CHAPTER 6

LUBRICATION SYSTEM

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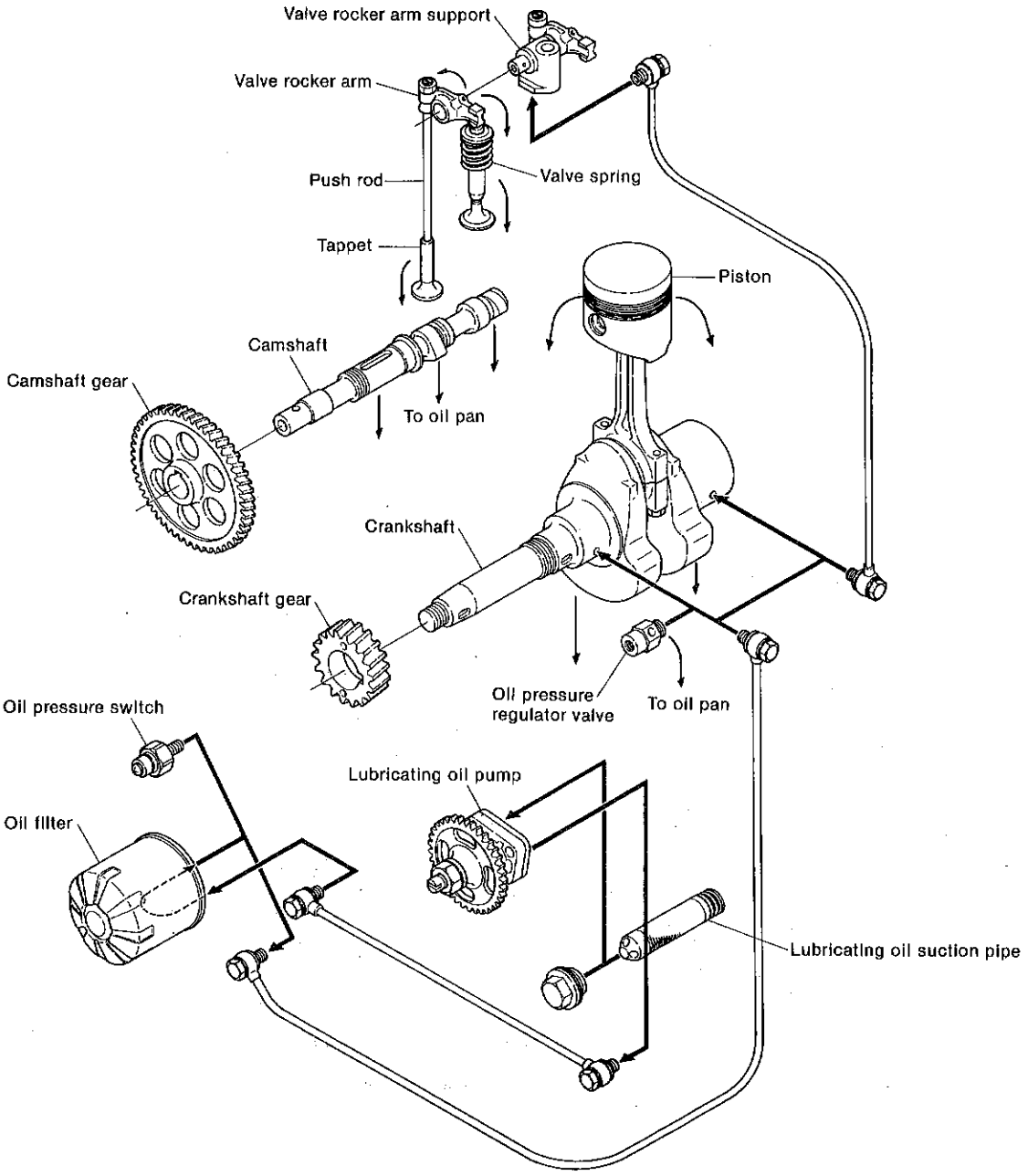
1. Lubrication System

Engine parts are lubricated by a trochoid pump forced lubrication system. To keep the engine exterior uncluttered and to eliminate vibration damage to piping, exterior piping has been minimized by transporting the lubricating oil through passages drilled in the cylinders and timing gear case.

1-1 Lubricating oil passage of model 1GM10(C)

The lubrication oil filling port is located at the top of the timing gear case, and the lubrication oil poured into the filler is stored in the oil sump after passing through the casting hole in the cylinder wall. The lubricating oil in the oil sump is drawn up the suction pipe through the drilled hole in the cylinder by the action of the trochoid pump, and it is then fed to the lubricating oil filter after passing through the drilled hole in the filter mounting base. The lubricating oil which has passed through the filter is fed through a pipe to the main gallery of the cylinder, and then fed to the main bearing through the oil pressure regulator valve.



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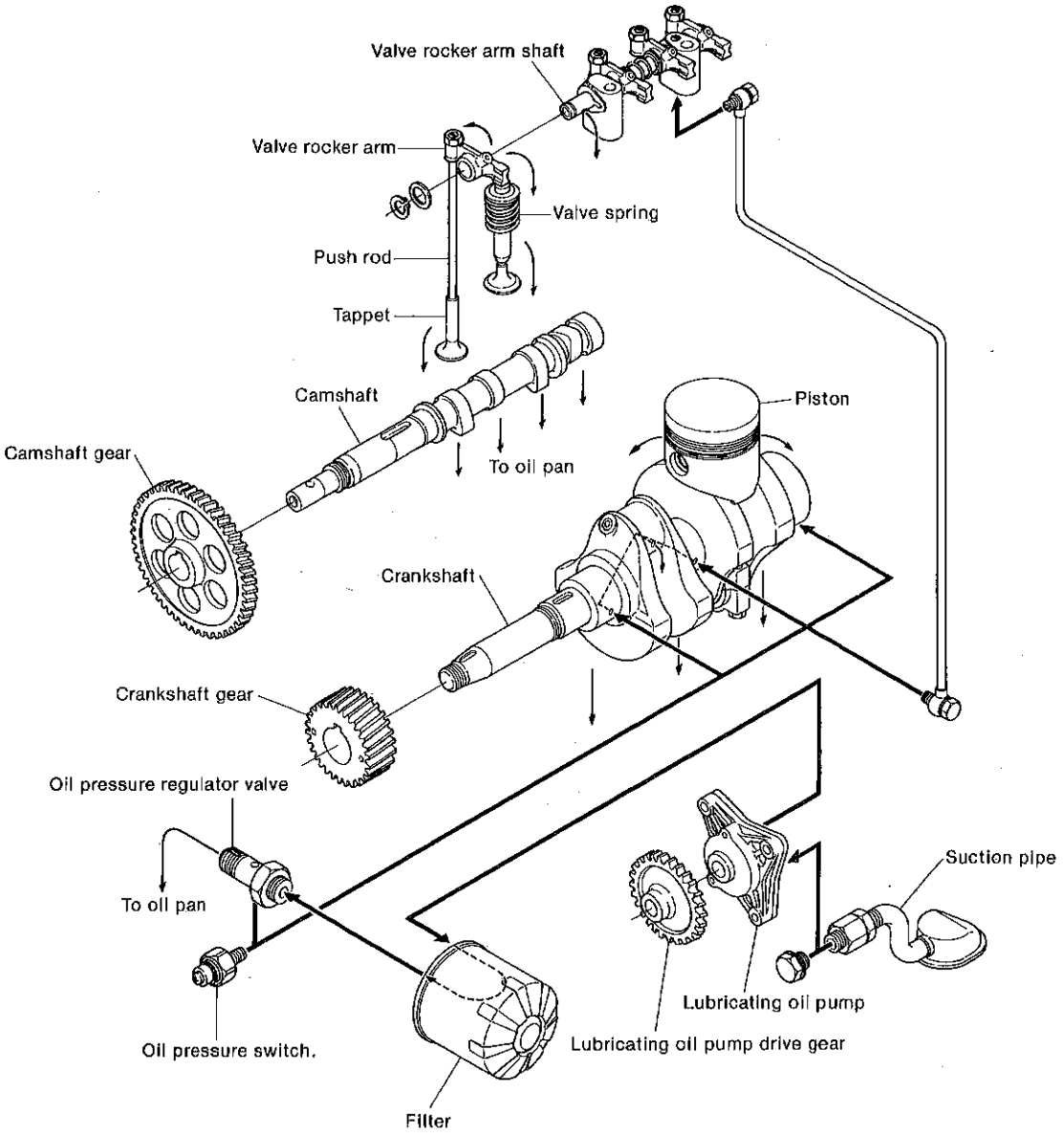
1-2 Lubrication oil passage of model 2GM20(F)(C)

The lubricating oil supplied from the oil filter in the rocker arm cover is collected through the tappet holes in the oil pan at the bottom of the cylinder block.
The lubricating oil is drawn back up through the lubricating oil suction pipe by the trochoid pump and fed to the oil filter, where impurities are filtered out. Then it is adjusted to the prescribed pressure by the oil pressure regulating valve and sent to the main bearing.
The lubricating oil sent to the gear side main bearing flows in two paths: one from the main bearing to lubricate the crank pin through the hole drilled through the crankshaft.
The lubricating oil sent to the flywheel side main bearing also flows in two paths: one from the main bearing to lubricate the crank pin through the hole drilled through the crankshaft, and the other to the rocker arm shaft through the hole drilled through the cylinders and cylinder head.
From the rocker arm shaft, the lubricating oil flows through the small hole in the rocker arm to lubricate the push rods and part of the valve head.
The oil that has dropped to the push rod chamber from the rocker arm chamber lubricates the tappets, cam and cam bearing, and returns to the oil pan.
The pistons, piston pins and contact faces of the cylinder liners are splash lubricated by the oil that has lubricated the crank pin. Moreover, an oil pressure switch is provided in the lubricating system to monitor normal circulation and the pressure of the lubricating oil. When the lubricating oil pressure drops 0.5kg/cm² (7.114 lb/in.²), the oil pressure switch illuminates the oil pressure lamp on the instrument panel to notify the operator.



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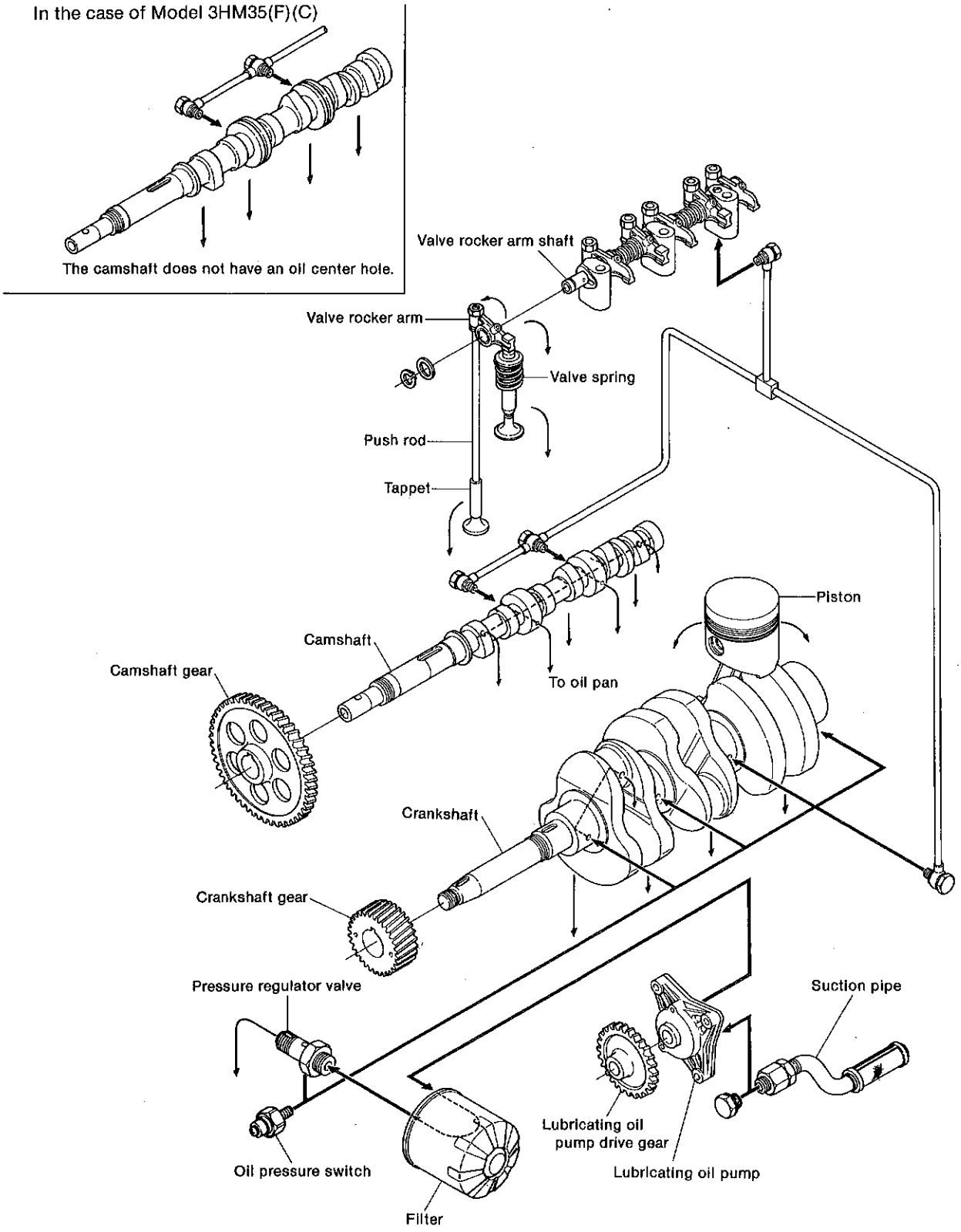
1-3 Lubrication oil passage of model 3GM30(F)(C) and 3HM35(F)(C)



1-4 Table of capacity for lubricating oil system

			1GM10(C)	2GM20(F)(C)	3GM30(F)(C)	3HM35(F)(C)
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)	2.6 (1.6)	5.4 (2.7)

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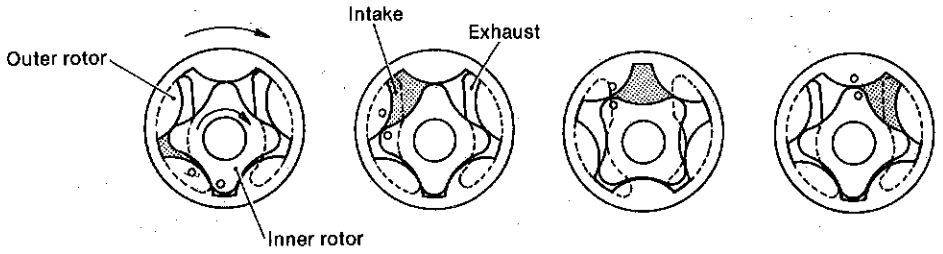
2. Oil Pump

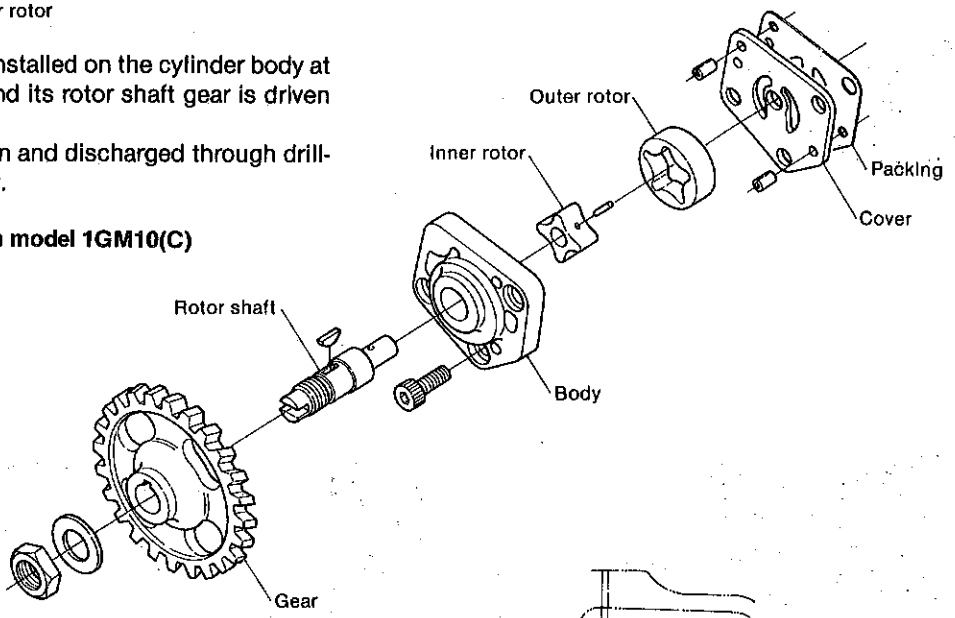
2-1 Construction

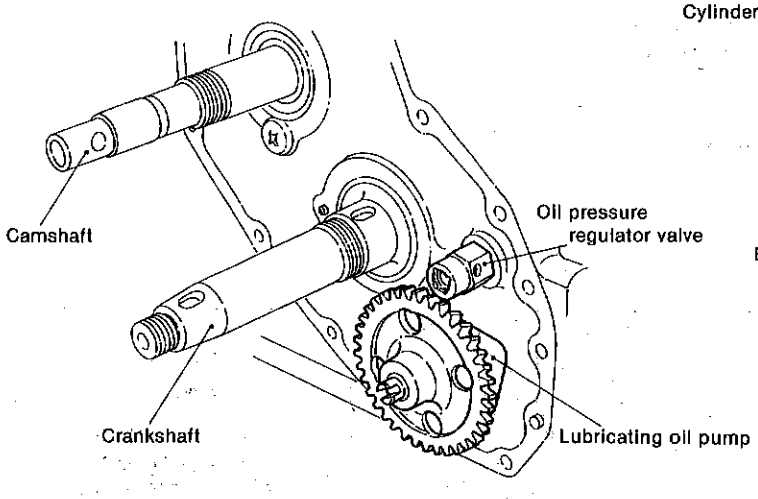
The oil pump is a compact, low pressure variation trochoid pump comprising trochoid curve inner and outer rotors. Pumping pressure is provided by the change in volume between the two rotors caused by rotation of the rotor shaft.

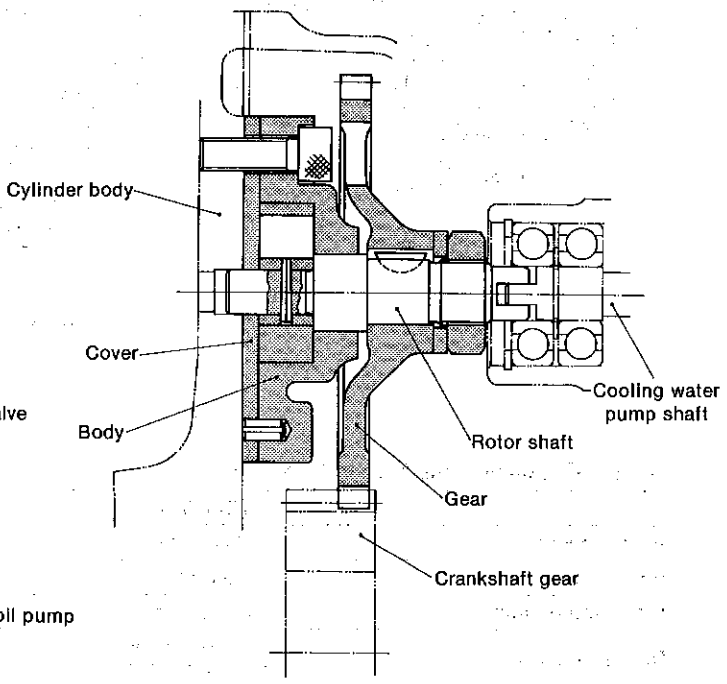


The lubricating oil pump is installed on the cylinder body at the timing gear case end, and its rotor shaft gear is driven by the crankshaft gear.
The lubricating oil is drawn in and discharged through drilled holes in the cylinder body.

2-1.1 Lubricating oil pump on model 1GM10(C)







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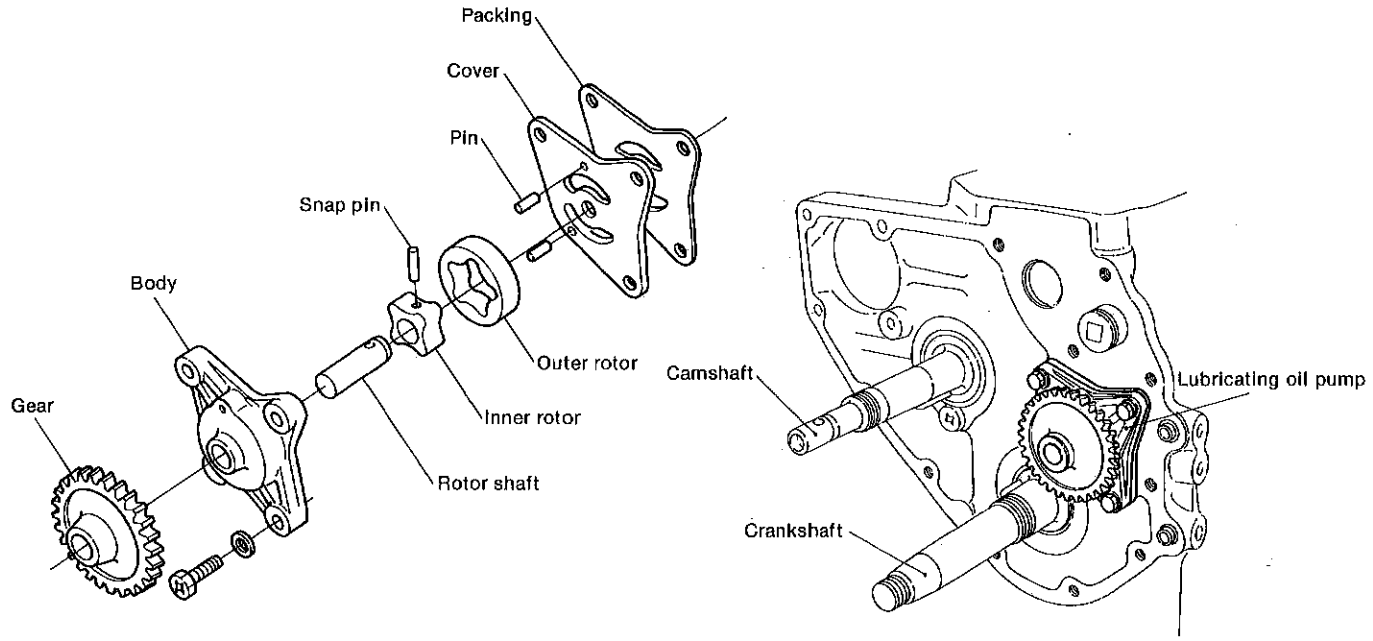
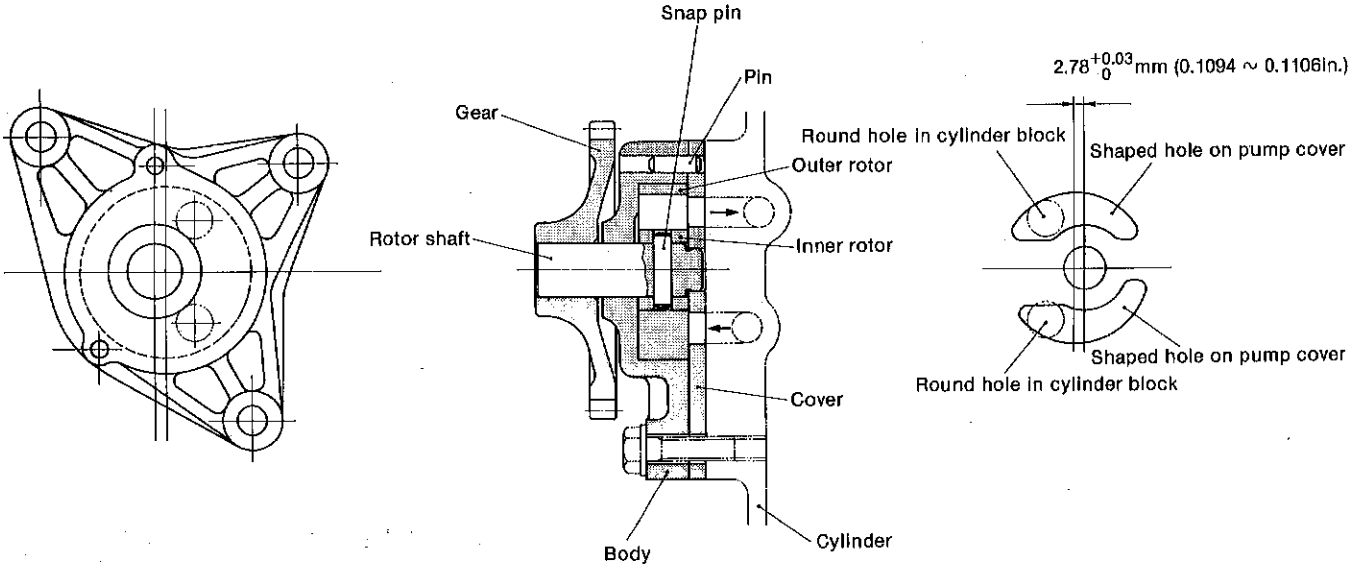
2-1.2 Lubricating oil pump on models 2GM20(F)(C), 3GM30 (F)(C) and 3HM35(F)(C)





2-1.3 Specifications of lubrication oil pump

	1GM10(C)	2GM20(F)(C), 3GM30(F)(C)	3HM35(F)(C)
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)

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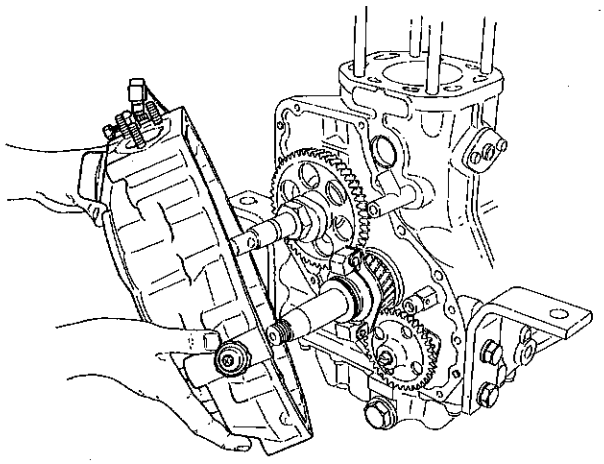
2-2 Disassembly

2-2.1 Model 1GM10(C)

(1) Remove the timing gear case



(1') Remove gear case

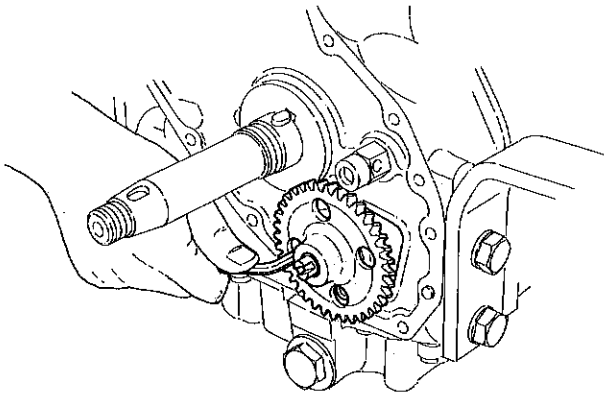
(2) Withdraw the governor sleeve and thrust bearing, and also take out the governor weight support after removing the hexagonal nut.

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') Remove the loosening bolt with a hexagonal bar spanner.

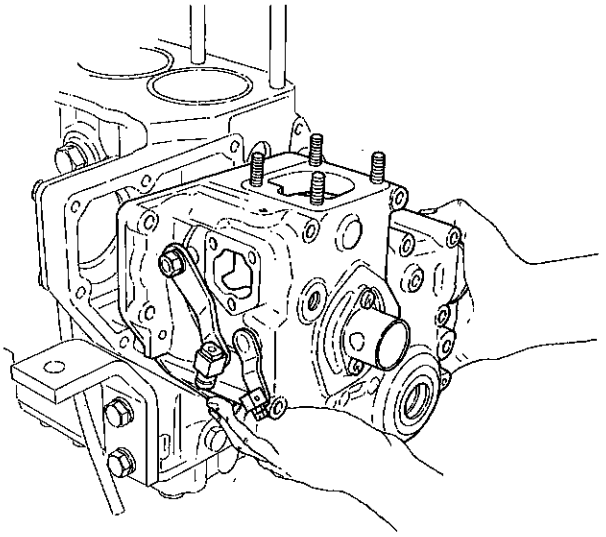


(5) Remove the pump cover.

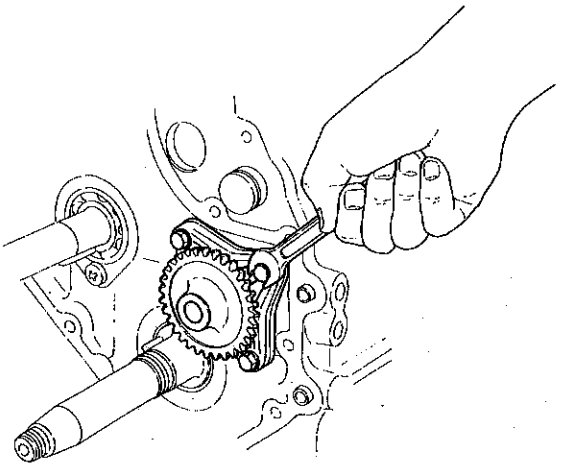
(6) Take out the outer rotor and the assembly of the inner rotor and rotor shaft.

2-2.2 Models 2GM20(F)(C), 3GM30(F)(C) and 3HM35(F)(C)

(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.

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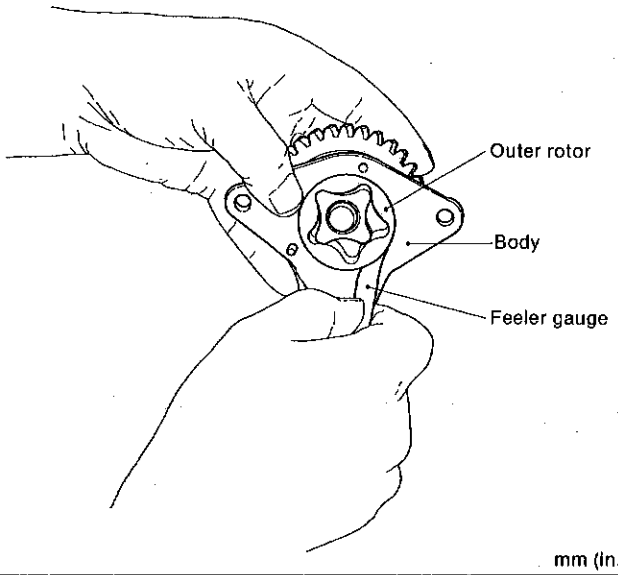
2-3 Inspection

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.

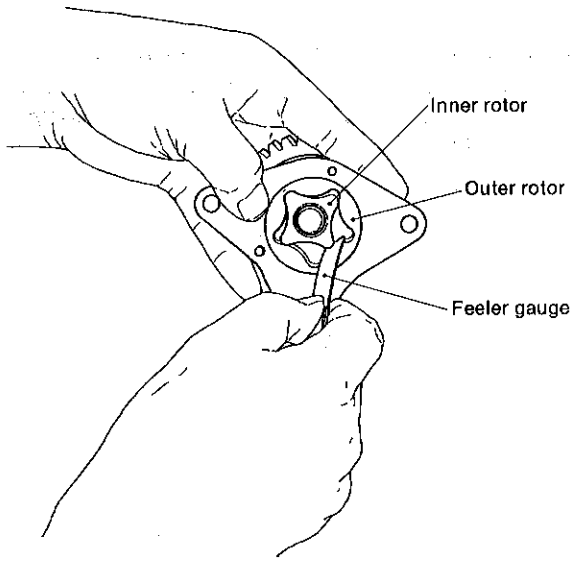


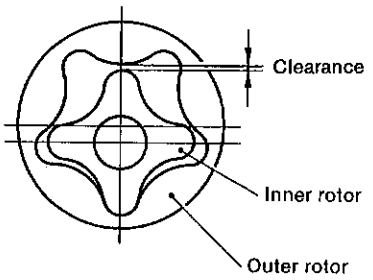
mm (in.)

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.





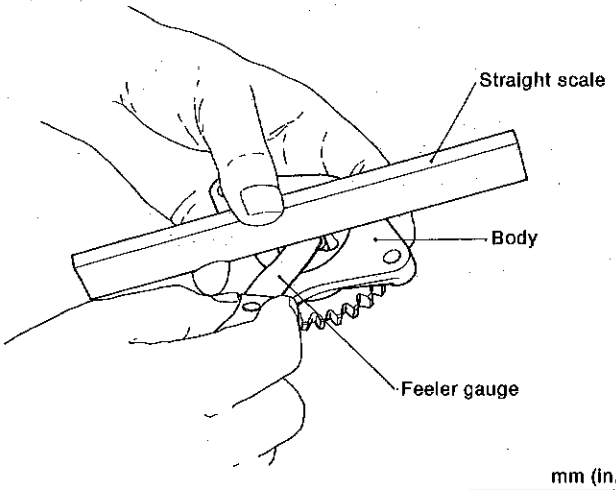
mm (in.)

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.)

	1GM10(C)	2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)
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.)

	1GM10(C)		
	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)		

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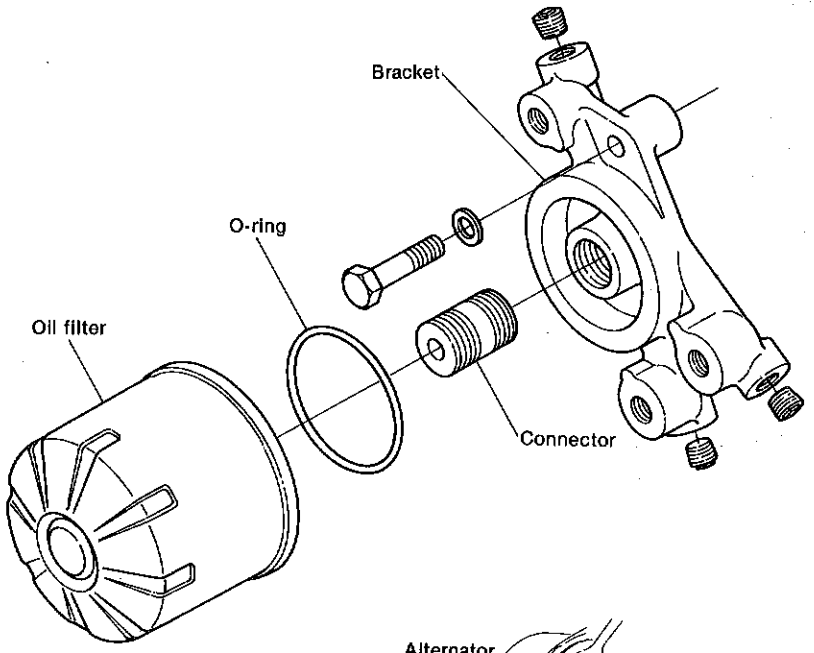
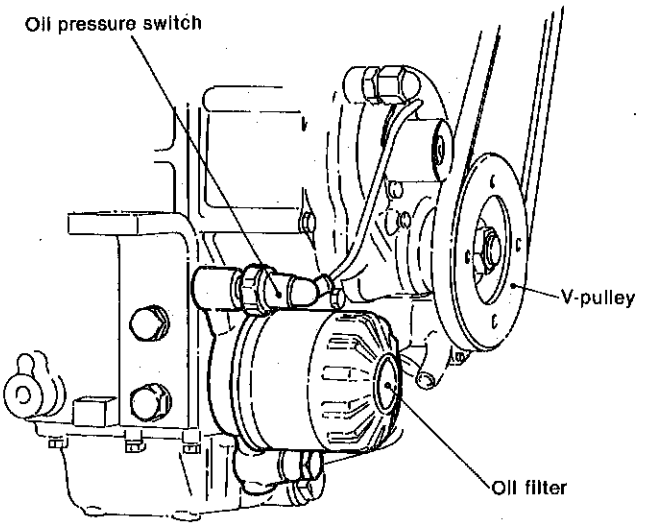
3. Oil Filter

3-1 Construction

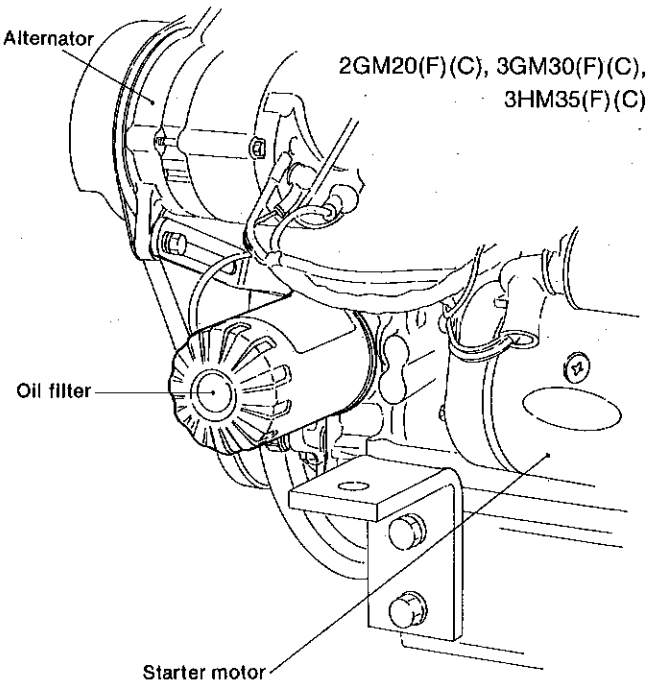
The oil filter removes the dirt and metal particles from the lubricating oil to minimize wear of moving parts. The construction of the oil filter is shown below.
The lubricating oil from the oil pump is passed through the filter paper and distributed to each part as shown by arrow A in the figure.
After 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 2GM20(F)(C), 3GM30(F)(C) and 3HM35(F)(C). However, in the case of engine model 1GM10(C), 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.



1GM10(C)



2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)



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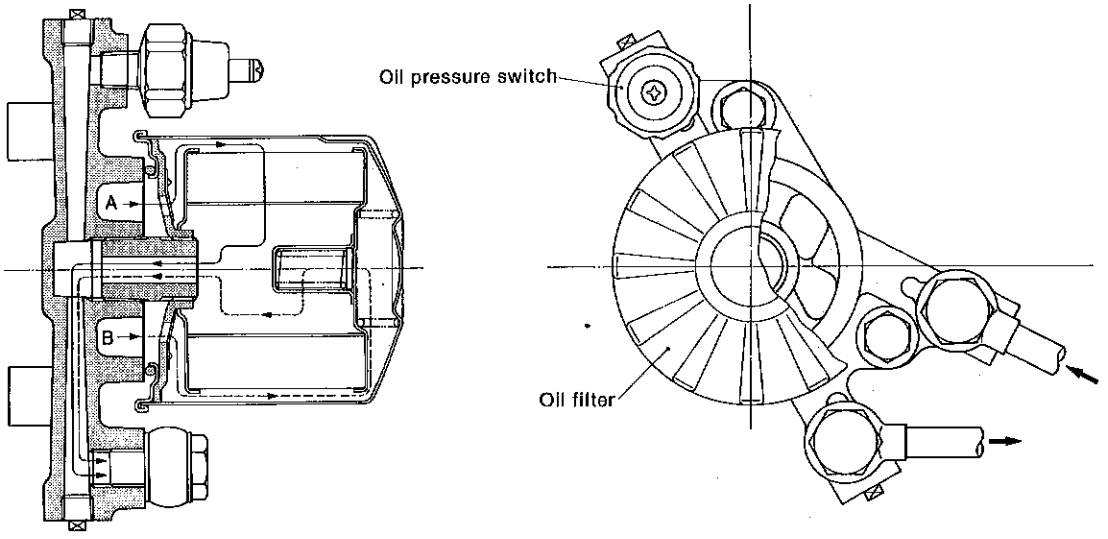
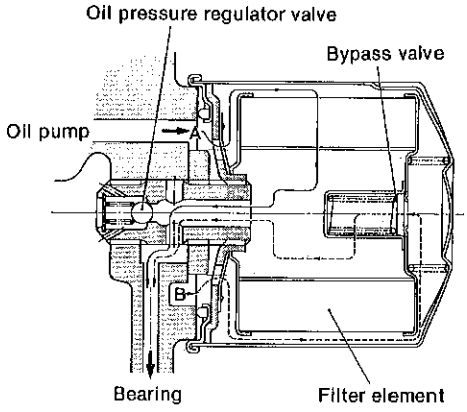
1GM10(C)



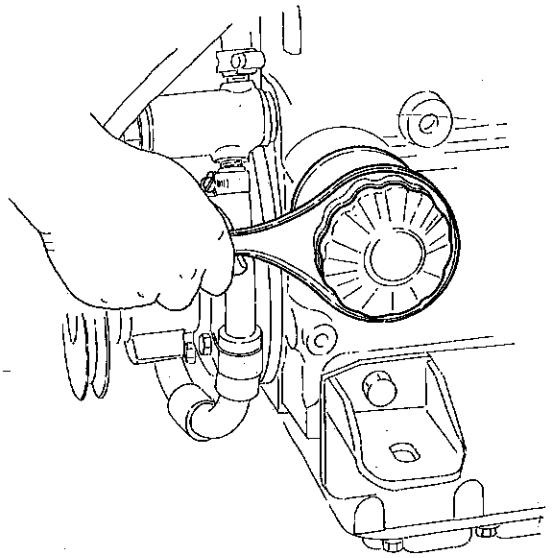
2GM20(F)(C), 3GM30(F)(C) and 3HM35(F)(C)



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 is a cartridge type oil filter, it is replaced as a complete unit.

Oil filter replacement period	Every 300 hours of engine operation



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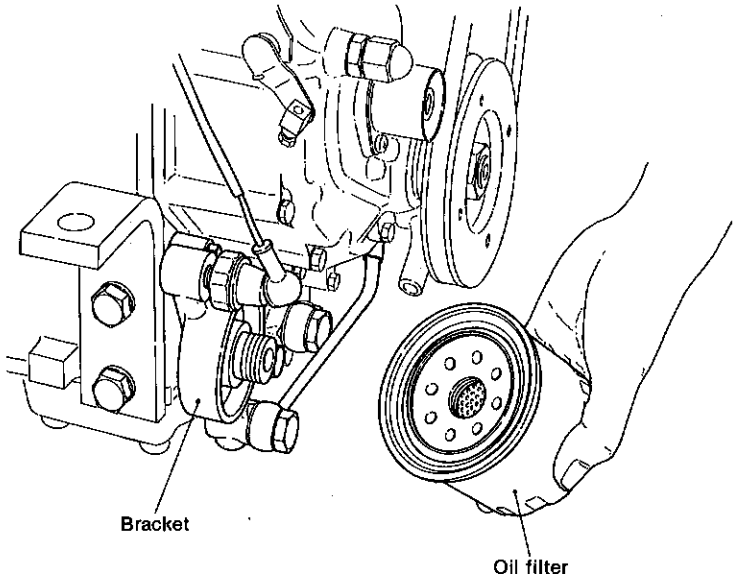
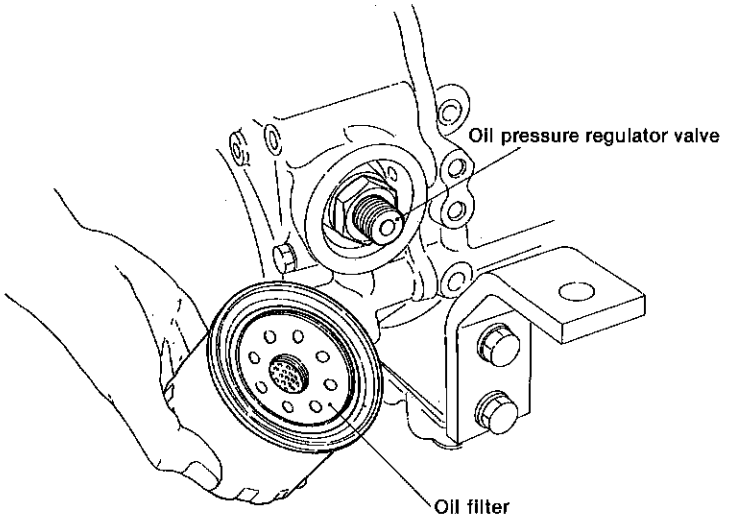
1GM10(C)



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



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.

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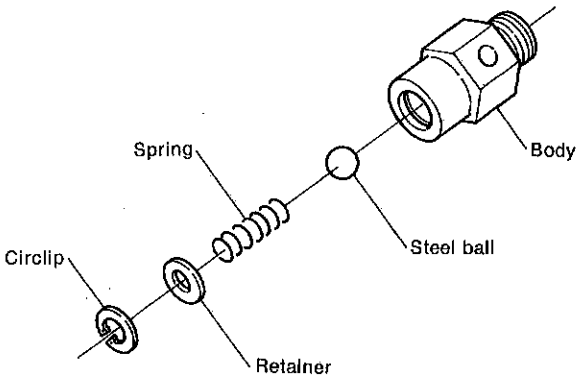
4. Oil Pressure Regulator Valve

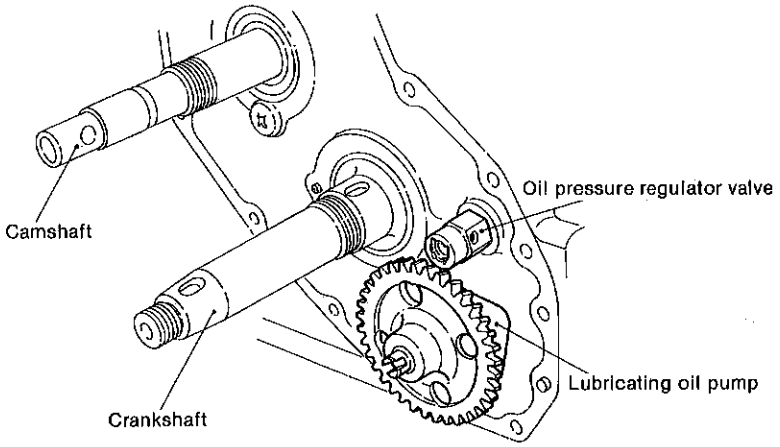
4-1 Construction

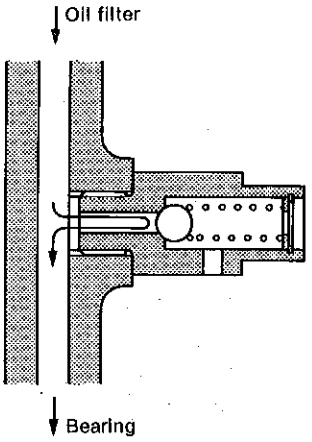
The oil pressure regulator valve serves to adjust the pressure of the lubricating oil to the prescribed pressure during operation. When the pressure of the lubricating oil from the oil filter exceeds the force of the spring, the metal ball is pushed away from the valve seat and the lubricating oil flows to the oil pan through the gap between the ball and seat. The spring's force is adjusted with a shim.
In engine model 1GM10(C), 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 of the timing gear case for engine models 2GM20(F)(C), 3GM30(F)(C) and 3HM35(F)(C)

4-1.1 Model 1GM10(C)



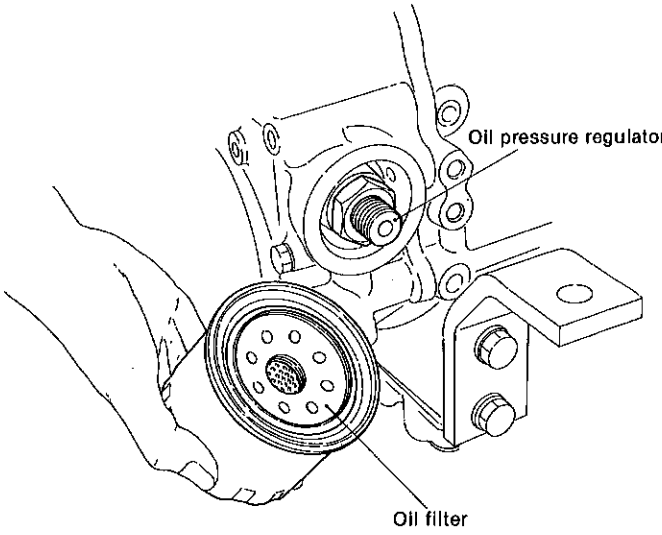
Mounting position for model 1GM10(C)

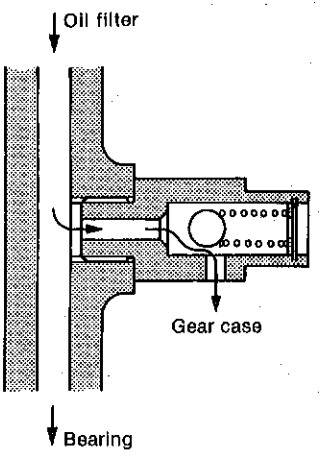




When the pressure is lower than the regulated pressure

Mounting position for model 2GM20(F)(C)





When the pressure is higher that the regulated pressure

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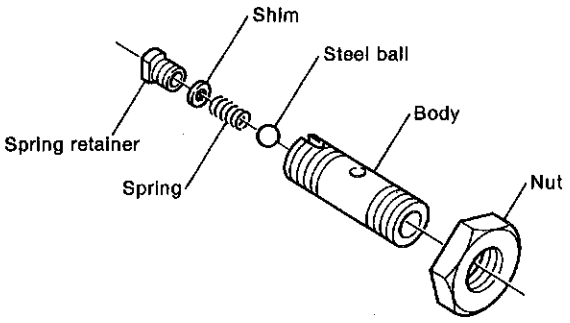
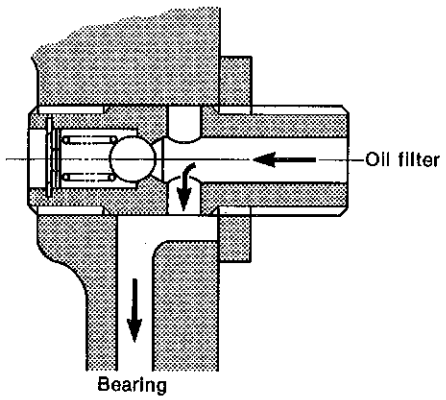
4-1.2 Models 2GM20(F)(C), 3GM30(F)(C) and 3HM35(F)(C)



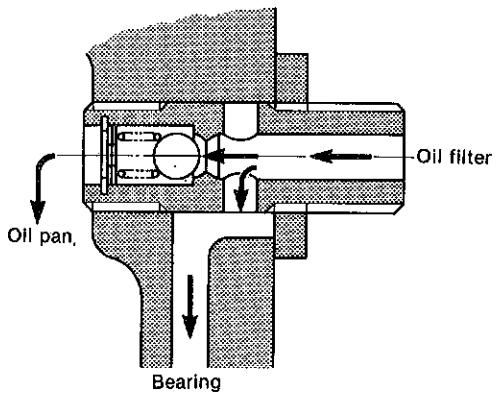
4-1.3 Specifications

	1GM10(C)	2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)
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.



When the pressure is lower that the regulated pessure



When the pressure is higher that the regulated pressure

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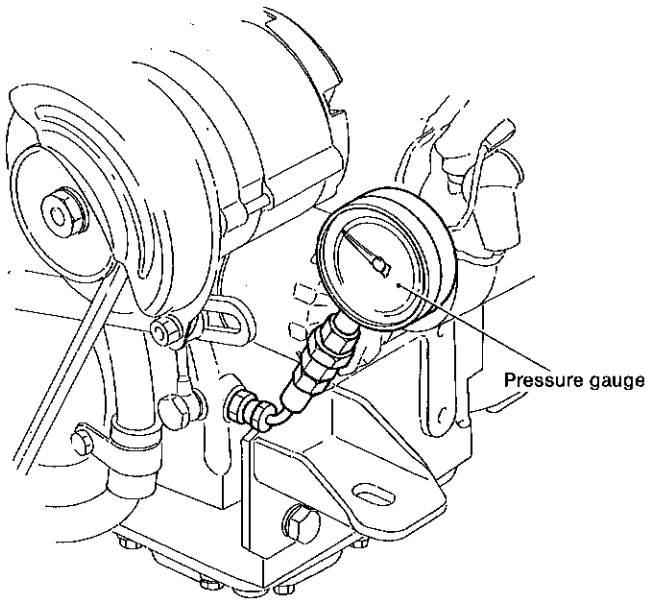
5. Oil Pressure Measurement

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 for secondary pressure, as shown in the 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)

	1GM10(C), 2GM20(F)(C), 3GM30(F)(C)		3HM35(F)(C)	
	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.

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