YANMAR

OPERATION MANUAL

MARINE AUXILIARY ENGINE

6N18(A)L-V SERIES

PREVIEW - ONLY

Thank you for purchasing
YANMAR product.

Be sure to read this Operation Manual for you to use this product safety and correctly. Even after reading it, carefully keep it, making clear to all personnel concerned where it's kept so that the operator, mechanic or supervisor will have an access to it whenever he wants to read or refer to it.

Document Only Marine Engine Parts

I.B.C.No. 06-6N18(A)-V-H-22E
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For safe use of your engine.

Be sure to abide by ⚠ -marked DANGERs, WARNINGs and CAUTIONs described in this Manual. As far as safety is concerned, they are particularly important parts of instructions.

- The following shows the safety marks used for caution indications in this Operation Manual and safety labels attached to this product and explains their meaning.

⚠ DANGER **It indicates that a danger of possible death or serious injury is very great when the proper precautions is not followed.**

⚠ WARNING **It indicates that there is a danger of resulting in death or serious injury when the proper precautions is not followed.**

⚠ CAUTION **It indicates that there is the possibility of resulting in injury or serious damage to the engine when an advice on safety handling or the proper precautions is not followed.**

- Where the safety labels are posted is shown in page 0 -12.

- The cautions prefixed with the △ mark in this Operation Manual are especially important for safe handing of this product. A failure to observe this caution may incur a deterioration of performances or trouble/accident of this product. Therefore, be sure to observe the items.

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4. OPERATION

CAUTION

During operation, the diesel engine runs at a high speed. Also, some parts of the engine are hot, and the compressed air and such pressurized fluids as oil and water are flowing inside it. Therefore, thoroughly read the safety precautions before operation, maintenance and inspection to handle the engine properly not to cause any accidents.

Chapter0, Section 3. Precautions on Safety

4-1. Operational Preparation

Before the initial start of the engine after its installation or before its restart after its overhaul servicing or a long-term stoppage, sufficiently perform the following inspection and operation preparation in addition to daily inspection and operational preparation, and make sure there is no abnormality and the operational preparation has completed.

(1) Make sure no part nor tool has been left in the crankcase.
(2) Check for a part not tightened yet.
(3) If you have disassembled the valve mechanism, check the suction/exhaust valve head clearance.

Chapter 6, 6-3-6. Adjustment of Suc./Exh. Valve Head Clearance

(4) Operate the lubricating oil priming pump, and open the pressure indicator cocks of all the cylinders. While turning the flywheel, make sure the lubricating oil is dropping from each part of the valve rocker arm shafts, piston pins, crank pins, main sure bearings and swing arms.
(5) Bleed the air from the lubricating oil strainer.
(6) Bleed the air from the fuel oil filter and inlet pipe of fuel injection pump.
(7) Manually lubricate the governor linkage, and make sure it moves smoothly.

[Procedures for turning the flywheel]

WARNING

Be careful not to allow your body to make contact with a moving part while turning the flywheel. (Never put you hand into the crankcase.)

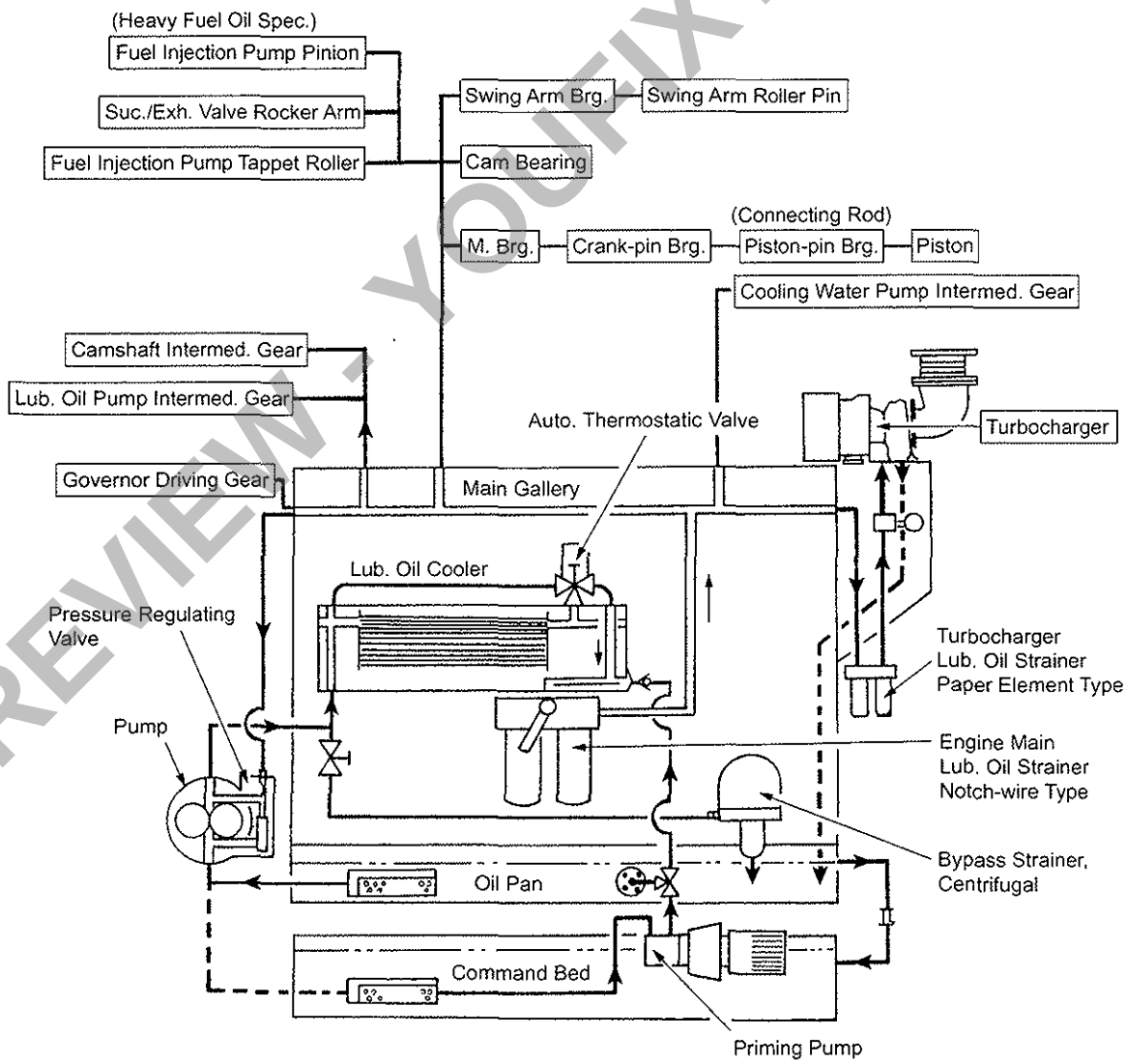
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2-3. Lubricating Oil System

- ○ The lubricating oil pump is a gear pump integrating the pressure regulating valve and safety, valve.
- ○ The lubricating oil strainers are a notch-wire type strainer and a centrifugal bypass strainer.
- ○ The lubricating oil cooler is a unit structure of the multi-tubular type fitted with an automatic thermostatic valve and a notch-wire type strainer.
- ○ The priming pump is a motored screw pump and is mounted on the common bed. The delivery pipe is connected with the inlet side of the notch-wire type strainer.

The lubricating oil discharged from the pump is regulated of its pressure to the specified value by the pressure regulating valve. Then, the lub. oil passes through the cooler and strainer and then enters the main gallery of the cylinder block. The lubricating oil line is branched at the main gallery. The oil passes through each part and returns to the oil pan and then the common bed.
Each lub. oil passage franched off from the main gallery is a drilled hole structure, excluding lines leading to the pressure regulating valve and governor driving gear.
The oil suction part of the pump varies according to the engine installation types. In the case an engine installed by the fixed supporting, the fixed suction part is the command bed; in the case of antivibration supporting, it is oil pan.

Drawing 2-2



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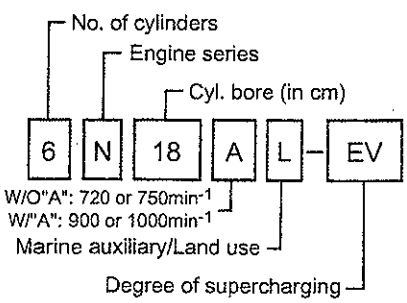
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1. ENGINE DESCRIPTION

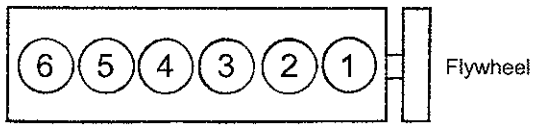
1-1. Engine Specification (1/2)

Model		Unit	6N18L-DV	6N18L-UV	6N18L-SV	6N18L-EV
Type		---	Vertical, water-cooled, 4-cycle diesel engine			
Combustion chamber		---	Direct injection type			
No. of cylinders		---	6			
Cylinder bore		mm	180			
Stroke		mm	280			
Total cylinder displacement		---	42.75			
Compression ratio		---	16.5			
Rated speed of revolution		min^{-1}(rpm)	720 or 750			
Direction of rotation of crankshaft		---	Counterclockwise as viewed from the flywheel end (XL)			
Operating side		---	On the left as viewed from the flywheel end			
Order of firing		---	1-4-2-6-3-5-1			
Supercharging system		---	Exhaust gas turbine supercharger (turbocharger) with air cooler			
Cooling system		---	Dual fresh water line cooling.			
Lubricating system		---	Forced lubrication (system oil also used as turbocharger lub.oil) (system oil also used as rocker arm lub.oil)			
Lubricating oil sump system		---	Sump incorporated in common bed			
Starting system		---	Air motor starting			
Dimensions	Overall length	mm	2,696			
	Overall width	mm	1,315			
	Overall height	mm	1,935			
Mass (of engine singly)		kg	6,500 (may vary as depending on specification)			

Constitution of Model Designation



[Configuration of Cylinders]



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3-3. Protective Device Setting Values

Item	Unit	Alarm Setting Value	Emer.Stop Setting Value
Lub.oil engine inlet pressure	MPa(kgf/cm^2)	0.34(3.5)	0.29(3.0)
Lub.oil turbocharger inlet pressure		0.25(2.5)	---
Cooling water engine outlet temperature	K(℃)	368(95)	373(100)
Rotational overspeed	min^{-1}(rmp)		115 ~ 120% of the rated speed
* Lub.oil priming pressure	MPa(kgf/cm^2)	0.02(0.2)	---
* Differential pressure(lub.oil strainer)		0.09(0.9)	---
* Differential pressure(fuel.oil filter)		0.09(0.9)	---
* Starting air pressure		0.65(6.6)	---
* Control air pressure		0.65(6.6)	---
* Cooling water pressure(jacket cooling line)		0.13(1.3)	---
* Cooling water pressure(cooler cooling line)		0.13(1.3)	---
* Lub.oil engine inlet(cooler outlet) temperature	K(℃)	348(75)	---

As for an asterisk(*), for equipment of each item varies as depended on the specification, refer to the Final Document.

3-4. Holding Volumes of Lubricating Oil and Cooling Water

[Unit: ltr.]

Item			Holding Volume	Remarks
Lubricating Oil	Engine(incl.inside the cooler, strainer & piping)		35	
	Lub.oil sump(common bed tank)		*	more than 1.0ℓ/ps
	* Governor	Type NZ61, RHD	1.3	
		Type PSG	2.0	
Cooling water	Cylinder jacket(fresh water)		75	
	Cooler		25	

As for an asterisk(*), refer to the Final Document as the volume may vary according to the specification.

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Table 6-1. Table of Routine Maintenance checking

Checking Area		Nature of Work		
		Daily	Weekly	Monthly (or 300-500hrs.)
Starting air tank		Pressure check	Draining	
Governor gear		Gov. oil volume check		Checking & lubrication of linkage system
Fuel Oil System	Fuel feed pump	Check on leak from oil seal		
	Fuel oil filter	Draining	Back-washing (blow-off)	Overhaul cleaning
	Fuel injection Pump			Check on rack scale position
				*Check on pinion lubricating Volume
	Injection timing adjust bolt			Check on looseness of lock nuts
Lub. Oil System	Common bed (or oil pan)	Oil volume check	Lub. oil cleaning The batch cleaning by the purifier	Lub. oil property analysis
	Lub. oil strainer	Draining	Back-washing (blow-off) * (2 ~ 3 days)	Overhaul cleaning * (10 ~ 15 days)
	Lub. oil bypass strainer	---	Overhaul cleaning	
Cooling water pump		Check on leak from mechanical seal		
Turbocharger			Prefilter washing	
			Blower washing	
Starting air motor				Check that electrical wiring is fastend firmly.
				Check that no air leaks from the air pipe and the joint.
Instrument	Each pressure gauge	Check on defective indication		
	Each thermometer	Check on defective indication		
Engine appearance		Check on looseness of bolts & nuts Check on leaks of various parts (cooling water, fuel oil, lub. oil, boost air & exhaust gas)		
Each pipe system		Leak check		

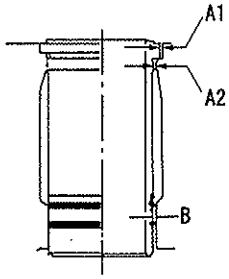
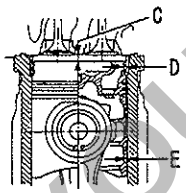
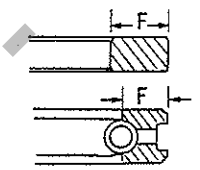
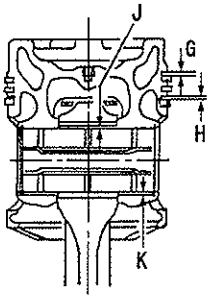
Note: An asterisk (*) refers to only for engine using heavy fuel oil (H.F.O.)

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10. CLEARANCES & WEAR LIMITS OF MAJOR PARTS

(Unit in mm)

	Item	Sketch	Dimension		St'd Clearance Assembling Time	Max. Allowance Clearance	Usage Limit of Parts
			Normal	Tolerance			
Cylinder & cylinder liner	Inner dia. of cylinder upper part		φ246	+0.029 0	A1=0.075 ~ 0.139	A1=0.25	+0.1
	Outer dia. of cylinder liner upper part			-0.075 -0.110			-0.2
	Inner dia. of cylinder lower part		φ222	+0.029 0	A2=0.020 ~ 0.094	A2=0.2	+0.13
	Outer dia. of cylinder liner lower part			-0.020 -0.065			-0.13
	Inner dia. of cylinder lower part		φ218	+0.029 0	B=0.015 ~ 0.088	B=0.2	+0.13
	Outer dia. of cylinder liner lower part			-0.015 -0.059			-0.13
	Top clearance		2.0	± 0.20	C=1.8 ~ 2.2	C=2.5	—
	Inner dia. of protection ring		φ178	± 0.05	D=0.905 ~ 1.045	—	+0.8
	Outer dia. of piston head		φ177.025	± 0.02			—
	Inner dia. of cylinder liner		φ180	+0.030 0	E=0.093 ~ 0.153	E=0.3	+0.4 deflection wear of 0.2
	Outer dia. of piston skirt part		φ179.892	± 0.015			-0.2
Piston piston pin & rings	Radial thick. of piston rings, No.1 ~ No.2		F=6.5	± 0.15	—	—	★
	Radial thick. of oil ring		F=5.0	± 0.25	—	—	4.7
	Width of piston ring, No.1		4.5	-0.065 -0.085	No.1 G=0.110 ~ 0.155	No.1 G=0.4	-0.2
	Width of piston ring groove, No.1			+0.070 +0.045			+0.3
	Width of piston ring, No.2		4.0	-0.010 -0.030	No.2 G=0.055 ~ 0.100	No.2 G=0.4	-0.2
	Width of piston ring groove, No.2			+0.070 +0.045			+0.3
	Width of oil ring		6.0	-0.010 -0.030	H=0.030 ~ 0.065	H=0.4	-0.2
	Width of oil ring groove			+0.035 +0.020			+0.3
	Inner dia. of piston pin metal		φ75	+0.100 +0.080	J=0.080 ~ 0.113	J=0.25	+0.17
	Outer dia. of piston pin			0 -0.013			-0.05
	Inner dia. of piston pin hole			+0.045 +0.030	K=0.030 ~ 0.058	K=0.15	+0.15
	Outer dia. of piston pin			0 -0.013			-0.15

★ : The 1st ring is to be replaced with the new one when its plated layer is worn out and base metal begins to be exposed; the 2nd ring, when the taper face is gone.

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9-3. Other Major Bolts (Torque Tightening)

(1) Before tightening a flywheel clamping bot or fuel injection valve nozzle sleeve, apply Protec gease on its thread and bearing surface.
(2) Before tightening a camshaft coupling nut, apply seizure inhibitor (Three-Bond 1910 or its equivalent) on its thread and bearing surface.
(3) The parts prefixed with an asterisk (*) in the following table are provided with an exclusive tool, respectivery.
(4) Be sure to tighten a part with a torque wrench to the specified torque.

Part Description	Screw Dia. × Pitch	Face-to-Face Width of Bolt/Nut (mm)	Tightening Torque		Remarks
			N-m	(kgf-m)	
Indicator cock tightening nut	M12 × 1.75	19	59 ~ 69	6 ~ 7	
Rocker arm shaft stand clamping bolt	M16 × 1.5	24	186 ~ 206	19 ~ 21	
* Fuel injection valve nozzle sleeve	M22 × 1.5	2 grooves	157 ~ 167	16 ~ 17	Engine Using MDO
	M30 × 1.5		245 ~ 265	25 ~ 26	Engine Using HFO
Fuel injection valve guard tightening nut	M10 × 1.5	17	39 ~ 44	4 ~ 4.5	
* Fuel injection valve case nut	M28 × 1.5	27	167 ~ 176	17 ~ 18	
* Fuel injection valve injection pressure regulating lock nut	M33 × 1.5	41	47 ~ 51	4.8 ~ 5.2	
* Fuel injection pipe joint bolt (on cyl. head side)	M8 × 1.25	6 (hex. socket)	20	2	
* Fuel injection pipe joint bolt (on pump side)	M10 × 1.5	8 (hex. socket)	69	7	
* Fuel injection pump tightening nut	M12 × 1.75	19	74 ~ 83	7.5 ~ 8.5	
Fuel injection pump equalizing valve body clamping bolt	M10 × 1.5	8 (hex. socket)	54 ~ 59	5.5 ~ 6.0	
Fuel injection pump barrel retaining bolt	M10 × 1.5	8 (hex. socket)	54 ~ 59	5.5 ~ 6.0	
Fuel injection pump protector	M20 × 1.5	32	49 ~ 59	5.0 ~ 6.0	
Fuel injection timing adjust bolt lock nut	M22 × 1.5	30	196 ~ 245	20 ~ 25	
Camshaft coupling nut	M12 × 1.25	17	88 ~ 98	9 ~ 10	U-nut
Cam gear clamping bolt	M14 × 1.5	19	137 ~ 157	14 ~ 16	Tightening together with tachometer driving disk
Idle gear shaft clamping bolt	M16 × 1.5	24	118 ~ 127	12 ~ 14	
Idle gear retainer clamping bolt	M12 × 1.75	19	59 ~ 69	6 ~ 7	
Cooling water pump impeller tightening nut	M16 × 1.5	24	64 ~ 74	6.5 ~ 7.5	Left hand screw
* Cooling water pump impeller	M22 × 2.5	round socket 4 points	137 ~ 157	14 ~ 16	Left hand screw
Cooling water pump driving gear tightening nut	M24 × 2.0	36	235 ~ 255	24 ~ 26	
Cooling water pump idle gear shaft clamping bolt	M16 × 1.5	24	118 ~ 137	12 ~ 14	
Main bearing cap side bolt	M22 × 1.5	32	343 ~ 382	35 ~ 39	
Flywheel clamping bolt	M20 × 1.5	24	510 ~ 569	52 ~ 58	
Exhaust manifold clamping bolt	M12 × 1.75	19	59 ~ 69	6 ~ 7	
Exhaust expansion joint clamping bolt	M12 × 1.75	19	59 ~ 69	6 ~ 7	
Lub.oil pump driving gear tightening nut	M24 × 2.0	36	157 ~ 177	16 ~ 18	
Swing arm shaft clamping bolt	M16 × 1.5	24	118 ~ 137	12 ~ 14	

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11-2. Rotational Speed Dropped Spontaneously

Cause	Countermeasure	
(1) Clogging of fuel oil filter	Clean the filter.	
(2) Seizure of moving part (piston, main bearing or turbocharger)	Check and repair the pertinent moving part, of replace it.	
(3) Air mixed in fuel oil pipe system	Check and repair the fuel oil pipe system, then bleed air.	
(4) Moisture content in fuel oil	Drain the filter, tank, etc.	
(5) Defect of fuel injection pump	Check and repair the pump, or replace it.	
(6) Defect of fuel injection valve	Check and adjust the valve, or replace it.	
(7) Malfunction of governor	Check and adjust the governor, or replace it.	

11-3. Output of Each Cylinder not in Uniformity. (Dispersion of the maximum combustion pressure and exhaust temperature is large among cylinders.)

Cause	Countermeasure	
(1) Air mixed in fuel oil pipe system	Check and repair the fuel oil pipe system, then bleed air.	
(2) Moisture content in fuel oil	Drain the filter, tank, etc.	
(3) Fuel injection volume not in uniformity among cylinders		
1.Nonuniform position of fuel injection pump racks	Check the position of fuel injection pump racks, then adjust it.	
2.Sticking or wear of fuel injection pump plunger	Check and repair the plunger, or replace it.	
3.Defect of fuel injection valve	Check and repair the valve, or replace it.	
4.Looseness or damage of fuel injection pipe	Check and repair the pipe, or replace it.	
5.Sticking of suction / exhaust valve or damage of suction / exhaust valve seat	Check and repair the pertinent valve or valve seat, or replace it.	
6.Damage of fuel cam, or damage of suction / exhaust cam	Check the fuel cam or suction / exhaust cam, then repair it, of replace it.	

11-4. Bad Color of Exhaust Gas

Cause	Countermeasure	
(1) Improper injection timing	Check and adjust the timing.	
(2) Defect of fuel injection valve (fuel injection pressure drop, sticking of nozzle)	Check the valve, then regulate the pressure, or replace it.	
(3) Defect of fuel injection pump	Check the pump, then repair it, or replace the pertinent valve sect.	
(4) Improper adjustment of suction / exhaust valve head clearance or damage of suction / exhaust valve seat	Adjust or correct the clearance, or replace the pertinent valve sect.	
(5) Sticking of suction / exhaust valve	Overhaul the suction / exhaust valve, and then correct it.	
(6) Damage of suction / exhaust cam	Replace the camshaft.	
(7) Defect of turbocharger		
1.Clogging of filter	Wash the filter.	
2.Fouling of the blower side or turbine side	Overhaul and wash the turbocharger / blower.	
(8) Fouling of boost air cooler (too high temperature of boost air)	Overhaul and clean the air cooler.	
(9) Shortage of fuel oil	Use a high-quality fuel oil.	
(10) Overload	Reduce the load.	

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付図1. シリンダヘッド仕組

Fig.1 CYLINDER HEAD ASS'Y

A 仕様：燃料 A重油 / A Spec.: A-Heavy Fuel Oil (M.D.O).

B 仕様：燃料 低質油 (1500秒油) / B Spec.: Low Quality Fuel Oil (1500Sec. Oil).

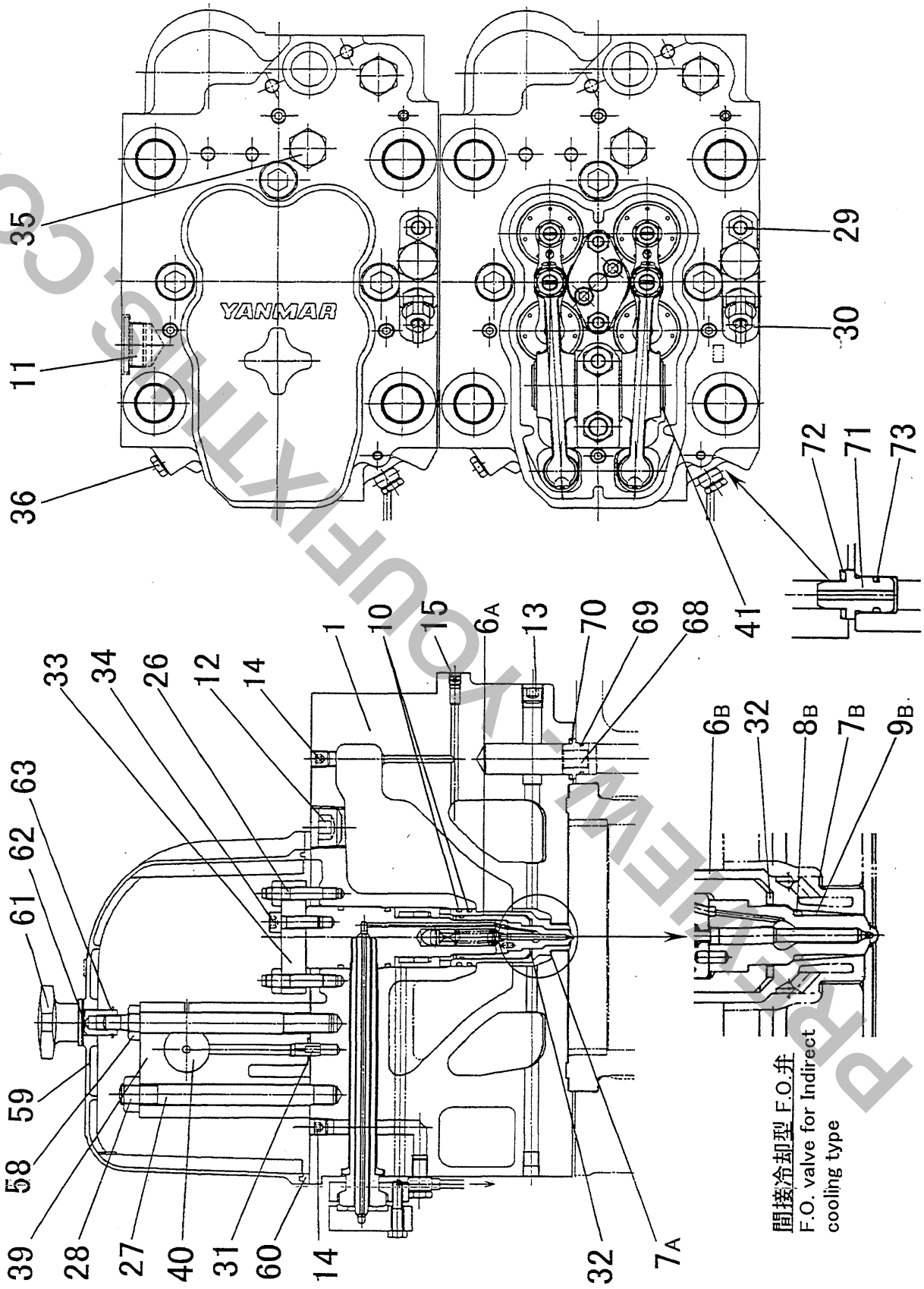
C 仕様：燃料 低質油 (3500秒油) / C Spec.: Low Quality Fuel Oil (3500Sec. Oil).

Item	部品名称	数量 Quantity			部品番号 Part No.	Part Name
		A	B	C		
	シリンダヘッド仕組	6set			746674-11121	CYLINDER HEAD Ass'y
	シリンダヘッド仕組		6set		746674-11104	CYLINDER HEAD Ass'y(1500Sec. Oil)
	シリンダヘッド仕組			6set	746674-11114	CYLINDER HEAD Ass'y(3500Sec. Oil)
1	シリンダヘッド	6			146673-11050	CYLINDER HEAD
	シリンダヘッド		6	6	146673-11031	CYLINDER HEAD
2	バルブシート (吸気弁)	12	12	12	146673-11701	VALVE SEAT, suction valve
3	バルブシート (排気弁)	12	12	12	146673-11090	VALVE SEAT, exhaust valve
4	Oリング (排気ﾊﾞﾙﾌﾞｼｰﾄ)	12	12	12	146603-11810	O-RING, exhaust valve seat
5	Oリング (排気ﾊﾞﾙﾌﾞｼｰﾄ)	12	12	12	146673-11810	O-RING, exhaust valve seat
6A	ノズルスリーブ (燃料弁)	6			146673-11860	NOZZLE SLEEVE, fuel oil Valve
7A	パッキン (ﾉｽﾞﾙｽﾘｰﾌﾞ)	6			146673-11870	GASKET, nozzle sleeve
10	Oリング (4D) G40	12			24326-000400	O-RING (4D) G40
6B	ノズルスリーブ (燃料弁)		6	6	146673-11611	NOZZLE SLEEVE, fuel oil Valve
7B	パッキン (ﾉｽﾞﾙｽﾘｰﾌﾞ)		6	6	147643-11870	GASKET, nozzle sleeve
8B	押え輪 (テフロンリング)		6	6	146673-11800	RETAINER, teflon ring
9B	テーパブッシュ (銅)		6	6	146673-11622	TAPER BUSH, copper
10	Oリング (4D) G40		12	12	24326-000400	O-RING (4D) G40
11	プラグ (シリンダヘッド)	48	48	48	146673-11950	PLUG, cylinder head
	パッキン (プラグ)	48	48	48	146673-11960	GASKET, plug
12	ねじプラグ PT1	18	18	18	23876-100000	PLUG PT1
13	ねじプラグ PT3/8	24	24	24	23876-030000	PLUG PT3/8
14	ねじプラグ PT1/4	30	30	30	23876-020000	PLUG PT1/4
15	プラグ PT1/8	42	42	42	23876-010000	PLUG PT1/8
16	吸気弁 120	12	12	12	146673-11720	SUCTION VALVE 120
17	排気弁 (Crメッキ)	12	12		146673-11110	EXHAUST VALVE, Cr plating
	排気弁 (ナイモニック)			12	146673-11170	EXHAUST VALVE, Nimonic
18	バルブガイド	24	24	24	141616-11171	VALVE GUIDE
19	バルブステムシール (吸気)	12	12	12	146673-11650	VALVE STEM SEAL, suction
20	バルブステムシール (排気)	12	12	12	141616-11751	VALVE STEM SEAL, exhaust
21	コッタ	24	24	24	27310-140000	COTTER

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付図1.　シリンダヘッド仕組

Fig.1　CYLINDER HEAD ASS'Y



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INSPECTION INSTRUCTIONS FOR MODEL 45MA AIR STARTER CONTROL MODULE

1. Before Inspection

Be sure to release the air pressure of the system before setting about the inspection.

When the starting power voltage of the air starter 45MA is 24VDC, refer to Fig.1.below. When the voltage is 100VDC refer to Fig.2.

Control Module for 24VDC: Part Number 2-24775-005 / Yanmar Part No. 146673-77191
Control Module for 100VDC: Part Number 2-24775-005-1 / Yanmar Part No.146673-77211

2. Inspection.

2-1. Trouble: The air starter does not start even with the application of the normal air pressure.

Measure: It is possible that no power is supplied to the control module. Remove the screws at the input and output connectors (see Fig.2 below) and pull them out from the control module body. Check that the power voltage is supplied to the input side connector lead wire.

2-2. Trouble: Solenoid valve does not open even when the power is supplied to the control module.

Measure:

① Check the control module body:
Impress the power voltage to the plus (+) and minus (-) poles of the input terminal and measure the voltage of the output terminal. The function is normal when the power voltage as impressed appears.

② Check the solenoid valve:
Supply 0.2MPa (2kg/cm^2) air pressure to the NC (normal closed) piping of the solenoid valve removed from the control module. Impress DC12V between the terminals (no polarity) of the solenoid valve, open it and check for the function. If the solenoid valve is normal, replace the control module.

③ When the function of the solenoid valve is not normal:

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Use the following exclusive tools for loosening and tightening each nut.

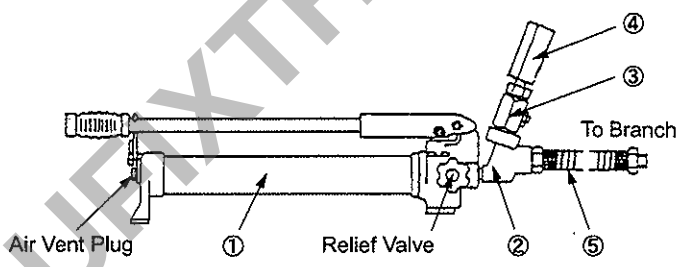
[Usage]

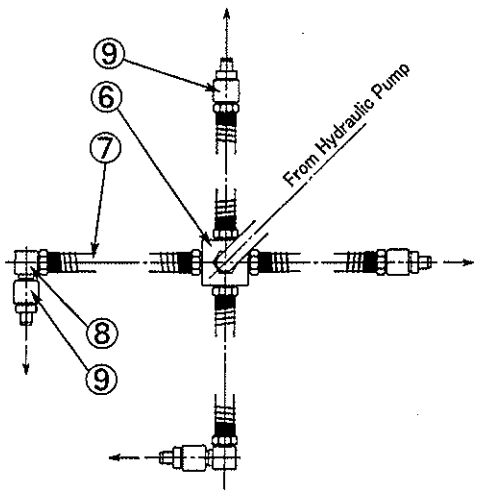
(1) When assembling the hydraulic jack, be sure to use the sealing tape at the threaded part so that there will be no leakage.
(2) Connect the hydraulic pump and branch with 3 m long rubber hose.
(3) Connect two 1 m long rubber hoses to the branch.
(4) Use the hydraulic pump placed horizontally.
(5) To operate the hydraulic pump, use it, opening the air valve.
(6) When a hydraulic jack is used for the first time, the rubber hose is filled with the hydraulic fluid. Therefore, when the hydraulic pressure begins to rise, loosen the air vent plug of hydraulic pump, and then checking the oil volume, replenish the hydraulic fluid.
(7) If the hydraulic jack does not work even though the hydraulic pressure has risen to the specified value, loose couples will be the cause.
Loosen the relief valve of hydraulic pump to lower the hydraulic pressure, and then check the connection of couples.

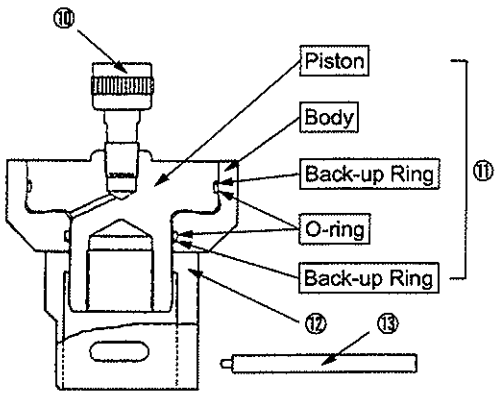
[Common Tools]

No.	Exclusive Tool Description	Qty.
①	Hydraulic pump	1
②	Connecting Piece	1
③	Gauge damper	1
④	Pressure gauge	1
⑤	Rubber hose, 3 m long	1
⑥	Branch	1
⑦	Rubber hose, 1 m long	4
⑧	Square elbow	2
⑨	Coupler, external threaded	4
⑩	Coupler, internal threaded	4
⑪	Hydraulic jack	4
⑫	Spacer	4
⑬	Handle	1

Drawing 7-3(1/2). Hydraulic Jack Handling Procedures [Common Tools]







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5. FUEL OIL, LUB. OIL & COOLING WATER

5-1. Fuel Oil

The properties of fuel oil applicable to this engine are shown in the following table.
The properties of fuel oil are uncertain and broadly ranged; thus they affect such factors as a smooth run of the engine, maintenance interval and service life of parts. Consequently, it might be necessary to change the specifications of engine or add attachment in accordance with the applied fuel oil.

5-1-1. Quantity Criteria of Fuel Oil

Quality Criteria \ Direct burning fuel oil			---	200sec.Oil	1,500sec.Oil	3,500sec.Oil	7,000sec.Oil
Viscosity	at 50 ℃	cSt	3 ~ 8	< 30	< 180	< 380	< 700
	R.W.No.1 at 100°F	sec.	37 ~ 58	< 200	< 1500	< 3500	< 7000
Property critical value	Specific gravity at 15/4 ℃		< 0.86	< 0.991	< 0.991	< 0.991	< 0.991
	Flash point	℃	> 60	> 60	> 60	> 60	> 60
	Residual carbon	mass.%	< 0.7	< 10	< 15	< 18	< 22
	Sulfur content	mass.%	< 1.0	< 3.5	< 5	< 5	< 5
	Ash content	mass.%	---	< 0.10	< 0.10	< 0.15	< 0.20
	Moisture content	vol.%	< 0.1	< 0.5	< 1.0	< 1.0	< 1.0
	Vanadium	ppm	---	< 150	< 300	< 500	< 600
	Sodium	ppm	---	< 30	< 40	< 100	< 200
	Aluminum	ppm	---	< 30	< 30	< 30	< 30
	Diesel index		(Cetane no. of > 45)	> 30	> 25	> 20	> 15
Quality criteria equivalent fuel oil	ISO		DBMorDMA	RMB10	RME25	RMG35	RMH55
	CIMAC		---	CIMAC B10	CIMAC E25	CIMAC G35	CIMAC H55
	BSI		---	(M4)	(M6)	(M7)	M9
	JIS		M.D.O	I.F.O	H.F.O.(heavy fuel oil)		

Note: M.D.O. = marine diesel oil; I.F.O. = intermediate fuel oil

" Use HFO with the CCAI, (an ignitability index), below 850 as an standard. (However, please note that the said value was estimated from the past operation data and that the value can vary depending on the future fuel oil quality.) The use of HFO with CCAI exceeding 850 will cause faulty combustion and aggravate exhaust color. If such use is inevitable, raise the intake air temperature. This will improve combustion to an extent. However, raise the intake air temperature carefully in relation with the exhaust temperature, since this will affect the exhaust temperature and other engine performance."

What is CCAI?
CCAI stands for **C**alculation **C**arbon **A**romaticity **I**ndex, which shows an ignitability index.
The index, in consideration of the relation between aromatic compound content in fuel oil and the ignitability is used to obtain the aromaticity degree in relation with the fuel oil properties. The larger the CCAI value, the larger the firing delay for inferior ignitability. In this case, the HFO direct starting is not possible or exhaust color is aggravated due to faulty combustion.

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6-3-20. Check & Replacement of Anticorrosive Zinc

In the case of the fresh & sea water 2-line cooling specification, anticorrosive zincs have been fitted to the boost air cooler, lub. oil cooler. Check them according to the following procedures:

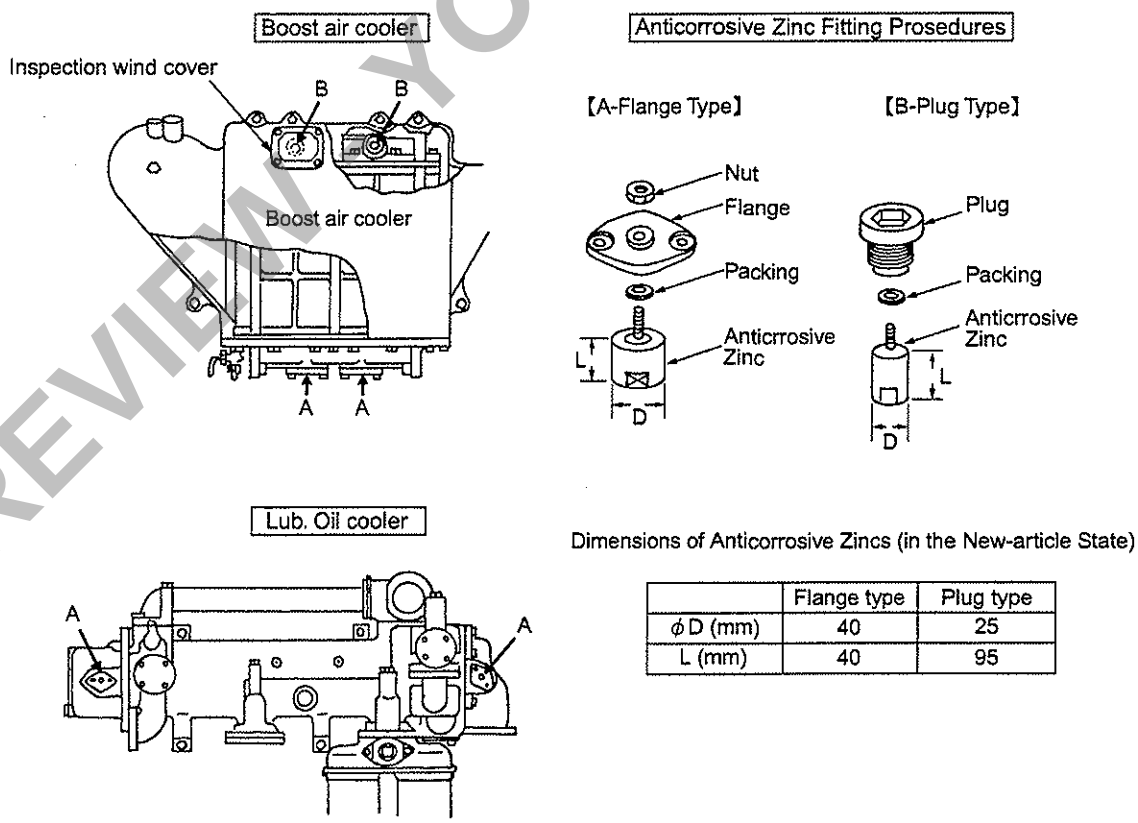
- In the case where such anticorrosive zinc is found consumed more than 70% of the state retained by the new article, replace it with the new one.

Fitting Area (Q'ty)	
Boost air cooler	Cooling water inlet/outlet cover (2) Water return cover (2) ··· plug type
Lub. oil cooler	Inlet side cover (1) Outlet side cover (1)

- In the case of continuous use of such anticorrosive zinc, get rid of the oxide layer from the surface of the zinc to expose the metallic texture.
- The anticorrosive zinc for boost air cooler upper part is of the plug type. Detach the inspection window cover from the boost air duct, and remove the plug, using a hexagonal wrench key (having the width across flats of 17mm).

△ After checking and replacing an anticorrosive zinc and before fitting the inspection window cover, check that there is no water leakage.

Drawing 6-33. Anticorrosive Zincs Equipped points



Dimensions of Anticorrosive Zincs (in the New-article State)

	Flange type	Plug type
ϕD (mm)	40	25
L (mm)	40	95

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7-8-2. Lub. Oil Cooler

The lub. oil cooler is of the multi tubular type, and chemical cleaning seats that enable cleaning of the oil cooler without removing it are equipped on the lubricating oil passage side.

1) Chemical cleaning procedures

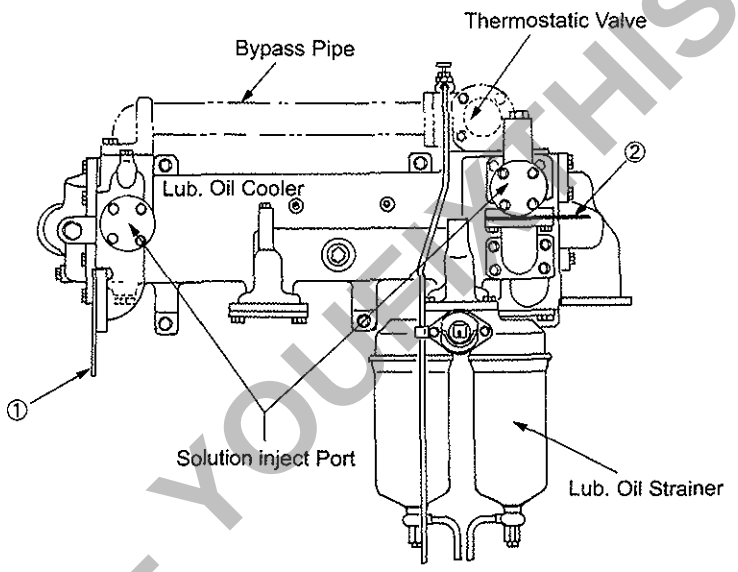
The hose, pump and the like required for chemical cleaning are not included in the standard provision of this engine.

(1) Drain the lubricating oil from the oil cooler, rearrange the respective baffle plates ① , ② & ③ at the oil cooler inlet and outlet.

(2) Remove the round covers from the chemical cleaning seats and connect a hose with each seat. Then, circulate the cleaning solution.

(3) After having finished cleaning, drain the cleaning solution, and return the baffle plates and round covers to their former condition.

Drawing 7-54. Chemical Cleaning Procedures



To prevent the cleaning solution from being mixed into the lubricating oil, be sure to treat the oil cooler after chemical cleaning.

2) Disassembly

Drain the lubricating oil from the lub. oil cooler, fix the cooler body with rope, and remove it from the engine.

(1) Remove the lub.oil strainer.

(2) Remove the caps from the cooling water inlet and outlet.

(3) Remove the lub. oil thermostatic valve.

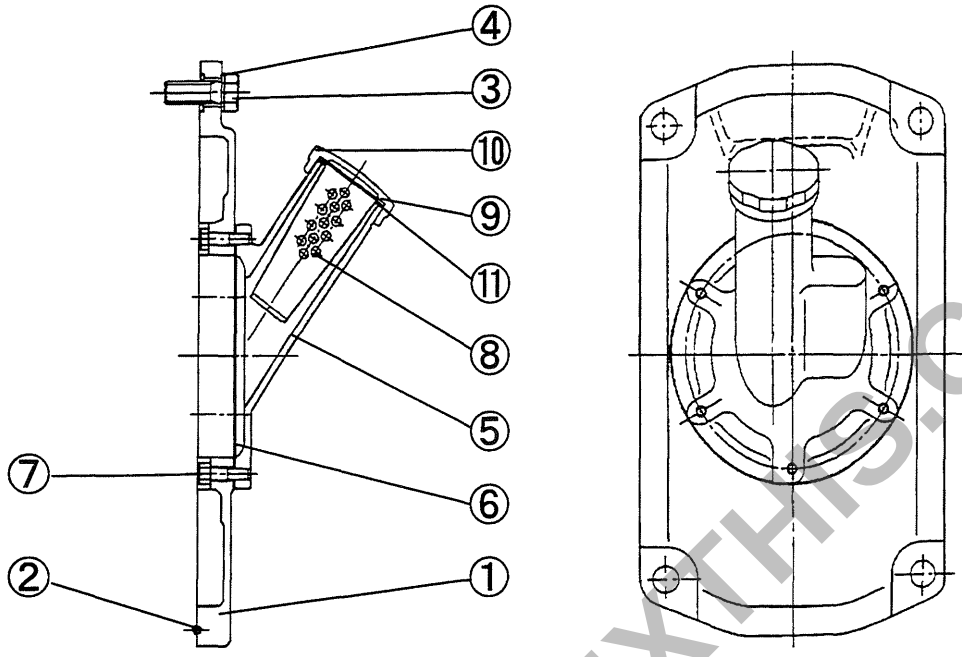
(4) Remove the cooling water pipe assembly.

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付図5-2. シリンダ側ふた仕組（給油口付）

Fig.5-2 CYLINDER-BLOCK SIDE COVER ASS'Y, with lub. oil filler



Item	部品名称	数量 Quantity	部品番号 Part No.	Part Name
	シリンダ側ふた仕組（給油口付）	1set	746673-01180	CYLINDER-BLOCK SIDE COVER ASS'Y, with lub. oil filler
	側ふた仕組	1s	146673-01390	SIDE COVER ASS'Y
1	シリンダ側ふた	(1)	146673-01430	CYLINDER SIDE COVER
2	パッキン	(1)	146673-01411	GASKET
3	ボルト M16×35	4	26152-160352	BOLT M16×35
4	座金 16	4	22137-160000	WASHER 16
5	給油口本体	1	153605-09410	BODY, oil filler
6	パッキン	1	142613-03541	GASKET
7	六角穴付ボルト M8×25	6	26450-080252	HEXAGON SOCKET HEAD BOLT M8×25
	銅パッキン 8×1	6	23414-080000	GASKET, copper 8×1
8	こし網	1	132310-03080	FILTER
9	パッキン（上）	1	137900-09420	GASKE, upper
10	給油口ふた	1	138613-09410	CAP, oil filler
11	パッキン（下）	1	137900-09430	GASKE, lower

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付図19. ピストンおよび連接棒仕組

Fig.19 PISTON & CONNECTING ROD ASS'Y

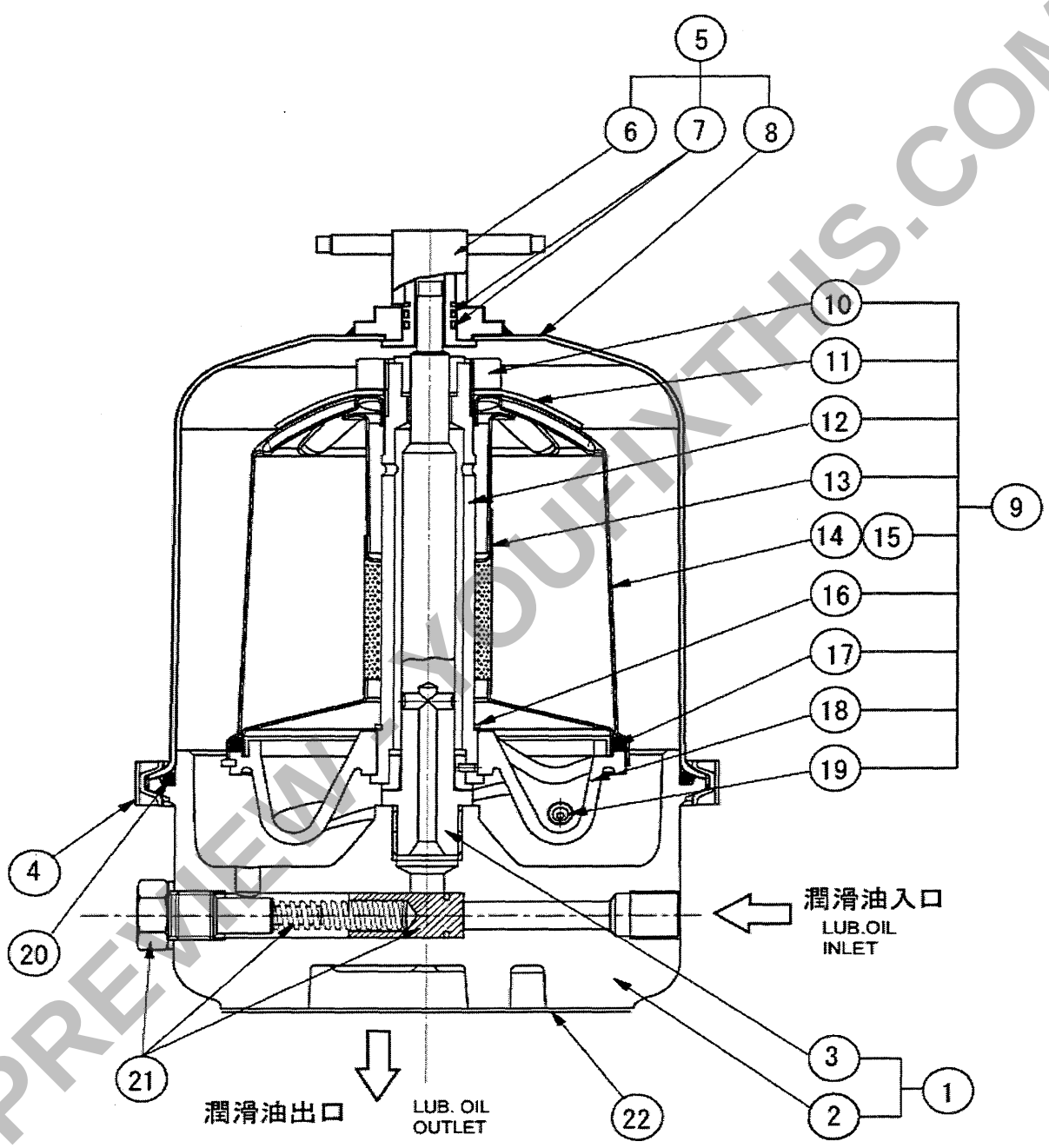
Item	部品名称	数量 Quantity	部品番号 Part No.	Part Name
	ピストン仕組	6set	746674-22011	PISTON ASS'Y
	ピストン仕組	6s	146674-22450	PISTON ASS'Y
1	ピストン	(6)	146674-22060	PISTON
2	ふた（冷却室/穴無）	(6)	146603-22850	COVER, cooling chamber / blind
3	ふた（冷却室/φ12穴）	(6)	146673-22850	COVER, cooling chamber / hole φ12
4	ボルト M8×12	(24)	26206-080122	BOLT M8×12
	ねじ用皿ばね	(24)	138613-23290	CUP WASHER
5	ピストンリング（No.1）（3面メッキ）	6	146673-22130	COMPRESSION RING, No.1 (3-face CR-plated)
6	ピストンリング（No.2）	6	146673-22140	COMPRESSION RING, No.2
7	オイルリング仕組	6s	146673-22180	OIL RING ASS'Y
	オイルリング（No.3）	(6)	146673-22160	OIL RING, No.3
	コイルエキスパンダ	(6)	146673-22170	COIL EXPANDER
	ピストンピン仕組	6s	146673-22310	PISTON PIN ASS7Y
8	ピストンピン	(6)	146673-22300	PISTON PIN
9	油止め管	(6)	146673-22320	TUBE, oil gallery
10	穴用C型止め輪 75	12	22252-000750	RETAINING RING, C type 75
11	平先止めねじ M10×12	6	26911-100122	SLOTTED SET SCREW M10×12
	【備 考】 再生ピストンの場合			【Remark】 In the case of piston ring groove plating repaired piston
5	ピストンリング（No.1）（1面メッキ）	6	146674-22110	COMPRESSION RING, No.1 (1-face CR-plated)
	『注 意』 ピストントップリング溝をクロームメッキで再生している場合は、3面クロームメッキリングを使用しないで下さい。			『CAUTION』 If the piston top ring groove have been repaired with Cr-plating. DO NOT USE THE 3-FACE-CR-PLATED TOP RING.

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付図25-3. 潤滑油バイパスこし器仕組 / FM200型（遠心式）

Fig.25-3 LUBRICATING OIL BY-PASS STRAINER / FM200 TYPE, (centrifugal type)



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付図33-1. 冷却水管装置 (低温水系：海水ポンプ船体付仕様)

Fig.33-1 COOLING WATER PIPE SYSTEM, cold water line : sea water pump hull fitting spec.

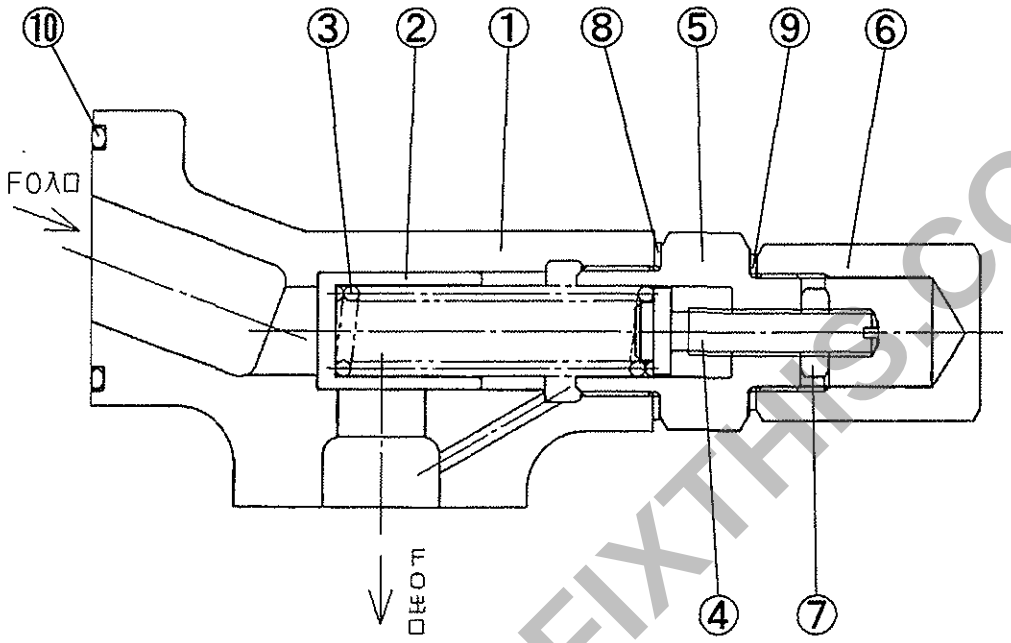
Item	部品名称	数量 Quantity Ⓐ	数量 Quantity Ⓑ	部品番号 Part No.	Part Name
22	パッキン	1	1	138613-49220	GASKET
	ボルト M16×40	4	4	26152-160402	BOLT M16×40
23	高温水ポンプ仕組	1set	1set	付図 30-1 参照 Refer to Fig.30-1	HOT WATER PUMP ASS'Y
	冷却水出口管仕組 (高温水ポンプ出口)	1set	1set	746673-49160	COOLING WATER OUTLET PIPE ASS'Y, hot water pump outlet
24	Oリング (4D) G90	1	1	24326-000900	O-RING (4D) G90
	ボルト M12×30	3	3	26206-120302	BOLT M12×30
25	冷却水連絡管	1	1	146676-49550	COOLING WATER CONNECTOR
26	Oリング (4D) G80	1	1	24326-000800	O-RING (4D) G80
	冷却水集合管仕組	1set	1set	746673-49110	COOLING WATER CONCENTRATOR ASS'Y,
27	冷却水連絡管 (ヘッド出口)	6	6	146673-49361	COOLING WATER CONNECTOR, head outlet
	パッキン 36×1.5	12	12	23428-360000	GASKET 36×1.5
	ボルト M12×30	12	12	26206-120302	BOLT M12×30
	遮熱カバー	6	6	146673-13331	COVER, heat off
28	冷却水集合管 A	1	1	146683-49340	COOLING WATER CONCENTRATOR A
	パッキン	1	1	146683-49400	GASKET
	ボルト M10×30	4	4	26206-100302	BOLT M10×30
	冷却水集合管 B	1	1	146673-49350	COOLING WATER CONCENTRATOR B
	ふた	1	1	146673-49570	COVER
	パッキン	1	1	147673-49410	GASKET
	ボルト M10×25	4	4	26206-100252	BOLT M10×25
29	パッキン	1	1	146683-49400	GASKET
	ボルト M10×35	4	4	26206-100352	BOLT M10×35
	ナット M10	4	4	26706-100002	NUT M10
30	冷却水出口管	1	1	146676-49370	COOLING WATER OUTLRT PIPE
	六角プラグ G3/8	1	1	23897-030002	HEXAGON PLUG G3/8
	銅パッキン 17×1	1	1	23414-170000	GASKET, Copper 17×1
	六角プラグ G1/2	2	2	23897-040002	HEXAGON PLUG G1/2
	銅パッキン 21×1	2	2	23414-210000	GASKET, Copper 21×1
	六角プラグ G3/4	1	1	23897-060002	HEXAGON PLUG G3/4
	銅パッキン 27×1	1	1	23414-270000	GASKET, Copper 27×1

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付図40. 燃料バイパス弁仕組（C重油仕様）

Fig.40 FUEL OIL BY-PASS VALVE ASS'Y, heavy fuel oil spec.



Item	部品名称	数量 Quantity	部品番号 Part No.	Part Name
	燃料バイパス弁仕組	1set	746673-59351	FUEL OIL BY-PASS VALVE ASS'Y
1	バイパス弁本体	(1)	146673-59741	BODY, by-pass valve
2	調整弁	(1)	135310-34030	REGULATING VALVE
3	ばね	(1)	151605-52580	SPRING
4	調整ねじ	(1)	135410-84281	ADJUSTING SCREW
5	弁押え	(1)	141644-59860	VALVE HOLDER
6	袋ナット	(1)	135410-84301	CAP NUT
7	止めナット M8	(1)	26796-080002	LOCK NUT M8
8	シールワッシャ 22×1.2	(1)	153672-59950	SEAL WASHER 22×1.2
9	シールワッシャ 20×1.2	(1)	153672-59970	SEAL WASHER 20×1.2
10	Oリング (4D) G40	1	24326-000400	O-RING (4D) G40
	取付ボルト M12×30	2	26206-120302	BOLT M12×30

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付図50 操作空気管装置(燃料流量制御)

Fig.50 OPERATION AIR PIPE SYSTEM, fuel oil control

Item	部品名称	数量 Quantity	部品番号 Part No.	Part Name
38	止めナット M16	1	26772-160002	LOCK NUT M16
39	空気管(燃料制限)	1	146673-73301	AIR PIPE (FUEL OIL LIMITATION)
40	管継手ボルト 8	1	23854-080000	PIPE JOINT BOLT 8
	銅パッキン 14×1	2	23414-140000	COPPER PACKING 14×1
	空気管仕組 (安全システム)	1set	746673-73130	AIR PIPE ASS'Y (SAFETY SYSTEM)
41	三方マグネットバルブ	1	46116-002380	3-WAY MAGNET VALVE
	ボルト M5×8	2	26116-050082	BOLT M5×8
	ソケット PT1/4×M14	2	43570-000080	SOCKET PT1/4×M14
42	空気管 (ﾏｸﾞﾈｯﾄﾊﾞﾙﾌﾞ ～ ｴｱﾎﾟﾝﾌﾟ)	1s	146673-73370	AIR PIPE (MAGNET VALNE ～ AIR PUMP)
43	管継手ボルト 8	1	23854-080000	PIPE JOINT BOLT 8
	銅パッキン 14×1	2	23414-140000	COPPER PACKING 14×1
44	貫通ユニオン	1	146673-73800	UNION
	止めナット M16	1	26772-160002	LOCK NUT M16
45	空気管(エアピストン入口)	1s	146673-73610	AIR PIPE (AIR PISTON INLET)
46	管継手ボルト 8	1	23854-080000	PIPE JOINT BOLT 8
	銅パッキン 14×1	2	23414-140000	COPPER PACKING 14×1
	空気管仕組(停止)	1set	746673-73211	AIR PIPE ASS'Y (STOP)
47	空気管 (マグネットバルブ入口)	1s	146673-73360	AIR PIPE (MAGNET VALVE INLET)
48	管継手ボルト 8	2	23854-080000	PIPE JOINT BOLT 8
	銅パッキン 14×1	4	23414-140000	COPPER PACKING 14×1
49	サポート(電磁弁)	1	146673-73452	SUPPORT (MAGNET VALVE)
	ボルト M8×14	2	26206-080142	BOLT M8×14
	ナット M8	2	26706-080002	
50	三方マグネットバルブ	1	46116-002380	3-WAY MAGNET VALVE
	ボルト M5×8	2	26116-050082	BOLT M5×8
	ソケット PT1/4×M14	2	43570-000080	SOCKET PT1/4×M14
51	空気管 (ﾏｸﾞﾈｯﾄﾊﾞﾙﾌﾞ ～ ｴｱﾎﾟﾝﾌﾟ)	1s	146673-73381	AIR PIPE (MAGNET VALVE ～ AIR PISTON)

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