

# ***YANMAR***

# ***SERVICE MANUAL***

## ***MARINE DIESEL ENGINE***

### **MODELS**

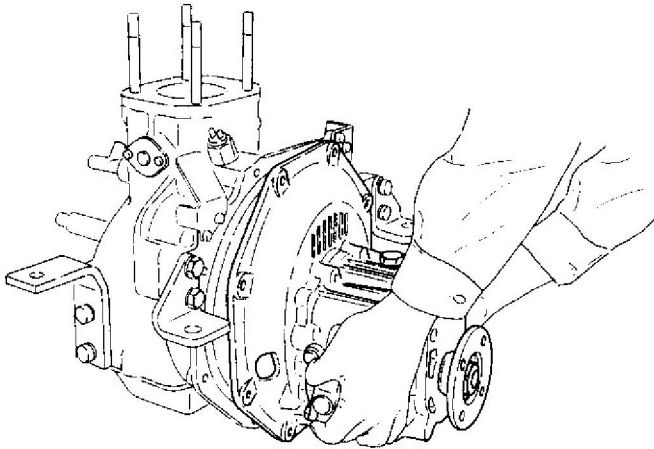
**1GM (10L)**

**2GM (F)(L)**

**3GM (D)(F)(L)**

**3HM (F)(L)**

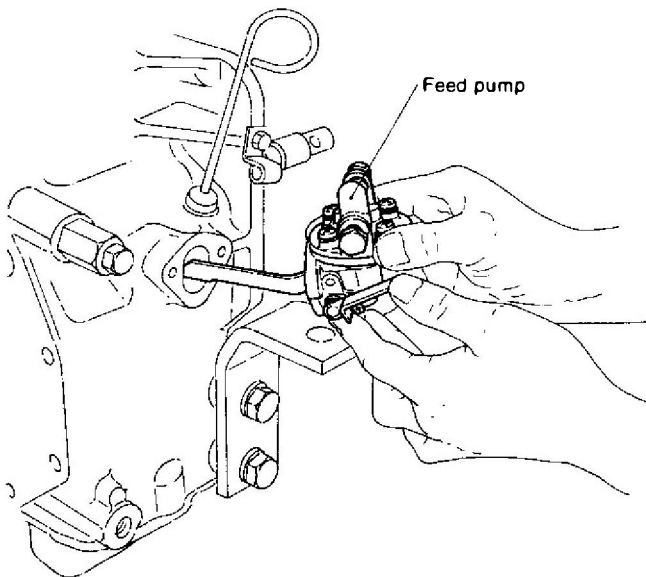
- (2) Align the disk and input shaft spline, and install the clutch assembly on the mounting flange.



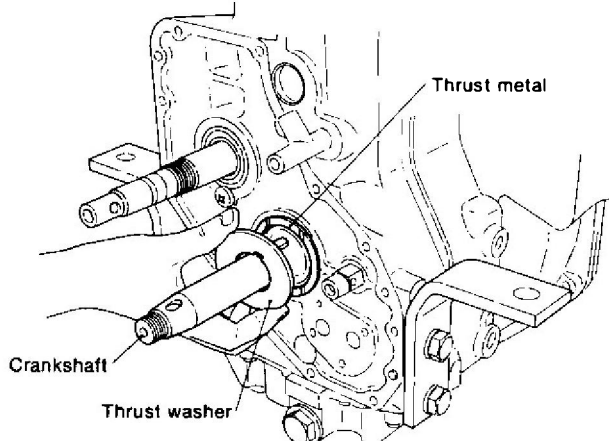
Tightening torque	2 ~ 2.5 kg-m (14.5 ~ 18 ft-lb)
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#### 5-2.11 Install the engine feet and set the engine in position

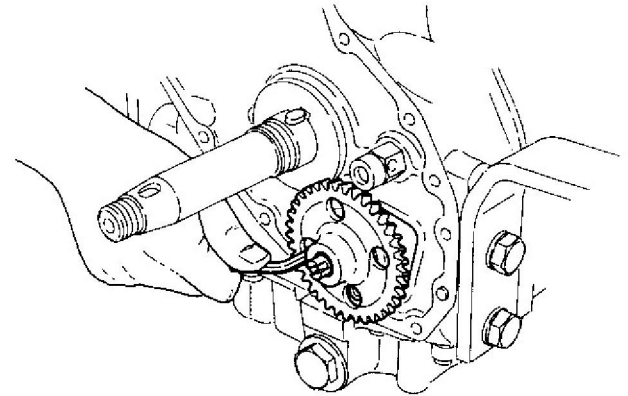
- (1) Dipstick
- (2) Fuel feed pump



#### 5-2.12 Assemble the thrust metal and thrust washer



#### 5-2.13 Install the lubricating oil pump and gear assembly

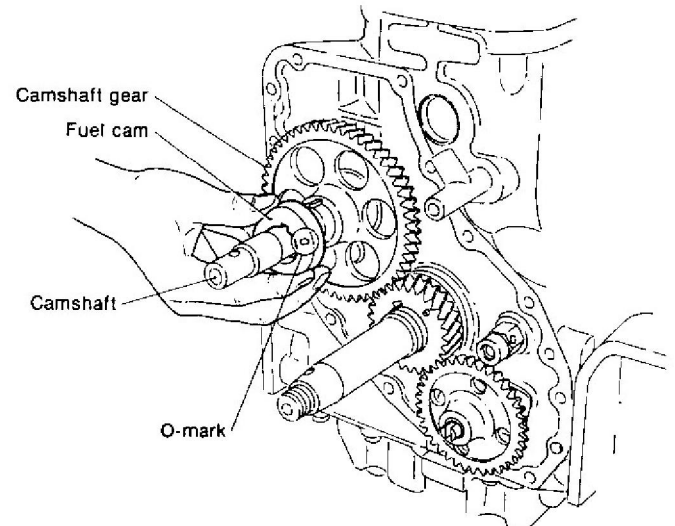


Lube pump body mounting bolt	0.9 kg-m (6.5 ft-lb)
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#### 5-2.14 Assemble the crankshaft gears

- (1) Coat the crankshaft section and the inside of the gear with oil.
- (2) Insert the crankshaft gear

#### 5-2.15 Assemble the camshaft gear and fuel cam

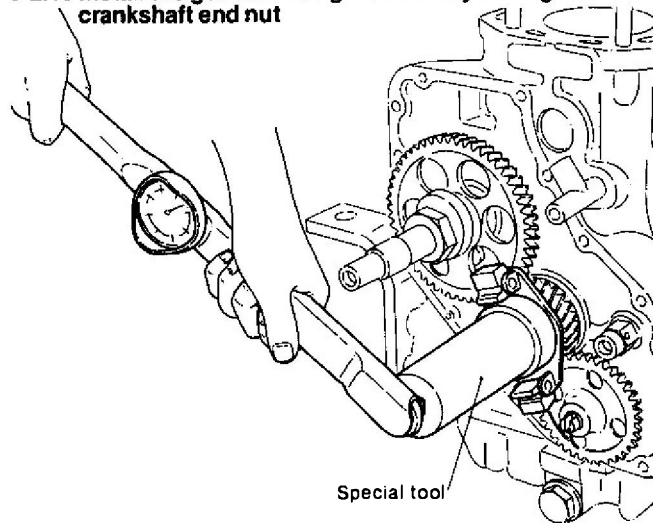


- (1) Coat the shaft hole of the camshaft gear with oil, and align the matching marks of the camshaft gear and the crankshaft gear and insert the camshaft gear.
- (2) Coat the fuel cam with oil and insert the cam by aligning the "O" mark opposite the camshaft gear.
- (3) Tighten the camshaft end nut

Tightening torque	7 ~ 8 kg-m (50.6 ~ 57.9 ft-lb)
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#### (4) Check the backlash

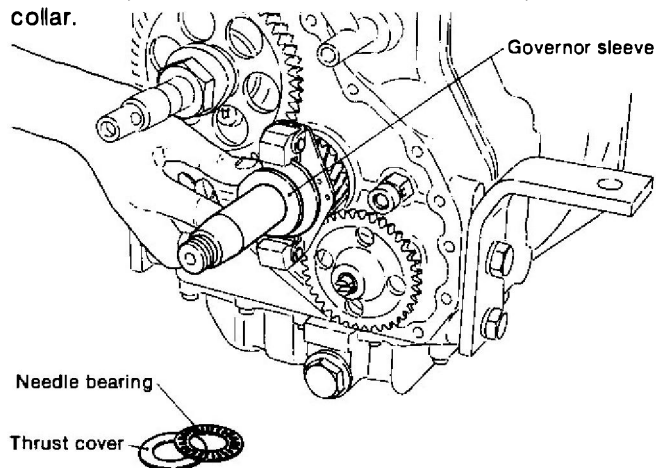
	Maintenance standard	Wear limit
Crankshaft gear and camshaft gear backlash		
Crankshaft gear and lubrication oil pump driven gear backlash	0.05 ~ 0.13 (0.0020 ~ 0.0051)	0.3 (0.0118)
Camshaft gear and fuel feed pump driven gear backlash		

**5-2.16 Install the governor weight assembly and tighten the crankshaft end nut**

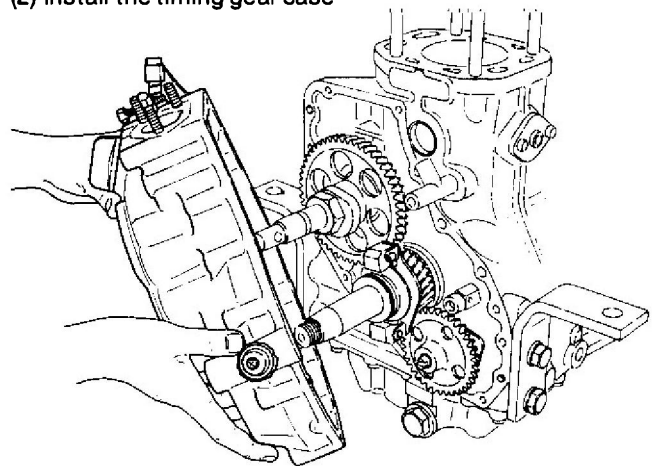
Tightening torque	8 ~ 10 kg-m (57.9 ~ 72.3 ft-lb)
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**5-2.17 Install the governor sleeve**

Install the governor sleeve, thrust needle bearing and thrust collar.

**5-2.18 Install the timing gear case**

- (1) Coat both sides of the new packing with "Three Bond 3B8-005" and install.
- (2) Install the timing gear case

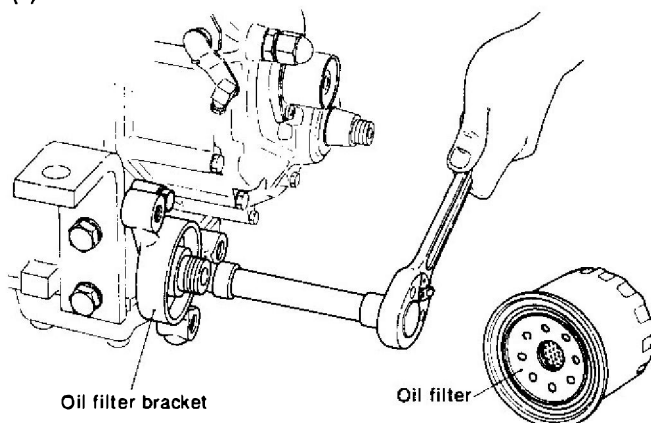


Tightening torque	0.9 kg-m (6.5 ft-lb)
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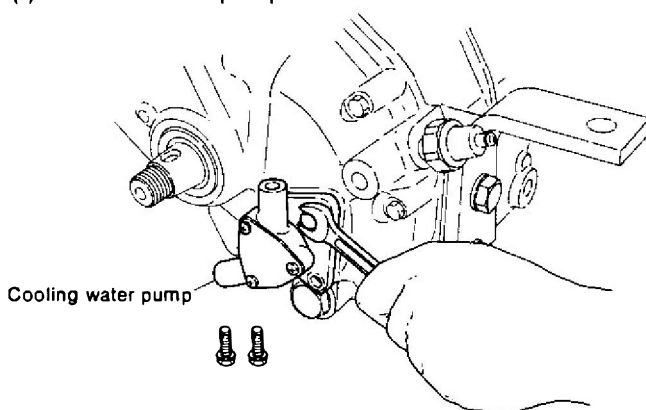
- (3) Insert the pin for fitting the handle into the camshaft and fix it by means of the bolt with the hexagonal socket head, then fit the starting shaft cover.

**5-2.19 Install the oil filter and bracket**

- (1) Install the oil filter bracket on the gear side of the cylinder block.
- (2) Install the oil pipes.
- (3) Install the oil filter.

**5-2.20 Install the water pump**

- (1) Install the water pump



Tightening torque	0.9 kg-m (6.5 ft-lb)
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- (2) Install the water pipe (pump to cylinder inlet joint)

**5-2.21 Install the crankshaft V-pulley**

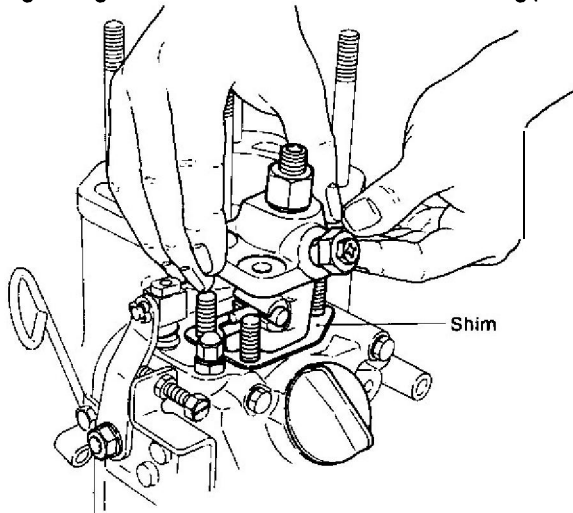
- (1) Install the crankshaft key
- (2) Coat the crankshaft V-pulley and the inside of the oil seal with oil.
- (3) Insert and tighten the V-pulley, making sure that the lip of the oil seal is not distorted.

Tightening torque	10 kg-m (72.3 ft-lb)
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**5-2.22 Install the fuel injection pump**

- (1) Remove grease from both sides of the fuel injection timing adjustment shims with thinner, and coat the shims with "Screw Lock Super 203M."

- (2) Insert the pump by looking through the oil filler and align the governor No.2 lever and rack connecting part.



- (3) Tighten the fuel pump

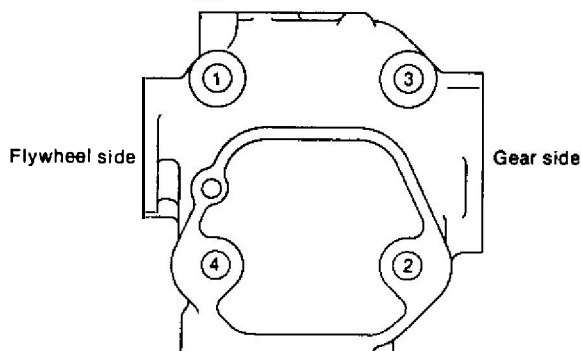
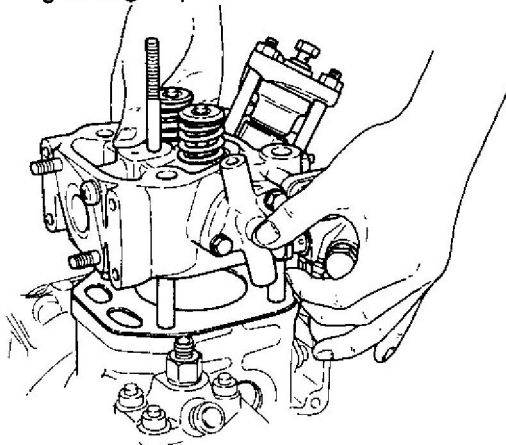
Tightening torque	2.5 kg-m (18 ft-lb)
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#### 5-2.23 Install the cylinder head

- (1) Install the gasket packing

**CAUTION:** Take particular note of the fitting surfaces. Fit the side with the recessed part of the cooling water passage to the cylinder block side.

- (2) Insert the cylinder head, being careful not to damage the threads of the tightening bolts, and tighten the nuts in the tightening sequence.

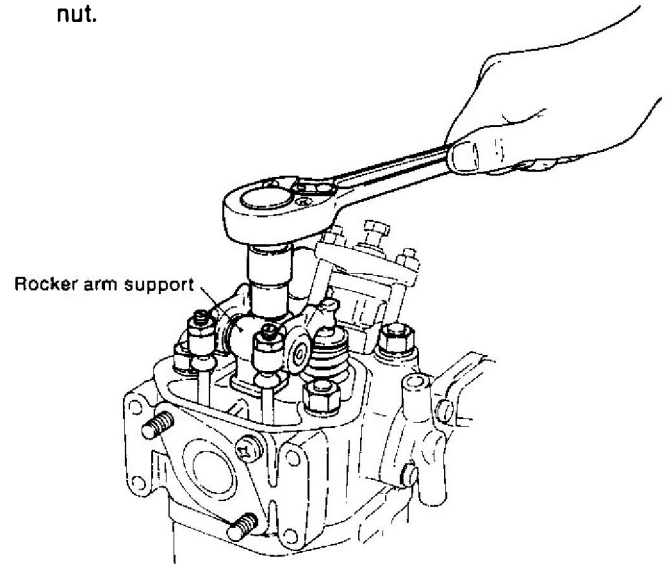


Tightening torque	7.5 kg-m (54.2 ft-lb)
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- (3) Install the water pipe  
(from the thermostat cover to the cylinder inlet joint)

#### 5-2.24 Install the rocker arms

- (1) Install the push rods on the tappets  
(2) Coat the inside of valve spring retainer with oil.  
(3) Install the rocker arm shaft assembly and tighten the nut.



Tightening torque	3.7 kg-m (27 ft-lb)
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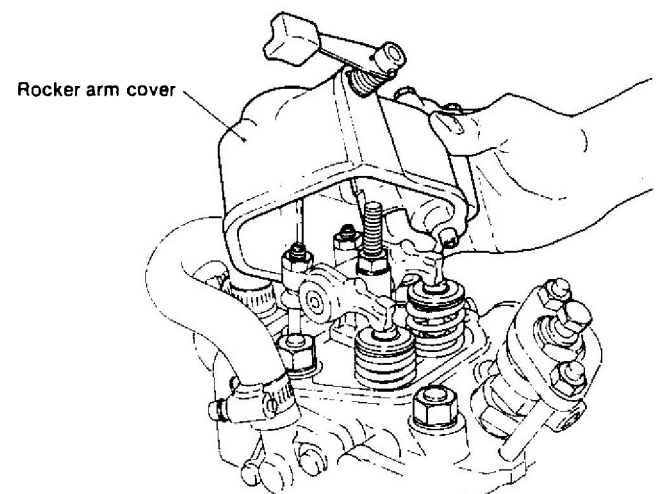
**CAUTION:** 1. Loosen the valve head clearance adjusting screw in advance.

2. Check that the arm moves smoothly.

- (4) Adjust the intake and exhaust valve head clearance and lock with the nut.

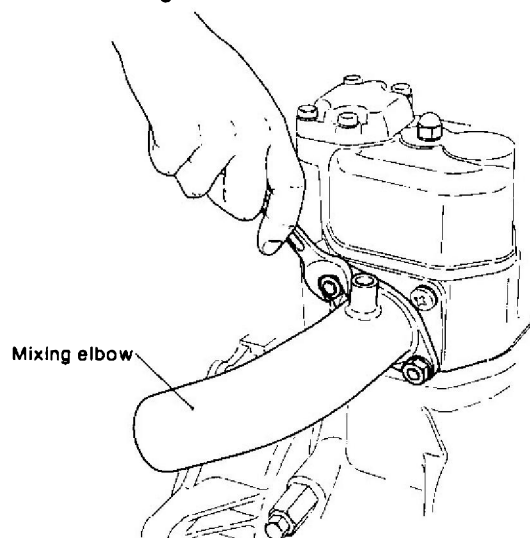
Intake and exhaust valve head clearance (engine cold):	0.2mm (0.008in.)
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#### 5-2.25 Install the rocker arm cover



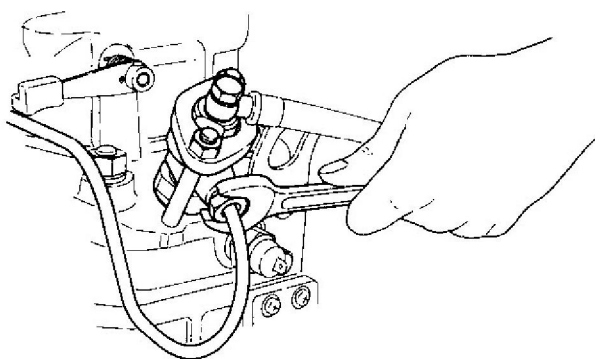
### 5-2.26 Install the mixing elbow

- (1) Install the mixing elbow



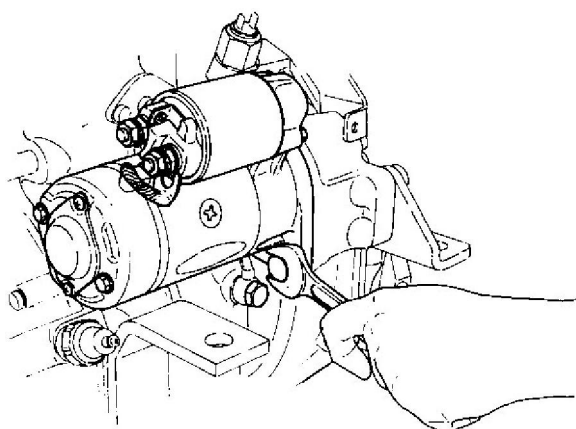
- (2) Install the cooling water bypass hose (from the mixing elbow to the thermostat cover)

### 5-2.27 Install the fuel pipe



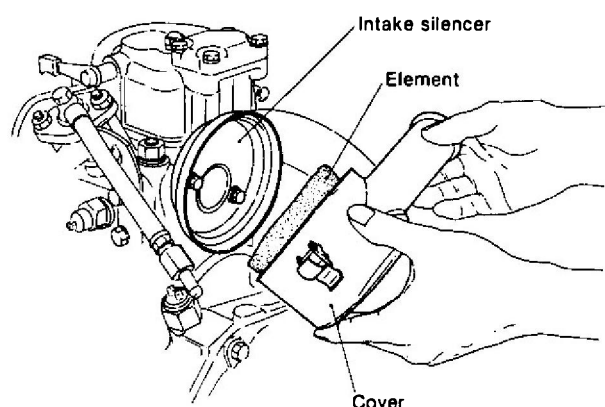
- (1) Install the feed pump to fuel filter pipe
- (2) Install the fuel filter to fuel injection pump pipe
- (3) Install the fuel high pressure pipe
- (4) Install the fuel return pipe

### 5-2.26 Install the starter motor



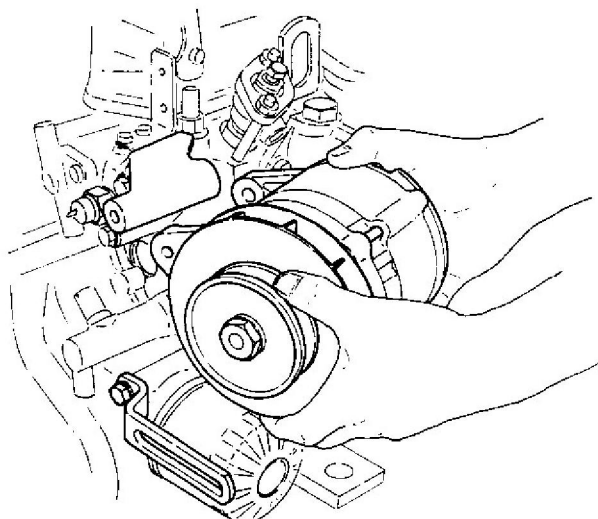
### 5-2.29 Install the intake silencer

- (1) Install the intake silencer cover to the intake port.
- (2) Install the intake silencer and tighten it with the clip.



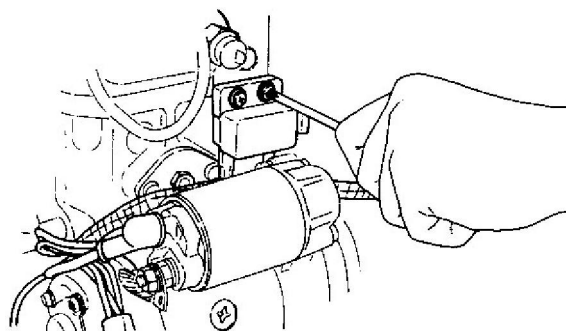
### 5-2.30 Install the alternator

- (1) Install the alternator to the bracket.



- (2) Install the V-belt and tighten the adjusting bolt while adjusting the V-belt tension.

### 5-2.31 Connect the electrical wiring



### 5-2.32 Install the remote control cables

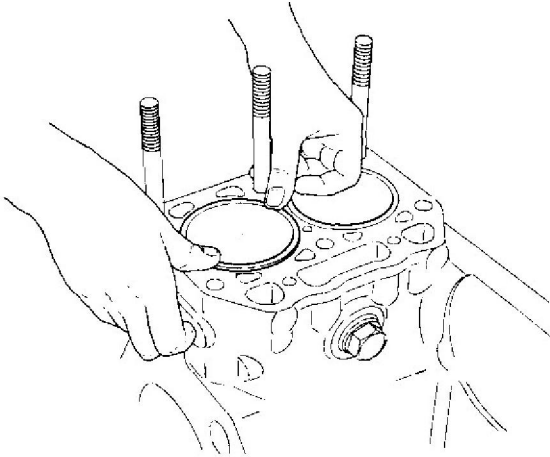
### 5-2.33 Connect the interior piping

### 5.3 Reassembly of engine models 2GM and 3GM(D)

Refer to the model 3GM(D) Instructions, as the models 3HM and 3GM(D) are almost the same.

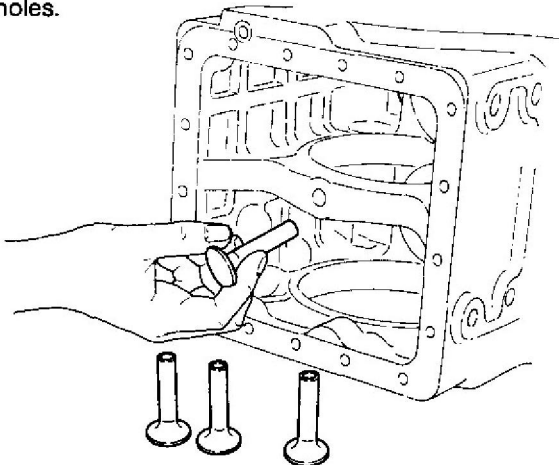
#### 5-3.1 Assemble the cylinder liners

- (1) Remove any rust from the cylinder block where it contacts the cylinder liners.
- (2) Coat the outside periphery of the liners with waterproofing paint.
- (3) Insert the liners into the cylinder block, making sure to check that the cylinder liner protrusion is correct.



#### 5-3.2 Insert the tappets

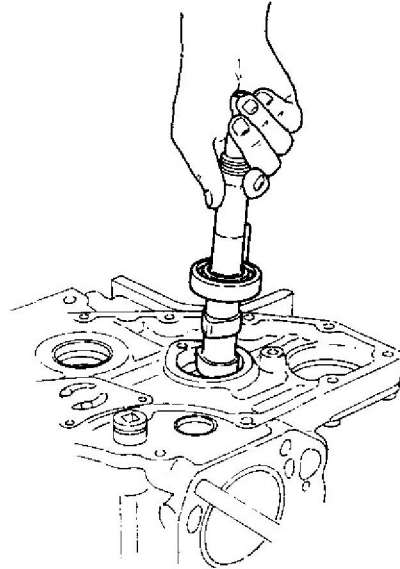
- (1) Turn the cylinder block over or turn it upside down.
- (2) Coat the tappets with oil and insert into the tappet holes.



**NOTE:** Assemble the tappets in their original positions, paying careful attention to the cylinder numbers and intake and exhaust groupings.

#### 5-3.3 Insert the camshaft

- (1) Coat the camshaft bearing section with oil and insert the camshaft into the cylinder block by tapping the shaft end with a plastic hammer.

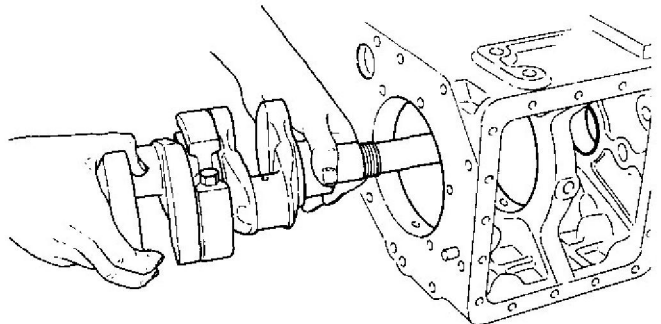


**NOTE:** Be careful not to damage the groove in the end of the shaft.

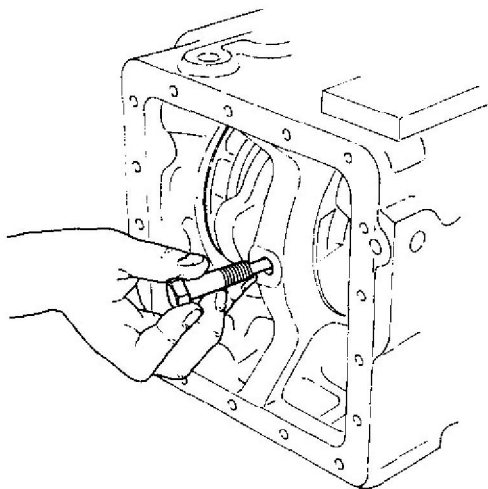
- (2) After inserting the camshaft, check that it rotates smoothly before tightening the camshaft bearing set screw.

Tightening torque	2 kg-m (14.5 ft-lb)
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#### 5-3.4 Install the crankshaft



### 5-3.5 Tighten the set bolt of the intermediate main bearing

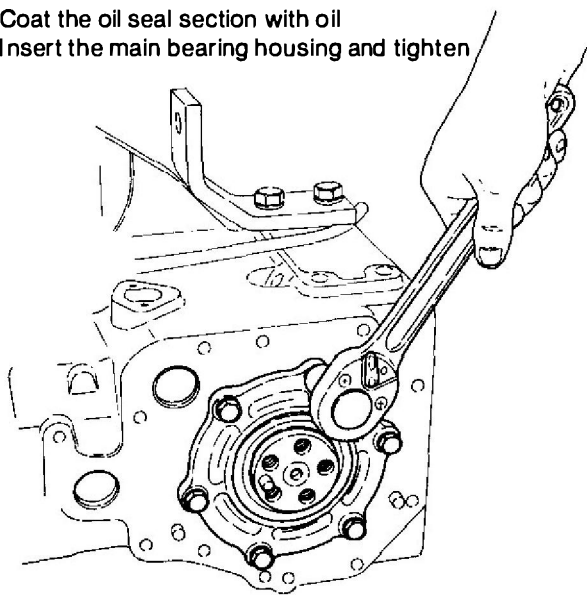


The two intermediate main bearings, viz No.1 and No.2, for model 3GM(D).

	kg·m (ft·lb)	
	2GM, 3GM(D)	3HM
Tighten torque	4.5 ~ 5.0 (32.5 ~ 36.2)	7.0 ~ 7.5 (50.6 ~ 54.2)

### 5-3.6 Install the main bearing housing

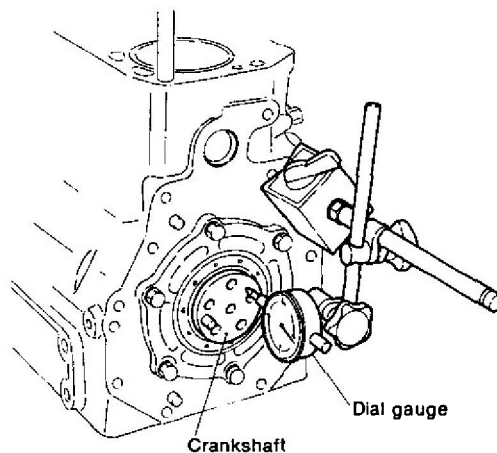
- (1) Coat the oil seal section with oil
- (2) Insert the main bearing housing and tighten



Tightening torque	2.5 kg·m (18 ft·lb)
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- (3) Check that the crankshaft rotates smoothly

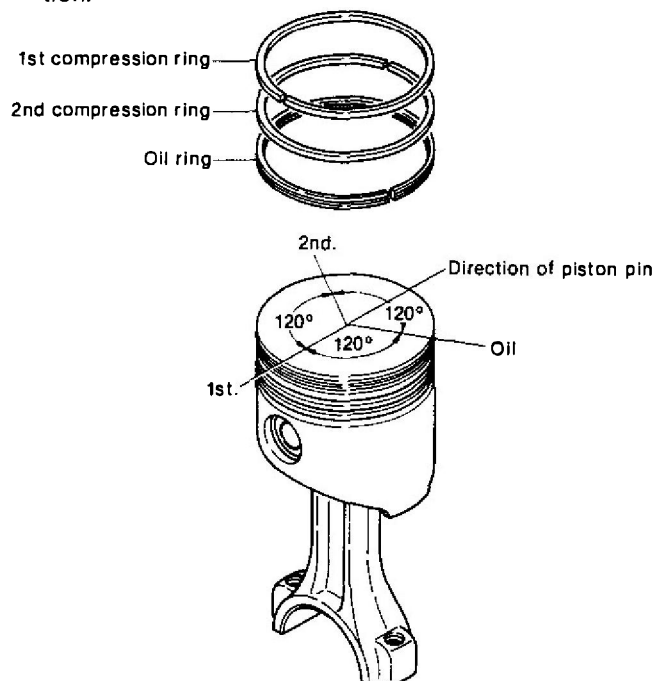
- (4) Measure the crankshaft side gap, and adjust it to the prescribed value by the thickness of the packing.



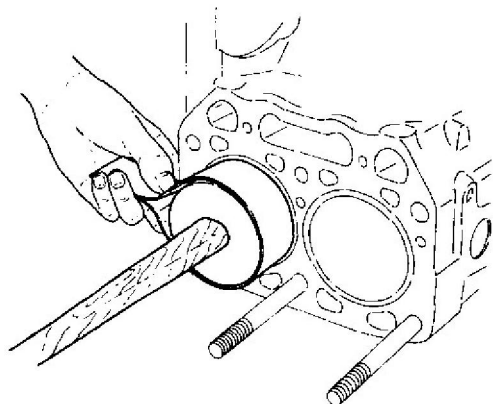
Crankshaft side gap	0.09 ~ 0.18mm (0.035 ~ 0.0071in.)
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### 5-3.7 Assemble the piston and connecting rod assembly

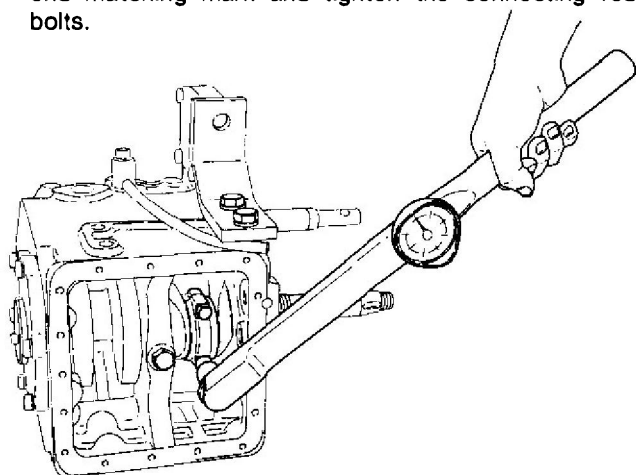
- (1) Coat the crankpin section with oil and position so that the insertion side crank is at the top.
- (2) Coat the piston and crankpin bearing with oil.
- (3) Position the piston rings so that the gaps are 120° apart, being sure that there is no gap at the side pressure section.



- (4) Insert the piston connecting rod assembly so that the side of the connecting rod big end with the identification number is on the exhaust side.  
Install the piston rings with a piston ring inserter.



- (5) After the connecting rod large end contacts the crankpin, push the piston crown down slowly to turn the crankshaft to bottom dead center.  
(6) Align the connecting rod cap and connecting rod large end matching mark and tighten the connecting rod bolts.



**CAUTION:** 1. Be careful to tighten the connecting rod bolts evenly.  
2. Coat the bolt threads and washer face with oil.

	kg·m (ft·lb)	
	2GM, 3GM(D)	3HM
Tightening torque	2.5 (18.1)	4.5 (32.5)

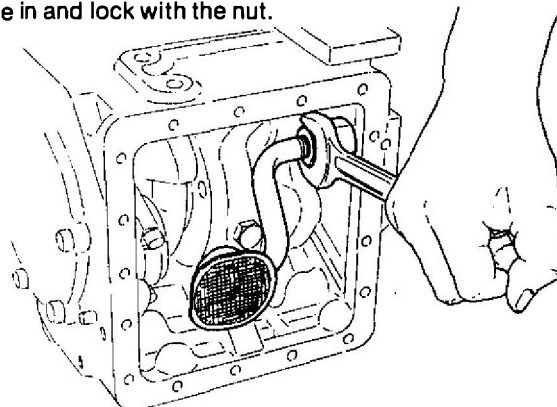
- (7) Measure the side clearance

Side clearance	0.2 ~ 0.4mm (0.0079 ~ 0.0157in.)
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- (8) Check that the crankshaft rotates smoothly

### 5-3.8 Install the lubricating oil intake pipe

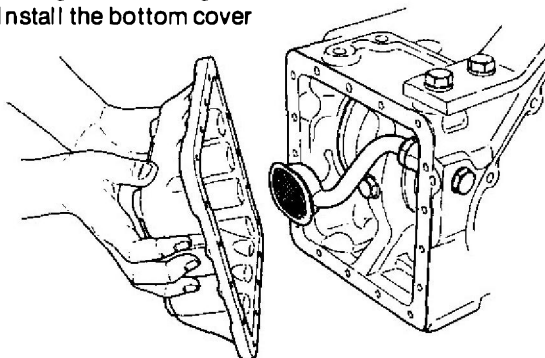
Coat the threads with "Screw Lock Super 203M", screw the pipe in and lock with the nut.



Screw-in distance	8 ~ 10mm (about 6 turns) (0.3149 ~ 0.3937in.)
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### 5-3.9 Install the engine bottom cover (oil pan)

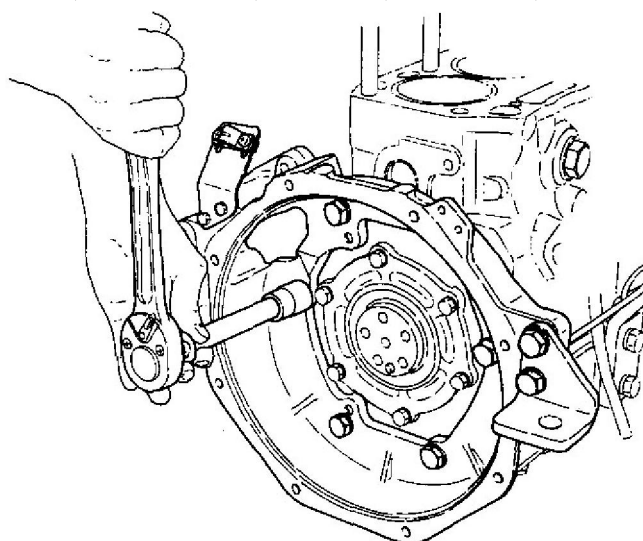
- (1) Change the packing  
(2) Install the bottom cover



Tightening torque	0.9 kg·m (6.5 ft·lb)
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### 5-3.10 Install the mounting flange

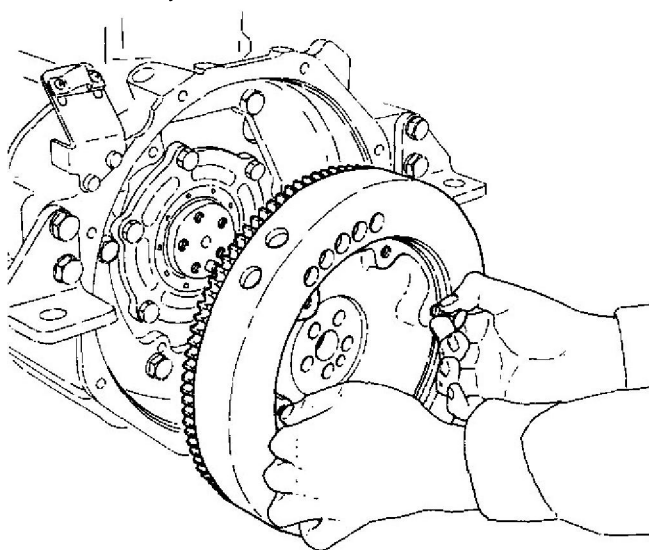
- (1) Set the engine upright  
(2) Align the positioning pins and tighten the flange



Tightening torque	4.5 kg·m (32.5 ft·lb)
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### 5-3.11 Install the flywheel

- (1) Align the reference pins
- (2) Install the flywheel

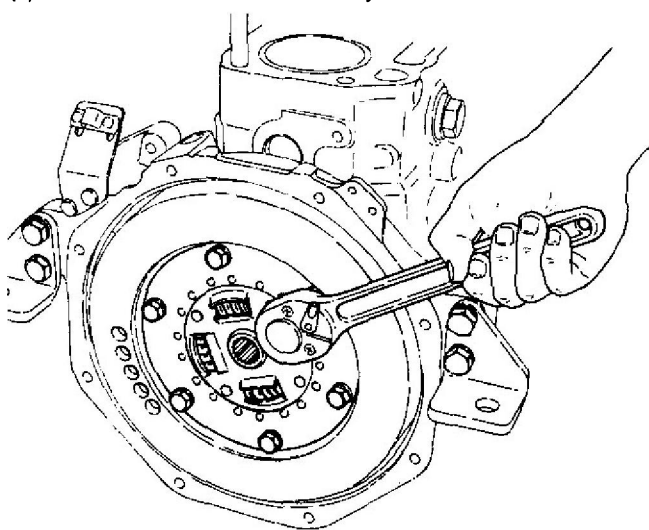


Tightening torque	6.5 ~ 7.0 kg-m (47 ~ 50.6 ft-lb)
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**NOTE:** After tightening, check the end run-out

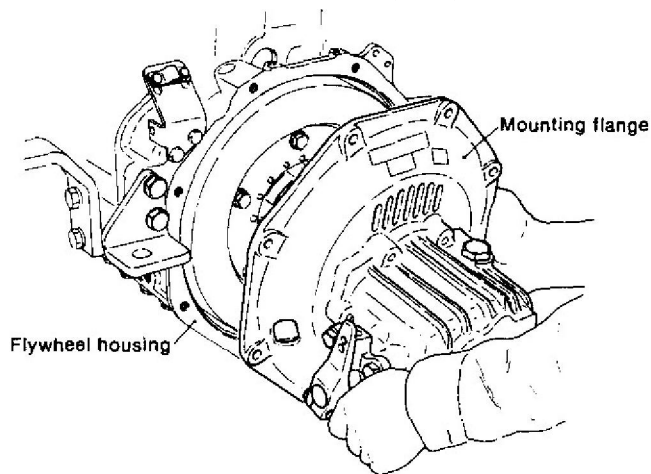
### 5-3.12 Install the clutch assembly

- (1) Install the clutch disc on the flywheel



Tightening torque	2.5 kg-m (18 ft-lb)
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- (2) Align the disc and input shaft spline, and install the clutch assembly on the mounting flange.



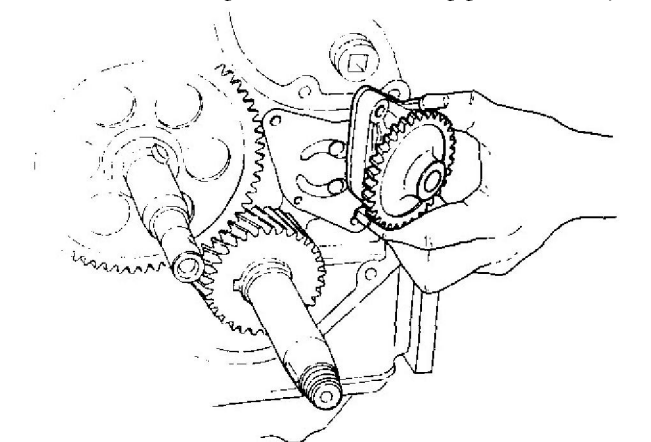
Tightening torque	2.0 ~ 2.5 kg-m (14.5 ~ 18.1 ft-lb)
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### 5-3.13 Install the engine feet and set the engine in position

- (1) Dipstick flange and dipstick
- (2) Fuel pump

### 5-3.14 Install the lubricating oil pump

Install the lubricating oil pump and driving gear assembly.

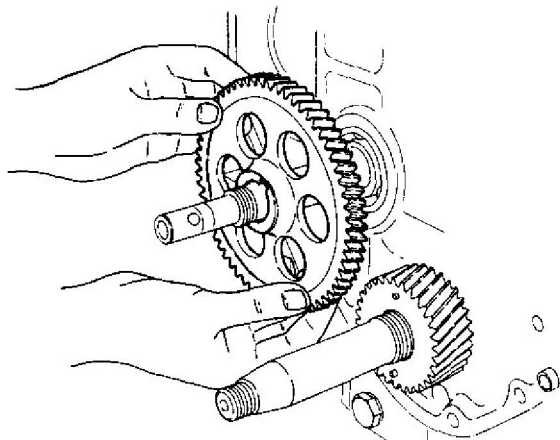


Lube pump body mounting bolt	0.9 kg-m (6.5 ft-lb)
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### 5-3.15 Assemble the camshaft gear and fuel cam

- (1) Coat the shaft hole of the camshaft gear with oil and insert the gear.

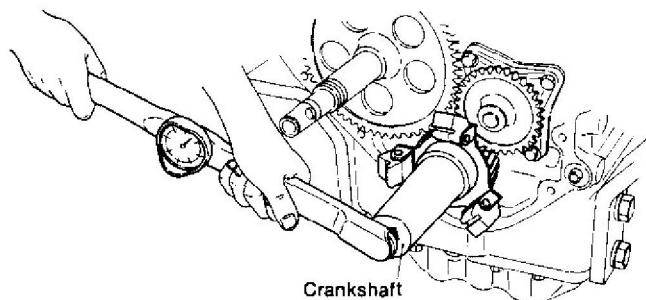
- (2) Coat the fuel cam with oil and insert the cam by aligning the "0" mark opposite the camshaft gear.



- (3) Tighten the camshaft end nut.

Tightening torque	7 ~ 8 kg-m (50.6 ~ 57.9 ft-lb)
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### 5-3.16 Assemble the crankshaft gears



- (1) Coat the crankshaft section and the inside of the gear with oil.  
 (2) Align the matching marks of the camshaft gear and the crankshaft gear and insert the crankshaft gear.  
 (3) After inserting the crankshaft gear, check the backlash.

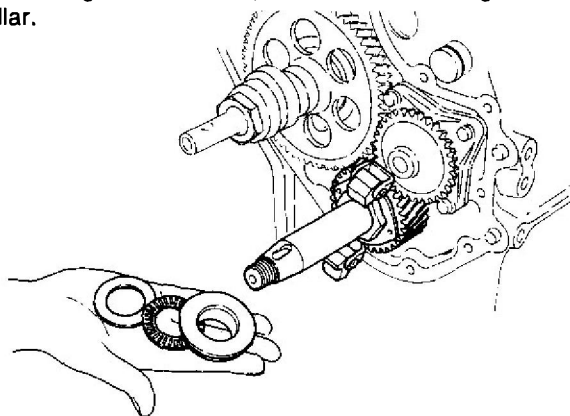
Backlash	0.05 ~ 0.13mm (0.0020 ~ 0.0051in.)
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- (4) Install the governor weight assembly and tighten the crankshaft end nut.

Tightening torque	8 ~ 10 kg-m (57.9 ~ 72.3 ft-lb)
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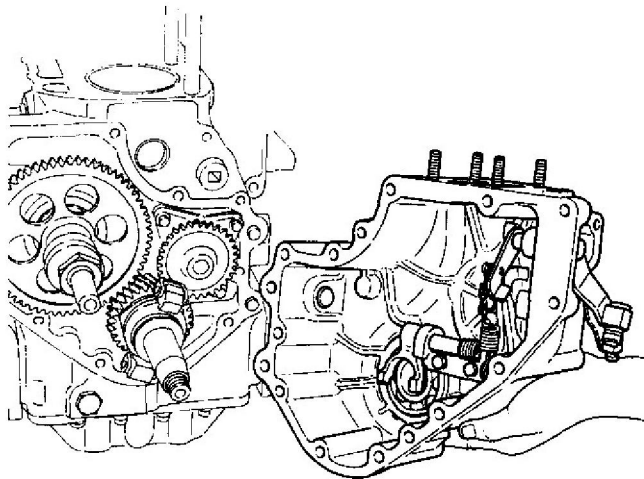
### 5-3.17 Install the governor sleeve

Install the governor sleeve, thrust needle bearing and thrust collar.



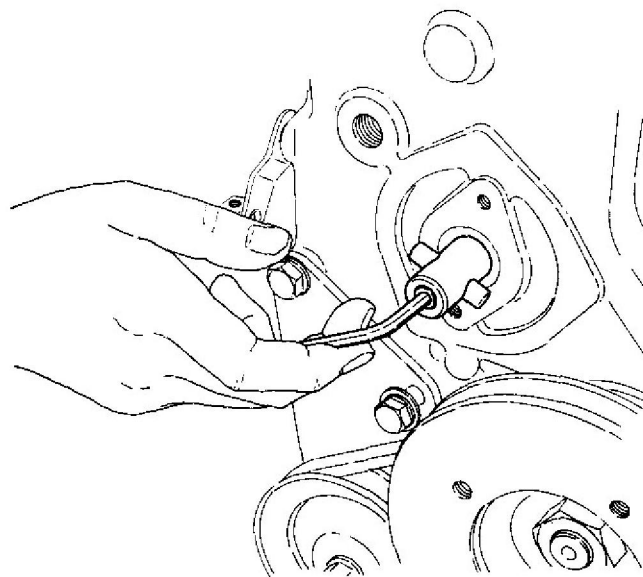
### 5-3.18 Install the timing gearcase

- (1) Coat both sides of the new packing with "Three Bond 3B8-005" and install.  
 (2) Install the timing gear case



Tightening torque	2.5 kg-m (18 ft-lb)
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- (3) Insert the pin for fitting the handle into the camshaft and fix it by means of the bolt with the hexagonal socket head, then fit the starting shaft cover.



## Chapter 12 Disassembly and Reassembly

### 5. Reassembly

#### 5-3.19 Install the crankshaft V-pulley

- (1) Install the crankshaft key
- (2) Coat the crankshaft V-pulley and the inside of the oil seal with oil.
- (3) Insert and tighten the V-pulley, making sure that the lip of the oil seal is not distorted.

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Tightening torque	10 kg·m (72.3 ft·lb)
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#### 5-3.20 Install the water pump

- (1) Install the V-belt to the crankshaft V-pulley and install the water pump.

- (2) Insert the pump by looking through the gear case side cover, and align the governor No.2 lever and rack connecting part.

- (3) Tighten the fuel pump

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Tightening torque	2.5 kg·m (18 ft·lb)
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- (4) Install the gear case side cover

#### 5-3.22 Install the cylinder head

- (1) Install the gasket packing

- (2) Tighten while adjusting the V-belt tension

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Tightening torque	2.5 kg·m (18 ft·lb)
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- (3) Install the water pipe (pump to cylinder inlet joint)

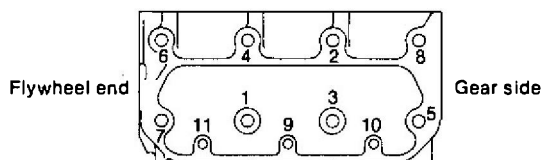
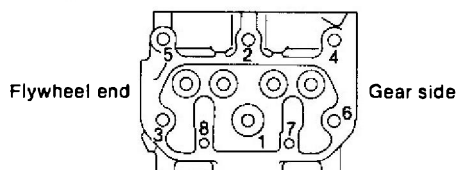
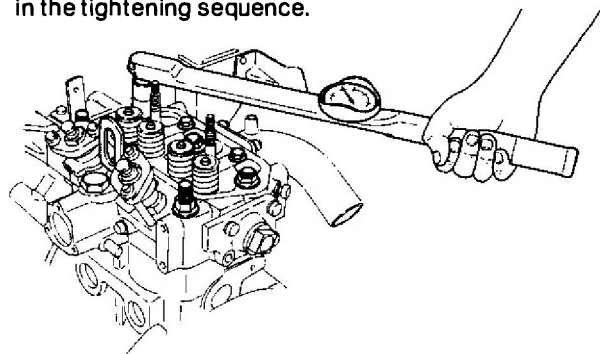
#### 5-3.21 Install the fuel injection pump

- (1) Remove grease from both sides of the fuel injection timing adjustment shims with thinner, and coat the shims with "Screw Lock Super 203M."

**CAUTION:** Take particular notice of the surfaces to be fitted.

Fit it keeping the TOP mark to the cylinder head side.

- (2) Insert the cylinder head, being careful not to damage the threads of the tightening bolts, and tighten the nuts in the tightening sequence.

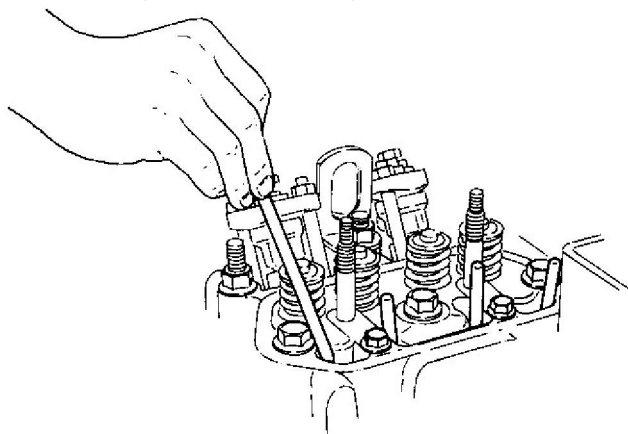


		kg·m (ft·lb)	
		2GM, 3GM(D)	3HM
Tightening torque	Main	10 (72.3)	13 (94.0)
	Sub	2.5 (18.1)	3 (21.7)

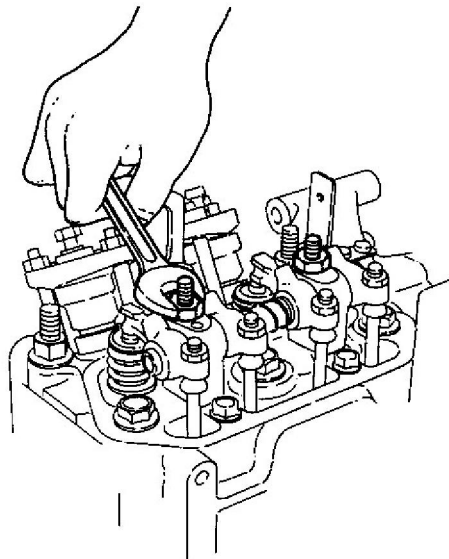
- (3) Install the water pipe  
(from the thermostat cover to the cylinder inlet joint)

### 5-3.23 Install the rocker arms

- (1) Install the push rods on the tappets



- (2) Coat the inside of valve spring retainer with oil  
(3) Install the rocker arm shaft assembly and tighten the nut.



Tightening torque	3.7 kg·m (27 ft·lb)
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**CAUTION:** 1. Loosen the valve head clearance adjusting screw in advance.

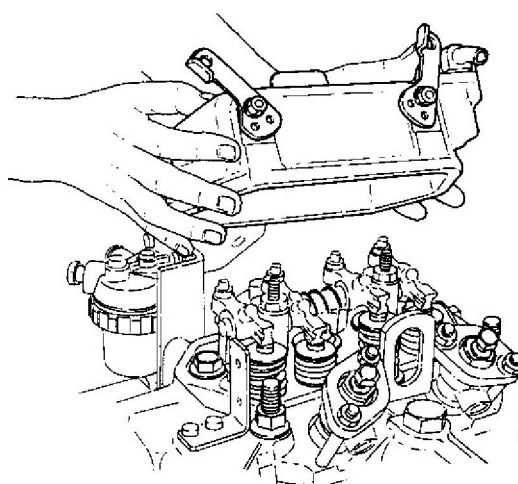
2. Check that the arm moves smoothly.

- (4) Adjust the intake and exhaust valve head clearance and lock with the nut.

Intake and exhaust valve head clearance (engine cold)	0.2mm (0.008in.)
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### 5-3.24 Install the rocker arm cover

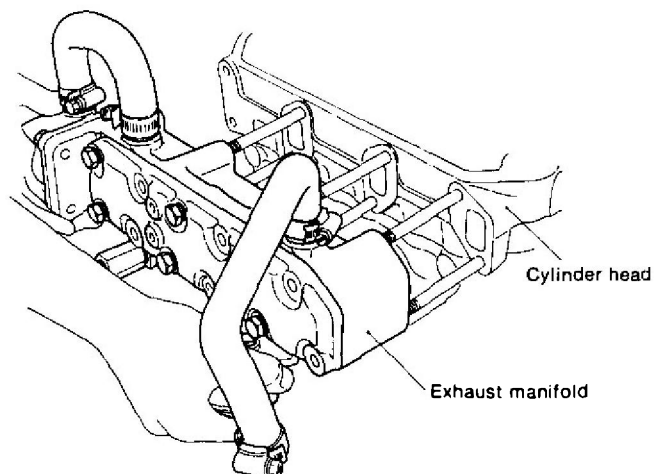
- (1) Install the rocker arm cover



- (2) Install the breather pipe to the air intake pipe (intake manifold...3GM).

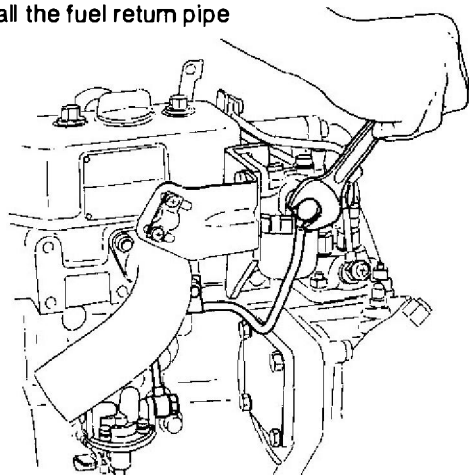
**5-3.25 Install the exhaust manifold [only for model 3GM(D)] and the mixing elbow**

- (1) Install the exhaust manifold with mixing elbow [3GM(D)].
- (2) Install the mixing elbow. (2GM).
- (3) Install the cooling water bypass hose to the thermostat cover.

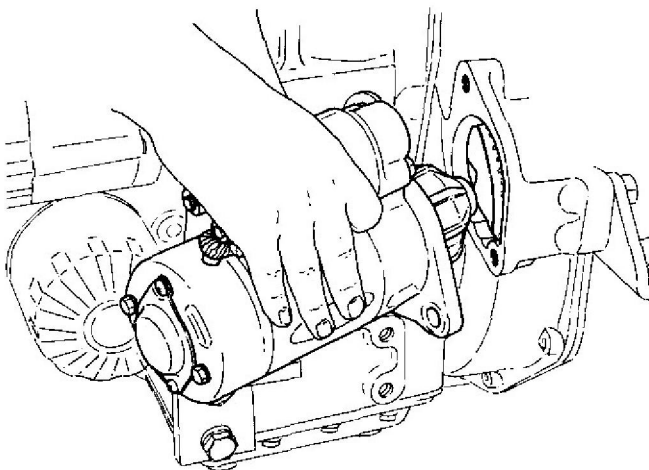


**5-3.26 Install the fuel pipe**

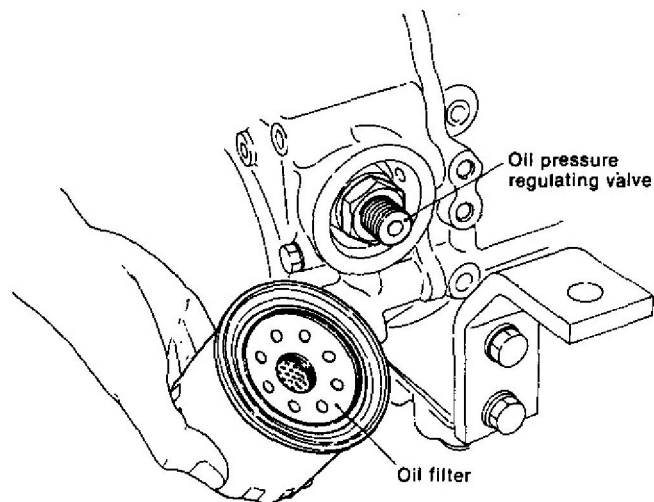
- (1) Install the feed pump to fuel filter pipe
- (2) Install the fuel filter to fuel injection pump pipe
- (3) Install the fuel high pressure pipe
- (4) Install the fuel return pipe



**5-3.27 Install the starter motor**

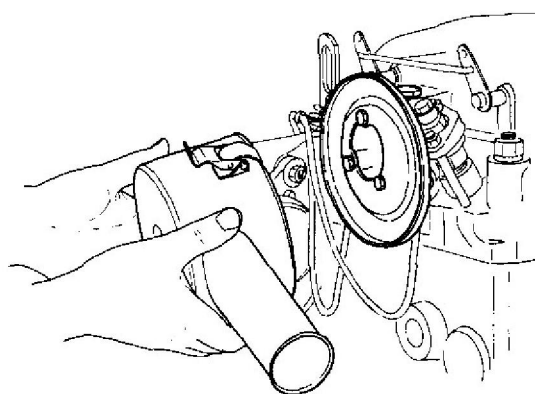


**5-3.28 Install the oil filter**



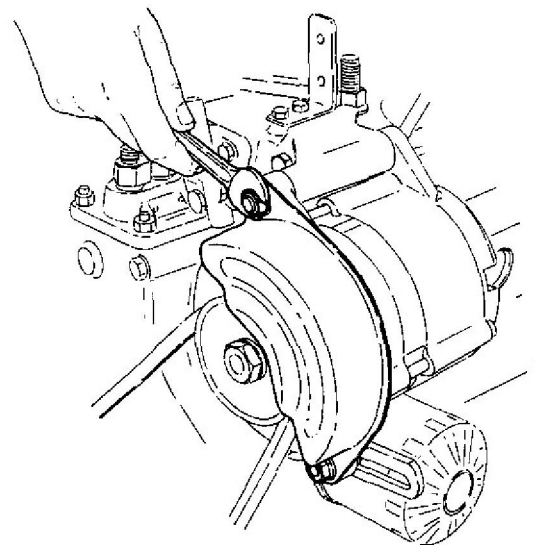
**5-3.29 Install the intake silencer**

- (1) Install the intake silencer cover to the air intake pipe. [intake manifold...3GM(D)].
- (2) Install the intake silencer and tighten it with the clip



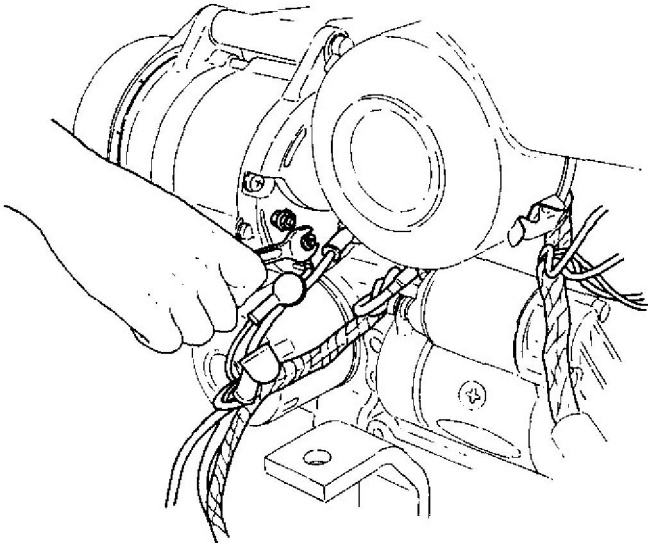
**5-3.30 Install the alternator**

- (1) Install the alternator to the bracket

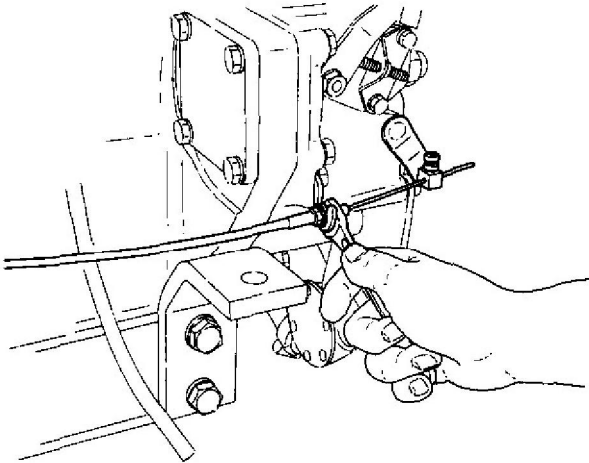


- (2) Install the V-belt and tighten the adjusting bolt while adjusting the V-belt tension.

**5-3.31 Connect the electrical wiring**



**5-3.32 Install the remote control cables**

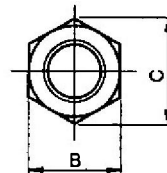


**5-3.33 Connect the interior piping**

## 6. Tightening Torque

The bolts and nuts used in this engine employ ISO general metric threads stipulated in JIS (Japanese Industrial Standards). Pay careful attention to the thread dimensions when replacing bolts and nuts.

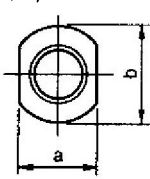
Tighten the bolts and nuts to the tightening torque given in the table below.



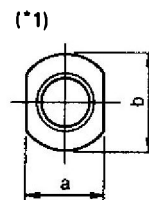
### 6-1 Main bolt and nut tightening torque

Location	Bolt/nut		1GM	2GM	3GM(D)	3HM	Remarks
Cylinder head	Cylinder head tightening bolt and nut	Thread diameter × pitch mm (in.)	M10 (0.3937)	M12 (0.4724)			Fix. nut
			—	M8 (0.3149)			Aux. bolt
		Width B/C mm (in.)	17/19.6 (0.6692/0.7716)				Fix. nut
			—	13/15 (0.5118/0.5905)			Aux. bolt
		Quantity	4	6	8	8	Fix. nut
			—	2	3		Aux. bolt
		Tightening torque kg-m (ft-lb)	7.5 (54.248)	10 (72.330)	13 (94.029)		Fix. nut
			—	2.5 (18.083)	3 (21.699)		Aux. bolt
	Rocker arm support nut	Thread diameter × pitch mm (in.)	M8 (0.3149)	M10 (0.3937)			
		Width B/C mm (in.)	13/15 (0.5118/0.5905)	17/19.6 (0.6692/0.7716)			
		Quantity	1	2	3	3	
		Tightening torque kg-m (ft-lb)	3.7 (26.762)				
	Exhaust manifold nuts	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	2	3	6		
		Tightening torque kg-m (ft-lb)	4.5 (32.549)				
	Anticorrosion zinc	Thread diameter × pitch mm (in.)	—	M25 (0.9842)			
		Width B/C mm (in.)	—	□22 (0.8661) Plug type			
		Quantity	—	1			
		Tightening torque kg-m (ft-lb)	—	5 ~ 6 (36.165 ~ 43.398)			
Timing gear	Timing gear case mounting bolt	Thread diameter × pitch mm (in.)	M6 × 1.0 (0.2362×0.0393)	M8 × 1.25 (0.3149×0.0492)			
		Width B/C mm (in.)	10/11.5 (0.3937/0.4527)	13/15 (0.5118/0.5905)			
		Quantity	12 (0.4724)				
		Tightening torque kg-m (ft-lb)	0.9 (6.510)	2.5 (18.083)			
	Camshaft end nut	Thread diameter × pitch mm (in.)	M20 × 1.5 (0.7874×0.0590)			M18×1.5 (0.3149×0.0492)	
		Width B/C mm (in.)	32/37 (1.2598/1.4566)			24/30 (*1) (0.9448/1.1811)	
		Quantity	1				
		Tightening torque kg-m (ft-lb)	7 ~ 8 (50.631 ~ 57.864)				
	Governor weight set nut	Thread diameter × pitch mm (in.)	M26 × 1.5 (1.0236 × 0.0590)				
		Width B/C mm (in.)	36/41.6 (1.4173/1.6377)				
		Quantity	1				
		Tightening torque kg-m (ft-lb)	8 ~ 10 (57.864 ~ 72.330)				

(\*1)



a: 24 (0.9448)  
b: 30 (1.1811)



(\*1)  
a: 24 (0.9448)  
b: 30 (1.1811)

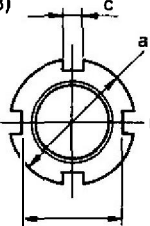
**Chapter 12 Disassembly and Reassembly**  
**6. Tightening Torque**

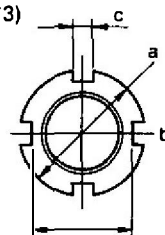
**SM/1GM•2GM•3GM(D)•3HM**

Location	Bolt/nut		1GM	2GM	3GM(D)	3HM	Remarks
Cylinder block	Mounting flange bolt	Thread diameter × pitch mm (in.)	M10 × 1.5 (0.3937 × 0.0590)				
		Width B/C mm (in.)	17/19.6 (0.6692/0.7716)				
		Quantity	6				
		Tightening torque kg-m (ft-lb)	4.5 (32.549)				
	Bottom cover bolt	Thread diameter × pitch mm (in.)	M6 × 1.0 (0.2362 × 0.0393)				
		Width B/C mm (in.)	10/15 (0.5118/0.5905)				
		Quantity	13	17	21	23	
		Tightening torque kg-m (ft-lb)	0.9 (6.510)				
	Oil pressure switch mounting	Thread diameter × pitch mm (in.)	PT 1/8				
		Width B/C mm (in.)	26.8/27.8 (1.0551/1.0944)				
		Quantity	1				
		Tightening torque kg-m (ft-lb)	1.0 (7.233)				
Crankshaft, pistons	Main bearing housing bolt	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				3HM: Counter-clockwise screw
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	6				
		Tightening torque kg-m (ft-lb)	2.5 (18.083)				
	Connecting rod bolt	Thread diameter × pitch mm (in.)	M7 × 1.0 (0.2755 × 0.0393)			M9 × 1.0 (0.3543×0.0393)	
		Width B/C mm (in.)	12/13.9 (0.4724/0.5472)			13/15 (0.5118/0.5905)	
		Quantity	1 × 2 = 2	2 × 2 = 4	3 × 2 = 6		
		Tightening torque kg-m (ft-lb)	2.5 (18.083)			4.5 (0.6221)	
	Crankshaft V-pulley bolt	Thread diameter × pitch mm (in.)	M18 (0.7086)				
		Width B/C mm (in.)	27/31.2 (1.0629/1.2283)				
		Quantity	1				
		Tightening torque kg-m (ft-lb)	10 (72.330)				
	Flywheel bolt	Thread diameter × pitch mm (in.)	M10 × 1.25 (0.3937 × 0.0492)				
		Width B/C mm (in.)	17/19.6 (0.6692/0.7716)				
		Quantity	5				
		Tightening torque kg-m (ft-lb)	6.5 ~ 7.0 (47.015 ~ 50.631)				
	Damper disk bolt	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	6			8	
		Tightening torque kg-m (ft-lb)	2.5 (18.083)				
	Intermediate main bearing housing bolt	Thread diameter × pitch mm (in.)	—	M8 × 1.25 (0.3149 × 0.0492)			
		Width B/C mm (in.)	—	13/15 (0.5118/0.5905)			
		Quantity	—	2 × 2 = 4	3 × 2 = 6		
		Tightening torque kg-m (ft-lb)	—	3.0 ~ 3.5 (21.699 ~ 25.316)			4.5 ~ 5.0 (32.549 ~ 36.165)
	Intermediate main bearing housing set bolt	Thread diameter × pitch mm (in.)	—	M10 × 1.25 (0.3937 × 0.0492)			
		Width B/C mm (in.)	—	17/19.6 (0.6692/0.7716)			
		Quantity	—	1	2		
		Tightening torque kg-m (ft-lb)	—	4.5 ~ 5.0 (32.549 ~ 36.165)			7.0 ~ 7.5 (50.631 ~ 54.248)
Cooling system	Water temperature sender bolt	Thread diameter × pitch mm (in.)	PT 3/8				
		Width B/C mm (in.)	21/23.8 (0.8267/0.9370)			26.5/30.5 (1.0433/1.2007)	
		Quantity	1				
		Tightening torque kg-m (ft-lb)	1.0 ~ 1.5 (7.2330 ~ 10.850)				

**Chapter 12 Disassembly and Reassembly**  
**6. Tightening Torque**

**SM/1GM·2GM·3GM(D)·3HM**

Location	Bolt/nut		1GM	2GM	3GM(D)	3HM	Remarks
Cooling system	Anticorrosion zinc mounting (Cylinder block)	Thread diameter × pitch mm (in.)					1GM: Flange type 2GM, 3GM and 3HM: Plug type
		Width B/C mm (in.)	13/15 (0.5118/0.5905)	24/27.5 (0.9448/1.0826)		27.5/31 (0.9448/1.2204)	
		Quantity	1		2		
		Tightening torque kg-m (ft-lb)	5 ~ 6 (36.165 ~ 43.398)				
	Cooling water inlet joint	Thread diameter × pitch mm (in.)					
		Width B/C mm (in.)	—				
		Quantity	1				
		Tightening torque kg-m (ft-lb)					
	Water pump body bolt	Thread diameter × pitch mm (in.)	M6 × 1.0 (0.2362×0.0393)	M8 × 1.25 (0.3149 × 0.0492)			
		Width B/C mm (in.)	10/11.5 (0.3937/0.4527)	13/15 (0.5118/0.5905)			
		Quantity	3	2			
		Tightening torque kg-m (ft-lb)	0.9 (6.5097)	2.5 (18.083)			
Fuel system	Nozzle nut	Thread diameter × pitch mm (in.)	M20 × 1.5 (0.7874 × 0.0590)				
		Width B/C mm (in.)	24 (0.9448)				
		Quantity	1	2	3		
		Tightening torque kg-m (ft-lb)	10 (72.330)				
	Delivery valve holder	Thread diameter × pitch mm (in.)	M18 (0.7086)				
		Width B/C mm (in.)	19/21.9 (0.7480/0.8622)				
		Quantity	1	2	3		
		Tightening torque kg-m (ft-lb)	4.0 ~ 4.5 (28.932 ~ 32.549)				
	Fuel injection nozzle flange nut	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	2 × 1 = 2	2 × 2 = 4	2 × 3 = 6		
		Tightening torque kg-m (ft-lb)	2 (14.466)				
Clutch system	Clutch housing nut	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				(*2) 1GM, 2GM and 3GMD: M18 × 1.5 (0.7086 × 0.0590) 3GM and 3HM: M24 (0.9443)
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	8				
		Tightening torque kg-m (ft-lb)	2.0 ~ 2.5 (14.466 ~ 18.083)				
	Clutch mounting bolt	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				(*3) 
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	8				
		Tightening torque kg-m (ft-lb)	2.0 ~ 2.5 (14.466 ~ 18.083)				
	Output shaft coupling tightening nut	Thread diameter × pitch mm (in.)	(*2)				a: 39.5 (1.5551) b: 32 (1.2598) c: 7 (0.2755)
		Width B/C mm (in.)	30/34.6 (1.1811/1.3622)	(*3)			
		Quantity					
		Tightening torque kg-m (ft-lb)	10 ± 1.5 (72.330 ~ 10.850)	9.5 (68.714)			
Electric system	Starter motor mounting bolt	Thread diameter × pitch mm (in.)	M10 × 1.5 (0.3937 × 0.0590)			M12 (0.4724)	
		Width B/C mm (in.)	17/19.6 (0.6692/0.7716)			19/21.9 (0.7480/0.8622)	
		Quantity	2				
		Tightening torque kg-m (ft-lb)	4.5 ~ 5.0 (32.549 ~ 36.165)			7.5 ~ 8.0 (54.248 ~ 57.864)	
	AC generator mounting bolt	Thread diameter × pitch mm (in.)	M8 × 1.25 (0.3149 × 0.0492)				
		Width B/C mm (in.)	13/15 (0.5118/0.5905)				
		Quantity	3				
		Tightening torque kg-m (ft-lb)	2.2 ~ 2.7 (15.913 ~ 19.530)				



a: 39.5 (1.5551)  
b: 32 (1.2598)  
c: 7 (0.2755)

## 6.2 General bolt and nut tightening torque

Diameter of thread	kg-m (ft-lb)	
	General bolts 7T	Pipe joint bolts
M6	0.9 <sup>±0.1</sup> (5.9 ~ 7.2)	—
M8	2.5 <sup>±0.2</sup> (16.6 ~ 19.5)	1.2 ~ 1.7 (8.7 ~ 12.3)
M10	4.7 <sup>±0.3</sup> (31.8 ~ 36.2)	—
M12	8.0 <sup>±0.5</sup> (54.2 ~ 61.5)	2.5 ~ 3.5 (18.1 ~ 25.3)
M14	13.0 <sup>±0.5</sup> (90.4 ~ 97.6)	4.0 ~ 5.0 (28.9 ~ 36.2)
M16	20.5 <sup>±0.5</sup> (144.7 ~ 151.9)	5.0 ~ 6.0 (36.2 ~ 43.4)

## 7. Packing Supplement and Adhesive Application Points

The packing used in this engine is asbestos sheet sealed at both mating faces.

Be sure to use the correct supplement in accordance with the table below.

Location	Packing (coated)	Packing agent and adhesive
Cylinder head	Both sides of cylinder head side cover packing Cylinder head top and bottom casting sand hole plug Rocker arm chamber packing (rocker arm chamber side) Both sides of cylinder head gasket packing Intake and exhaust manifold bolt threads Exhaust manifold stud bolt thread Rocker arm support stud bolt Cooling water outlet joint threads	"Three Bond No. 4"  "Three Bond No. 50" "Screw Lock Super 203M" "Screw Lock Super 203M"
Timing gear	Both sides of timing gear case packing Both sides of fuel injection timing adjustment shims Both sides of governor chamber packing Governor drive shaft bearing cover packing	"Three Bond 3B8-005" "Screw Lock Super 203M" "Three Bond 3B8-005"
Cylinder block	Both sides of oil pan packing Outside surface of cylinder liner Cooling water pipe joint threads Lubricating oil suction pipe threads Lubricating oil intake pipe blind plug threads Oil pressure regulator valve threads Oil pressure switch threads Cylinder head bolt stud Mounting flange face Lube oil pump face Both sides of bushing shell packing Both sides of dipstick flange packing Both sides of fuel pump packing	"Three Bond 3B8-005" White paint "Three Bond No. 20" "Screw Lock Super 203M"  "Three Bond 3B8-005"
Crankshaft, piston	Crankshaft V-pulley key groove tightening section Connecting rod bolt threads	"Three Band 3B8-005"
Cooling system	Both sides of water pump packing Both sides of water pump packing Anticorrosion zinc flange threads Water temperature switch threads Water drain joint (cylinder, exhaust pipe)	"Three Bond No. 2" "Three Bond No. 4"
Clutch system	Mounting flange face Clutch housing face	

# **INSPECTION AND SERVICING**

## **CHAPTER 13**

1. Periodic Inspection and Servicing . . . . .	13-1
2. Service Standard . . . . .	13-6

# 1. Periodic Inspection and Servicing

Periodic inspection and servicing is necessary to keep the engine in top condition at all times.

The routine inspection period depends on engine application and usage conditions, fuel and lubricating oil quality, engine handling, etc., and cannot be definitely stated. However, a general guideline will be given here. The relationship between inspection and maintenance

activities and operating time is given below.

Refer to pertinent inspection sections of this manual for details.

- (1) Perform inspection at the operating times given below, and quickly correct any defects found.
- (2) Before reusing disassembled parts, check that they are in good condition.

## 1-1 Routine inspection

○ Checking and adjustment  
● Replacement

① Daily check

② Initial check after one month or 50 hrs.

③ Every 100 hrs.

④ Every 250 hrs.

⑤ Every 500 hrs.

⑥ Every 1000 hrs.

Classification	Work item	Adjustment standard				①	②	③	④	⑤	⑥
		1GM	2GM	3GM/3GMD	3HM						
Fuel system	Checking the fuel level					○					
	Draining the fuel tank						○		○		
	Cleaning or replacement of fuel filter						○		●		
	Checking and adjusting the nozzle	165 ~ 175 kg/cm <sup>2</sup> (2347 ~ 2489 lb/in. <sup>2</sup> )		155 ~ 165 kg/cm <sup>2</sup> (2205 ~ 2347 lb/in. <sup>2</sup> )						○	
	Adjusting the fuel injection timing	15° bTDC		18° bTDC	21° bTDC					○	
Lubricating system	Checking the engine lubricating oil level and condition	1.3ℓ	2.0ℓ	2.7ℓ	5.5ℓ	○	●	●			
	Replacing the engine oil filter								●	Every 300 hrs.	
	Checking the clutch lubricating oil level and condition	0.25ℓ		0.7ℓ/0.3ℓ	0.7ℓ		●		●		
	Checking the oil pressure lamp action					○					
Cooling system	Checking the cooling water discharge					○					
	Checking the pump and impeller									○	●
	Checking the thermostat									○	
	Checking the anticorrosion zinc									○	
	Adjusting the pump drive V-belt						○		○		
Intake and exhaust system	Cleaning of intake silencer element								○		
	Checking the exhaust mixing elbow								○		
	Condition of exhaust smoke					○					
Electrical system	Checking the charge lamp action					○					
	Adjusting the alternator V-belt						○		○		
	Checking the battery electrolyte level	On electrode plate 10 ~ 15mm (0.3937 ~ 0.5906in.)				○	Every month				
	Checking each connector						○				
Engine block	Checking for oil, water, or fuel leaks					○	○				
	Additional tightening of cylinder head bolts and nuts	M10 7.5 kg-m (54.2 ft-lb)	M12 10 kg-m (72.3 ft-lb)				○				○
	Additional tightening of each bolt						○		○		
	Checking and adjusting the valve clearance	Both for intake and exhaust valves 0.2mm (0.0016in.)					○			○	
Others	Checking and adjusting the remote control system						○			○	
	Checking V-belt or hose damage	Rubber hose must be replaced every 4 years									○●
	Adjusting the propeller shaft center line	Plane or center line off-set must be within 0.2mm (0.0016in.)					○		○		

## 1-2 Routine maintenance and inspection procedures

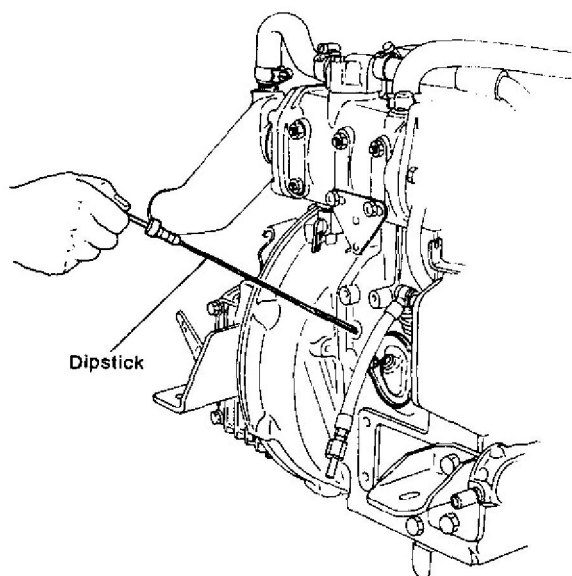
Only the most common maintenance items will be described here. Refer to the pertinent chapters of this manual for details on various parts and workshop service.

### 1-2.1 Daily maintenance

#### (1) Oil level check

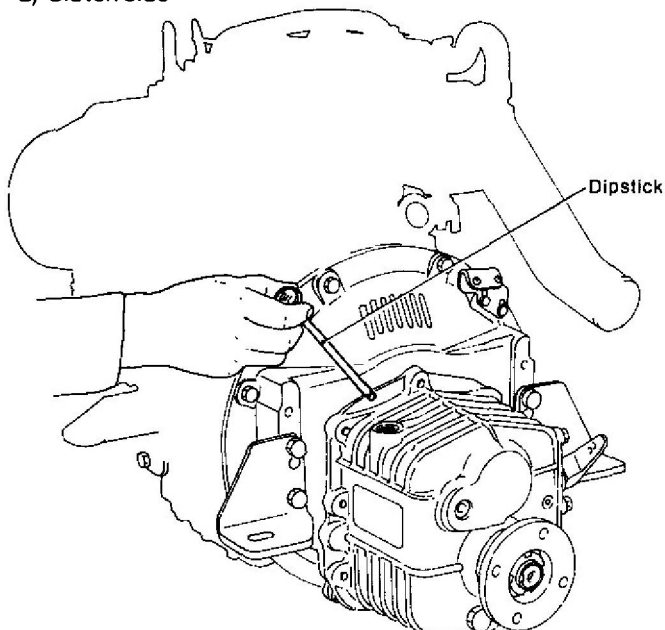
Check the engine and clutch oil levels with the dipsticks, and add oil up to the mark. Oil level must not be allowed to fall below the bottom mark.

##### 1) Engine side



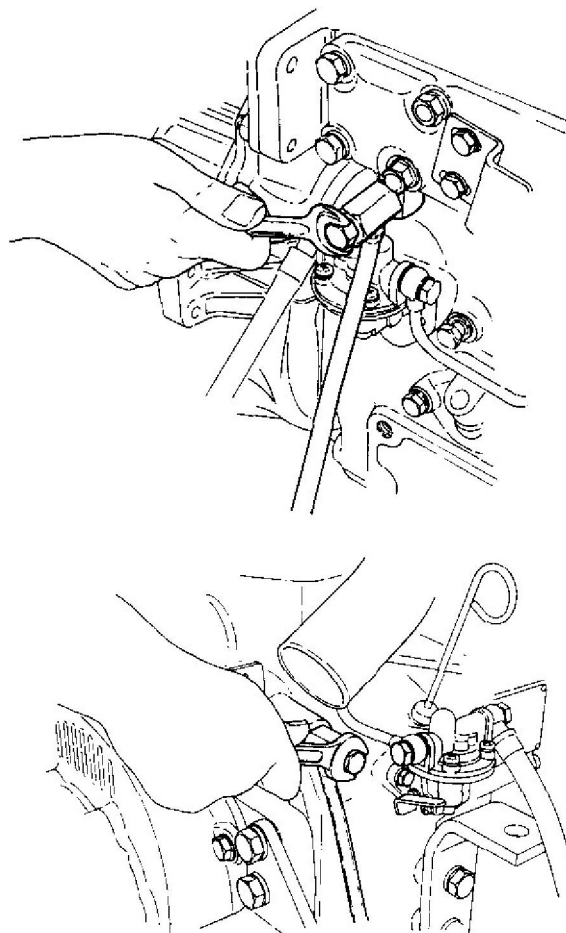
	Crankcase	Clutch case
Dipstick	Cylinder block exhaust side	Top of clutch case (filling plug with dipstick)
Filler	Top of rocker arm cover Side of gear case (1GM)	

##### 2) Clutch side



#### (2) Draining the cooling water

The cooling water will freeze in cold weather, causing faulty operation and cracking of the cylinders, cylinder head, and exhaust manifold. Therefore, always drain the water from the engine after use if the engine must sit in freezing weather.

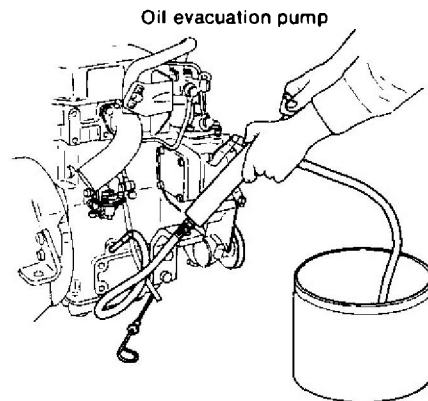
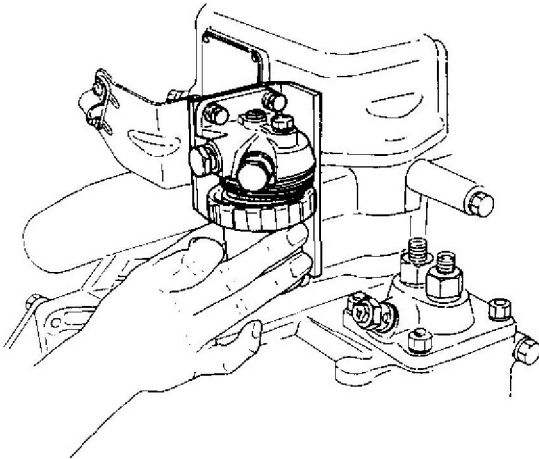


1GM 2GM	Cylinder block exhaust side drain cock
3GM, 3GM(D) 3HM	Cylinder block intake side drain cock Exhaust manifold bottom drain cock

**1-2.2 Maintenance every 50 engine hours**

**(1) Clean the fuel filter**

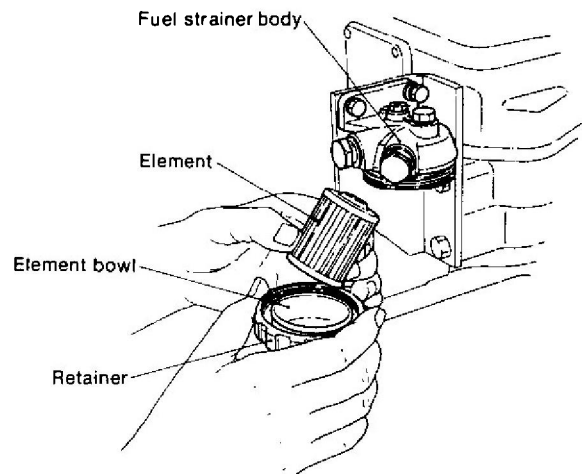
Close the fuel tank cock and remove the bowl of the fuel filter, then clean the inside of the bowl and the filter element. After reinstalling the bowl and element, open the fuel tank cock and bleed the air from the fuel system.



**1-2.4 Maintenance every 250 engine hours**

**(1) Fuel filter element replacement**

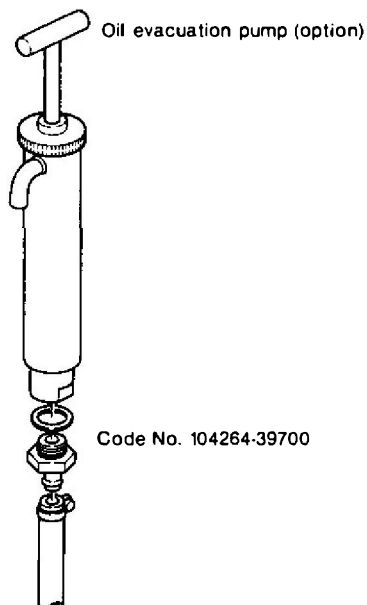
Close the fuel tank cock, remove the fuel filter bowl and replace the element and clean the inside of the bowl. After reinstalling the element and bowl, open the fuel tank cock and bleed the air from the fuel system.



**1-2.3 Maintenance every 100 engine hours**

**(1) Change lubricating oil in crankcase**

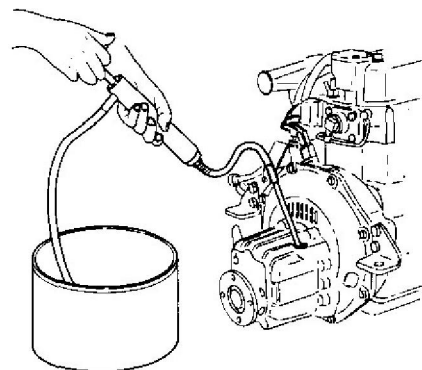
While the engine is still warm, pump the lubricating oil from the crank case with a waste oil pump and refill crankcase with new oil up to the top mark on the dipstick.



**(2) Change lubricating oil in clutch case**

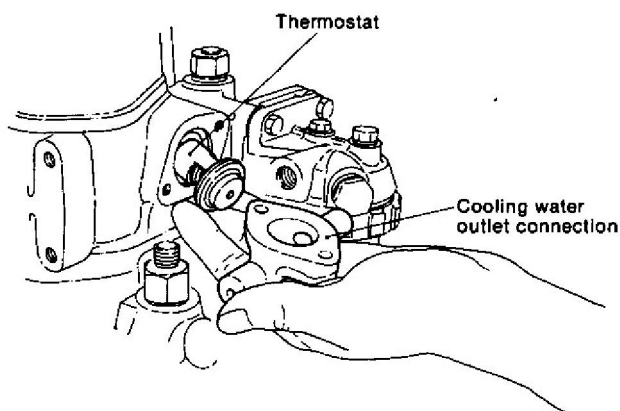
Change oil in clutch case in the same method as crankcase.

If the drain plug can be used, drain the oil by removing the drain plug.



**(3) Clean thermostat**

- 1) Replace the thermostat cover.
- 2) Take out the thermostat and clean.

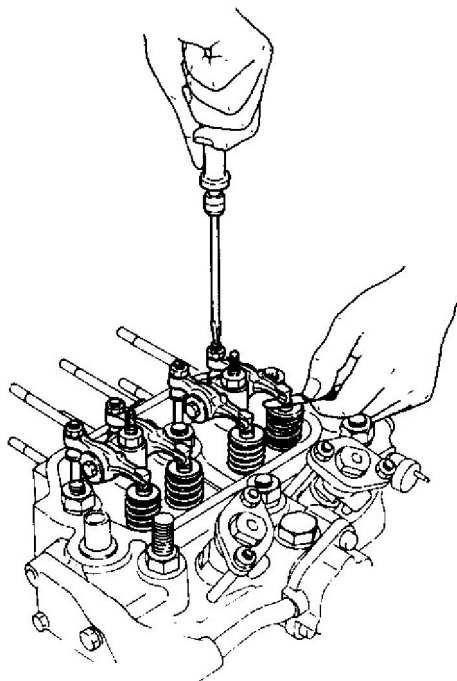


**(4) Tightening bolts**

Check the engine mounting bolts, cylinder head bolts, gear case bolts, and the bolts of other main parts and tighten as required.  
 (Refer to the bolt tightening torque table).

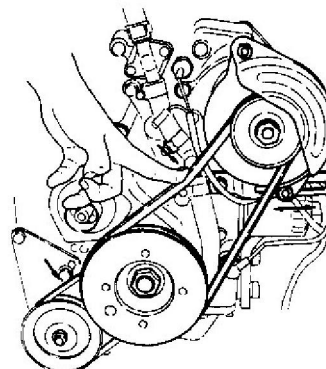
**(5) Intake and exhaust valve adjustment**

Remove the rocker arm chamber and check the intake and exhaust valve head clearance with a feeler gauge. Adjust if not within the prescribed limit. (Refer to the cylinder head chapter of this manual for a description of the adjustment method.)



**(6) V-belt tension adjustment**

Check the tension of the water pump drive V-belt and alternator drive V-belt, and adjust as required.



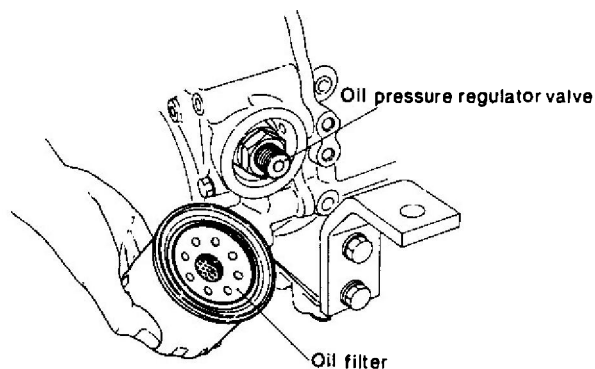
**V-belt tension**

[Pushed with a force of 10 kg (22 lb)]

	mm (in.)
Water pump	5 ~ 7 (0.1968 ~ 0.2755)
Alternator	10 (0.3937)

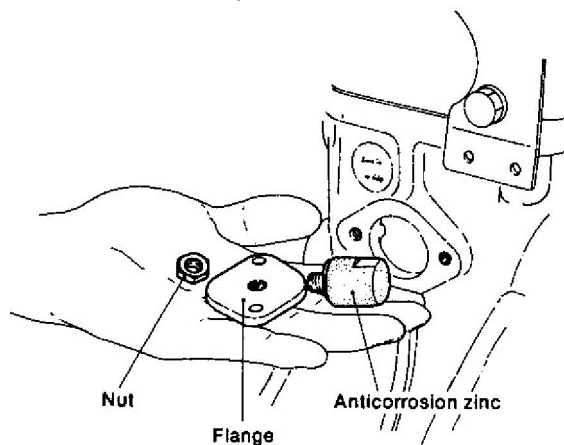
**1-2.5 Maintenance every 300 engine hours**

- (1) Replace lub. oil filter element.



**1-2.6 Maintenance every 500 engine hours**

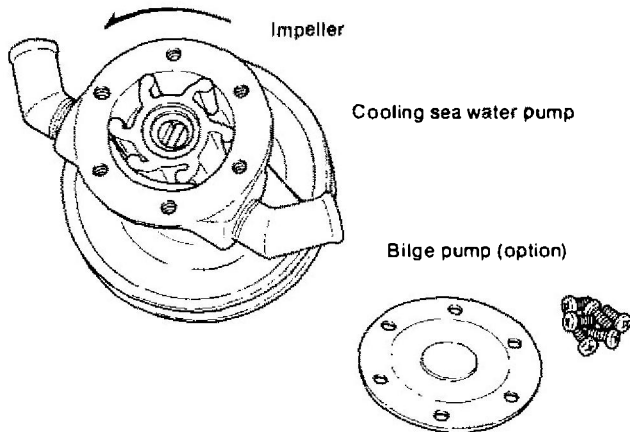
- (1) Anticorrosion zinc replacement



**Anticorrosion zinc positions**

1GM	1	Cylinder block starter motor side
2GM	2	Cylinder head flywheel side cover Cylinder block exhaust side
3GM(D)	3	Cylinder head flywheel side cover
3HM		Cylinder block exhaust side (2)

(2) Check C.W. impeller.



(3) Inspect the fuel injection system

- Injection timing check and adjustment
  - Delivery valve inspection
  - Injection spray inspection
  - Injection pressure check and adjustment
  - Nozzle valve disassembly and cleaning
- Refer to the FUEL SYSTEM chapter of this manual for a detailed description of inspection and adjustment methods.

## 2. Service Standard

### 2-1 Standard values for adjustment purposes

#### 2-1.1 1GM

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Engine body	Cylinder block	Inside diameter of cylinder block	ø72	ø72.1	Remove rust with emery paper. Rectify by boring and honing.	(2-5)
		Cylinder and piston clearance		0.3		
		Distortion of the cylinder	—	0.07	Liner should have a projection.	(2-6)
		Roundness of the cylinder	0 ~ 0.01	0.1	Check for a hole in the cylinder block liner.	Make measurement when inserting cylinder liner in the cylinder block. (2-5)
		Cylindricity of the cylinder			Check the rubber packing of the liner.	
	Cylinder head	Intake or exhaust valve sinkage	0.95	1.25	Replace valve and cylinder head.	Valve seat angle is 45°. (2-16)
		Valve seat width	1.77		Correct width by using valve seat cutter or grinder.	Fit contact surface after correction. (2-15)
		Distortion of cylinder head (fitting surface)	0	0.07	Correct distortion by using surface grinder.	(2-14)
		Tightening torque of the cylinder head fixing nuts	7.5 kg·m	—	Apply oil to bolts and tighten in the specified sequence.	(2-17)
		Top clearance	0.7	—	Rotate slowly.	Fuse strip is 1.2mm in diam. Length of squeezed fuse strip is less than 10mm. (2-23)
Main moving parts	Piston	Piston-to-cylinder clearance				Measure it at room temperature and at the lower end of piston skirt.
		Maximum diameter of piston	ø72 <sup>-0.057</sup> <sub>-0.087</sub>	ø71.85	Replace.	Measure it at room temperature and at the lower end of piston skirt. (2-31)
		Interference between piston and piston pin	-0.005 ~ +0.017	—	Replace piston when noise is produced.	Heat piston to about 80°C so that piston pin can be forced into it. (2-32)
		Wear of outside diameter of piston pin	ø20 <sup>0</sup> <sub>-0.009</sub>	ø19.98	Replace.	(2-32)
	Piston ring	Gap between piston ring ends (within cylinder)	1st	0.20 ~ 0.40	Replace. When disassembling and servicing engine, replace piston ring.	Measure at a point about 100mm below the cylinder liner top which is free from wear. (2-34)
			2nd	0.20 ~ 0.40		
			Oil	0.20 ~ 0.40		
		Gap between piston ring and groove	1st	0.06 ~ 0.10	Replace piston ring or piston.	Mount piston ring with its marking surface directed toward piston top. (2-31)
			2nd	0.035 ~ 0.070		
			Oil	0.020 ~ 0.055		
		Size of piston ring	1st	Thickness	3.2 ± 0.10	Replace.
				Width	2 <sup>-0.01</sup> <sub>-0.03</sub>	
			2nd	Thickness	2.8 ± 0.20	
				Width	4 <sup>-0.01</sup> <sub>-0.03</sub>	
			Oil	Thickness	2.8 ± 0.20	(2-34)
			Oil	Width	4 <sup>-0.01</sup> <sub>-0.03</sub>	

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							(mm)
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks <i>Refer to (page)</i>
Valve gear	Timing gear	Timing gear backlash (Crankshaft gear and camshaft gear)		0.05 ~ 0.13	0.3	Replace gear.	(2-66)
		Backlash					(2-66)
		Lubricating oil pump gear and crankshaft gear		0.05 ~ 0.13	0.3		(2-66)
	Intake-exhaust valve	Wear on the intake-exhaust valve stem		ø7	ø6.9	Replace intake-exhaust valve.	When replacing a valve due to valve seat wear, also replace the valve guide. (2-20)
		Inside diameter of the valve guide		ø7	ø7.08		
		Gap between valve guide and valve stem	Intake	0.045 ~ 0.070	0.15		Intake and exhaust valve guides are different. (2-20)
			Exhaust	0.045 ~ 0.070	0.15		
		Interference between the valve guide and cylinder head		0.005 ~ 0.034		Lubricate the valve guide before press-fitting.	
		Valve thickness		0.75 ~ 1.15		Replace valve.	
		Width of the intake-exhaust valve seat		3.15		Correct or replace valve seat.	Be sure to properly fit after correcting the seat. (2-19)
		Intake-exhaust valve sinkage		0.95	1.25		Valve recess. (2-19)
		Valve stem seal damage		—	—	Replace valve stem seal.	Be careful not to damage the seal lip. (2-19)
		Valve spring	Spring load (load at fitting time/compressed dimension)	16.16kg	13.7kg	Replace valve spring.	
			Free length	38.5	37		
			Collapse				
		Intake-exhaust valve head clearance		0.2	—	Adjust.	(2-26)
		Contact surface between valve stem and rocker arm		—	—	If there is excessive wear on the rocker arm tip or valve, correct or replace the rocker arm or valve stem. (2-26)	
		Outside diameter of the rocker arm shaft		ø12	ø11.9	Replace rocker arm shaft or bearing.	
		Inside diameter of the rocker arm shaft bearing		ø12	ø12.1		
		Oil clearance between rocker arm shaft and bearing		0.016 ~ 0.052	0.15		
	Push rod bend		0.03 or less	0.3	Correct or replace.	(2-61)	
	Push rod length		143	—	Correct or replace.	(2-61)	
	Decompressor lift					After adjustment, check valve and piston contact.	
	Tappet	Outside diameter of the tappet		ø10.0	ø9.95		(2-60)
		Inside diameter of the cylinder hole for the tappet		ø10.0		Replace tappet.	(2-60)
		Gap between tappet and cylinder block		0.025 ~ 0.060	0.10		(2-60)
		Contact surface between tappet and cam		—	—	If contact surface is worn excessively or deformed, replace tappet. (2-60)	

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Lubricating system	Oil pressure	Lubricating oil pressure kg/cm <sup>2</sup>	3.5 ±0.5	—	Correct any oil leakage and clear any clogged parts.	(6-6)
	Lubricating oil pump	Gap between outer rotor and body	0.050 ~ 0.105	0.15		
		Gap between inner rotor and outer rotor	0.050 ~ 0.105	0.15		
		Body-to-rotor side clearance	0.03 ~ 0.08	0.13		(6-8)
	Oil filter	Clogged or malfunctioning of filter element	—	—	Replace filter element every 300 hours.	(6-8)
Cooling system	Water pump	Clearance between rubber impeller and pump cover	0.2	0.4	If impeller is damaged, replace pump.	(7-10)
		Water leakage from the sealing section	—	—	Replace pump.	
		Driving V-belt	—	—	Replace.	
Fuel injection device	Piping, etc.	Clogging, cracks, loose connection, and defective packing of fuel pipe, priming pump, fuel injection pump, and injector	—	—	Correct or replace.	
	Fuel filter	Clogging or failure of fuel filter element	—	—	Clean or replace.	
		Time interval for replacing element	Every 250 hours	—		First time 50 hours. (3-29)
	Delivery valve	Oil tightness of the delivery valve (Time required for pressure drop of 10 kg/cm <sup>2</sup> from initial pressure of 100 kg/cm <sup>2</sup> )	20 sec. or more	5 sec. or less	Replace delivery valve assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length. (3-23)
		Wear on the piston section of the delivery valve	—	—	If wear is excessive, replace delivery valve assembly.	(3-23)
		Torque for tightening delivery valve holder	4.0 ~ 4.5 kg-m	—		(3-18)
	Plunger	Pressure generated by plunger			Replace plunger and barrel assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length.
		Plunger wear	—	—	If the lead section, etc. are excessively worn, replace plunger assembly.	
		Top clearance of the plunger	1.0 ±0.05	—	Adjust by using adjusting shim.	(3-22)
		Injection spacing angle (crankshaft angle)	720°	—	Adjust tappet, or replace tappet and camshaft.	Crankshaft angle.
		Injection amount pump speed	1800 rpm	—		(3-24)
		Plunger diameter × stroke	ø6 × 7	—		(3-8)
		Injection nozzle type	YDN-OSDYD1	—		(3-24)
		Pressure for fuel injection	170 kg/cm <sup>2</sup>	—		(3-24)
		Amount of injection at matching mark position	20 ±0.5cc	—		(3-24)
		Allowable error between cylinders	—	—		(3-24)
		Stroke	1000	—		(3-24)

(mm)

Classi- fica- tion	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Fuel injection device	Fuel injection valve	Fuel injection timing (FID)	bTDC 15°	—		(3-21)
		Nozzle valve type	YDN-OSDYD1	—		Semi-throttle. (3-24)
		Oil tightness of nozzle valve seat section (150 kg/cm <sup>2</sup> )	No oil leakage from nozzle with injection pressure being lowered by 20 kg/cm <sup>2</sup> from the specified injection pressure.	—	If oil leaks from valve seat section, correct or replace valve seat.	(3-28)
		Spray and injection (Adjust nozzle valve opening pressure to 170 kg/cm <sup>2</sup> )	1) There should be no scattering of comparatively large drops observable by the naked eye. 2) There should be no discrete drops flying sideways. 3) After injection the oil should not adhere to the nozzle body.	—	Replace malfunctioning nozzle valve.	(3-28)
		Injection pressure	170±5 kg/cm <sup>2</sup>	—	Adjust.	(3-28)
Electrical equipment	Wiring	Loose connections, disconnections, or bare wire	—	—	Repair or replace.	
	Battery	Battery terminal	—	—	Repair, if rusted or corroded.	
		Plate, separator, cell, etc.	—	—	Repair, if any damage is detected.	
		Specific gravity of electrolyte	1.260/20°: 100% charge 1.200/20°: 50% charge	—	Adjust specific gravity and charge the battery.	Coefficient of temperature conversion by taking 20°C as standard: -0.007 per +1°C +0.007 per -1°C (10-5)
		Capacity	70AH or more	—		(10-4)
		Terminal voltage	12V	—		(10-4)
	Starter motor	Brush	Spring force	1.6 ±0.2kg	—	Replace. Brush should be able to move smoothly in the brush holder. (10-14)
			Brush height	16	12	(10-13)
		Magnetic switch resistance	Series coil	0.324Ω	—	Replace. at 20°C (10-14)
			Shunt coil	0.694Ω	—	
		Commutator	Outside diameter	ø33	ø32	Replace. (10-12)
			Difference between max. and min. diam.	Repair limit 0.4	Repair accuracy 0.05	(10-12)
			Depth of mica between segments	0.2	0.5 ~ 0.8	Correct. (10-12)
			Commutator runout			Correct. (10-12)

(mm)

Classification	Part	Inspection point			Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Electrical equipment	Starter motor	ℓ dimension			0.3 ~ 2.5	—	Correct.	The clearance between the end of the pinion & its stopper. (10-9)
		Bearing and shaft S/B = Shaft/ Bearing inside	Brush side bearing	S/B	12.450~12.468/ 12.500~12.527			
			Intermediate bearing	S/B	—			
			Pinion slide way	S/B	12.450~12.468/ 12.530~12.550			
			Pinion side bearing	S/B	12.450~12.468/ 12.500~12.527			
		Type			S114-303	—		(10-16)
		No-load	Terminal voltage		12V	—		
	Current		60A or less	—				
	Speed of rotation		7000 rpm or greater	—		(10-7)		
	Alternator	Stator coil resistance			0.149Ω	—	Replace.	at 20°C, for 2 phase (10-23)
		Rotor	Rotor coil resistance		3.29Ω	—		at 20°C (10-23)
			Slip ring outside diam.		ø31.6	ø30.6		
			Slip ring runout		Limit of correction 0.3	Accuracy of correction 0.05	Correct or replace.	(10-22)
		Brush	Brush length		16.0	9.0	Repair or replace brush when there is not full contact with the slip ring; when brush spring force is not uniform or incorrect; when brush is worn; when part of the brush is gone; or when the brush holder is improperly holding the brush.	(10-23 or 10-32)
			Brush spring strength		300 ±45g	—		When the brush protrudes 2mm from the brush holder. (10-24)
		Stain on slip ring surface			—	—	Repair, if stained or damaged.	(10-24)
		Adjusting voltage			14.3 ±0.3V	—		at 20°C Full batt. (10-24)
		Rated output current			27.5 ±2A/ 2500 rpm 35 ±2A/ 5000 rpm	—		(10-18)
Alarm		Water temperature unit	Operating temperature		ON 60 ±2°C OFF 53°C or more	— —		(10-30)
			Current capacity		DC 12V, 1A	—		(10-30)
	Pilot lamp		12V, 3.4W	—				
	Oil pressure unit	Rated voltage		12V				
		Operating pressure		0.2 ±0.1 kg/cm²				
		Lamp capacity		12V, 5W			(10-29)	
	Buzzer	Current consumption		100mA or below				
		Range of operating voltage		10 ~ 15V				
Sound output		75dB (A) (at 1m, 12V)						
Frequency		3 ±0.5kHz (at 12V)			(10-30)			

## 2-1.2 2GM and 3GM(D)

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Engine body	Cylinder block and liner	Inside diameter of cylinder block liner hole	ø76		Remove rust with emery paper.	
		Wear on the inside diameter of the cylinder liner	ø72	ø72.10	Replace liner. Correct stepped wear on the upper part or replace liner.	(2-8)
		Projection of the cylinder liner	0.005 ~ 0.075	—	Liner should have a projection.	(2-8)
		Roundness of the liner	0.02	0.04	Check for a hole in the cylinder block liner.	Make measurement when inserting cylinder liner in the cylinder block.
		Cylindricity of the liner			Check the rubber packing of the liner.	
	Cylinder head	Intake or exhaust valve sinkage	0.95	1.25	Replace valve and cylinder head.	Valve seat angle is 45° (2-16)
		Valve seat width	Intake valve Exhaust valve	1.77	Correct width by using valve seat cutter or grinder.	Fit contact surface after correction. (2-15)
		Distortion of cylinder head (fitting surface)	0	0.07	Correct distortion by using surface grinder.	(2-14)
		Torque for tightening the cylinder head bolts and nuts	Nut for stud bolt Aux. bolt	10 kg-m 2.5 kg-m	Apply oil to bolts and tighten in the specified sequence.	(2-18)
		Top clearance	0.7	—	Rotate slowly.	Fuse strip is 1.2mm in diam. Length of squeezed fuse strip is less than 10mm. (2-23)
Main moving parts	Piston	Piston-to-cylinder clearance	0.057 ~ 0.117			Measure it at room temperature and at the lower end of piston skirt.
		Maximum diameter of piston	ø72 <sup>-0.057</sup> <sub>-0.087</sub>	ø71.85	Replace.	Measure it at room temperature and at the lower end of piston skirt. (2-31)
		Interference between piston and piston pin	-0.005 ~ +0.017	—	Replace piston when noise is produced.	Heat piston to about 80°C so that piston pin can be forced into it. (2-32)
		Wear of outside diameter of piston pin	ø20 <sup>0</sup> <sub>-0.009</sub>	ø19.98	Replace.	(2-32)
	Piston ring	Gap between piston ring ends (within cylinder)	1st	0.20 ~ 0.40	Replace. When disassembling and servicing engine, replace piston ring.	Measure at a point about 100mm below the cylinder liner top which is free from wear. (2-34)
			2nd	0.20 ~ 0.40		
			Oil	0.20 ~ 0.40		
		Gap between piston ring and groove	1st	0.06 ~ 0.10	Replace piston ring or piston.	Mount piston ring with its marking surface directed toward piston top. (2-31)
			2nd	0.035 ~ 0.070		
			Oil	0.020 ~ 0.055		
		Size of piston ring	1st 2nd	Thickness	3.2 ± 0.10	Replace. (2-34)
				Width	2 <sup>-0.01</sup> <sub>-0.03</sub>	
			Oil	Thickness	2.8 ± 0.20	
				Width	4 <sup>-0.01</sup> <sub>-0.03</sub>	

							(mm)
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Main moving parts	Connecting rod	Inside diameter of crankpin bearing		ø40.0	ø40.10	Replace crankpin bearing.	Tighten connecting rod bolts to the prescribed torque. (2-37)
		Crankpin-to-crankpin-bearing oil clearance		0.028 ~ 0.086	0.13		
		Contact of crankpin bearing		—	—	If contact is not correct, replace crankpin bearing.	Check the dimensional tolerance of crankpin.
		Inside diameter of piston pin bearing		ø20.0	ø20.1	Replace piston pin bearing.	(2-39)
		Oil clearance between piston pin and bearing		0.025 ~ 0.047	0.11	Replace either piston pin or bearing.	
		If the big end hole and small end hole are parallel (per 100mm)		0.03 or less	0.08	Replace.	(2-36)
		Torque for tightening the connecting rod bolt		25 kg-m	—	Apply oil to the bolt before tightening.	(2-37)
	Crankshaft	Wear on the crankshaft journal	Gear case side	ø44 <sup>-0.036</sup> <sub>-0.050</sub>	ø43.90	Replace or correct.	Carefully arrange so that the corner angle of both crankpin and crankshaft journal is 4 <sup>+0.3</sup> <sub>0</sub> .
			Intermediate bearing	ø44 <sup>-0.036</sup> <sub>-0.050</sub>	ø43.90		
			Flywheel side	ø60 <sup>-0.036</sup> <sub>-0.050</sub>	ø59.90		
		Crankpin wear		ø40 <sup>-0.036</sup> <sub>-0.050</sub>	ø39.90		
		Uneven wear on the crankpin and crankshaft journal		—	0.01		(2-42)
		Oil clearance between crankshaft journal and journal bearing	Gear side	0.036 ~ 0.092	0.15	Replace bearing or crankshaft.	
			Intermediate gear side	0.036 ~ 0.092	0.15		
			Intermediate wheel side	0.036 ~ 0.092	0.15		
			Wheel side	0.036 ~ 0.095	0.15		
		Oil clearance between crankpin and bearing		0.028 ~ 0.086	0.13		(2-42)
		Side gap of crankshaft		0.09 ~ 0.19	0.30	Replace crankshaft bearing.	Replace standard bearing. (2-45)
		Torque for tightening set bolts to the intermediate main bearing journal		3.0 ~ 3.5 kg-m	—	Apply oil to the threads before tightening.	Be sure that there is no score on the fitting surfaces of the bearing and bearing gap, and no dust, etc. between the fitting surfaces. (2-46)
		Torque for tightening the main bearing journal		2.5 kg-m	—		(2-47)
		Bend in the crankshaft		Less than 0.015	0.15	Replace.	(2-44)
		Oil seal wear	Timing gear side	25408	—	Replace oil seal.	Be careful that the oil seal doesn't collapse. (2-50)
			Main bearing journal side	60823	—		
	Camshaft	Outside diam. of journal	Flywheel side	ø30		Replace bearing or camshaft.	
			Intermediate	ø41.5 [3GM(D) only]			
		Inside diam. of bearing	Flywheel side	ø30			(2-57)
			Intermediate	ø41.5 [3GM(D) only]			
		Oil clearance between camshaft and bearing	Flywheel side	0.050 ~ 0.100	0.15		(2-57)
			Intermediate	0.050 ~ 0.100 [3GM(D) only]	0.15 [3GM(D) only]		
		Side clearance of camshaft				Replace gear side bearing.	
		Height of cam	Intake-exhaust valve	35	34.70	Replace camshaft.	Correct slightly stepped wear on the cam.
			Fuel pump	33	—		

(mm)

Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks <i>Refer to (page)</i>	
Valve gear	Timing gear	Timing gear backlash (Crankshaft gear and camshaft gear)		0.05 ~ 0.13	0.3	Replace gear.	(2-66)	
		Backlash					(2-66)	
		Lubricating oil pump gear and crankshaft gear		0.05 ~ 0.13	0.3		(2-66)	
	Intake-exhaust valve	Wear on the intake-exhaust valve stem		ø7	ø6.9	Replace intake-exhaust valve.	When replacing a valve due to valve seat wear, also replace the valve guide. (2-20)	
		Inside diameter of the valve guide		ø7	ø7.08			
		Gap between valve guide and valve stem	Intake	0.040 ~ 0.065	0.15		Intake and exhaust valve guides are different. (2-20)	
			Exhaust	0.045 ~ 0.070	0.15			
		Clearance between the valve guide and cylinder head		0.018 ~ 0.047		Lubricate the valve guide before press-fitting.		
		Valve thickness		0.75 ~ 1.15		Replace valve.	(2-19)	
		Width of the intake-exhaust valve seat		3.15		Correct or replace valve seat.	Be sure to properly fit after correcting the seat. (2-19)	
		Intake-exhaust valve sinkage		0.95	1.25		Valve recess. (2-19)	
		Valve stem seal damage		—	—	Replace valve stem seal.	Be careful not to damage the seal lip.	
		Valve spring	Spring load (load at fitting time/compressed dimension)		16.16kg	13.7kg	Replace valve spring.	(2-22)
			Free length		38.5	37		
			Collapse					
		Intake-exhaust valve head clearance		0.2	—	Adjust.	(2-26)	
		Contact surface between valve stem and rocker arm		—	—	If there is excessive wear on the rocker arm tip or valve, correct or replace the rocker arm or valve stem.	(2-26)	
		Outside diameter of the rocker arm shaft		ø14	ø13.9	Replace rocker arm shaft or bearing.	(2-25)	
		Inside diameter of the rocker arm shaft bearing		ø14	ø14.1			
		Oil clearance between rocker arm shaft and bearing		0.016 ~ 0.052	0.15			
		Push rod bend		0.03 or less	0.3	Correct or replace.	(2-61)	
		Push rod length		136	—	Correct or replace.	(2-61)	
		Decompressor lift					After adjustment, check valve and piston contact.	
	Tappet	Outside diameter of the tappet		ø10.0	ø9.95			
		Inside diameter of the cylinder hole for the tappet		ø10.0		Replace tappet.	(2-60)	
		Gap between tappet and cylinder block		0.010 ~ 0.040	0.10		(2-60)	
		Contact surface between tappet and cam		—	—	If contact surface is worn excessively or deformed, replace tappet.	(2-60)	

## Chapter 13 Inspection and Servicing

### 2. Service Standard

SM/1GM-2GM-3GM(D)-3HM

(mm)						
Classi- fica- tion	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Lubricating system	Oil pressure	Lubricating oil pressure kg/cm <sup>2</sup>	3.5 ±0.5	—	Correct any oil leakage and clear any clogged parts.	(6-6)
	Lubricating oil pump	Gap between outer rotor and body	0.050 ~ 0.105	0.15		(6-8)
		Gap between inner rotor and outer rotor	0.050 ~ 0.105	0.15		
		Body-to-rotor side clearance	0.03 ~ 0.07	0.13		
Cooling system	Oil filter	Clogged or malfunctioning of filter element	—	—	Replace filter element every 300 hours.	
	Water pump	Clearance between rubber impeller and pump cover	0.2	0.4	If impeller is damaged, replace pump.	(7-10)
		Water leakage from the sealing section	—	—	Replace pump.	
		Driving V-belt	M19in.	—	Replace.	(7-9)
Fuel injection device	Piping, etc.	Clogging, cracks, loose connec- tion, and defective packing of fuel pipe, priming pump, fuel injection pump, and injector	—	—	Correct or replace.	
	Fuel filter	Clogging or failure of fuel filter element	—	—	Clean or replace.	
		Time interval for replacing element	Every 250 hours	—		First time 50 hours. (3-29)
	Delivery valve	Oil tightness of the delivery valve (Time required for pressure drop of 10 kg/cm <sup>2</sup> from initial pressure of 100 kg/cm <sup>2</sup> )	20 sec. or more	5 sec. or less	Replace delivery valve assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length. (3-23)
		Wear on the piston section of the delivery valve	—	—	If wear is excessive, replace delivery valve assembly.	(3-23)
		Torque for tightening delivery valve holder	4.0 ~ 4.5 kg-m	—		(3-22 or 3-23)
	Plunger	Pressure generated by plunger			Replace plunger and barrel assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length. (3-22 or 2-23)
		Plunger wear	—	—	If the lead section, etc. are excessively worn, replace plunger assembly.	(3-22 or 3-23)
		Top clearance of the plunger	1.0 ±0.05	—	Adjust by using adjusting shim.	(3-22)
		Injection spacing angle (crankshaft angle)	(*1)	—	Adjust tappet, or replace tappet and camshaft.	Crankshaft angle. (3-23)
		Injection amount pump speed	1800 rpm	—		(3-24)
		Plunger diameter × stroke	ø6 × 7	—		(3-24)
		Injection nozzle type	YDN-OSDYD1	—		(3-24)
		Pressure for fuel injection	170 kg/cm <sup>2</sup>	—		(3-24)
		Amount of injection at matching mark position	20 ±0.5cc	—		(3-24)
		Allowable error between cylinders	Less than 1 cc	—		(3-24)
		Stroke	1000	—		(3-24)

(\*1) 2GM =  $\begin{matrix} 180^\circ & 540^\circ \\ 1 & \sim 2 & \sim 1 \end{matrix}$  3GM(D) =  $\begin{matrix} 240^\circ & 240^\circ & 240^\circ \\ 1 & \sim 3 & \sim 2 & \sim 1 \end{matrix}$

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Fuel injection device	Fuel injection valve	Fuel injection timing (FID)	bTDC 15° 2GM bTDC 18° 3GM(D)	—		(3-21)
		Nozzle valve type	YDN-OSDYD1	—		Semi-throttle. (3-24)
		Oil tightness of nozzle valve seat section (150 kg/cm <sup>2</sup> )	No oil leakage from nozzle with injection pressure being lowered by 20 kg/cm <sup>2</sup> from the specified injection pressure.	—	If oil leaks from valve seat section, correct or replace valve seat.	(3-28)
		Spray and injection (Adjust nozzle valve opening pressure to 170 kg/cm <sup>2</sup> )	1) There should be no scattering of comparatively large drops observable by the naked eye. 2) There should be no discrete drops flying sideways. 3) After injection the oil should not adhere to the nozzle body.	—	Replace malfunctioning nozzle valve.	(3-28)
		Injection pressure	170±5 kg/cm <sup>2</sup>	—	Adjust.	(3-28)
Electrical equipment	Wiring	Loose connections, disconnections, or bare wire	—	—	Repair or replace.	
	Battery	Battery terminal	—	—	Repair, if rusted or corroded.	
		Plate, separator, cell, etc.	—	—	Repair, if any damage is detected.	
		Specific gravity of electrolyte	1.260/20°: 100% charge 1.200/20°: 50% charge	—	Adjust specific gravity and charge the battery.	Coefficient of temperature conversion by taking 20°C as standard: −0.007 per +1°C +0.007 per −1°C (10-5)
		Capacity	70AH or more	—		(10-4)
		Terminal voltage	12V	—		(10-4)
	Starter motor	Brush	Spring force	1.6 ±0.2kg	Replace. Brush should be able to move smoothly in the brush holder.	(10-14)
			Brush height	16		(10-13)
		Magnetic switch resistance	Series coil	0.324Ω	Replace.	at 20°C
			Shunt coil	0.694Ω		(3-14)
		Commutator	Outside diameter	ø33	Replace.	
			Difference between max. and min. diam.	0.4		(3-12)
			Depth of mica between segments	0.2		(3-12)
			Commutator runout			(3-12)

							(mm)
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Electrical equipment	Starter motor	l dimension		0.3 ~ 2.5	—	Correct.	The clearance between the end of the pinion & its stopper. (10-9)
		Bearing and shaft S/B = Shaft/ Bearing inside	Brush side bearing	S/B	12.450~12.468/ 12.500~12.527		
			Intermedi- ate bearing	S/B	—		
			Pinion slide way	S/B	12.450~12.468/ 12.530~12.550		
			Pinion side bearing	S/B	12.450~12.468/ 12.500~12.527		
		Type		S114-303	—		(10-16)
		No-load	Terminal voltage		12V	—	
			Current		60A or less	—	
			Speed of rotation		7000 rpm or greater	—	(10-17)
	Alternator	Stator coil resistance		0.149Ω	—	Replace.	at 20°C, for 2 phase (10-23)
		Rotor	Rotor coil resistance		3.29Ω	—	at 20°C (10-23)
			Slip ring outside diam.		ø31.6	ø30.6	
			Slip ring runout		Limit of correction 0.3	Accuracy of correction 0.05	Correct or replace. (10-22)
		Brush	Brush length		16.0	9.0	Repair or replace brush when there is not full contact with the slip ring; when brush spring force is not uniform or incorrect; when brush is worn; when part of the brush is gone; or when the brush holder is improperly holding the brush. (10-23)
			Brush spring strength		300 ±45g	—	When the brush protrudes 2mm from the brush holder. (10-24)
		Stain on slip ring surface		—	—	Repair, if stained or damaged.	
		Adjusting voltage		14.3 ±0.3V	—		at 20°C Full batt. (10-24)
		Rated output current		27.5 ±2A/ 2500 rpm 35 ±2A/ 5000 rpm	—		(10-18)
Alarm	Water tem- perature unit	Operating temperature	ON	60 ±2°C	—		
			OFF	53°C or more	—		(10-30)
		Current capacity		DC 12V, 1A	—		(10-30)
	Oil pressure unit	Pilot lamp		12V, 3.4W	—		
		Rated voltage		12V			
		Operating pressure		0.2 ±0.1 kg/cm <sup>2</sup>			
	Buzzer	Lamp capacity		12V, 5W			(10-29)
		Current consumption		100mA or below			
		Range of operating voltage		10 ~ 15V			
		Sound output		75dB (A) (at 1m, 12V)			
		Frequency		3 ±0.5kHz (at 12V)			(10-30)

## 2-1.3 3HM

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Engine body	Cylinder block and liner	Inside diameter of cylinder block liner hole	ø79		Remove rust with emery paper.	
		Wear on the inside diameter of the cylinder liner	ø75	ø75.10	Replace liner. Correct stepped wear on the upper part or replace liner.	(2-8)
		Projection of the cylinder liner	0.005 ~ 0.075	—	Liner should have a projection.	(2-9)
		Roundness of the liner	0.02	0.04	Check for a hole in the cylinder block liner.	Make measurement when inserting cylinder liner in the cylinder block. (2-8)
		Cylindricity of the liner			Check the rubber packing of the liner.	
	Cylinder head	Intake or exhaust valve sinkage	1.25	1.55	Replace valve and cylinder head.	Valve seat angle is 45°. (2-16)
		Valve seat width	Intake valve Exhaust valve	1.77	Correct width by using valve seat cutter or grinder.	Fit contact surface after correction. (2-15)
		Distortion of cylinder head (fitting surface)	0	0.07	Correct distortion by using surface grinder.	(2-14)
		Torque for tightening the cylinder head bolts and nuts	Nut for stud bolt 13 kg-m	—	Apply oil to bolts and tighten in the specified sequence.	(2-18)
			Aux. bolt 3 kg-m			
		Top clearance	0.8	—	Rotate slowly.	Fuse strip is 1.2mm in diam. Length of squeezed fuse strip is less than 10mm. (2-23)
Main moving parts	Piston	Piston-to-cylinder clearance	0.038 ~ 0.148			Measure it at room temperature and at the lower end of piston skirt. (2-31)
		Maximum diameter of piston	ø75 <sup>-0.063</sup> <sub>-0.093</sub>	ø74.85	Replace.	Measure it at room temperature and at the lower end of piston skirt.
		Interference between piston and piston pin	-0.005 ~ +0.017	—	Replace piston when noise is produced.	Heat piston to about 80°C so that piston pin can be forced into it. (2-32)
		Wear of outside diameter of piston pin	ø23 <sup>0</sup> <sub>-0.009</sub>	ø22.98	Replace.	(2-32)
	Piston ring	Gap between piston ring ends (within cylinder)	1st	0.20 ~ 0.40	Replace. When disassembling and servicing engine, replace piston ring.	Measure at a point about 100mm below the cylinder liner top which is free from wear. (2-34)
			2nd	0.20 ~ 0.40		
			Oil	0.20 ~ 0.40		
		Gap between piston ring and groove	1st	0.065 ~ 0.10	Replace piston ring or piston.	Mount piston ring with its marking surface directed toward piston top. (2-31)
			2nd	0.035 ~ 0.07		
			Oil	0.020 ~ 0.055		
		Size of piston ring	1st	Thickness	3.3 ± 0.10	Replace. (2-34)
				Width	2 <sup>-0.01</sup> <sub>-0.03</sub>	
			2nd	Thickness	2.6 ± 0.20	
				Width	4 <sup>-0.01</sup> <sub>-0.03</sub>	

							(mm)
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Main moving parts	Connecting rod	Inside diameter of crankpin bearing		ø44.0	ø44.10	Replace crankpin bearing.	Tighten connecting rod bolts to the prescribed torque. (2-37)
		Crankpin-to-crankpin-bearing oil clearance		0.036 ~ 0.092	0.13		
		Contact of crankpin bearing		—	—	If contact is no correct, replace crankpin bearing.	Check the dimensional tolerance of crankpin.
		Inside diameter of piston pin bearing		ø23.0	ø23.1	Replace piston pin bearing.	(2-39)
		Oil clearance between piston pin and bearing		0.025 ~ 0.047	0.11	Replace either piston pin or bearing.	
		If the big end hole and small end hole are parallel (per 100mm)		0.03 or less	0.08	Replace.	(2-36)
		Torque for tightening the connecting rod bolt		4.5 kg-m	—	Apply oil to the bolt before tightening.	(2-37)
	Crankshaft	Wear on the crankshaft journal	Gear case side	ø47 <sup>+0.036</sup> <sub>-0.050</sub>	ø46.90	Replace or correct.	Carefully arrange so that the corner angle of both crankpin and crankshaft journal is 4 <sup>+0.3</sup> <sub>0</sub>
			Intermediate bearing	ø47 <sup>+0.036</sup> <sub>-0.050</sub>	ø46.90		
			Flywheel side	ø65 <sup>+0.036</sup> <sub>-0.050</sub>	ø64.90		
		Crankpin wear		ø44 <sup>+0.036</sup> <sub>-0.050</sub>	ø43.90		
		Uneven wear on the crankpin and crankshaft journal		—	0.01		(2-42)
		Oil clearance between crankshaft journal and journal bearing	Gear side	0.036 ~ 0.095	0.15	Replace bearing or crankshaft.	
			Intermediate gear side	0.036 ~ 0.095	0.15		
			Intermediate wheel side	0.036 ~ 0.095	0.15		
			Wheel side	0.036 ~ 0.099	0.15		
		Oil clearance between crankpin and bearing		0.036 ~ 0.092	0.13		(2-42)
		Side gap of crankshaft		0.09 ~ 0.18	0.30	Replace crankshaft bearing.	Replace standard bearing. (2-45)
		Torque for tightening set bolts to the intermediate main bearing journal		4.5 ~ 5.0 kg-m	—	Apply oil to the threads before tightening.	Be sure that there is no score on the fitting surfaces of the bearing and bearing gap, and no dust, etc. between the fitting surfaces. (2-46)
		Torque for tightening the main bearing journal		2.5 kg-m	—		(2-47)
		Bend in the crankshaft		Less than 0.015	0.15	Replace.	(2-44)
		Oil seal wear	Timing gear side	25408	—	Replace oil seal.	Be careful that the oil seal doesn't collapse. (2-50)
			Main bearing journal side	66889	—		
	Camshaft	Outside diam. of journal	Flywheel side	ø30		Replace bearing or camshaft.	
			Intermediate	ø41.5			
		Inside diam. of bearing	Flywheel side	ø30			(2-59)
			Intermediate	ø41.5			
		Oil clearance between camshaft and bearing	Flywheel side	0.050 ~ 0.100	0.15		(2-59)
			Intermediate	0.050 ~ 0.100	0.15		
		Side clearance of camshaft				Replace gear side bearing.	(2-59)
		Height of cam	Intake-exhaust valve	35	34.70	Replace camshaft.	Correct slightly stepped wear on the cam. (2-59)
			Fuel pump	33.5			

(mm)						
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair
						Remarks Refer to (page)
Valve gear	Timing gear	Timing gear backlash (Crankshaft gear and camshaft gear)		0.05 ~ 0.13	0.3	Replace gear.
		Backlash				
		Lubricating oil pump gear and crankshaft gear		0.05 ~ 0.13	0.3	
	Intake-exhaust valve	Wear on the intake-exhaust valve stem		ø7	ø6.9	Replace intake-exhaust valve.
		Inside diameter of the valve guide		ø7	ø7.08	
		Gap between valve guide and valve stem	Intake	0.040 ~ 0.065	0.15	Intake and exhaust valve guides are different.
			Exhaust	0.045 ~ 0.070	0.15	
		Clearance between the valve guide and cylinder head		0.018 ~ 0.047		Lubricate the valve guide before press-fitting.
		Valve thickness		0.85 ~ 1.15		Replace valve.
		Width of the intake-exhaust valve seat		3.04		Correct or replace valve seat.
		Intake-exhaust valve sinkage		1.25	1.55	
		Valve stem seal damage		—	—	Replace valve stem seal.
		Valve spring	Spring load (load at fitting time/compressed dimension)	14.43kg	12.2kg	Replace valve spring.
			Free length	38.5	37	
			Collapse			
		Intake-exhaust valve head clearance		0.2	—	Adjust.
		Contact surface between valve stem and rocker arm		—	—	If there is excessive wear on the rocker arm tip or valve, correct or replace the rocker arm or valve stem.
		Outside diameter of the rocker arm shaft		ø14	ø13.9	Replace rocker arm shaft or bearing.
		Inside diameter of the rocker arm shaft bearing		ø14	ø14.1	
		Oil clearance between rocker arm shaft and bearing		0.016 ~ 0.052	0.15	
		Push rod bend		0.03 or less	0.3	Correct or replace.
		Push rod length		171	—	Correct or replace.
		Decompressor lift				After adjustment, check valve and piston contact.
	Tappet	Outside diameter of the tappet		ø10.0	ø9.95	
		Inside diameter of the cylinder hole for the tappet		ø10.0		
		Gap between tappet and cylinder block		0.010 ~ 0.040	0.10	
		Contact surface between tappet and cam		—	—	If contact surface is worn excessively or deformed, replace tappet.

(mm)

Classification	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Lubricating system	Oil pressure	Lubricating oil pressure kg/cm <sup>2</sup>	3.5 ±0.5	—	Correct any oil leakage and clear any clogged parts.	(6-6)
	Lubricating oil pump	Gap between outer rotor and body	0.050 ~ 0.105	0.15		(6-8)
		Gap between inner rotor and outer rotor	0.050 ~ 0.105	0.15		
		Body-to-rotor side clearance	0.03 ~ 0.07	0.13		
	Oil filter	Clogged or malfunctioning of filter element	—	—	Replace filter element every 300 hours.	
Cooling system	Water pump	Clearance between rubber impeller and pump cover	0.2	0.4	If impeller is damaged, replace pump.	(7-10)
		Water leakage from the sealing section	—	—	Replace pump.	
		Driving V-belt	M19in.	—	Replace.	(7-9)
Fuel injection device	Piping, etc.	Clogging, cracks, loose connection, and defective packing of fuel pipe, priming pump, fuel injection pump, and injector	—	—	Correct or replace.	
	Fuel filter	Clogging or failure of fuel filter element	—	—	Clean or replace.	
		Time interval for replacing element	Every 250 hours	—		First time 50 hours. (3-29)
	Delivery valve	Oil tightness of the delivery valve (Time required for pressure drop of 10 kg/cm <sup>2</sup> from initial pressure of 100 kg/cm <sup>2</sup> )	20 sec. or more	5 sec. or less	Replace delivery valve assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length. (3-23)
		Wear on the piston section of the delivery valve	—	—	If wear is excessive, replace delivery valve assembly.	(3-23)
		Torque for tightening delivery valve holder	4.0 ~ 4.5 kg-m	—		(3-20 or 3-23)
	Plunger	Pressure generated by plunger			Replace plunger and barrel assembly.	The inside diameter of the pressure gauge pipe is 1.6mm and 100mm in length.
		Plunger wear	—	—	If the lead section, etc. are excessively worn, replace plunger assembly.	
		Top clearance of the plunger	1.0 ±0.05	—	Adjust by using adjusting shim.	(3-22)
		Injection spacing angle (crankshaft angle)	240° 240° 240° 1 ~ 3 ~ 2 ~ 1	—	Adjust tappet, or replace tappet and camshaft.	Crankshaft angle. (3-23)
		Injection amount pump speed	1700 rpm	—		(3-24)
		Plunger diameter × stroke	ø6.5 × 7	—		(3-24)
		Injection nozzle type	YDN-OSDYD1	—		(3-24)
		Pressure for fuel injection	160 kg/cm <sup>2</sup>	—		(3-24)
		Amount of injection at matching mark position	22 ±0.5cc	—		(3-24)
		Allowable error between cylinders	Less than 1 cc	—		(3-24)
		Stroke	1000	—		(3-24)

(mm)

Classi- fica- tion	Part	Inspection point	Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Fuel injection device	Fuel injection valve	Fuel injection timing (FID)	bTDC 21°	—		(3-21)
		Nozzle valve type	YDN-OSDYD1	—		Semi-throttle. (3-24)
		Oil tightness of nozzle valve seat section (140 kg/cm <sup>2</sup> )	No oil leakage from nozzle with injection pressure being lowered by 20 kg/cm <sup>2</sup> from the specified injection pressure.	—	If oil leaks from valve seat section, correct or replace valve seat.	(3-28)
		Spray and injection (Adjust nozzle valve opening pressure to 160 kg/cm <sup>2</sup> )	1) There should be no scattering of comparatively large drops observable by the naked eye. 2) There should be no discrete drops flying sideways. 3) After injection the oil should not adhere to the nozzle body.	—	Replace malfunctioning nozzle valve.	(3-28)
		Injection pressure	160±5 kg/cm <sup>2</sup>	—	Adjust.	(3-28)
Electrical equipment	Wir- ing	Loose connections, disconnections, or bare wire	—	—	Repair or replace.	
	Battery	Battery terminal	—	—	Repair, if rusted or corroded.	
		Plate, separator, cell, etc.	—	—	Repair, if any damage is detected.	
		Specific gravity of electrolyte	1.260/20°: 100% charge 1.200/20°: 50% charge	—	Adjust specific gravity and charge the battery.	Coefficient of temperature conversion by taking 20°C as standard: -0.007 per +1°C +0.007 per -1°C (10-5)
		Capacity	100AH or more	—		(10-4)
		Terminal voltage	12V	—		(10-4)
	Starter motor	Brush	Spring force	0.85 ±0.2kg	Replace. Brush should be able to move smoothly in the brush holder.	(10-14)
			Brush height	22		(10-13)
		Magnetic switch resistance	Series coil	0.267Ω	Replace.	at 20°C
			Shunt coil	0.590Ω		(10-14)
		Com- mutator	Outside diameter	ø43	Replace.	
			Difference between max. and min. diam.	Repair limit 0.4		(10-12)
			Depth of mica between segments	0.2	Correct.	(10-12)
			Commutator runout		Correct.	(10-12)

							(mm)
Classi- fica- tion	Part	Inspection point		Nominal dimension	Limiting dimension	Instructions for repair	Remarks Refer to (page)
Electrical equipment	Starter motor	t dimension		0.2 ~ 1.5	—	Correct.	The clearance between the end of the pinion & its stopper. (10-9)
		Bearing and shaft S/B = Shaft/ Bearing inside	Brush side bearing	S/B	14.950~14.968/ 15.000~15.018		
			Intermedi- ate bearing	S/B	20.250~20.268/ 20.500~20.518		
			Pinion slide way	S/B	13.950~13.968/ 14.030~14.050		
			Pinion side bearing	S/B	13.950~13.968/ 14.000~14.018		
		Type		S12-79	—		(10-16)
		No-load	Terminal voltage	12V	—		
			Current	90A or less	—		
			Speed of rotation	4000 rpm or greater	—		(10-7)
	Alternator	Stator coil resistance		0.149Ω	—	Replace.	at 20°C, for 2 phase (10-23)
		Rotor	Rotor coil resistance	3.29Ω	—		at 20°C (10-23)
			Slip ring outside diam.	ø31.6	ø30.6		
			Slip ring runout	Limit of correction 0.3	Accuracy of correction 0.05	Correct or replace.	(10-22)
		Brush	Brush length	16.0	9.0	Repair or replace brush when there is not full contact with the slip ring; when brush spring force is not uniform or incor- rect; when brush is worn; when part of the brush is gone; or when the brush holder is improperly hold- ing the brush.	(10-23)
			Brush spring strength	300 ±45g	—		When the brush protrudes 2mm from the brush holder. (10-24)
		Stain on slip ring surface		—	—	Repair, if stained or damaged.	(10-24)
		Adjusting voltage		14.3 ±0.3V	—		at 20°C Full batt. (10-24)
		Rated output current		27.5 ±2A/ 2500 rpm 35 ±2A/ 5000 rpm	—		(10-18)
Alarm	Water tem- perature unit	Operating temperature	ON	60 ±2°C	—		
			OFF	53°C or more	—		(10-30)
		Current capacity		DC 12V, 1A	—		(10-30)
	Oil pressure unit	Pilot lamp		12V, 3.4W	—		
		Rated voltage		12V			
		Operating pressure		0.2 ±0.1 kg/cm <sup>2</sup>			
	Buzzer	Lamp capacity		12V, 5W			(10-29)
		Current consumption		100mA or below			
		Range of operating voltage		10 ~ 15V			
		Sound output		75dB (A) (at 1m, 12V)			
		Frequency		3 ±0.5kHz (at 12V)			(10-30)

## 2-2 Summary of main adjustments

Classification	Inspection point			1GM	2GM	3GM(D)	3HM	Refer to (page)
Engine	Top clearance		mm (in.)	0.7 (0.0275)			0.8 (0.0314)	(2-23)
	Decomp lift		mm (in.)					
	Valve clearance (intake & exhaust)		mm (in.)	0.2 (0.0078) (When cold)				(2-26)
	Valve timing	Intake valve open	b.T.D.C.	20 °				(2-59)
		Intake valve close	a.B.D.C.	50°				
		Exhaust valve open	b.B.D.C.	50°				
		Exhaust valve close	a.T.D.C.	20°				
	Lube oil pressure		kg/cm <sup>2</sup> (lb/in <sup>2</sup> )	3.5 ±0.5 (42.67 ~ 56.89)				(10-18)
	Fuel oil injection pressure		kg/cm <sup>2</sup> (lb/in <sup>2</sup> )	170 ±5 (2347 ~ 2489)			160 ±5 (2205 ~ 2347)	(3-28)
	Fuel oil injection timing		b.T.D.C.	bTDC 15°		bTDC 18°	bTDC 21°	(3-21)
Installation	Alignment (thrust & propeller shaft)		mm (in.)	0.005 (0.0019) or less				
	Deviation face (both coupling for thrust & propeller shaft)		mm (in.)	0.2 (0.0078) or less				
	Maximum rake angle			15°				

## CHAPTER 14

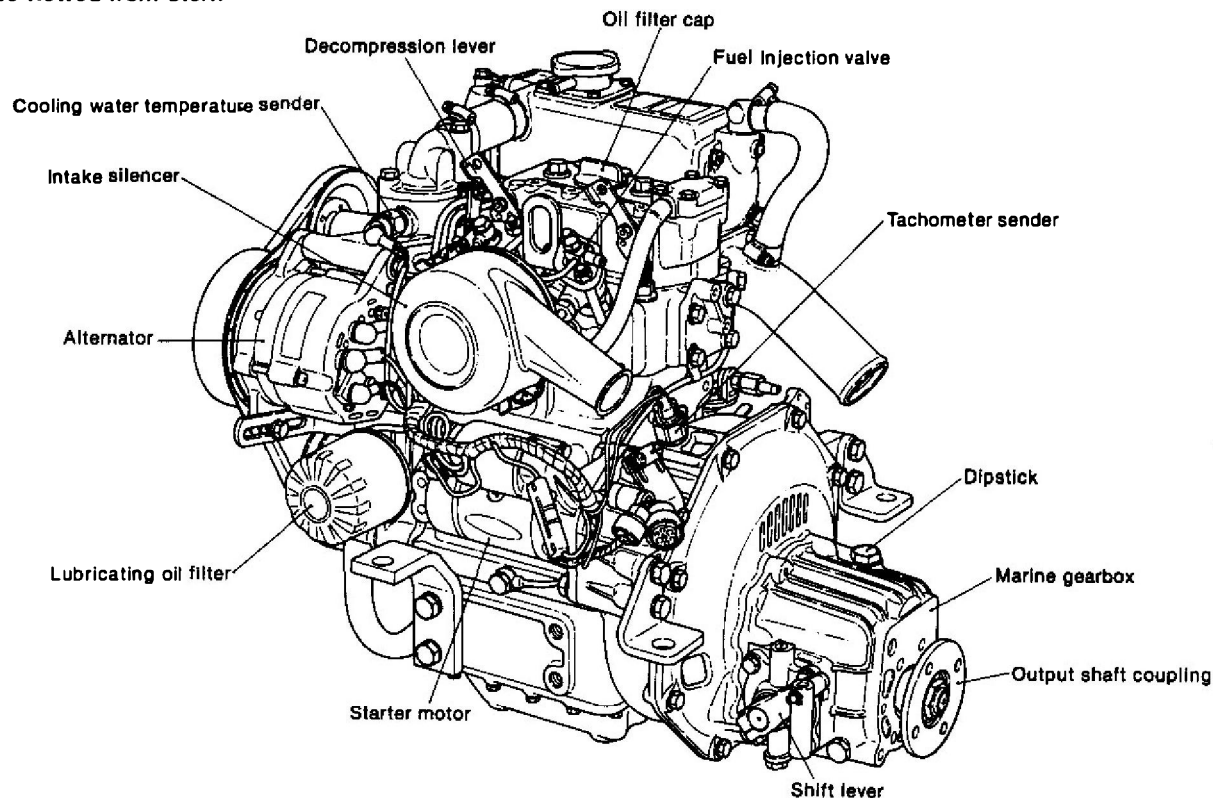
# GENERAL

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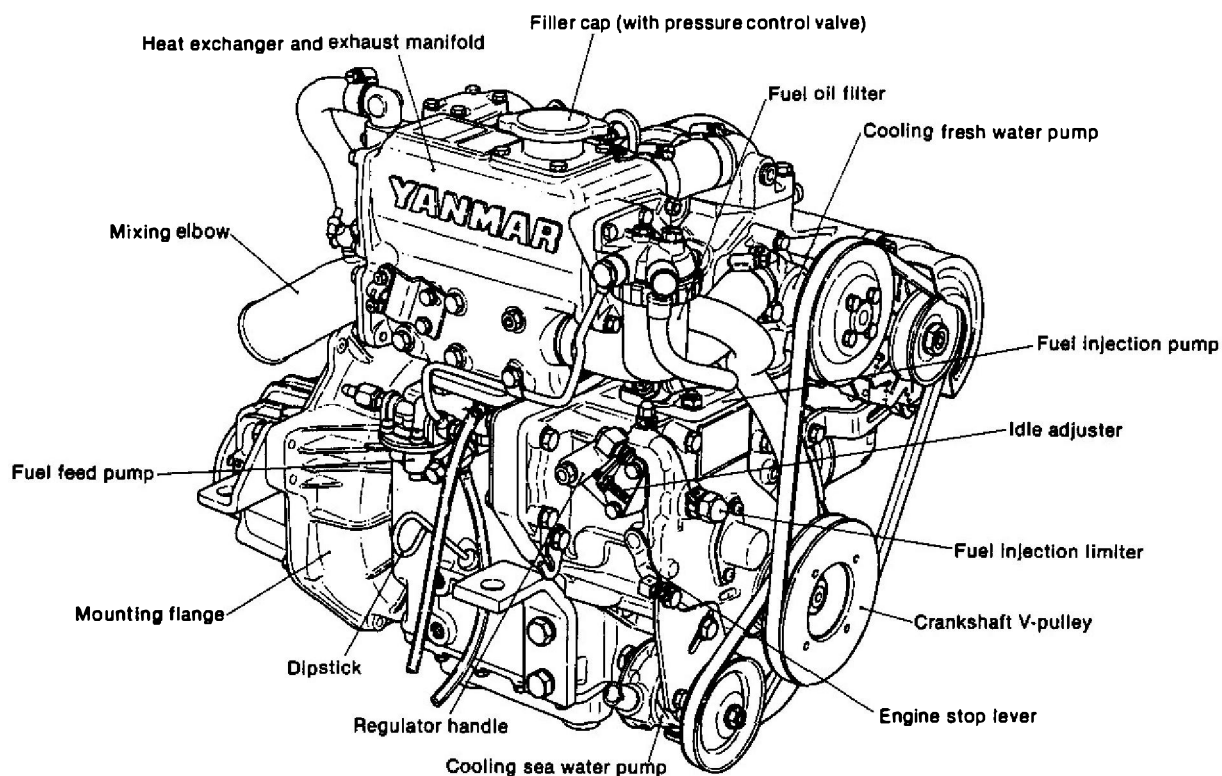
# 1. Exterior Views

## 1-1. 2GMF

Intake side viewed from stern



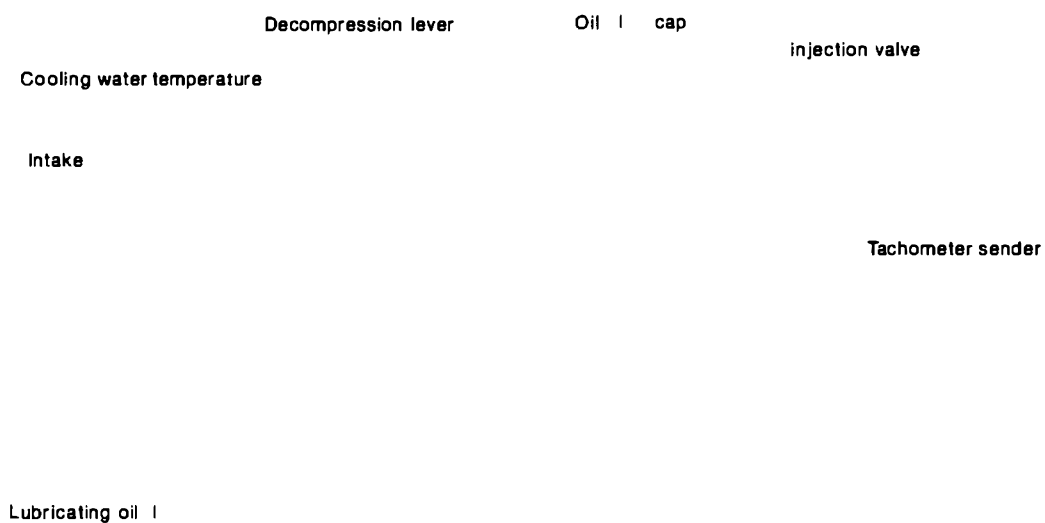
Exhaust side viewed from bow



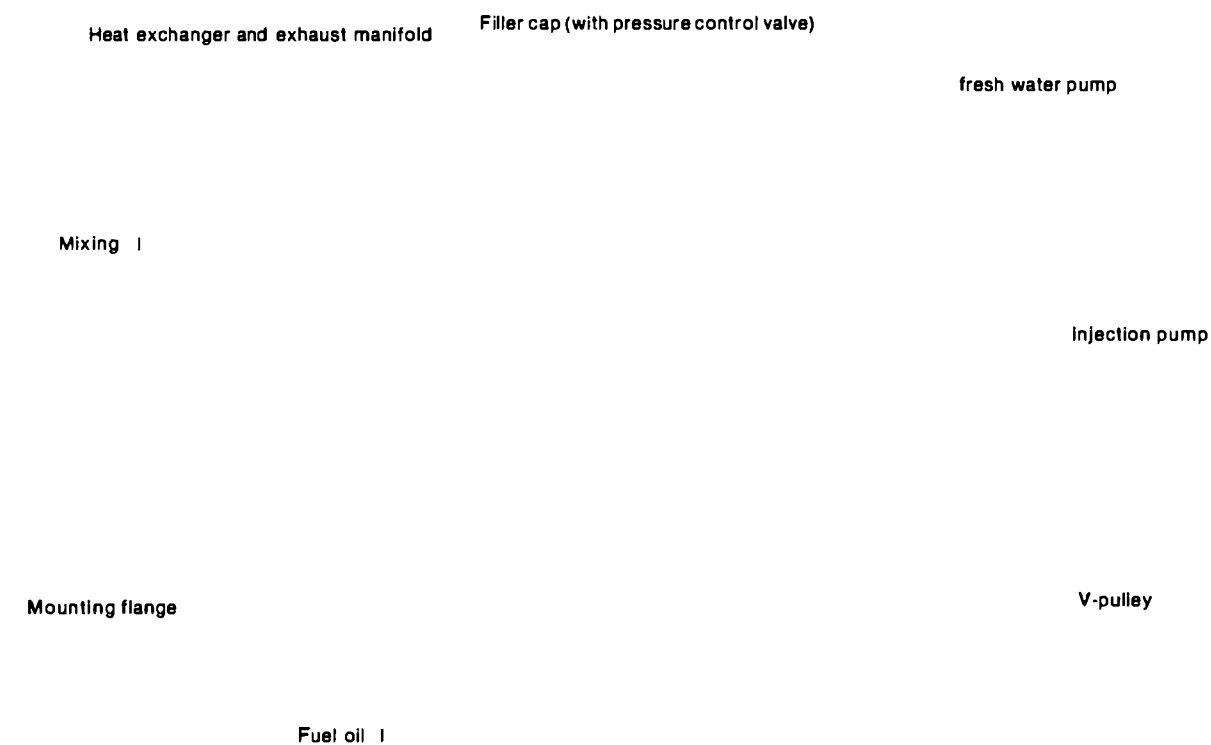
## ***Chapter 14 General***

### **1-2. 3GMF**

#### **Intake side viewed from stern**

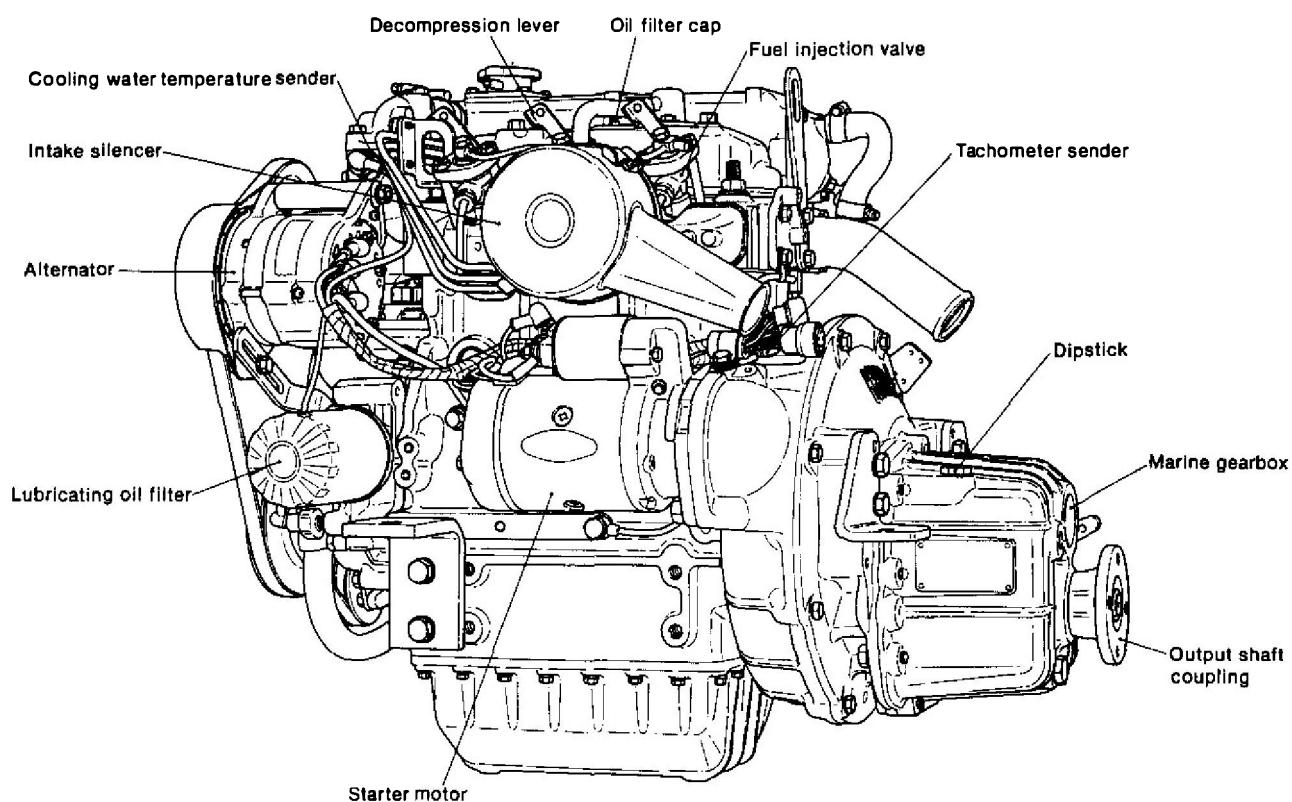


#### **Exhaust side viewed from bow**

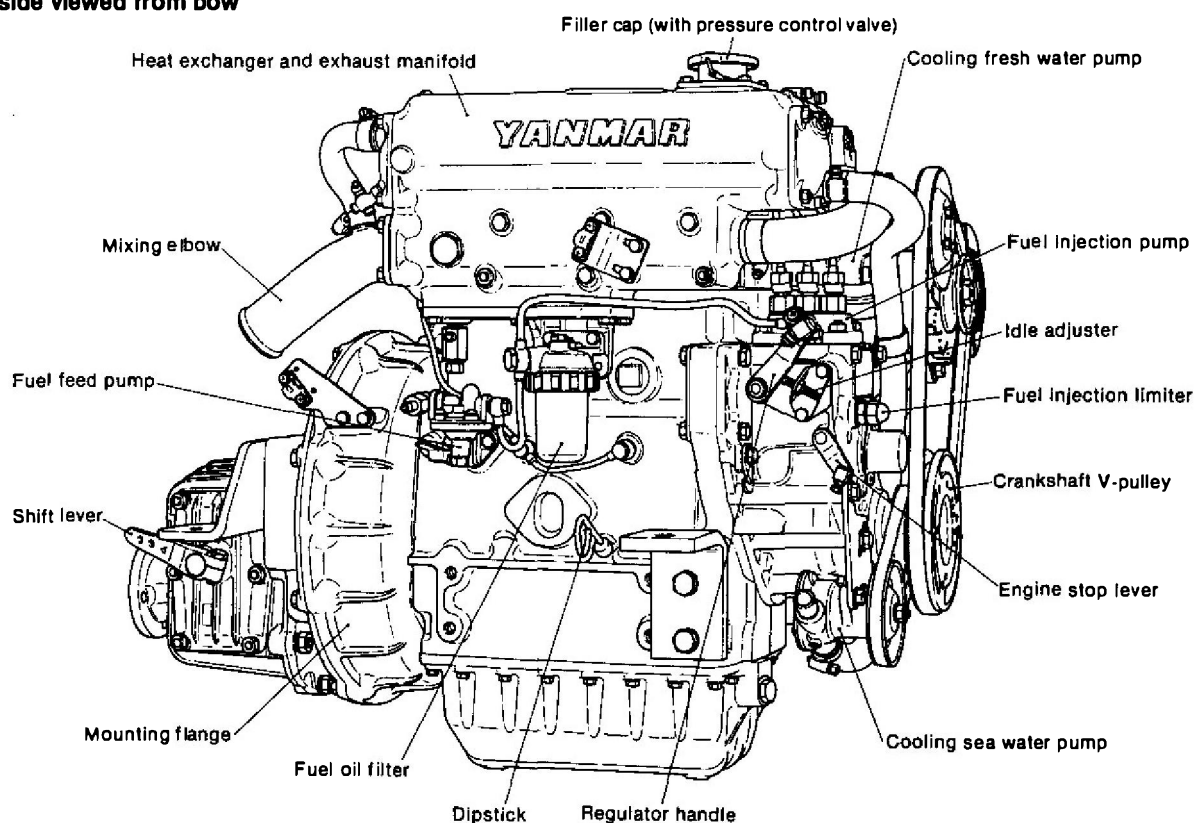


### 1-3. 3HMF

#### Intake side viewed from stern



#### Exhaust side viewed from bow



2 Specifications

Model	2GMF	3GMF	3HMF
Type	Vertical 4-cycle water cooled diesel engine Swirl pre-combustion chamber		
Combustion chamber			
Number of cylinders	3		
Bore × stroke	2	3	
Displacement		72 × 72 (2.83 × 2.83)	75 × 85 (2.95 × 3.35)
		0.596 (35.76)	0.879 (53.64)
		130400 (8.73400)	202400 (14.83400)
Continuous rating output (DIN6270A)			
Output/Crankshaft speed			
Brake mean effective pressure			
HP/cm <sup>2</sup> (lb/in. <sup>2</sup> )			
Piston speed			
in/sec. (ft/sec.)			
Output/Crankshaft speed			
Brake mean effective pressure			
HP/cm <sup>2</sup> (lb/in. <sup>2</sup> )			
Piston speed			
in/sec. (ft/sec.)			
Compression ratio		23.0	22.7
Fuel injection timing (FTD)			
Fuel injection pressure			
Main power take off			
Front power take off			
Direction of rotation			
Crankshaft			
Propeller shaft (Ahead)			
Cooling system			
Lubrication system			
Starting system			
Model	KM2A	KM3A	KBW10E
Type	Mechanical cone clutch with single stage for both ahead and astern		
Reduction ratio (Ahead/Astern)	2.2/12.06	2.62/3.06	2.14/2.50
Propeller speed DIN A rating (Ahead/Astern)	1540/1113	1258/1113	1498/1290
Lubricating oil capacity			
Clutch weight			
Overall length			
Overall width			
Overall height			
Total			
Lubricating oil capacity (raise angle 8°)			
Effective			
Engine weight with clutch (dry)			

\*marked points are different from sea water-cooled engine.

## 3. Principal Construction

Engine model		2GMF	3GMF	3HMF
Group	Part	Construction		
Engine block	Cylinder block	Integrally-cast water jacket and crankcase		
	Cylinder liner	Dry sleeve type		
	Main bearing	Metal housing type		
	Oil sump	Oil pan		
Intake and exhaust systems and valve mechanism	Cylinder head	Integrated type cylinders		
	Intake and exhaust valves	Poppet type, seat angle 90°		
	* Exhaust manifold	Incorporated type with heat exchanger		
	Exhaust silencer	Water-cooled mixing elbow type		
	Valve mechanism	Overhead valve push rod, rocker arm system		
	Intake silencer	Round polyurethane sound absorbing type		
Main moving elements	Crankshaft	Stamped forging		
	Flywheel	Attached to crankshaft by flange, with ring gear		
	Piston	Oval type		
	Piston pin	Floating type		
	Piston rings	2 compression rings, 1 oil ring		
Lubrication system	Oil pump	Trochoid pump		
	Oil filter	Full-flow cartridge type, paper element		
	Oil level gauge	Dipstick		
* Cooling system	Sea water pump	Rubber impeller type B		
	Fresh water pump	Centrifugal type		
	Thermostat	Wax pellet type (Bottom bypath)		
	Heat exchanger	Multi-tube type		
Fuel system	Fuel Injection pump	YPFR-0707-2	YPFR-0707-3	
	Fuel injection valve	530 semi-throttle valve		
	Fuel strainer	Filter paper		
Governor	Governor	Centrifugal all-speed mechanical type		
Starting system	Electric	Pinion ring gear type starter motor		
Electrical system	Charger	Alternator (with built-in IC regulator)		
Reduction reversing	Reduction gear	Helical gear constant-mesh system		
Clutch system	Clutch	Servo-cone type		Wet multi-disc mechanical type

\* marked parts are different from sea water-cooled engine.