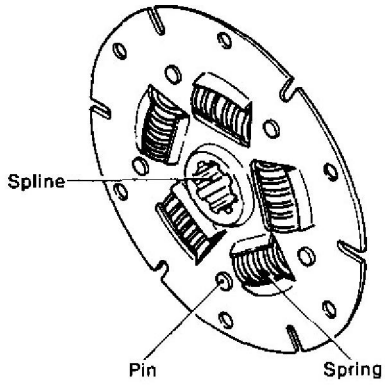




kg (lb)

	Standard value	Limit value
Tension (at the position of 5mm stroke)	2.8 (6.17)	2.5 (5.51)

3-13 Damper disc

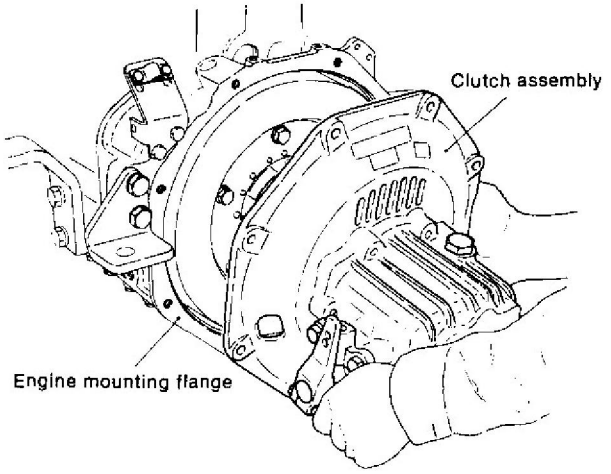


(1) Spline part.
Whenever uneven wear and/or scratches are found, replace with a new part.
(2) Spring.
Whenever uneven wear and/or scratches are found, replace with a new part.
(3) Pin wear.
Whenever uneven wear and/or scratches and found, replace with a new part.
(4) Whenever a crack or damage to the spring slot is found replace the defective part with a new one.

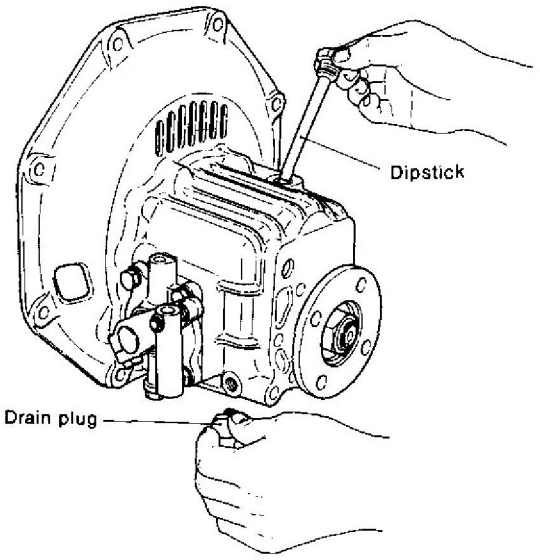
4. Disassembly

4-1 Dismantling the clutch

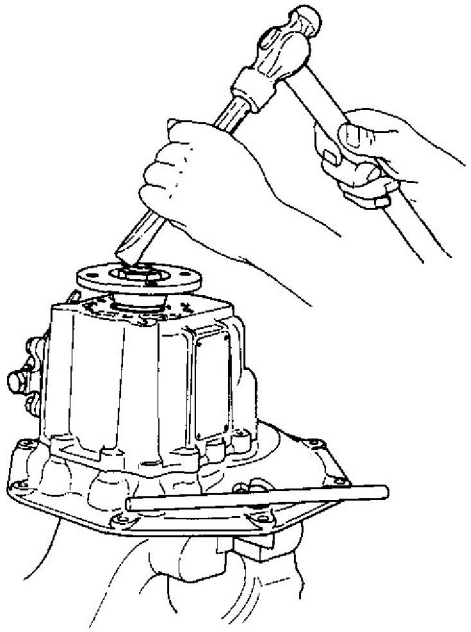
(1) Remove the remote control cable.
(2) Remove the clutch assembly from the engine mounting flange.

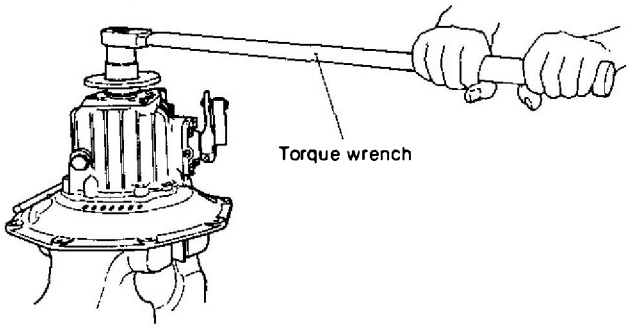


(3) Drain the lubricating oil.
Drain the lubricating oil by loosening the plug at the bottom of the clutch case.



(4) Remove the end nut and output shaft coupling.





NOTE: Take care as it has a left-handed thread.

(5) Remove the oil dip stick and packing.
(6) Remove the fixing bolts on the side cover, and also remove the shift lever shaft, shift lever and shifter.