YANMAR

SERVICE MANUAL

MARINE DIESEL ENGINE

MODEL 6CX-ETE

FOREWORD

This service manual outlines procedures for servicing and maintaining Yanmar 6CX-ETE engines to obtain maximum life and performance. It explains about the structure, performance, dis- and re-assembly procedures, 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
   ①When was the last service?
   ②How many months or hours has the engine been used since the lasteding service?
   ③What was the trouble and what parts were replaced in the last service?
   ④What 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.

CONTENTS

1. Specifications

1-1. Major Specification

(Without marine gear)

ENGINE MODEL			UNIT	6CX-ETE			
Type				Vertical, water-cooling, 4-cycle diesel engine			
Combustion system				Direct injection			
Aspiration				Turbocharger with air cooler			
No. of cyl.- bore×Stroke			mm	6−110×125			
Displacement			ℓ	7.127			
Continuous rating	Output/Crankshaft speed		HP/rpm	375/2600			
	Brake mean effective pressure		kgf/cm²	18.21			
	Piston speed		m/sec	10.83			
Max. rating	Specifications			Flywheel end			
	Output/Crankshaft speed		HP/rpm	420/2700			
	Brake mean effective pressure		kgf/cm²	19.64			
	Piston speed		m/sec	11.25			
Non-load rotation speed(Max./Min)			rpm	3000±25/700±25			
Starting system				Electric starting, 12V-4KW			
Firing order				1−4−2−6−3−5−1			
Direction of rotation (viewed from stem)	Crankshaft			Counter-clockwise			
	Propeller shaft			Bi-rotation			
Lub. oil capacity	Max.		ℓ	23			
	Effect		ℓ	12			
Marine gear	Model			YX-70S			
	Type			Hydraulic wet multi-disk type			
	Reduction ratio(forward)			1.52	1.96	2.50	
	Propeller shaft speed(at cont. rating)		rpm	1716	1324	1040	
	Direction of rotation(propeller shaft)			Clockwise or counterclockwise viewed from stem			
	Dry weight		kg	160			
	Lubricating oil capacity	Max.	ℓ	5			
		Effective	ℓ	0.7			
	Hydraulic oil pressure		kgf/cm²	24±5			
Fuel system	Fuel injection pump			In-line type			
	Injection timing			b.T.D.C 12±1			
	Type of injection nozzle degree			Hole type 5−φ0.34×150°			
	Injection pressure		kgf/cm²	240±5			
	Applicable fuel			Diesel oil or light oil(Cetane value≥45)			
	Fuel filter			Paper element			
Engine lub. oil system	Lubrication			Forced lubrication by geared pump			
	Lub. oil discharge volume		ℓ/hr./rpm	≥6720/2600			
	Lub. oil pressure		kgf/cm²	5±0.5			
	Lub. oil			API Service grade CD			
	Lub. oil filter			(Suction side) Perforated steel plate (Discharge side) Paper element			
Cooling water system	Sea water pump			Rubber impeller type, gear driving type			
	Freshwater pump			Center type, V-belt driving type			
	Cooling			Fresh water cooling			
	Pump discharge volume		ℓ/hr./rpm	Seawater : ≥9820/2600 Fresh water : ≥13000/2600			
	Fresh water capacity inside engine		ℓ	36			
	Fresh water capacity in sub-tank		ℓ	1.1			
Turbocharger	Type			Garret TW51			
	Cooling			Water cooling			
	Lubrication			Common with engine			
Air cooler	Type and capacity			Fin tube type 6.5m²			
	Cooling			Seawater cooling			
Engine dimension: Overall length × overall width × overall height			mm	1607×869×994			
Piston stroke height(from installation floor)				797			
Engine dry weight(inc. clutch)			kg	990			

⚠ *NOTE Max. rating: Continuous operation hours at max. below 0.5 hours.*

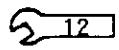
1-2. Marine Gear

Reduction and reversing gear	Model		YX-70S		
	Type		Constant mesh gear with multiple disc clutch		
	Reduction ratio(Ahead/Astern)		1.52/1.52	1.96/1.96	2.50/2.50
	Propeller speed(Ahead)(at condinuous rating)	rpm	1716/1716	1324/1324	1040/1040
Direction of rotation	Crankshaft		Counterclockwise viewed from stern		
	Propeller shaft		Changeable(Cockwise/conter-clockwise)		
Hydrauric oil pressure			24kg/㎠±0.5/2700rpm		
Lube oil pressure			2.5kg/㎠±0.5/2700rpm		
API Service grade			CD		
Dry weight		kg	210		

2. Disassembly and Reassembly

2-1. Preparations before Disassembly and Reassembly

2-1-1 Visual Mark List for Disassembly and Reassembly

Visual Mark		Visual Mark	
	See		※1 Apply liquid packing
	Caution		Safety
	Measure		Clean
	Oil supply		※2 Use torque wrench

※1 THREE BOND 3B-388-055
※2 The figure shows the widths across flat of the hexagonal part.

2-1-2 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.

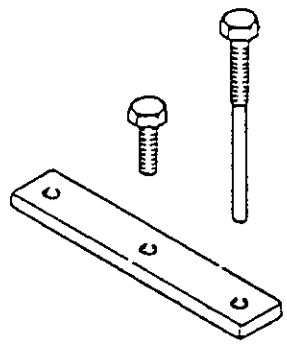
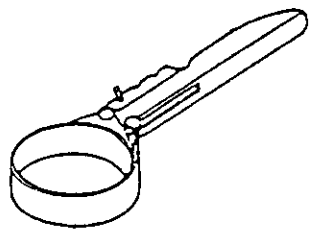
2-1-3 Reassembly

(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 alluminum alloy parts.
(8)Apply engine oil to the threads and seat of the major bolts and tighten them to the specified tightening torque.

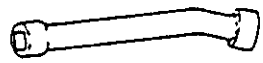
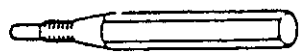
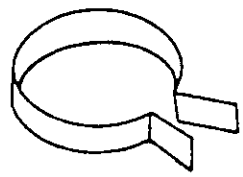
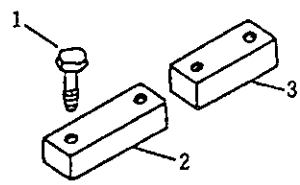
2-2. Disassembly and Reassembly Tools

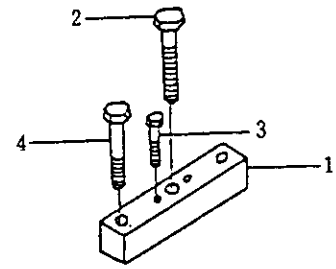
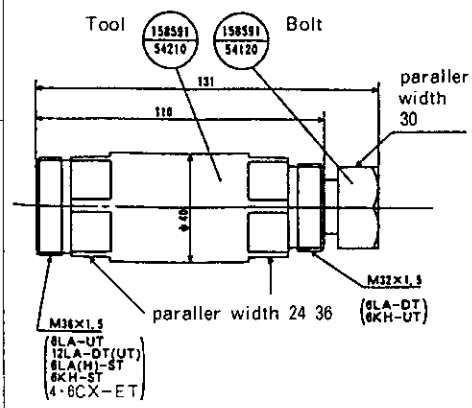
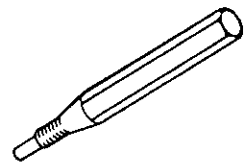
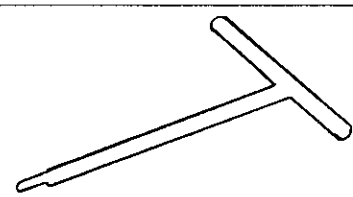
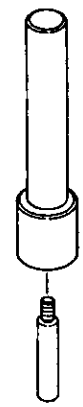
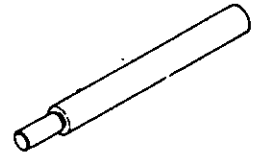
Standard tools

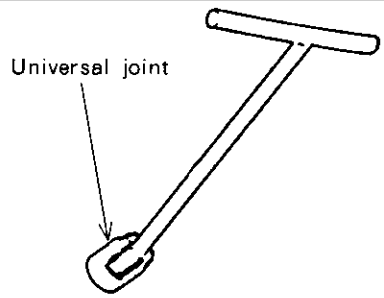
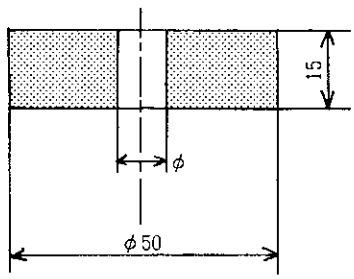
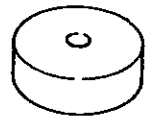
The following are the standard disassembly and reassembly tooLs:

Name of tool	Size	Shape
Double-headed wrench	8×10, 12×14, 13×17 19×22, 24×27	(for removing fuel valve)
Wrench	7, 26	
Monkey wrench	200	
Screw driver	⊕,⊖ changeable	
Hexagon bar wrench	(for clutch emergency bolt)	
Double-head wrench	17×19	
Pliers		
Box wrench	19×12 (for cyl. head) 13×17 (for fuel oil pump)	
Extractor	(for fuel valve adiabatic packing) 127610-92910	
Extractor	(for removing fuel valve) 127616-92500	
Clearance gauge	(for adjusting intake/exhaust valve clearance	
Hammar		
Filter wrench	(for removing filters) 127610-92750	
Oiler		
Turning handle		(Filter wrench)

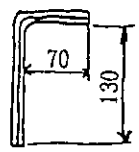
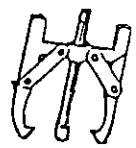
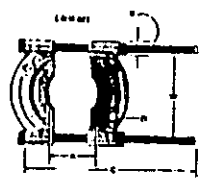
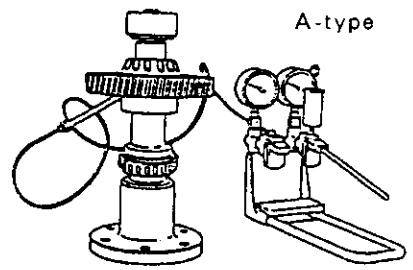
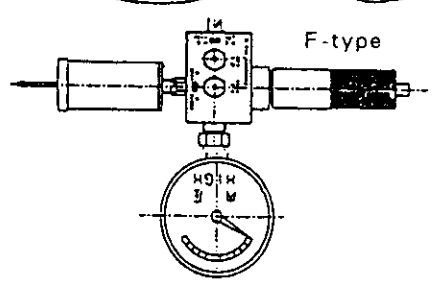
Tools (to be specially ordered)

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 potitioning tool	1. Bolt (4pcs) 127610-92700 2. Spacers A 127610-92680 3. Spacers B 127610-92690	

Name of tool	Code No.	shape
Fresh water pump impeller (cam gear puller) (Press-fitting type)	1. Spacer 127610-92430 2. Bolt 124160-77511 3. Bolt (for impeller) ×2 26116-060302 4. Bolt (for cam gear) ×2 26116-080502	
Automatic timer tool (adiabatic material puller)	158591-54120 158591-54200	
Adiabatic material puller	127610-92910 (Standard)	
Protector puller	127695-92910	
Stem seal insertion tool		
Valve guide puller		

Name of tool	Code No.	shape
Exhaust manifold puller		
Fuel valve puller tool 127616--92500		

Special tools for clutch

No.	Name of tool	Note	shape
1	Emergency bolt span	For tightening the emergency bolt on clutch failure	
2	Gear puller		
3	Bearing separator	For removing bearing; used together with the gear puller	
4	Hydraulic fitting tool	For disassembly of output shaft joint Output shaft joint and large gear	 

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 serveral 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		21	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 safety be mixed withanti-rust agent.

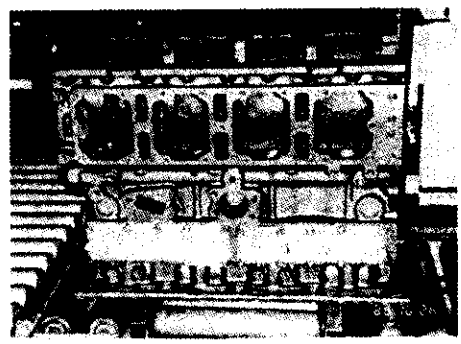
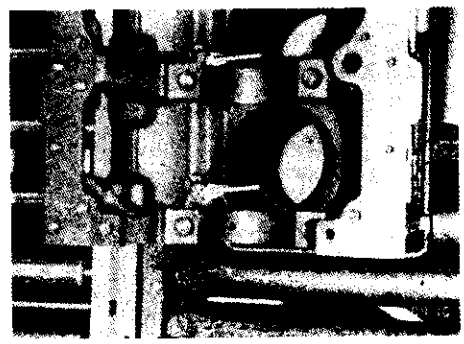
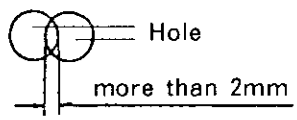
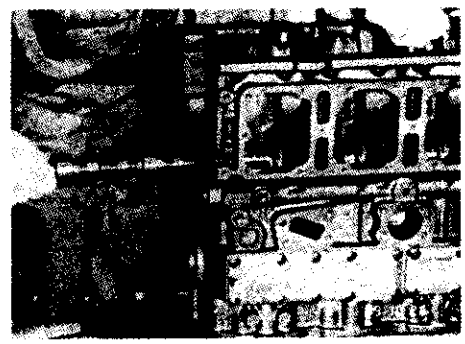
Temp.	-5℃	-10℃	-15℃	-20℃	-25℃	-30℃	-35℃	-40℃
Volume ratio	15%	25%	30%	35%	40%	45%	50%	55%

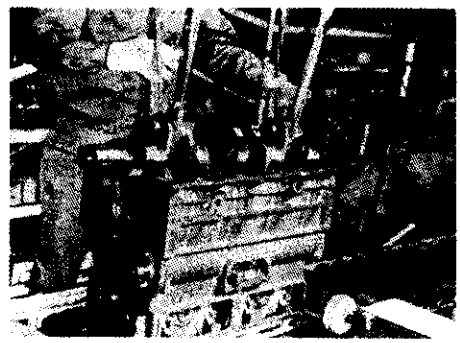
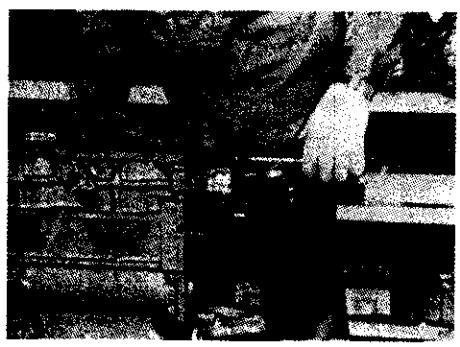
Name	quantity	Code No.	using
Metal Clean Y (cleaning agent)	1kg × 20	975600–02000	Has strong performance to remove accumulated carbon. Can safety be heated to double the cleaning performance. Corrodes almost no metals, including iron. (Also has anti-rust effect.) To use, dissolve 1kg of the agent in 40 liters of water. When a cleaning machine is used, use 4–6% solution and heat in to 60–80℃. 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	

Measuring Device

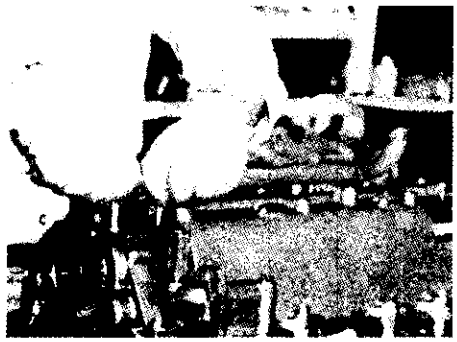
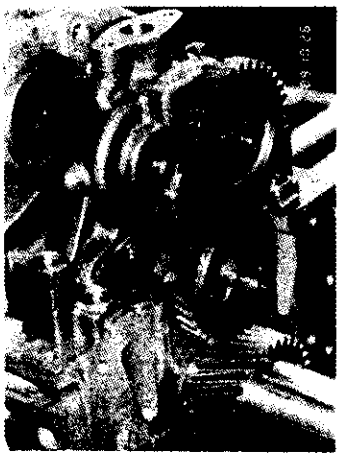
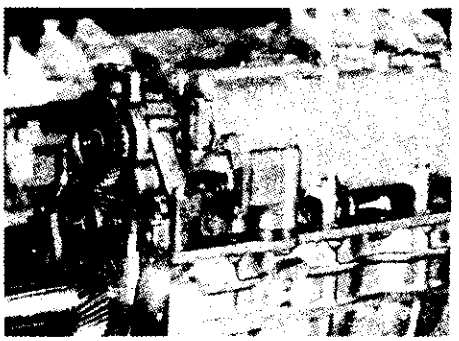
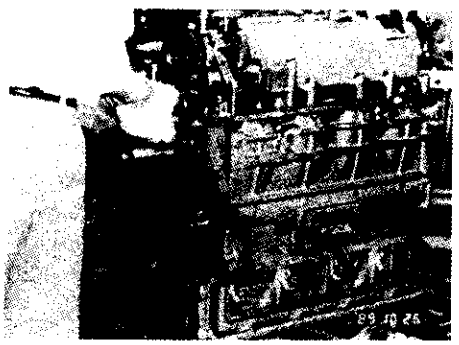
Name	quantity	Code No.	using
Cap tester	RCT–2A	955000–055000	For testing the radiater and the cap.

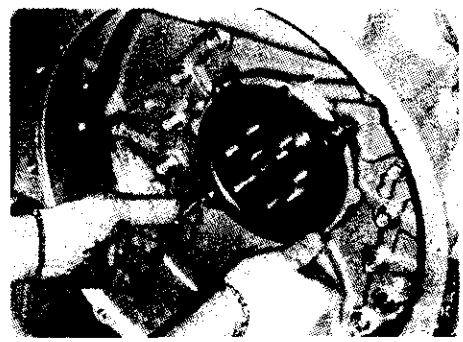
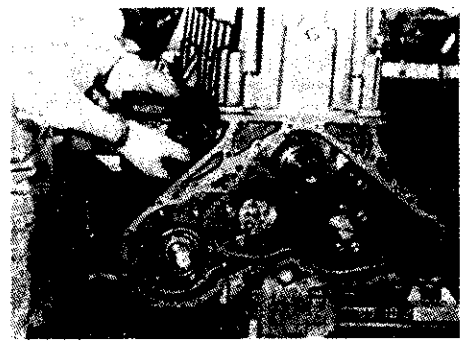
2-3. Reassembly Procedures

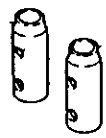
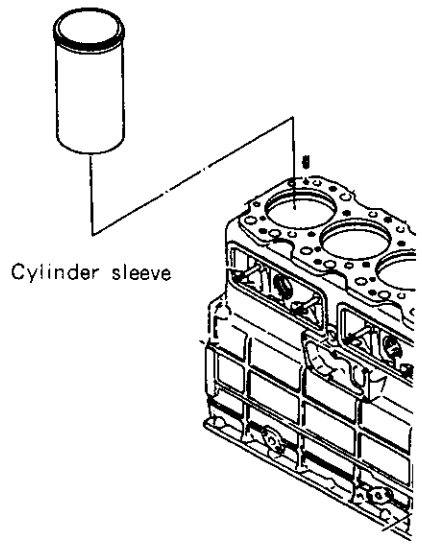
No.	Item	Procedure	Tool& Caution	Illustration
1	Cylinder Block	Clean the bearing holes completely. Reverse the cylinder block before reassembly. T-plug 1/8 tightening torque: 0.5kgf - m	5	 Cylinder Block
2	Piston Cooling Nozzle	Install the nozzle correctly according to the positioning pin. Take care not to over-tighten the nozzle. Tightening torque: 2.0kgf-m 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.	△ 17	 Piston Cooling Nozzle
3	Cam Shaft	Apply lube oil to the cam chaft journal. Insert the cam shaft. Install the thrust plate. Tightening torque: $2.6^{\pm 0.2}$ kgf-m Measure the side clearance. Side clearance: 0.10–0.25mm Installation of cam shaft metal. Replace the cam shaft metal as follows: 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 2mm 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.)  	  12	 Cam Shaft  Installation of the thrust metal

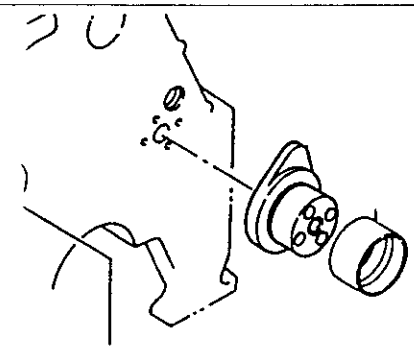
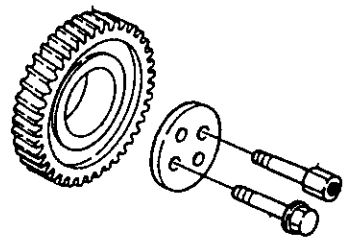
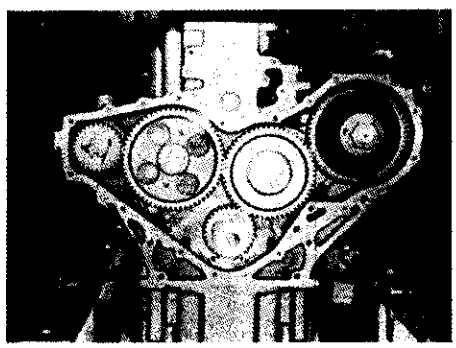
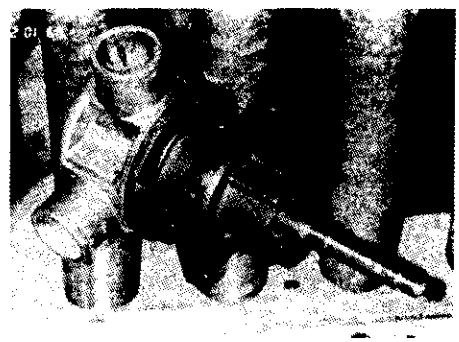
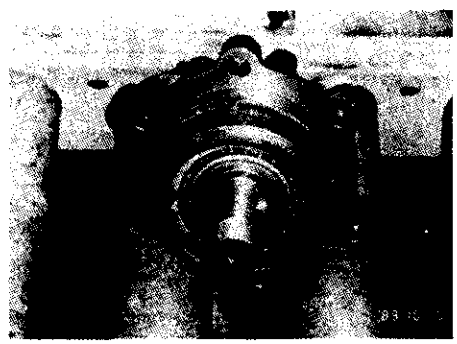
No.	Item	Procedure	Tool& Caution	Illustration
4	Cooling Water Passage Cover	Install the cooling water passage cover.	12	 Fitting the upper bearing
5	Crankshaft and Main Bearing	The upper bearing (block side) has an oil groove; no oil groove in the lower bearing. The standard bearing is at the flywheel 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 bolt to the specified tightening torque. Turn manually to check that it turns lightly. Measure the side clearance. Cap bolt tightening torque: $28^{\pm 1.0}$ kgf-m Side clearance: 0.155 – 0.296mm Crankshaft bearing oil clearance: 0.04 – 0.108mm		 Fitting the crank shaft
		 Fitting the cap bolt	24	 Apply lube oil
		 Measure the side clearance		 Fitting the bearing cap

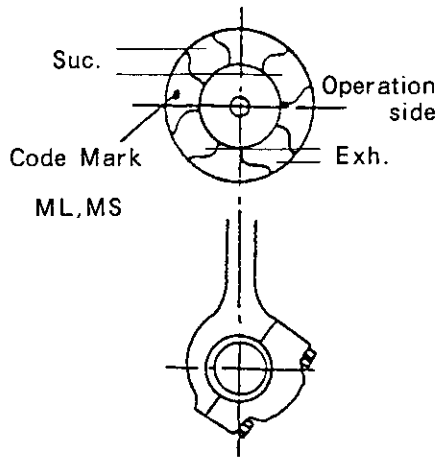
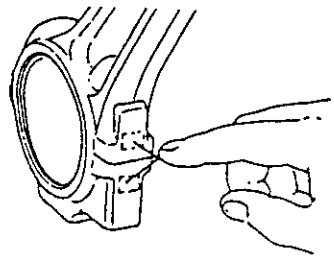
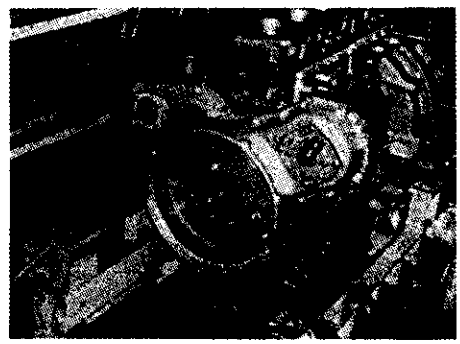
No.	Item	Procedure	Tool& Caution	Illustration
6	Idle Gear (Lube Oil Pump)	Check the gear side clearance. Gear side clearance: 0.066–0.114mm Check the gear backlash. Gear backlash: 0.08–0.16mm Install the idle gear to the cap. Tightening torque: 1.5–2.0kgf-m		 Fitting the idle gear

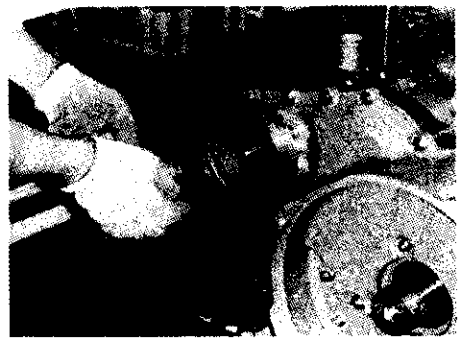
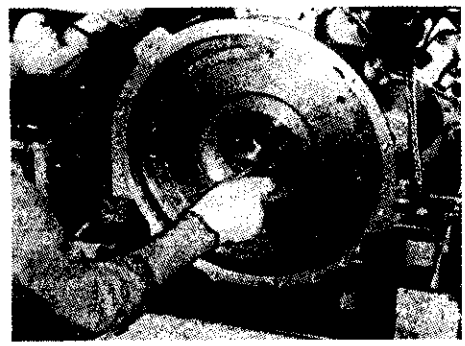
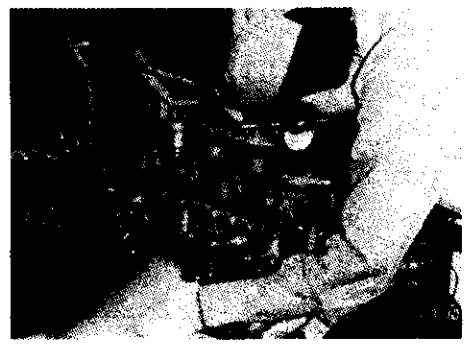
No.	Item	Procedure	Tool& Caution	Illustration
7	Lube Oil Pump	Install the lube oil assembly. Install the suction and discharge pipes. (Bolt head width 12) Tightening torque: $2.5^{\pm 0.2}$ kgf-m Check the gear backlash (to the crankshaft). Backlach for crank gear: 0.12–0.22mm  Fitting to the suction pipe	12 · 14 	 Fitting to the lube oil pump  Fitting to the Safety valve and dischanger pipe
8	Gear Case	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. (Bolt head width 12) Tightening torque: $2.6^{\pm 0.2}$ kgf-m Cut off the protruding packing.	12	 Fitting the gear case
9	Oil Pan	Bring the gear case level so that the packing will not break. (Use the fitting tool.) (Bolt head width 12) Tightening torque: $2.6^{\pm 0.2}$ kgf-m After tightening, cut off the packing protruding on the wheel housing side. *Note :* *Apply THREEBOND to both sides 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: 0.1mm	12 	 Fit the oil pan useing the tool

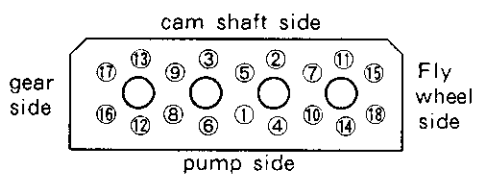
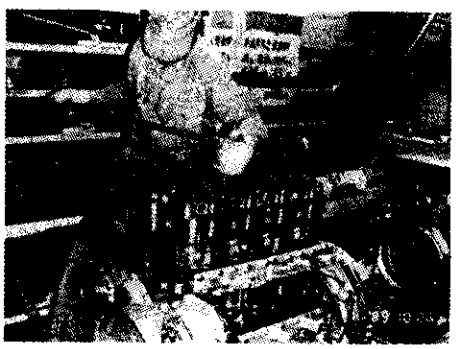
No.	Item	Procedure	Tool& Caution	Illustration
10	Flywheel Housing	Assemble the flywheel housing according to the positioning parallel pin. Deviation at the oil seal insertion area: 0.2mm Face deviation from the crankshaft center: 0.3mm Flywheel housing tightening torque: $5^{\pm 0.5}$ kgf-m Install the lube oil piping (flywheel housing – oil filter).		 Assemble the Fly wheel housing
11	Oil Seal Case	Press-fit the seal into the oil seal case (with the press-fitting tool). *Note :* *(Apply lube oil to the outside lip of the oil seal before press-fitting.)* Install the oil seal case assembly to the flywheel side with its oil escape hole vertical.	12	 Assemble the oil seal case
12	Engine Foot	Install the engine foot.		 Install the engine foot
13	Reverse the cylinder block	Reverse the cylinder block.		

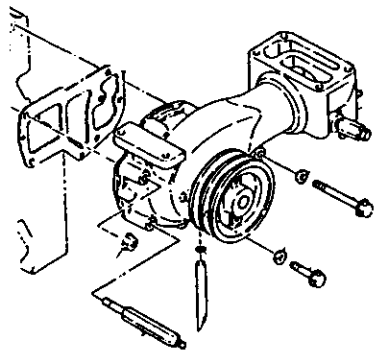
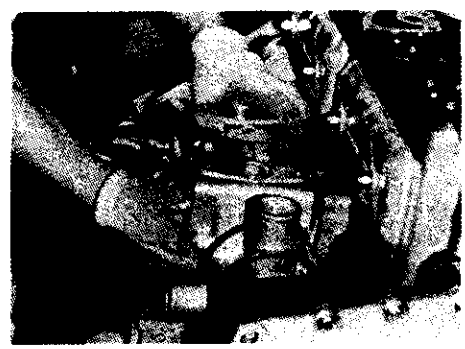
No.	Item	Procedure	Tool& Caution	Illustration
14	Tappets and Tappets Case cover	Insert the tappets into the cylinder block hole. (Apply engine oil to the tappets. Move the tappets manually to check that they are inserted smoothly.) Tappet hole oil clearance: 0.04−0.082mm Install the tappet case cover after inserting all tappets. (Bolt head width 12) Tightening Torque: 1.2−1.7kgf-m	12	 Tappet
15	Cylinder Sleeve	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. *Note :* *Before inserting the cylinder sleeve, check the cylinder number and the insertion direction.* *(Size code is for the cyliner 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.)* *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.)* Measure the protrusion of the cylinder liner. Liner protrution: 0.03−0.09mm Measure the distortion of the cylinder liner. Cylindricality: ≦0.03mm (The mark at the cylinder block side is punched on the head joint face of the operation side.)		 Cylinder sleeve Size code is for the cylinder sleeve. Marked in black paint at the anti-operation side. 「BM」 Piston fitting code Cylinder block fitting code

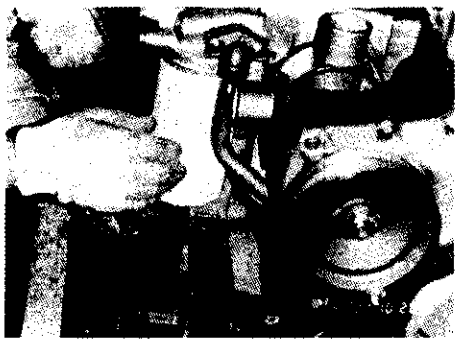
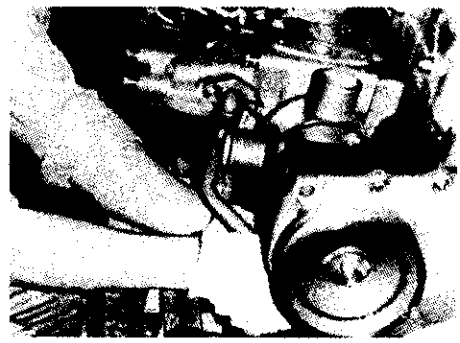
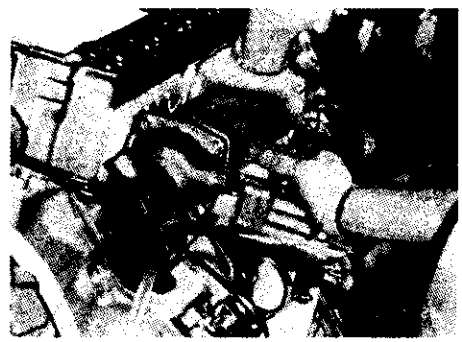
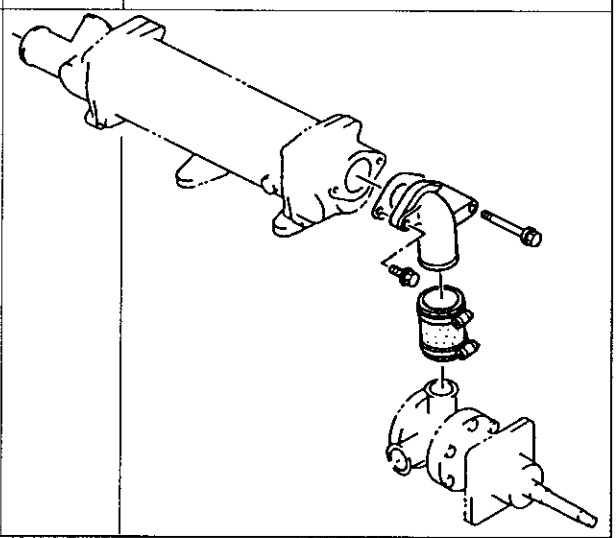
No.	Item	Procedure	Tool& Caution	Illustration
16	Idle Gear	Install the idle gear shaft. Direct the shaft's oil hole upwards. Tightening torque: $2.6^{\pm 0.3}$ kgf-m Install the idle gear. Gear side clearance: 0.15–0.35mm Install the cam gear shaft. Gear backlash: 0.08–0.16mm Gear side clearance: 0.10–0.25mm Use the puller tool to remove the cam gear. Install the fuel pump drive gear. Tightening torque: $20^{\pm 1.0}$ kgf-m	12 • 36	  **Idle gear**
17	Sea water Pump	Install the sea water pump to the gear case, directing the oil receiving port upwards. Install the drive gear and tighten the nut to the specified tightening torque. Drive gear fixing nut tightening torque: $14.5^{\pm 0.5}$ kgf-m Install the fuel pump driving bearing case assembly to the gear case. Gear backlash: 0.08–0.16mm  Match up the alignment marks of gears at the same time.	12 • 30	 **Sea water pump**  **Fuel pump driving bearing case**

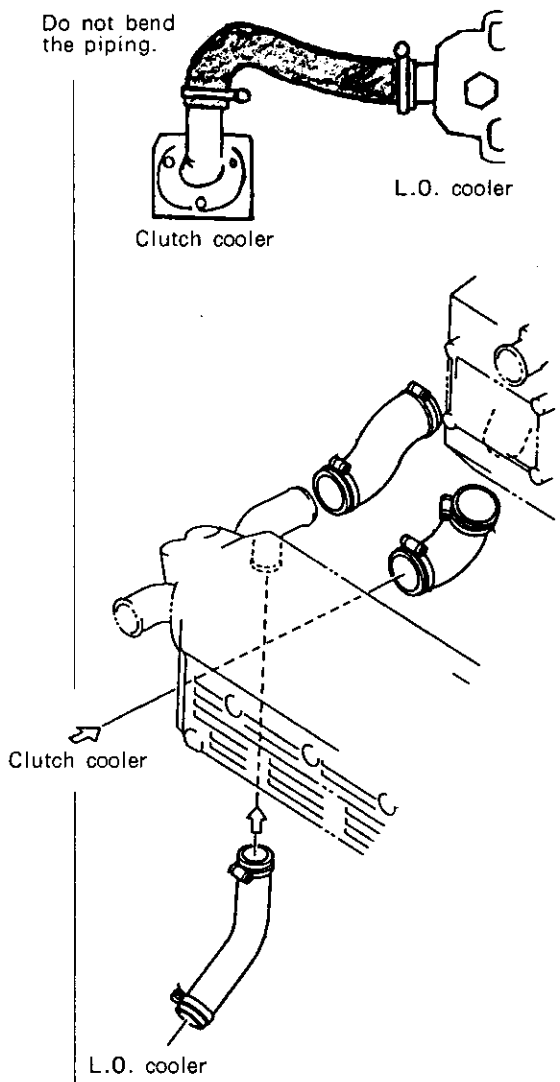
No.	Item	Procedure	Tool& Caution	Illustration
18	Piston and Connecting Rod	Assemble the connecting rod to the piston. The size code, ML or MS, is provided on the piston head. Match up the code with the correctly code of the cylinder sleeve. Distribute the end gaps of the piston rings evenly on the piston. Insert the piston into the cylinder liner, placing the con. rod alignment mark on the operation side. Apply lube oil. 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. Tightening torque: $23^{\pm 0.5}$ kgf-m Measure the side clearance after tightening the bolts. Rod large end side clearance: 0.15–0.35mm 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.)		 Assemble the piston and con.rod.  alignment mark
19	Gear Case Cover	Install the oil seal to the gear case. *Note :* *Apply lube oil to the exterior and lip of the oil seal before press-fitting it.* Install the gear case cover. *Note :* *The positioning pin (spring pin) is provided at the joint face of the gear case and cylinder block.* Measure the face deviation of the front drive installation. Face deviation: Less than 0.05mm for crank center		 Fitting the side cover  Fitting the gear case cover

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.		 Assemble the bearing case  Install the V-pulley
21	Flywheel	Install the flywheel. (Align the positioning parallel pin holes.) Tighten the bolts to the specified tightening torque. Tightening torque: $29^{\pm 1}$ kgf-m Measure and check the flywheel face deviation and centering location deviation. Face deviation: less than 0.13mm Follow the instructions below when replacing the top indication plate: 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.	P	 Assemble the flywheel  Check the No1 cyl.top.

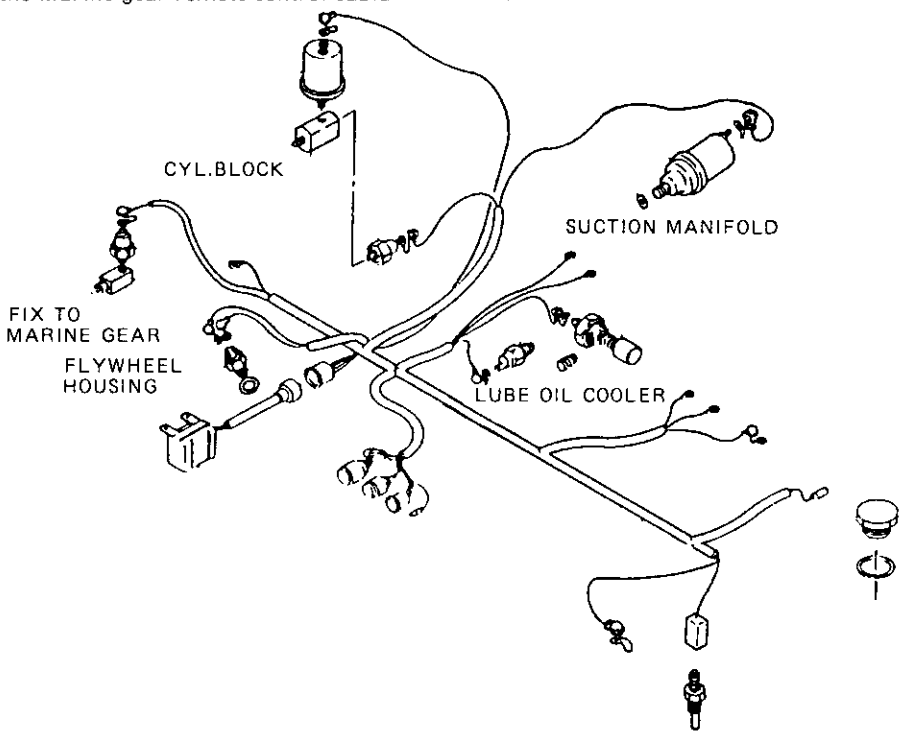
No.	Item	Procedure	Tool& Caution	Illustration
22		Install the injection timing adjustment and turning window covers. 1)Adjust the injection timing with the governor control lever at its max. position (pump rack's max. scale). 2)After adjusting the fuel timing, punch an injection alignment mark aligned with the punched scale on the flange side mounting of the fuel pump. 3)Install the turning window cover. Tightening torque: $5^{\pm 0.5}$ kgf-m Injection timing: 12±1°	14 • 24	 Indication plate
23	Breather	Install the breather.		
24	Cylinder Head	Valve sink: Intake 0.2mm, Exhaust 0.2mm Install the head gasket according to the positioning pin. Lift the cylinder head level and install it according to the positioning pins (spring pins)(4 pcs.). Apply lube oil to the threads and seat of the head bolts and tighten them 3 times to the specified tightening torque in the proper tightening order. Tightening torque: $25^{\pm 0.5}$ kgf-m procedures for the head bolts.) Measure the top clearance. Top clearance: $0.95^{\pm 0.09}$ mm (Head gasket tightening torque and tightening order)  Install the fuel return pipe joint.	22	 Cylinder head  Tightening of the cyl. head

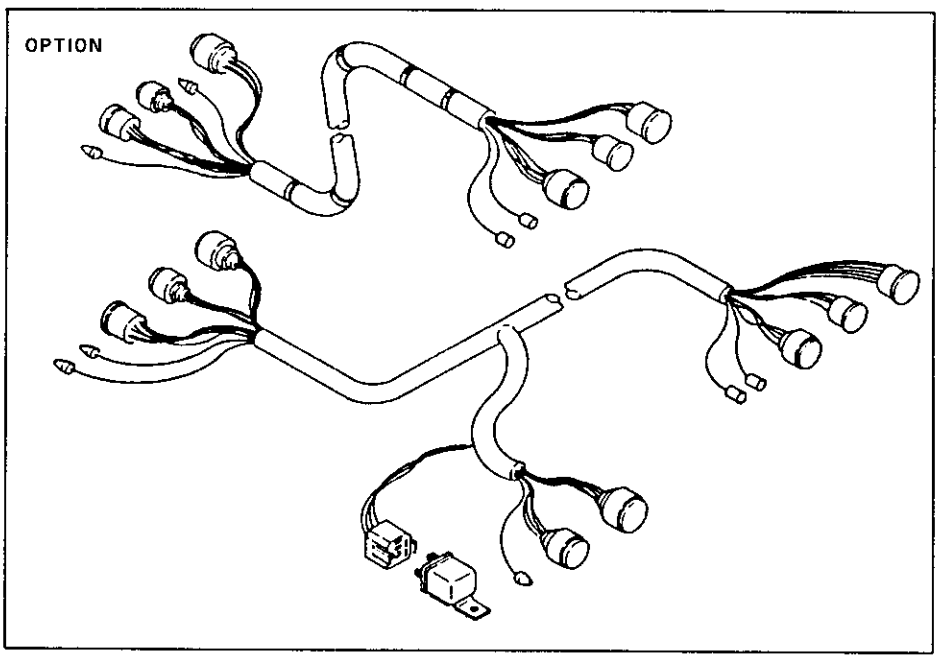
No.	Item	Procedure	Tool& Caution	Illustration
25	Fresh water Tank	Install the fresh water tank to the freshwater pump. Tightening torque: $2.6^{\pm 0.2}$ kgf-m Install the stay of the fresh water tank.	12	 Install the freshwater tank
26	Fresh water Pump	Install the fresh water pump assembly to the cylinder block. Install the thermostat to the fresh water pump body. Thermostat valve opening temperature:71℃ Full-open lift test temperature:85℃	12	 freshwater pump
27	Starting Motor	Install the starting motor to the flywheel housing. Tightening torque: $9^{\pm 0.5}$ kgf-m	17	 Install the starting motor
28	Lube Oil Pipe and Lube Oil Filter	Install the lube oil filter mount to the cylinder block.		 Install the lube oil filter mount

No.	Item	Pocedure	Tool& Caution	Illustration
		Install the lube oil piping (Lube oil filter–flywheel housing). Install the lube oil piping (Lube oil filter–cylinder block). Install the filter.  (Install the filter)		 (Lube oil filter–flywheel housing)  (Lube oil filter–cylinder block)
29	Lube oil Cooler	Install the oil cooler assembly to the oil cooler mount. (Install the elbow of the Lube oil pipe filter and union Lube oil pipe to the filter in advance.)	12	 (Install the oil cooler assembly)
30	Cooling Water Pipe	Install the cooling water piping (sea water pump–Lube oil cooler).		

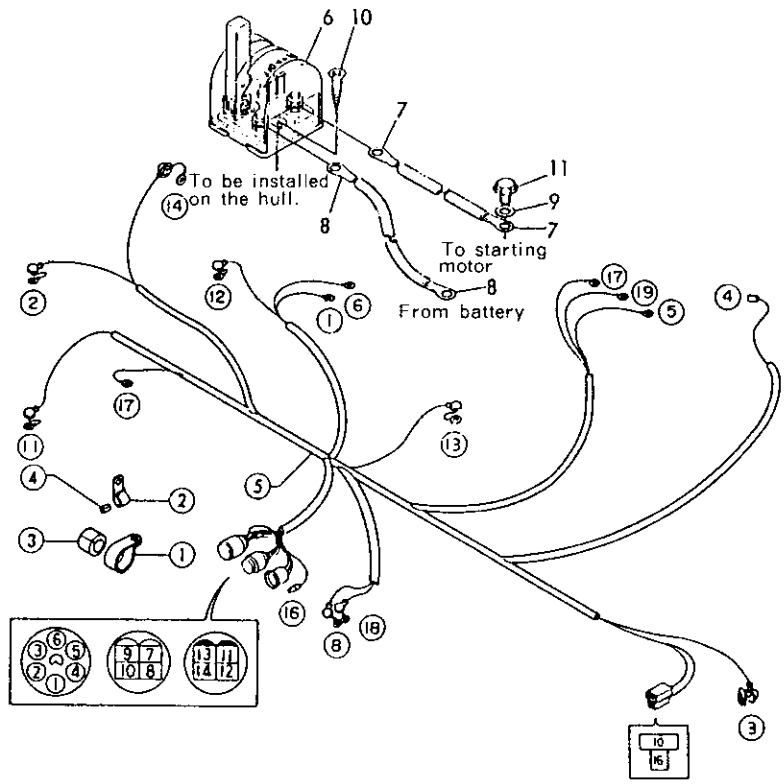
No.	Item	Procedure	Tool& Caution	Illustration
		Install the cooling water piping (LO cooler-Marine gear cooler). Install the cooling water piping (Marine gear cooler-intercooler). Install the cooling water piping (intercooler-fresh water cooler). Install the cooling water piping (lube oil cooler-fresh water cooler).		
31	Engine Lift Fixture	Install the engine lift fixture..		 Install the engine lift fixture

No.	Item	Procedure	Tool& Caution	Illustration
32	Wire Harness	Install the wire harness (engine side): *Note :* *1)Beware of the heated area of the exhaust and bend pipes as well as the moving parts when wiring.* *2)Refer to the electircal wiring diagram and ensure correct terminal connections.* Install the remote control cable support mount. (To be installed to the installation seat at the top of the side cover on the operation side of the block.) Install the Marine gear remote control cable mount.	12	



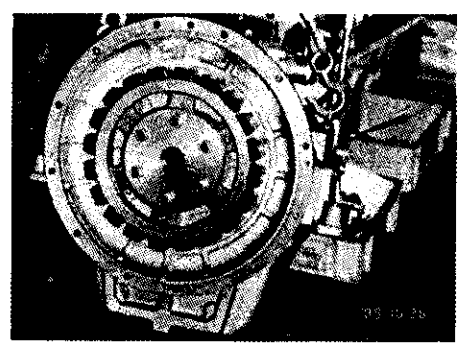


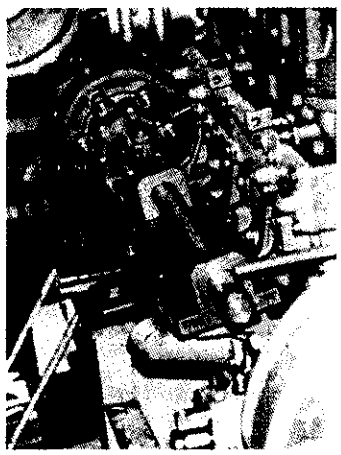
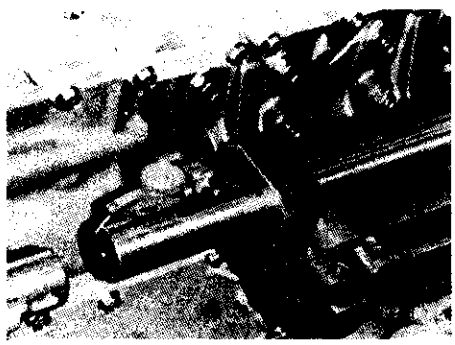
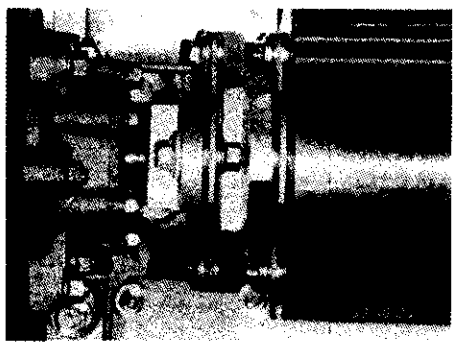
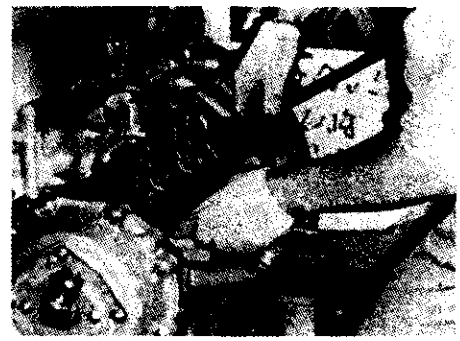
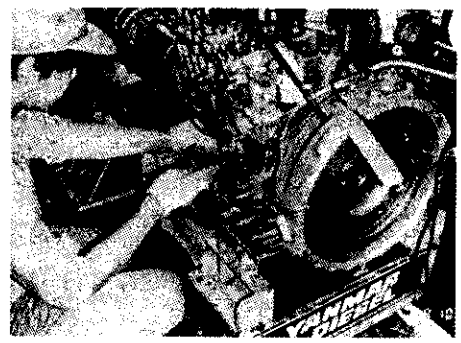
No.	Item	Procedure	Tool& Caution	Illustration

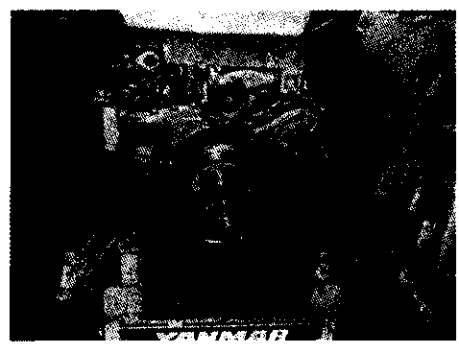


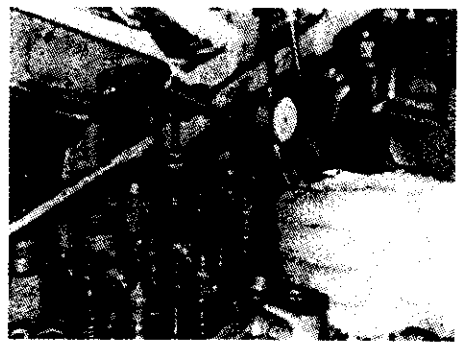
for 6CX-ETE

No.	dia.	color	Note	No.	dia.	color	Note
①	5	White	Starting motor "s"	⑩	0.85	White,Black	CW meter "U"
②	0.85	Yellow, White	L.O "SW"	⑪	0.85	Yellow, Green	Clutch L.O "SW"
③	0.85	White,Blue	CW temp. "SW"	⑫	0.85	Green	L.O filter " SW"
④	0.85	White,Red	CW level "SW"	⑬	0.85	Yellow, Black	L.O press.meter "U"
⑤	0.85	Blue,Black	generator "L"	⑭	0.85	Green,Black	Boost meter " U"
⑥	5	Red	Starting motor "B"	⑯	0.85	Green,Red	WAIT "SW"
⑦	0.85	Black	⊖	⑰	5	Black	⊖
⑧	0.85	Blue,Red	Tachmeter "P" or "G"	⑱	0.85	Black	⊖
				⑲	5	Red	⊕

33	Direct Coupling of Reduction and Reversing Gear	Install the rubber block flange ring to the flywheel. Install the rubber block flange to the input shaft joint of the reduction reversing gears. Apply silicon oil to the rubber block, lift the reduction reversing gear (assembly) level, and insert it into the ring for direct coupling.		 **Install the reduction clutch**

No.	Item	Procedure	Tool& Caution	Illustration
34	Fuel Pump	Install the fuel pump mount to the cylinder block. (Axial deviation TIR within 0.3; deviation angle within 30 degrees) (TIR:Total Indicator Reading) Install the fuel injection pump. Install the lube oil piping (cylinder block–fuel pump). *CAUTION:* *(Do not overtighten the block or it may crack.)* Union tightening torque: 0.5– 1 kgf-m  Tool for centering  Measure the center  Timer and Flexible coupling	12 17	 Fuel pump mount  Assemble the flexible coupling  Assemble the Fuel pump  Titting the Lube oil pipe

No.	Item	Procedure	Tool& Caution	Illustration
35	Fuel Injection Valve and Pipe	Put in the protector and adiabatic material and install the fuel injection valve to the cylinder head. Fuel valve retainer tightening torque: $3.2^{\pm 0.2}$ kgf-m *Note* *1)Provisionally tighten the fuel injection pipe joint until it contacts with the fuel valve seat to a tightening torque of 2.5–3.0kg-m. Then, the fuel injection valve and the fuel injection pipe joint.* *2)Apply molybdenum disulfide to both the outside and the inside circumferences of the protector before inserting it.* Install the fuel injection pipe. Tightening torque: 3.5kgf-m Install the fuel return pipe. Install the rocker arm case.	12 19	Fuel injection valve Packing Hear insulator Protector No.1 No.2 No.3 No.4 No.5 No.6 Fuel injection pipe
36	Exhaust manifold	Install the exhaust manifold.		 Install the exhaust manifold.
37	Viscous damper	Install the viscous damper.		 Viscous damper

No.	Item	Procedure	Tool& Caution	Illustration
38	Intake/ Exhaust Rocker Arm (Assembly)	Install the valve bridge. *Note* *1) The installation range of the rocker arm shaft mount is 180 degrees. If the mount is installed in reverse, the valve head position will be varied. (See fig. at the right.)* *2) Check the performance of the intake/ exhaust valve.* Fit the push rod to the dent in the tappet. Adjust the bridge valve head adjust bolt, and tighten the set nut. Bridge valve head clearance: Intake 0.25mm, Exhaust 0.4mm Tightening torque: 2.0kgf-m Install the intake/exhaust rocker arm (assembly). Valve arm A'ssy Tightening Torque: M8 bolt $2.6^{\pm 0.5}$ kgf-m; M10 bolt $4^{\pm 0.5}$ kgf-m *Note* *When replacing the valve guide, note that the guide is lightly calked to the head. (Assemble the push rod, adjust the intake/ exhaust valve head clearance, and install the rocker arm assembly.)*	14 • 17 12 • 14	 Adjust the bridge valve head  Assemble the push rod  Assemble the rocker arm a'ssy  Adjust the valve clearlance

No.	Item	Procedure	Tool& Caution	Illustration
39	Cooling Water Pipe (Fresh Water)	Install the piping between the exhaust manifold and the fresh water tank. Install the piping between the head and the fresh water cooler.	12	
40	Fuel Piping	Install the piping between the feed pump and the filter. Install the piping between the filter and the injection pump. Install the feed pump inlet piping.	12