

M9961-H11250

SERVICE MANUAL

MARINE DIESEL ENGINE

6CXM-GTE

2000. 3. 10

FOREWORD

This service manual outlines procedures for servicing and maintaining Yanmar 6CXM-GTE engines to obtain maximum life and performance. It explains about the structure, performance, important inspection points, servicing instructions and the wear limit of parts. For a full understanding of this manual, also refer to the Operation Manual and Parts Catalog. Besides reference use at your service shop, this manual can also be used as a text for your service engineers. You should understand the contents of this manual fully to offer accurate and efficient service to your customers.

For accurate and efficient work, the following preparations are necessary:

1. Check the service date of your customer

- 1) When was the last service?
- 2) How many months or hours has the engine been used since the last service?
- 3) What was the trouble and what parts were replaced in the last service?
- 4) What parts must be replaced in the present service?

2. Preparation of Parts

Check the inventory of parts that are necessary for servicing.

3. Preparation of Report Forms

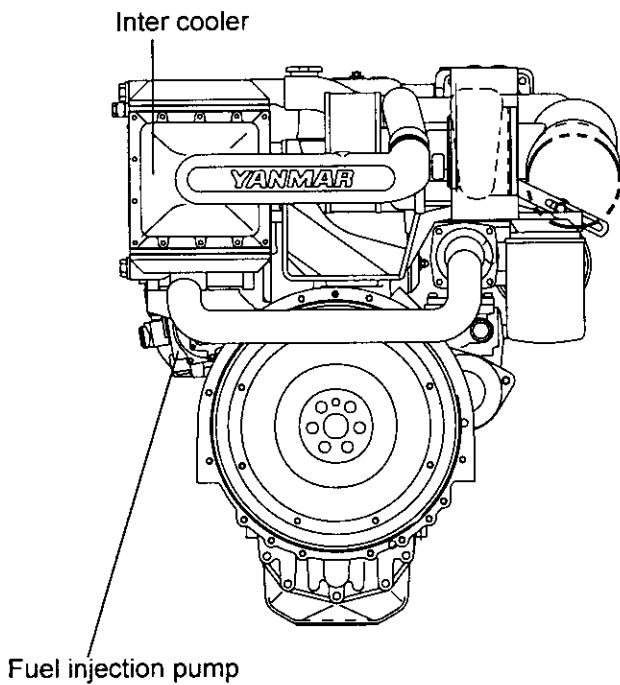
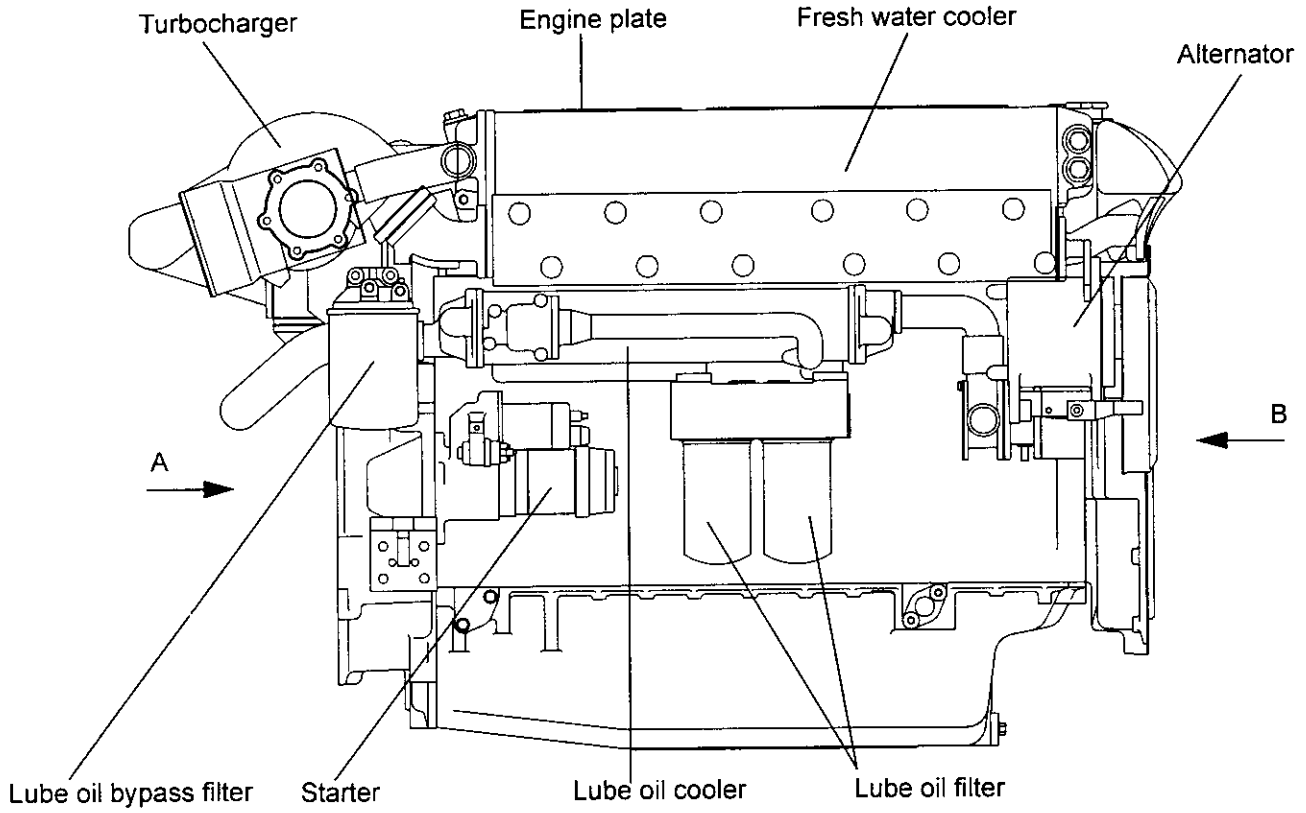
Inspection and service check sheets, parts measurement record form, operation test record form.

4. Prepare the servicing tools, measuring devices, containers, etc.

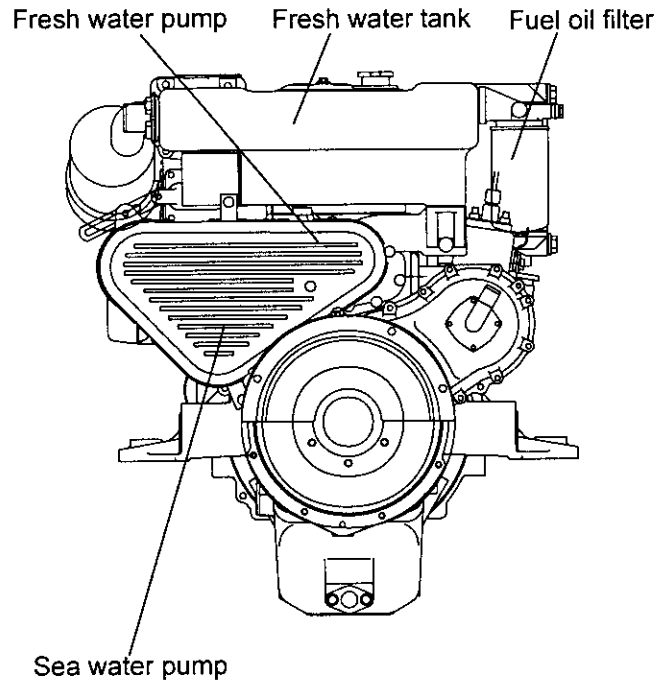
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1 Exterior Views



See from A



See from B

2 Specifications

2.1 Major Specification

ENGINE MODEL		UNIT	6CXM-GTE
Type		——	Vertical water-cooling 4-cycle diesel engine
Combustion system		——	Direct injection
Aspiration		——	Turbocharger with air cooler
No.of cyl. bore × stroke		mm	6-110 × 130
Displacement		ℓ	7.413
Continuous rating	Output/Crankshaft speed	KW(HP)/rpm	305(415)/2750
	Brake mean effective pressure	MPa(kgf/cm ²)	1.797(18.32)
	Piston speed	m/s	11.92
Max.rating	Output/Crankshaft speed	KW(HP)/rpm	342(465)/2850
	Brake mean effective pressure	MPa(kgf/cm ²)	1.943(19.81)
	Piston speed	m/s	12.35
Non-load rotation speed(Max./Min.)		rpm	3200 ± 25/700 ± 25
Starting system		——	Electric starting
Firing order		——	1 — 4 — 2 — 6 — 3 — 5
Direction of rotation (viewed from stem)	Crankshaft	——	Counter-clockwise
Lub.oil capacity	Max	ℓ	22
	Efect	ℓ	8
Fuel system	Fuel injection pump	——	In-line type
	Injection timing	——	b.T.D.C 13° ± 1
	Type of injection nozzle	——	Hole type (Φ0.34×150°)
	Injection pressure	MPa(kgf/cm ²)	23.5±0.5 (240±5)
	Applicable fuel	——	Diesel oil (Cetan value ≥45)
	Fuel filter	——	Paper element
Engine lub.oil system	Lubrication	——	Forced lubrication by gear pump
	Lub.oil discharge volume	ℓ/hr	7100 (at crank shaft speed 2750 rpm)
	Lub.oil pressure	MPa(kgf/cm ²)	0.49(5.0)
	Lub.oil filter	——	Suction side:Perforated steel plate Discharge side:Paper element

ENGINE MODEL		UNIT	6CXM-GTE
Cooling water system	Sea water pump	————	Rubber impeller type:gear driving type
	Fresh water pump	————	Centrifugal type:V-belt driving type
	Cooling	————	Water cooling
	Pump discharge volume	ℓ/hr	Sea water: ≥10300 (at crank shaft speed 2750 rpm) Fresh water: ≥22700 (at crank shaft speed 2750 rpm)
	Fresh water capacity inside engine	ℓ	35
	Fresh water capacity in subtank	ℓ	1.5
Turbocharger	Type	————	HX50(Holset make)
	Cooling	————	Water cooling
	Lubrication	————	Common with engine
Air cooler	Type	————	Fin tube type
	Cooling	————	Sea water cooling
Engine dimension: Overall length×overall width×overall hight		mm	1190×805×905
Piston stroke height (from installation floor)		mm	800 (from back plate of damper rubber)
Engine dry mass		kg	840

Note Max.rating: Continuous operation hours at Max. bellow 0.5 hours.

3 Disassembly and Reassembly

3.1 Preparations before Disassembly and Reassembly

3.1.1 Disassembly


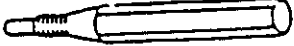
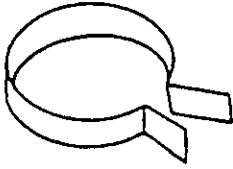

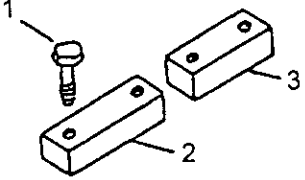
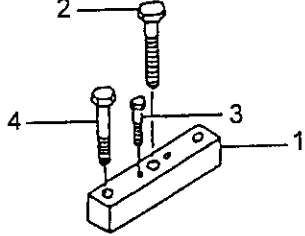
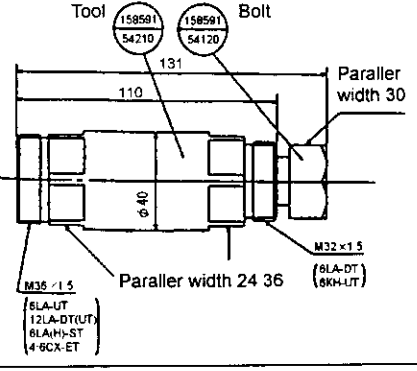
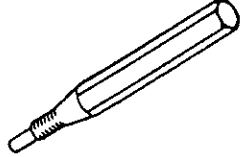
- (1) Prepare the disassembly tools, measuring devices and record forms.
- (2) Prepare the cleaning machine and cleaning cans.
- (3) Prepare a place for putting parts and parts containers.
- (4) Extract cooling water and lube oil.
- (5) Put the disassembled parts in order.
- (6) Return bolts and nuts to their original positions temporarily to avoid confusion with different bolt and nut types.
- (7) Locate the cause of trouble accurately before disassembly, and do not remove or disassemble unnecessary parts.

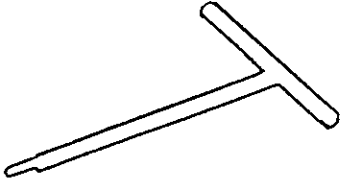

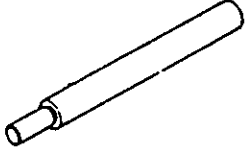
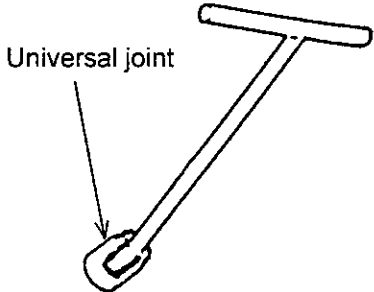
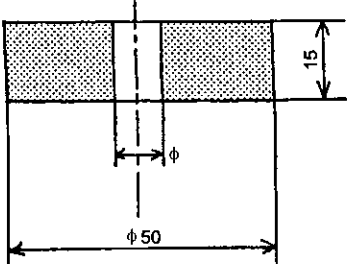
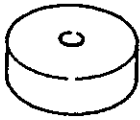
3.1.2 Reassembly

- (1) Clean and inspect the disassembled parts completely.
- (2) Apply clean engine oil to the sliding and rotational parts before installation.
- (3) Replace all gaskets and O-rings.
- (4) Apply liquid packing to the necessary parts to prevent water or oil leakage.
- (5) Check and ensure the correct oil and thrust clearance during reassembly.
- (6) Install the parts according to the alignment marks when they are provided. Take care of the combination of the parts with selective engagement.
- (7) Do not mix up bolts, nuts and washers. Tighten the major bolts and nuts to the specified tightening torque. Take special care when tightening aluminum alloy parts.
- (8) Apply engine oil to the threads and seat of the major bolts and tighten them to the specified tightening torque.

3.2 Tools and Agent

Tools(to be specially ordered)

Name of tool	Code No.	Shape
Socket(for rod bolt)	127610-92730	
Extractor for valve guide	127411-92160	
Extractor for fuel oil valve	127616-92500	
Piston insertion tool	122310-92140	
Piston rings fitting/removal tool	135410-92140	
Oil pan position tool	1. Bolt (4pcs) 127610-92700 2. Spacers A 127610-92680 3. Spacers B 127610-92690	
Fresh water pump impeller (cam gear puller) (Press-fitting type)	1. Spacer 127610-92430 2. Bolt 124160-77511 3. Bolt (for impeller) x 2 26116-060302 4. Bolt (for cam gear) x 2 26116-080502	
Automatic timer tool (adiabatic material puller)	158591-54120 158591-54200	 <p>Tool (158591, 54210) Bolt (158591, 54120)</p> <p>110, 131, Paraller width 30, Paraller width 24 36, M32 x 1.5 (8LA-DT) (8KH-LT), M36 x 1.5 (8LA-UT) (12LA-DT(UT)) (8LAH-ST) (46CX-ET)</p>
Adiabatic material puller	127610-92910 (Standard)	

Name of tool	Code No.	Shape
Protector puller	127695-92910	
Stem seal insertion tool	—	
Valve guide puller	—	
Exhaust manifold puller	—	
Fuel valve puller tool 127616-92500		

Agent (to be used at maintenance)

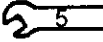
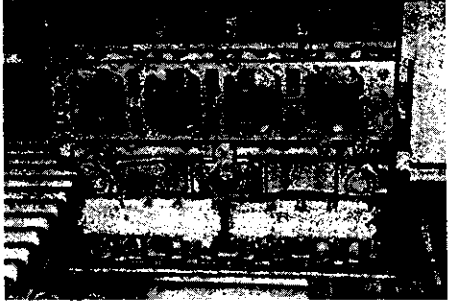

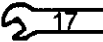
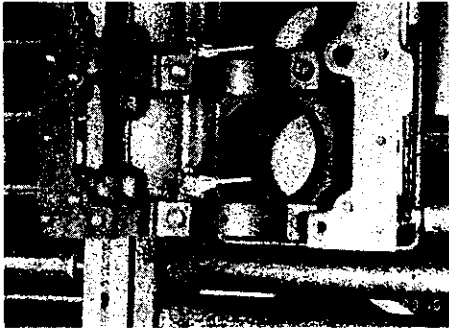
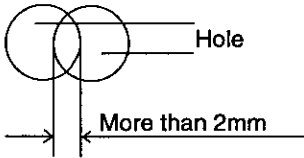


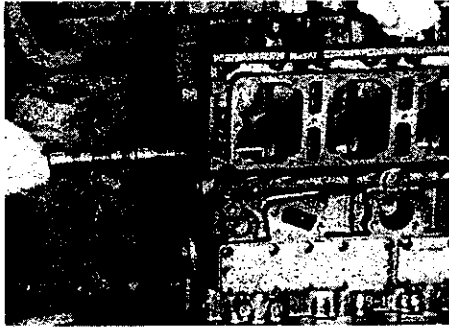
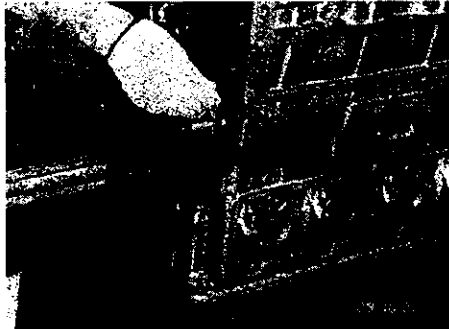
Name		For using							
Liquid packing (THREEBOND auxiliary packing):		The silver grey semi-dry type viscoelastic liquid packing based on extreme heat-resisting synthetic rubber and synthetic resin. Apply the packing to the seal surface and join the part after several minutes when the packing has become semi-dry. The white liquid packing based on nylon resin. Brush the packing on the seal surface and join the part after several minutes when the packing has become semi-dry. Be sure to stir well before use.							
White paint		Coat the paint on the contact area with the cylinder body before inserting the cylinder liner to prevent rust and water leakage. (Use the oil type make-up paint.)							
Name		Quantity	Code No.	Note					
Scale removing agent	UNICON	1 case (4kg×4)	974100-01460	The strong scaling agent removes scale quickly(1-10 hrs.). Dissolve the agent in 10 parts of water or seawater(by weight ratio) and stir it well. Scale can be removed by just immersing the disassembled parts. To speed up the treatment, stir the solution. When the cleaning performance drops, neutralize the solution and throw it away.					
	Counteragent (caustic soda)	1 case (2kg×4)	974100-0200						
	PH test paper	—	974100-04200						
Anti-rust agent		2 ℓ	974100-04200	Mix the agent in ten parts of fresh water and stir the solution by operating the engine for about 5 minutes. The anti-rust performance lasts for about 6 months.					
Yanmar Super Freeze				Can be used both as anti-freeze in winter and coolant in summer. The performance lasts for 2 years. The Super Freeze can safely be mixed with anti-rust agent.					
Temp.		-5℃	-10℃	-15℃	-20℃	-25℃	-30℃	-35℃	-40℃
Volume ratio		15%	25%	30%	35%	40%	45%	50%	55%

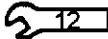





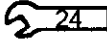

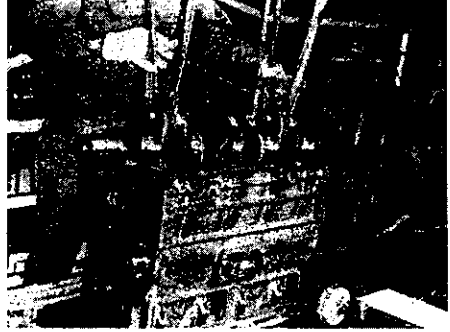


Name		Quantity	Code No.	Using
Metal Clean Y (cleaning agent)		1kg × 20	975600-02000	Has strong performance to remove accumulated carbon. Can safely be heated to double the cleaning performance. Corrodes almost no metals, including iron. (Also has anti-rust effect.) To use, dissolve 1kg of the agent in 40 liters of water. When a cleaning machine is used, use 4-6% solution and heat in to 60-80°C. This will further raise the effect.
Blower Clean (Special cleaning agent for turbocharger)		4 l × 4	919200-10000	Special cleaning agent for turbocharger blower. Needs on water washing.
		18 l × 1	919200-30000	
		1500cc × 6	919200-20000	
Yanmar Genuine Oil	Yanmar Super Royal Oil	4 l 20 l 200 l	—	API CD Class. Use SAE 15W40 oil for 4/6CX ET.



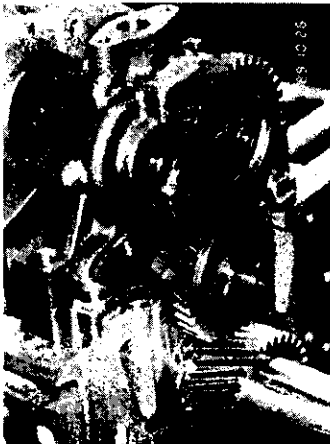
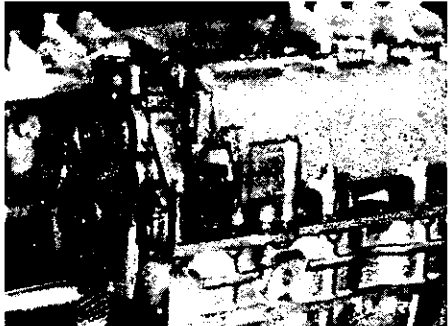
Measuring Device

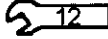
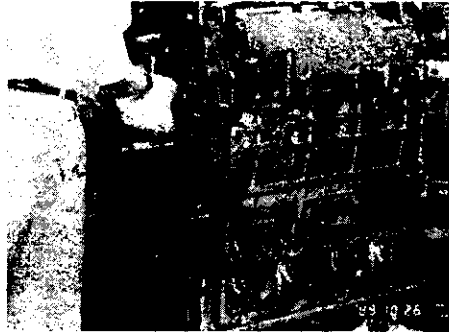
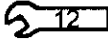


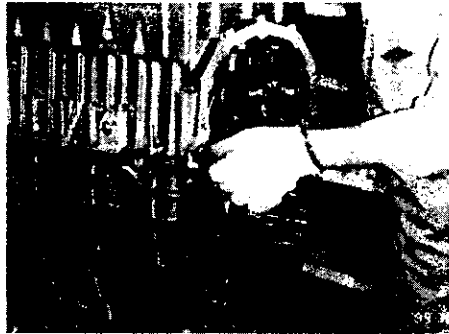

Name		Quantity	Code No.	Using
Cap tester		RCT-2A	955000-055000	For testing the radiator and the cap.


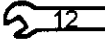

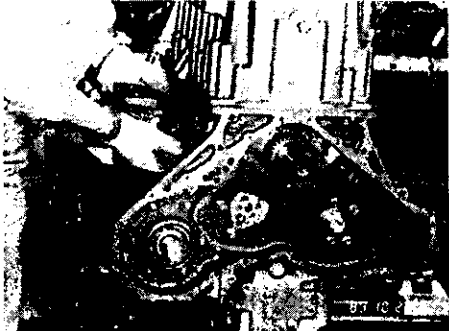

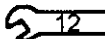

3.3 Reassembly Procedures

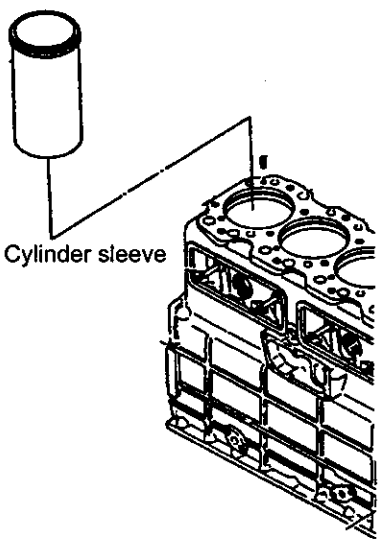

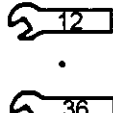
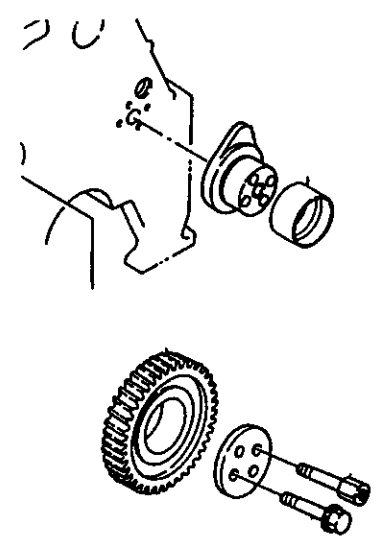
No.	Item	Procedure	Tool & Caution	Illustration				
1	Cylinder Block	<p>Clean the bearing holes completely. Reverse the cylinder block before reassembly.</p> <table border="1" data-bbox="456 461 831 524"> <tr> <td>T-plug 1/8 tightening torque</td> <td>4.9 N·m (0.5 kgf·m)</td> </tr> </table>	T-plug 1/8 tightening torque	4.9 N·m (0.5 kgf·m)		 <p style="text-align: center;">Cylinder Block</p>		
T-plug 1/8 tightening torque	4.9 N·m (0.5 kgf·m)							
2	Piston Cooling Nozzle	<p>Install the nozzle correctly according to the positioning pin. Take care not to over-tighten the nozzle.</p> <table border="1" data-bbox="456 833 831 896"> <tr> <td>Tightening torque</td> <td>19.6 N·m (2.0 kgf·m)</td> </tr> </table> <p>Check carefully that there are no chips or dust in the oil holes of the nozzle body, nozzle installation hole and check nozzle. Check that the nozzle body does not touch the cylinder block.</p>	Tightening torque	19.6 N·m (2.0 kgf·m)	 	 <p style="text-align: center;">Piston Cooling Nozzle</p>		
Tightening torque	19.6 N·m (2.0 kgf·m)							
3	Cam Shaft	<p>Apply lube oil to the cam shaft journal. Insert the cam shaft. Install the thrust plate.</p> <table border="1" data-bbox="456 1236 831 1299"> <tr> <td>Tightening torque</td> <td>25.5 N·m (2.6^{±0.2} kgf·m)</td> </tr> </table> <p>Measure the side clearance.</p> <table border="1" data-bbox="456 1348 831 1411"> <tr> <td>Side clearance</td> <td>0.10 - 0.25 mm</td> </tr> </table> <p>Installation of cam shaft metal. Replace the cam shaft metal as follows:</p> <ol style="list-style-type: none"> 1. Apply lube oil to the outside circumference of the cam shaft metal and the inside bore of the block. 2. Align the oil hole so that the joint of the winding metal comes to the upper side. 3. Overlapping of not less than 2 mm will suffice for the alignment of the oil holes of the block and cam shaft metal. (Check the alignment after knocking in the cam shaft metal.) <div style="text-align: center;">  </div>	Tightening torque	25.5 N·m (2.6 ^{±0.2} kgf·m)	Side clearance	0.10 - 0.25 mm	 	 <p style="text-align: center;">Cam Shaft</p>  <p style="text-align: center;">Installation of the thrust metal</p>
Tightening torque	25.5 N·m (2.6 ^{±0.2} kgf·m)							
Side clearance	0.10 - 0.25 mm							

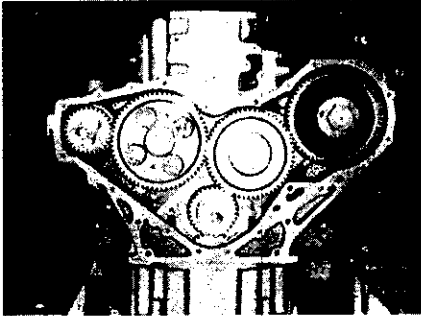
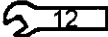
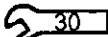

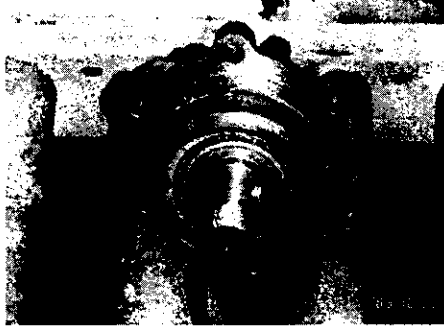
No.	Item	Procedure	Tool & Caution	Illustration						
4	Cooling Water Passage Cover	Install the cooling water passage cover.								
5	Crankshaft and Main Bearing	<p>The upper bearing (block side) has an oil groove; no oil groove in the lower bearing. The standard bearing is at the flywheel side (with flange). Apply lube oil to the crank and assemble. Confirm the alignment number on the bearing cap and block. Assemble with the F-mark at the flywheel side. Apply lube oil to the bolt threads and seat face and tighten the the bolt to the specified tightening torque. Turn manually to check that it turns lightly. Measure the side clearance.</p> <table border="1" data-bbox="421 824 798 992"> <tr> <td>Cap bolt tightening torque</td> <td>275±9.8 N·m (28^{+1.0} kgf·m)</td> </tr> <tr> <td>Side clearance</td> <td>0.155 - 0.296 mm</td> </tr> <tr> <td>Crankshaft bearing oil clearance</td> <td>0.04 - 0.108 mm</td> </tr> </table>  <p style="text-align: center;">Fitting the cap bolt</p>  <p style="text-align: center;">Measure the side clearance</p>	Cap bolt tightening torque	275±9.8 N·m (28 ^{+1.0} kgf·m)	Side clearance	0.155 - 0.296 mm	Crankshaft bearing oil clearance	0.04 - 0.108 mm	  	 <p style="text-align: center;">Fitting the upper bearing</p>  <p style="text-align: center;">Fitting the crank shaft</p>  <p style="text-align: center;">Apply lube oil</p>  <p style="text-align: center;">Fitting the bearing cap</p>
Cap bolt tightening torque	275±9.8 N·m (28 ^{+1.0} kgf·m)									
Side clearance	0.155 - 0.296 mm									
Crankshaft bearing oil clearance	0.04 - 0.108 mm									

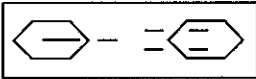

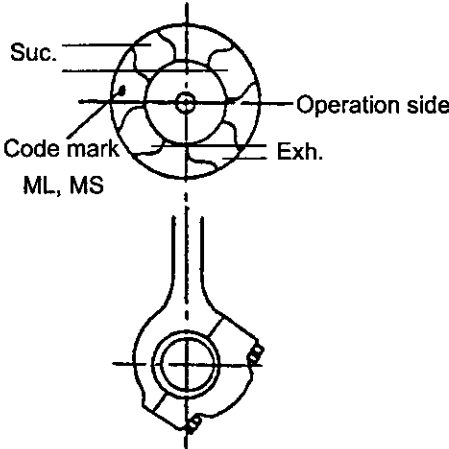
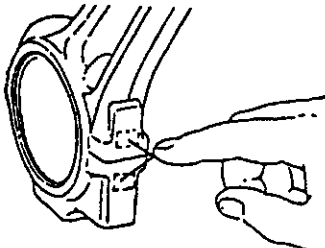

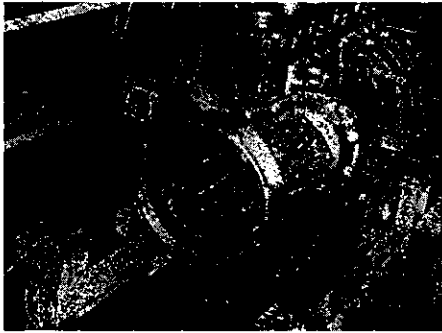

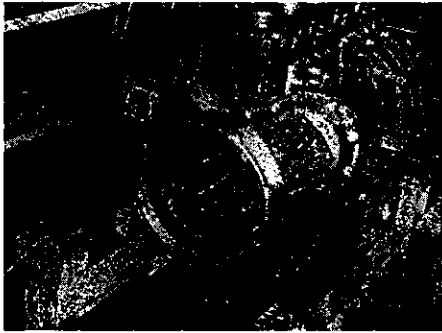
No.	Item	Procedure	Tool & Caution	Illustration						
6	Idle Gear (Lube Oil Pump)	<p>Check the gear side clearance.</p> <table border="1" data-bbox="459 331 836 394"> <tr> <td>Gear side clearance</td> <td>0.066 - 0.114 mm</td> </tr> </table> <p>Check the gear backlash.</p> <table border="1" data-bbox="459 461 836 524"> <tr> <td>Gear backlash</td> <td>0.08 - 0.16 mm</td> </tr> </table> <p>Install the idle gear to the cap.</p> <table border="1" data-bbox="459 595 836 658"> <tr> <td>Tightening torque</td> <td>14.7 - 19.6 N·m (1.5 - 2.0 kgf·m)</td> </tr> </table>	Gear side clearance	0.066 - 0.114 mm	Gear backlash	0.08 - 0.16 mm	Tightening torque	14.7 - 19.6 N·m (1.5 - 2.0 kgf·m)		 <p>Fitting the idle gear</p>
Gear side clearance	0.066 - 0.114 mm									
Gear backlash	0.08 - 0.16 mm									
Tightening torque	14.7 - 19.6 N·m (1.5 - 2.0 kgf·m)									
7	Lube oil Pump	<p>Install the lube oil assembly. Install the suction and discharge pipes.</p> <table border="1" data-bbox="459 808 836 871"> <tr> <td>(Bolt head width 12) Tightening torque</td> <td>24.5±2 N·m (2.5±0.2 kgf·m)</td> </tr> </table> <p>Check the gear backlash (to the crankshaft).</p> <table border="1" data-bbox="459 969 836 1032"> <tr> <td>Backlash for crank gear</td> <td>0.12 - 0.22 mm</td> </tr> </table>  <p>Fitting to the suction pipe</p>	(Bolt head width 12) Tightening torque	24.5±2 N·m (2.5±0.2 kgf·m)	Backlash for crank gear	0.12 - 0.22 mm	<p>12</p> <p>.</p> <p>14</p> <p>?</p>	 <p>Fitting to the lube oil pump</p>  <p>Fitting to the Safety valve and discharger pipe</p>		
(Bolt head width 12) Tightening torque	24.5±2 N·m (2.5±0.2 kgf·m)									
Backlash for crank gear	0.12 - 0.22 mm									





No.	Item	Procedure	Tool & Caution	Illustration						
8	Gear Case	<p>Install the bolt for fixing the fuel pump and the stud bolt for fixing the seawater pump to the gear case in advance. Match up the mounting surfaces of the oil pan. Align the positioning pin to the block and install the gear case.</p> <table border="1" data-bbox="424 524 802 584"> <tr> <td>(Bolt head width 12) Tightening torque</td> <td>25.5±2 N·m (2.6^{+0.2} kgf·m)</td> </tr> </table> <p>Cut off the protruding packing.</p>	(Bolt head width 12) Tightening torque	25.5±2 N·m (2.6 ^{+0.2} kgf·m)		 <p>Fitting the gear case</p>				
(Bolt head width 12) Tightening torque	25.5±2 N·m (2.6 ^{+0.2} kgf·m)									
9	Oil pan	<p>Bring the gear case level so that the packing will not break. (Use the fitting tool.)</p> <table border="1" data-bbox="424 815 802 875"> <tr> <td>(Bolt head width 12) Tightening torque</td> <td>25.5±2 N·m (2.6^{+0.2} kgf·m)</td> </tr> </table> <p>After tightening, cut off the packing protruding on the wheel housing side.</p> <table border="1" data-bbox="408 981 820 1131"> <tr> <td>Note:</td> <td>Apply THREEBOND to both side of the packing at the three-face joint of the gear case and flywheel side. Match up the installation faces of the wheel housing.</td> </tr> </table> <table border="1" data-bbox="424 1153 802 1214"> <tr> <td>Step of the joint face at the flywheel housing side.</td> <td>0.1 mm</td> </tr> </table>	(Bolt head width 12) Tightening torque	25.5±2 N·m (2.6 ^{+0.2} kgf·m)	Note:	Apply THREEBOND to both side of the packing at the three-face joint of the gear case and flywheel side. Match up the installation faces of the wheel housing.	Step of the joint face at the flywheel housing side.	0.1 mm	  	 <p>Fit the oil pan using the tool</p>
(Bolt head width 12) Tightening torque	25.5±2 N·m (2.6 ^{+0.2} kgf·m)									
Note:	Apply THREEBOND to both side of the packing at the three-face joint of the gear case and flywheel side. Match up the installation faces of the wheel housing.									
Step of the joint face at the flywheel housing side.	0.1 mm									
10	Flywheel Housing	<p>Assemble the flywheel housing according to the positioning parallel pin.</p> <table border="1" data-bbox="424 1317 802 1377"> <tr> <td>Deviation at the oil seal insertion area.</td> <td>0.2 mm</td> </tr> </table> <table border="1" data-bbox="424 1400 802 1460"> <tr> <td>Face deviation from the crankshaft center.</td> <td>0.3 mm</td> </tr> </table> <table border="1" data-bbox="424 1482 802 1543"> <tr> <td>Flywheel housing tightening torque.</td> <td>49±5 N·m (5^{+0.5} kgf·m)</td> </tr> </table> <p>Install the lube oil piping (flywheel housing-oil filter).</p>	Deviation at the oil seal insertion area.	0.2 mm	Face deviation from the crankshaft center.	0.3 mm	Flywheel housing tightening torque.	49±5 N·m (5 ^{+0.5} kgf·m)		 <p>Assemble the Fly wheel housing</p>
Deviation at the oil seal insertion area.	0.2 mm									
Face deviation from the crankshaft center.	0.3 mm									
Flywheel housing tightening torque.	49±5 N·m (5 ^{+0.5} kgf·m)									

No.	Item	Procedure	Tool & Caution	Illustration				
11	Oil Seal Case	<p>Press-fit the seal into the oil seal case (with the press-fitting tool).</p> <div data-bbox="454 360 831 454" style="border: 1px solid black; padding: 2px;"> <p>Note: Apply lube oil to the outside lip of the oil seal before press-fitting.</p> </div> <p>Install the oil seal case assembly to the flywheel side with its oil escapes hole vertical.</p>	 	 <p style="text-align: center;">Assemble the oil seal case</p>				
12	Engin Foot	Install the engine foot.		 <p style="text-align: center;">Install the engine foot</p>				
13	Reverse the cylinder block	Reverse the cylinder block.						
14	Tappets and Tappets Case cover	<p>Insert the tappets into the cylinder block hole. (Apply engine oil to the tappets. Move the tappets manually to check that they are inserted smoothly.)</p> <div data-bbox="454 1630 831 1693" style="border: 1px solid black; padding: 2px;"> <table border="1"> <tr> <td>Tappet hole oil clearance</td> <td>0.04 - 0.082 mm</td> </tr> </table> </div> <p>Install the tappet case cover after inserting all tappets.</p> <div data-bbox="454 1794 831 1856" style="border: 1px solid black; padding: 2px;"> <table border="1"> <tr> <td>(Bolt head width 12) Tightening torque</td> <td>11.8 - 16.7 N·m (1.2 - 1.7 kgf·m)</td> </tr> </table> </div>	Tappet hole oil clearance	0.04 - 0.082 mm	(Bolt head width 12) Tightening torque	11.8 - 16.7 N·m (1.2 - 1.7 kgf·m)	 	 <p style="text-align: center;">Tappet</p>
Tappet hole oil clearance	0.04 - 0.082 mm							
(Bolt head width 12) Tightening torque	11.8 - 16.7 N·m (1.2 - 1.7 kgf·m)							

No.	Item	Procedure	Tool & Caution	Illustration										
15	Cylinder Sleeve	<p>Clean the sleeve fitting area of the cylinder block completely. Clean the outside circumference of the cylinder sleeve completely and insert it manually into the cylinder block.</p> <div style="border: 1px solid black; padding: 5px;"> <p>Note: Before inserting the cylinder sleeve, check the cylinder number and the insertion direction.</p> <ul style="list-style-type: none"> • Size code is for the cylinder sleeve • Identical code for the cylinder block and sleeve • Make a combination of A, B, C and D. • Direct the code side to the anti-operation side. • Marked in black paint at the anti-operation side. <p>Do not place on the cylinder head face after inserting the cylinder sleeve. Be sure to assemble the cylinder sleeve manually. • Do not use a hammer.</p> </div> <p>Measure the protrusion of the cylinder liner.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Liner protrusion</td> <td style="width: 40%;">0.03 - 0.09 mm</td> </tr> </table> <p>Measure the distortion of the cylinder liner.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Cylindricity</td> <td style="width: 40%;">≤ 0.03 mm</td> </tr> </table> <p>(The mark at the cylinder block side is punched on the head joint face of the operation side.)</p>	Liner protrusion	0.03 - 0.09 mm	Cylindricity	≤ 0.03 mm		 <p>Cylinder sleeve</p> <p>Size code is for the cylinder sleeve. Marked in black paint the anti-operation side.</p> <div style="text-align: center;"> <p>[BM]</p> <p>↑</p> <p>↑</p> <p>Piston fitting code</p> <p>↑</p> <p>Cylinder block fitting code</p> </div>						
Liner protrusion	0.03 - 0.09 mm													
Cylindricity	≤ 0.03 mm													
16	Idle Gear	<p>Install the idle gear shaft. Direct the shaft's oil hole upwards.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Tightening torque</td> <td style="width: 40%;">25.5 ± 2.9 N·m (2.6^{+0.3} kgf·m)</td> </tr> </table> <p>Install the idle gear.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Gear side clearance</td> <td style="width: 40%;">0.15 - 0.35 mm</td> </tr> </table> <p>Install the cam gear shaft.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Gear backlash</td> <td style="width: 40%;">0.08 - 0.16 mm</td> </tr> <tr> <td style="width: 60%;">Gear side clearance</td> <td style="width: 40%;">0.10 - 0.25 mm</td> </tr> </table> <p>Use the puller tool to remove the cam gear. Install the fuel pump drive gear.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Tightening torque</td> <td style="width: 40%;">196 ± 9.8 N·m (20^{+1.0} kgf·m)</td> </tr> </table>	Tightening torque	25.5 ± 2.9 N·m (2.6 ^{+0.3} kgf·m)	Gear side clearance	0.15 - 0.35 mm	Gear backlash	0.08 - 0.16 mm	Gear side clearance	0.10 - 0.25 mm	Tightening torque	196 ± 9.8 N·m (20 ^{+1.0} kgf·m)	 	 <p>Idle gear</p>
Tightening torque	25.5 ± 2.9 N·m (2.6 ^{+0.3} kgf·m)													
Gear side clearance	0.15 - 0.35 mm													
Gear backlash	0.08 - 0.16 mm													
Gear side clearance	0.10 - 0.25 mm													
Tightening torque	196 ± 9.8 N·m (20 ^{+1.0} kgf·m)													

No.	Item	Procedure	Tool & Caution	Illustration				
17	Sea water Pump	<p>Install the sea water pump to the gear case, directing the oil receiving port upwards.</p> <p>Install the drive gear and tighten the nut to the specified tightening torque.</p> <table border="1" data-bbox="456 477 831 539"> <tr> <td>Drive gear fixing nut tightening torque</td> <td>142±4.9 N·m (14.5^{+0.5} kgf·m)</td> </tr> </table> <p>Install the fuel pump driving bearing case assembly to the gear case.</p> <table border="1" data-bbox="456 647 831 710"> <tr> <td>Gear backlash</td> <td>0.08 - 0.16 mm</td> </tr> </table>  <p>Match up the alignment marks of gear at the same time.</p>	Drive gear fixing nut tightening torque	142±4.9 N·m (14.5 ^{+0.5} kgf·m)	Gear backlash	0.08 - 0.16 mm	 	 <p>Sea water pump</p>  <p>Fuel pump driving bearing case</p>
Drive gear fixing nut tightening torque	142±4.9 N·m (14.5 ^{+0.5} kgf·m)							
Gear backlash	0.08 - 0.16 mm							

No.	Item	Procedure	Tool & Caution	Illustration						
18	Piston and Connecting Rod	<p>Assemble the connecting rod to the piston. The size code, ML or MS, is provided on the piston head. Match up the code with the correctly code of the cylinder sleeve.</p> <p>Distribute the end gaps of the piston rings evenly on the piston.</p> <p>Insert the piston into the cylinder liner, placing the con. rod alignment mark on the operation side. Apply lube oil.</p> <p>Confirm the alignment marks on the connecting rod and cap, and install the cap. Apply lube oil to the thread seat face and tighten the rod bolt to the specified tightening torque. Tighten the bolts by turns evenly 3 times to avoid uneven tightening.</p> <table border="1" data-bbox="486 846 863 909"> <tr> <td>Tightening torque</td> <td>226±5 N·m (23^{+0.5} kgf·m)</td> </tr> </table> <p>Measure the side clearance after tightening the bolts.</p> <table border="1" data-bbox="486 1016 863 1079"> <tr> <td>Rod large end side clearance</td> <td>0.15 - 0.35 mm</td> </tr> </table> <p>Install the cylinder block side cover. (An alignment mark is provided on the rod bolt. This is because a torque wrench cannot be used in restricted engine room spaces.)</p> 	Tightening torque	226±5 N·m (23 ^{+0.5} kgf·m)	Rod large end side clearance	0.15 - 0.35 mm		 <p>Assemble the piston and con. rod.</p>  <p>Alignment mark</p>  <p>Fitting the side cover</p>  <p>Fitting the gear case cover</p>		
Tightening torque	226±5 N·m (23 ^{+0.5} kgf·m)									
Rod large end side clearance	0.15 - 0.35 mm									
19	Gear Case Cover	<p>Install the oil seal to the gear case.</p> <table border="1" data-bbox="486 1420 863 1496"> <tr> <td>Note:</td> <td>Apply lube oil to the exterior and lip of the oil seal before press-fitting it.</td> </tr> </table> <p>Install the gear case cover.</p> <table border="1" data-bbox="486 1563 863 1680"> <tr> <td>Note:</td> <td>The positioning pin (spring pin) is provided at the joint face of the gear case and cylinder block.</td> </tr> </table> <p>Measure the face deviation of the front drive installation.</p> <table border="1" data-bbox="486 1787 863 1850"> <tr> <td>Face deviation</td> <td>Less than 0.05 mm for crank center</td> </tr> </table>	Note:	Apply lube oil to the exterior and lip of the oil seal before press-fitting it.	Note:	The positioning pin (spring pin) is provided at the joint face of the gear case and cylinder block.	Face deviation	Less than 0.05 mm for crank center		 <p>Fitting the side cover</p>  <p>Fitting the gear case cover</p>
Note:	Apply lube oil to the exterior and lip of the oil seal before press-fitting it.									
Note:	The positioning pin (spring pin) is provided at the joint face of the gear case and cylinder block.									
Face deviation	Less than 0.05 mm for crank center									

No.	Item	Procedure	Tool & Caution	Illustration			
20	Bearing Case	Install the sea water pump drive bearing case. Install the V-pulley. Bend the washer after tightening the nut. Install the breather.		 <p data-bbox="1078 658 1401 685">Assemble the bearing case</p>  <p data-bbox="1134 1061 1353 1088">Install the V-pulley</p>			
21	Flywheel	Install the flywheel. (Align the positioning parallel pin holes.) Tighten the bolts to the specified tightening torque. <table border="1" data-bbox="456 1256 834 1317"> <tr> <td>Tightening torque</td> <td>284 ± 10 N·m (29^{±1} kgf·m)</td> </tr> </table> Measure and check the flywheel face deviation and centering location deviation. <table border="1" data-bbox="456 1458 834 1518"> <tr> <td>Face deviation</td> <td>Less than 0.13 mm</td> </tr> </table> Follow the instructions below when replacing the top indication plate: <ol style="list-style-type: none"> 1) Bring the No.1 piston at the flywheel side to the top position. (Check using the dial gauge.) 2) Install aligning the top punched line of the flywheel to the piston top position. 3) The alignment error between the top mark of the indication plate and the top punched line of the flywheel should be within + 30 min. 	Tightening torque	284 ± 10 N·m (29 ^{±1} kgf·m)	Face deviation	Less than 0.13 mm	 <p data-bbox="1110 1487 1375 1514">Assemble the flywheel</p>  <p data-bbox="1102 1935 1383 1962">Check the No.1 cyl. top.</p>
Tightening torque	284 ± 10 N·m (29 ^{±1} kgf·m)						
Face deviation	Less than 0.13 mm						