

YANMAR

OPERATION MANUAL

MARINE PROPULSION ENGINE

**12AYM-WGT
12AYM-WET
12AYM-WST**

en English

YANMAR MARINE DIESEL ENGINE OPERATION MANUAL

Thank you for purchasing a YANMAR Marine Diesel Engine.

[INTRODUCTION]

- This Operation Manual describes the operation, maintenance and inspection of the YANMAR marine diesel engine.
- Read this Operation Manual carefully before operating the engine to ensure that the engine is used correctly and that it stays in the best possible condition.
- Keep this Operation Manual in a convenient place for easy access.
- If this Operation Manual is lost or damaged, order a new one from your YANMAR dealer or distributor.
- Make sure this manual is transferred to subsequent owners. This manual should be considered a permanent part of the engine and remain with it.
- Constant efforts are made to improve the quality and performance of YANMAR products, so some details included in this Operation Manual may differ slightly from your engine. If you have any questions about such differences, please contact your YANMAR dealer or distributor.
- The specifications and components (instrument panel, fuel tank, etc) described in this manual may differ from the ones installed on your vessel.
Please refer to the manual provided by the manufacturer of these components.

OPERATION MANUAL	Model	12AYM-WGT, 12AYM-WET, 12AYM-WST
	Code No.	0AAYV-G00203

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FOR YOUR SAFETY

Following the precautions described in this manual will enable you to use this engine with complete satisfaction. Failure to observe any of the rules and precautions, however, may result in injury, burns, fires and engine damage. Read this manual carefully and be sure you fully understand it before beginning operation.

Safety Symbols

These are the warning signs used in this manual and on the product.



This safety alert symbol appears with most safety statements. It means attention, become alert, your safety is involved! Please read and abide by the message that follows the safety alert symbol.

 **DANGER**

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

 **WARNING**

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

 **CAUTION**

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE indicates a situation which can cause damage to the machine, personal property and/or the environment or cause the equipment to operate improperly.

Safety Precautions

Safety precautions for operation

DANGER



Burns from steam

- Never remove the filler cap from the coolant tank while the engine is still hot. Steam and hot air will spurt out and seriously burn you. After engine stop, wait until the water temperature drops. Wrap a cloth around the filler cap and slowly loosen the cap.
- After inspection, tighten the filler cap firmly. If the cap is not secure, steam or hot air can spurt out during operation and seriously burn you.



Ventilation of the battery area

- Make sure that the area around the battery is well-ventilated and that no flammable materials are near.
- The battery emits hydrogen gas during operation and charging. The gas can catch fire.



Fires from oil ignition

- Be sure to use the correct type of fuel oil. Always double-check before fueling. The wrong fuel oils (e.g. gasoline) can cause a fire.
- Be sure to stop the engine before fueling. If you spill fuel oil, wipe the spillage carefully.
- Keep oil and other inflammable materials away from the engine. They can catch fire.

WARNING



Exhaust gas poisoning

- Never cover or block the windows, air vents, fans or other ventilation devices in the engine room. Always maintain good ventilation in the engine room during operation. Breathing exhaust gas is dangerous to your health.



Moving parts

- Keep your hands, other body parts and clothing away from moving parts (e.g. the front drive shaft, V-belt or propeller shaft). You will get caught and injured.
- Never operate the engine without the covers on the moving parts.
- Before engine start, check that you removed all tools and cloths from the area near the engine.



Alcohol and drugs

- Never operate the engine while you are under the influence of alcohol or drugs. Never operate the engine when you feel ill or unwell.

⚠ CAUTION



Burns

- Be careful of burns. The entire engine is very hot during and after operation.
- Keep your hands, other body parts and clothing away from the exhaust manifold, exhaust pipes, turbocharger, air cooler and engine body.

Safety precautions for maintenance

⚠ DANGER



Burns from steam

- Never remove the filler cap from the coolant tank while the engine is still hot. Steam and hot air will spurt out and seriously burn you. After engine stop, wait until the water temperature drops. Wrap a cloth around the filler cap and slowly loosen the cap.
- After inspection, tighten the filler cap firmly. If the cap is not secure, steam or hot air can spurt out during operation and seriously burn you.



Fires from oil ignition

- Be sure to use the correct type of fuel oil. Always double-check before fueling. The wrong fuel oils (e.g. gasoline) can cause a fire.
- Be sure to stop the engine before fueling. If you spill fuel oil, wipe the spillage carefully.
- Keep oil and other inflammable materials away from the engine. They can catch fire.

⚠ WARNING



Fires from electric short-circuits

- Always turn off the battery switch or detach the earth cable (-) before you inspect the electrical system.
- If you cause a short-circuit, a fire can occur.



Moving parts

- Stop the engine before you inspect it. If you have no choice but to inspect the engine while it operates, keep your hands, other body parts and clothing away from rotating parts. You will get caught and injured.



Exhaust gas poisoning

- Never cover or block the windows, air vents, fans or other ventilation devices in the engine room. Always maintain good ventilation in the engine room during operation. Breathing exhaust gas is dangerous to your health.

⚠ WARNING**Side cover opening**

Do not open the side cover when the engine is hot. The new air intrusion may lead to an explosion.

⚠ CAUTION**Battery fluid**

Be very careful not to expose your skin or eyes to the battery electrolyte.

The electrolyte is a strong acid and can cause inflammations.

If you come in contact with the battery fluid, wash it off immediately with a lot of freshwater.

Burns

• Be careful of burns. The entire engine is very hot during and after operation.

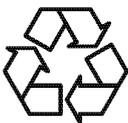
• Keep your hands, other body parts and clothing away from the exhaust manifold, exhaust pipes, turbocharger, air cooler and engine body.

NOTICE**No modification**

To keep the engine in good condition, the engine has been sealed to control the engine speed limit and the fuel injection quantity. If a seal is removed, the sliding and moving parts of the engine will suffer from increased wear. Engine performance will deteriorate and service life may shorten significantly. Removing a seal may also lead to increased lubricating oil and fuel consumption, seizure and breakage in all portions of the engine. Therefore, do not remove any seals. If the seal is removed, no warranty will be given even during the warranty period.

Regulation on NOx

Laws on maritime pollution and hazard prevention regulate the replacement of certain parts. The laws require that a record and the signature of personnel who replaces these parts is kept. All inspections and maintenance must be performed by our professional service technicians with the necessary expertise and skills.

Waste disposal

- Never dispose of waste oil, such as lubricating oil, by dumping it into a sewer, river, lake or ocean waters.
- Do not spill waste oil into ocean waters. Use a container to collect waste oil from the engine.
- Comply with relevant laws and/or regulations for the disposal of hazardous materials such lubricating oil, fuel, filters or batteries.

Warning Labels

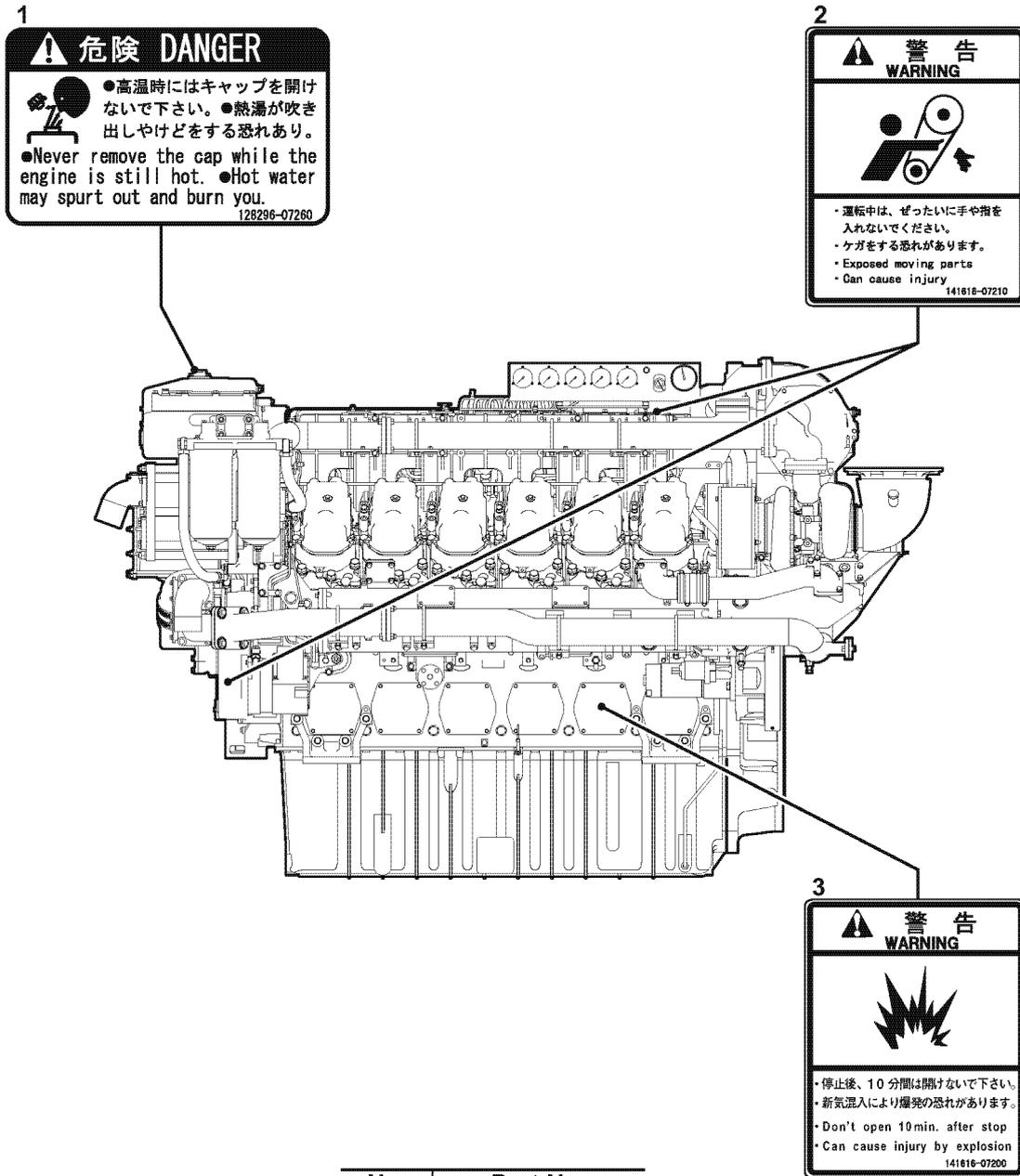
To ensure safe operation, the engine has warning labels attached at the locations described below.

Read the warning labels carefully to prevent accidents.

Also, if you need to replace a part that has a label attached to it, make sure that you order the new part together with the label.

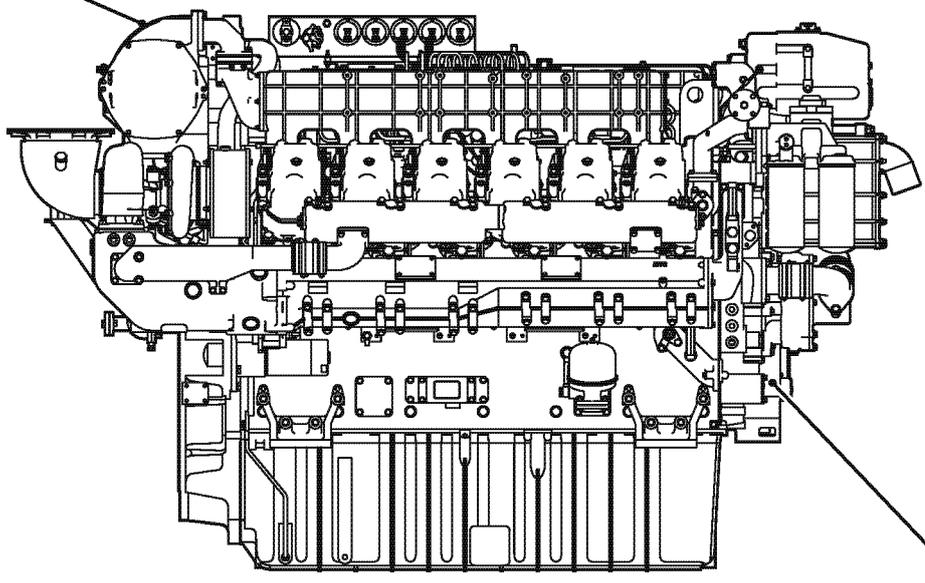
If the warning label is damaged or has fallen off, order a new one from your YANMAR dealer or distributor.

■ Operation side



No.	Part No.
1	128296-07260
2	141616-07210
3	141616-07200

■ Non-operation side



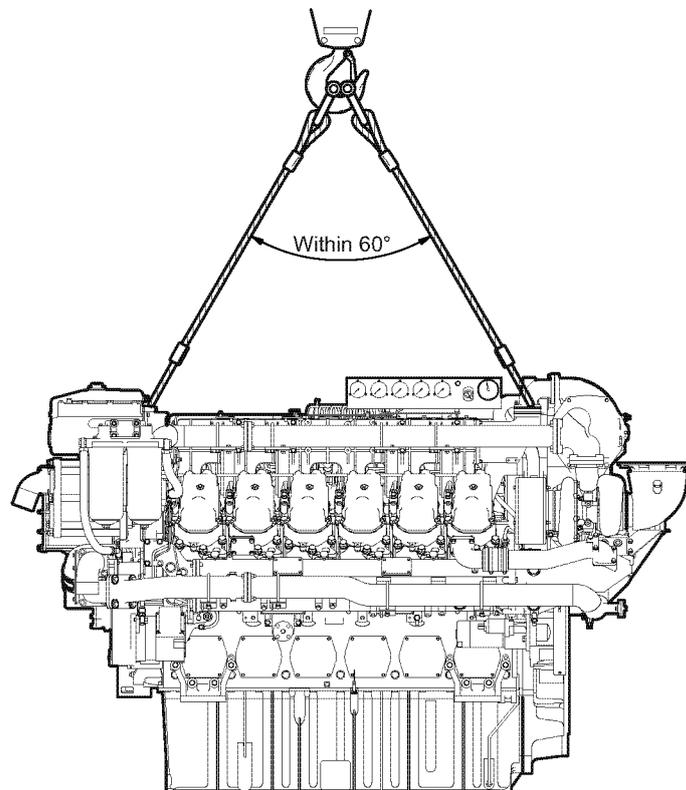
No.	Part No.
1	141616-07220
2	141616-07210

Precautions for Lifting the Engine

The engine can cause serious injury when it falls during lifting. Obey the below instructions to prevent accidents during lifting.

⚠ WARNING

- Make sure that the engine is lifted by qualified persons.
- Before lifting, make sure that the engine lifting bracket and mounting bolt have no damage and are in good shape. If you find a fault, stop immediately and contact your YANMAR dealer or distributor.
- Select lifting tools (e.g. wire rope and shackle) that are appropriate for heavy loads.
- Select the wire rope length so that the engine does not tilt during lifting.
- Before lifting, examine the lifting tools and make sure that they have no damage and are in good shape.
- Protect the parts of the engine or driven equipment that touch the wire rope with protective material.
- The tension of the wire rope changes depending on the lifting angle. Make sure that the angle is within 60°.
- If you use a marine gear that is not listed in this operation manual, separate the marine gear from the engine, and lift the marine gear and engine separately.
- During lifting and moving the engine, do not go under the engine or near the engine.



036947-03EN00

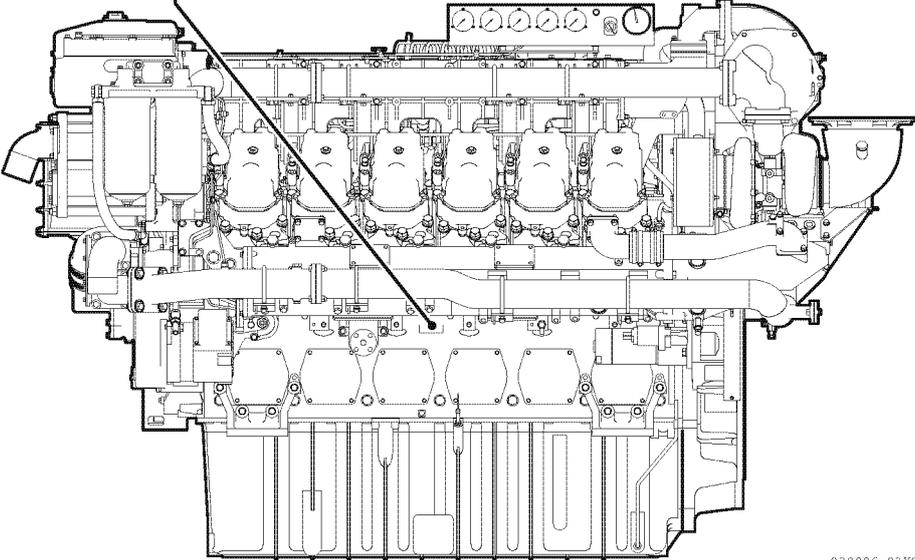
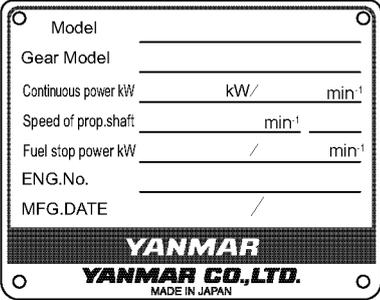
For the mass, refer to Specifications in the Operation Manual.

Engine Nameplate

Periodic inspection and maintenance are important to keep the engine in good condition. The serial number of your engine is required when requesting maintenance or ordering parts. Confirm it beforehand.

■ Location of the engine nameplate

The nameplate is on the A-bank (left) side on the top of the cylinder side cover of the cylinder block.



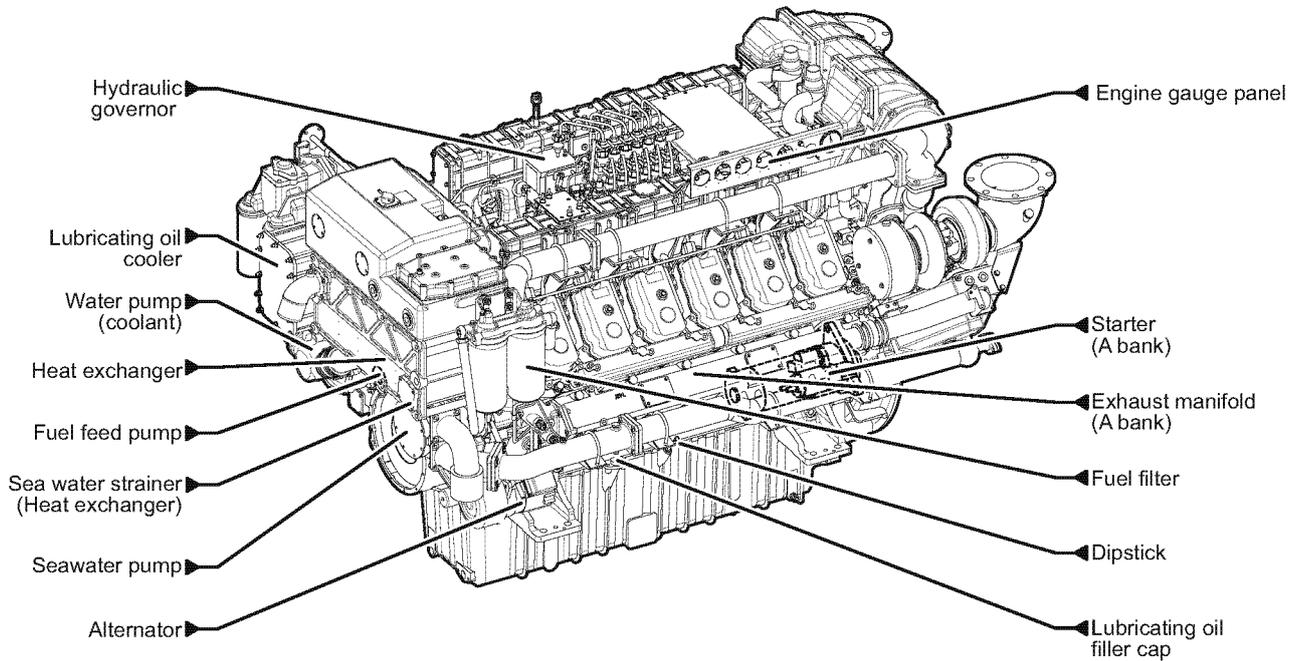
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SPECIFICATIONS

Model		Unit	12AYM-WGT	12AYM-WET	12AYM-WST		
Type		–	V-type, vertical, water-cooled, 4-cycle diesel engine				
Combustion system		–	Direct injection				
Number of cylinders		–	12				
Bore × stroke		mm	155 × 180				
Displacement		ℓ	40.757				
Rated output (flywheel output)	Rating	–	L	M	H	H	
	Output	kW	1340	1220	1140	1030	882
	Crankshaft speed	min ⁻¹	1940	1900	1840	1900	1850
Direction of rotation		–	Counterclockwise (viewed from flywheel side)				
Cooling system		–	Constant temperature cooling system (with heat exchanger)				
Coolant capacity	Engine	ℓ	225				
	Reservoir tank	ℓ	–				
Lubrication system		–	Forced lubrication with gear pump				
Lubricating oil capacity	Engine (oil pan)	ℓ	170				
	Marine gear	ℓ	Refer to marine gear manual				
Turbocharger type		–	Exhaust gas turbocharger (with air cooler)				
Starting system		–	Electric starting or air starting				
Engine dry mass (without marine gear)		kg	4950				

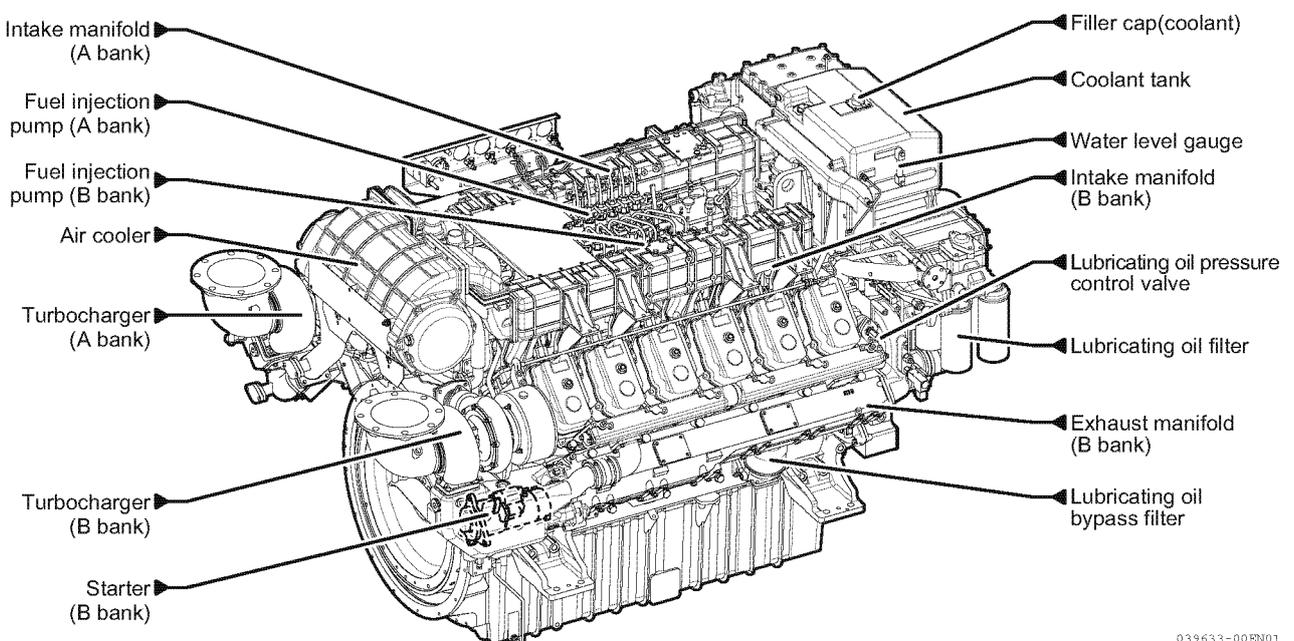
Location of Components

■ A-bank (left)



039627-00EN02

■ B-bank (right)



039633-00EN01

Functions of Major Components

Fuel oil system

■ Fuel feed pump

This mechanical fuel pump sends fuel oil to the fuel injection pump.

■ Fuel filter

This filter removes dust and unwanted material from the fuel. Replace the filter at regular intervals before the internal element gets clogged.

■ Fuel priming pump (hull fitting)

This manual wing pump sends fuel oil to the fuel feed pump. Use it when you bleed air from the fuel oil system. Move the handle to send the fuel oil.

■ Water separator (option/hull fitting)

This device separates water from fuel. Drain the excess water from the drain plug.

Lubricating oil system

■ Engine lubricating oil filter

This filter removes small metal particles and carbon from the lubricating oil. Replace the filter at regular intervals before the internal element gets clogged.

■ Engine lubricating oil bypass filter (centrifugal)

This filter removes sludge and metal powder with the use of centrifugal force by constantly bypassing a small quantity of lubricating oil. Do periodic inspections and clean the filter before the element gets clogged.

■ Lubricating oil priming pump (option/hull-installed)

This pump sends lubricating oil to the oil gallery and drains lubricating oil from the oil pan. Move the handle to send the lubricating oil.

Cooling system

■ Engine lubricating oil cooler

This heat exchanger cools the lubricating oil of the engine with coolant.

■ Coolant tank

This tank stores the coolant connecting to the heat exchanger. It has a water level gauge to check the coolant.

■ Filler cap

The cap has a pressure regulating valve. When the cooling water temperature rises, pressure rises inside the fresh water system, then the valve opens to release pressure and then inside pressure is going down the valve closes.

■ Heat exchanger

This heat exchanger cools hot coolant with seawater. Standard: It is installed to the engine. Option: It is installed separately to the hull.

■ Water pump (coolant)

This centrifugal pump sends coolant to cool the engine. The coolant flows through the engine and cools it. Then it returns to the coolant tank.

■ Seawater pump

This rubber-impeller pump takes in seawater, sends it to the heat exchangers and returns it to the sea. The centrifugal pump is an option.

■ Zinc anode

The metal area of the seawater cooling system is prone to electrical corrosion. The zinc is itself reduced over time by electrical corrosion, so it must be replaced at fixed intervals before it is completely consumed in order to ensure that the metal area of the seawater cooling system remains fully protected.

Supply air system

■ Turbocharger

The pressurized intake air feeding device: the exhaust gas turbine is rotated by the exhaust gas, and the power is used to rotate the blower. This pressurizes the intake air for sending to the cylinder.

■ Air cooler

This heat exchanger cools the air that comes from the turbocharger with seawater.

Electric system

■ Alternator

The alternator is driven by the V-belt. It creates electricity during operation and charges the battery.

■ Starter

The starter is a DC motor for electric starting. It is powered by a battery.

A compressed-air starter is available as an option.

Governor system

■ Hydraulic governor

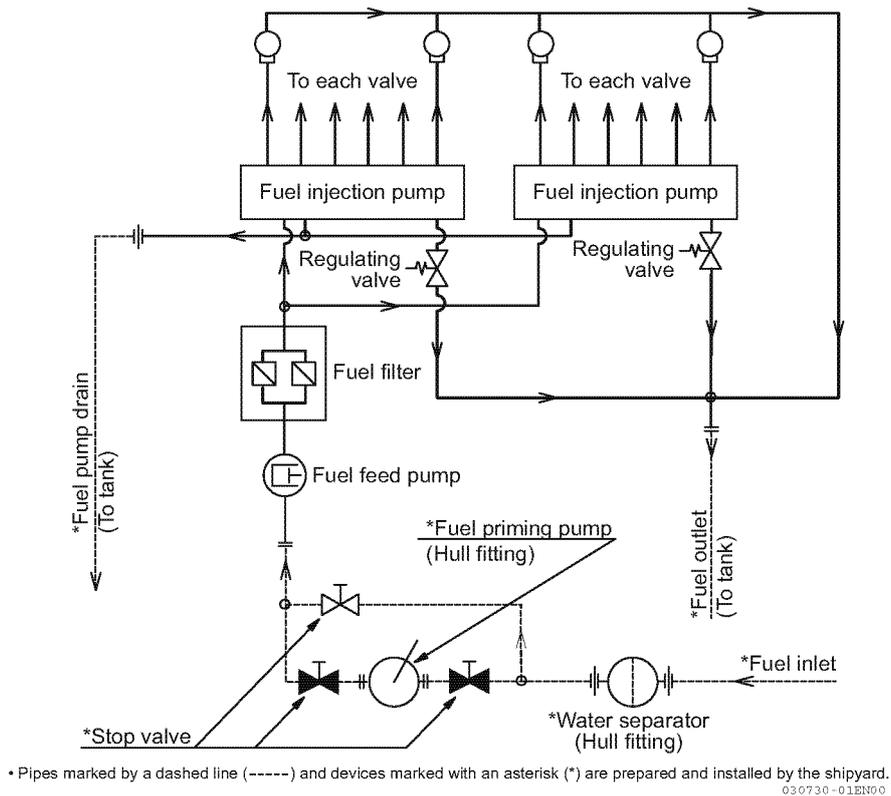
The hydraulic governor maintains an even engine speed. It adjusts the engine speed with hydraulic pressure by increasing or decreasing the fuel injection quantity.

Piping Diagram of Major Engine Parts

Fuel oil system

The fuel oil flows from the tank through the water separator (option), fuel feed pump, fuel filter, fuel injection pump and fuel injection pipes into the fuel injection valve.

Leak fuel from the injection valve and the injection pump flows back to the fuel tank.

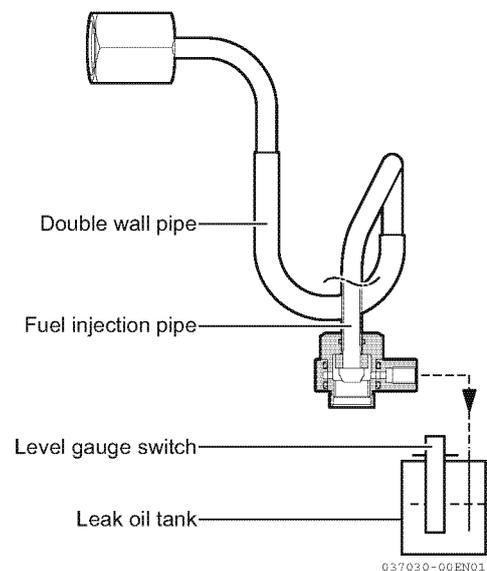


■ Fuel injection pump

The fuel injection pump is an assembly of 6 cylinders. The pumps are installed in groups of 2. The governor operates with hydraulic pressure.

■ Double wall fuel high pressure pipe (option)

This fuel injection pipe is a double wall pipe. It prevents fuel oil that is under high pressure from splashing out. Leak oil flows through the double wall pipe to the leak oil tank. If the quantity of oil in the tank is higher than the specified level, the level gauge switch actuates and starts an alarm.



Cooling water system

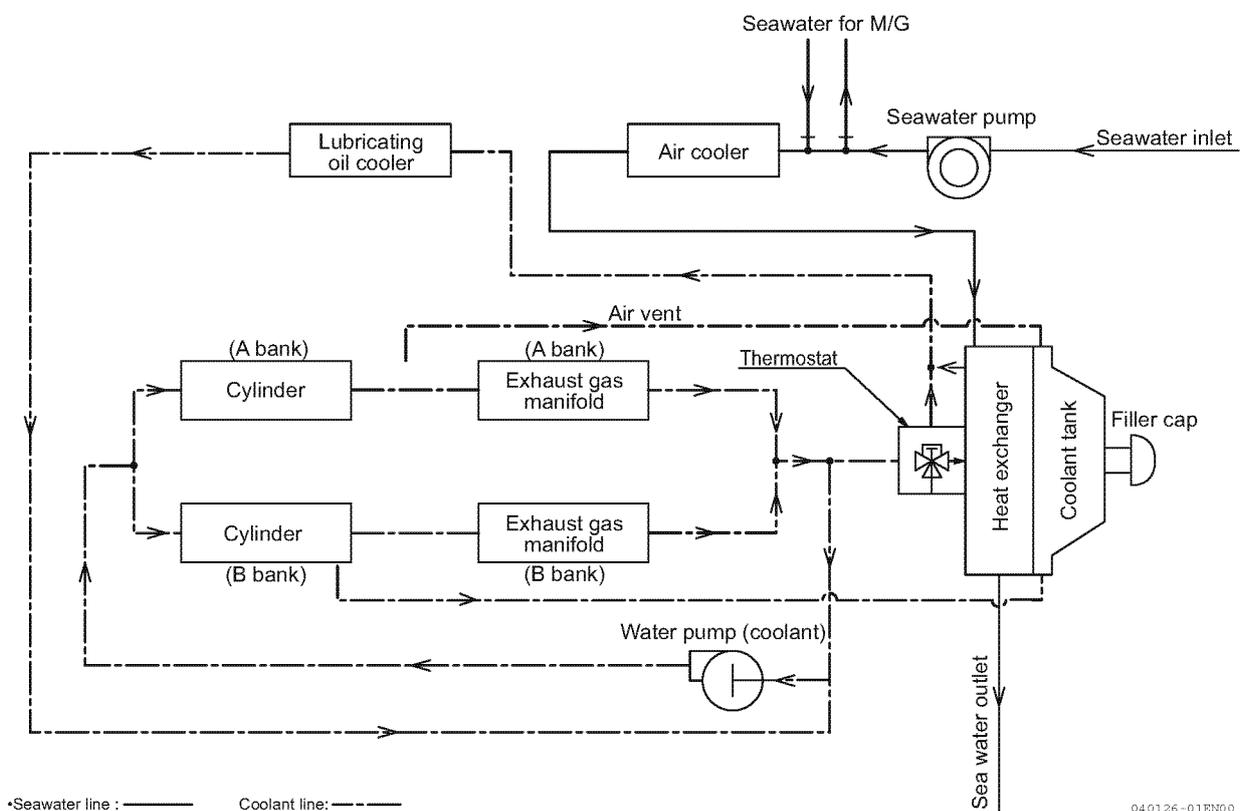
The cylinder and the cylinder head are cooled by a constant high-temperature coolant cooling system (coolant circulation with heat exchanger). This keeps the temperature of the coolant nearly constant at any engine load. Thus the engine performance is kept stable.

■ Seawater system

The seawater pump sends seawater to the air cooler, where it cools the air. Then the seawater is sent to the heat exchanger, where it cools the coolant. Then it flows back into the sea.

■ Coolant system

The water pump (coolant) sends coolant to the cylinder block jacket. There it cools the cylinder, cylinder liner and cylinder head. Then it flows through the exhaust manifold into the thermostat. Then it flows from the thermostat to the coolant tank and the heat exchanger. In the engine lubricating oil cooler, it cools the lubricating oil. Then it flows back to the water pump (coolant).

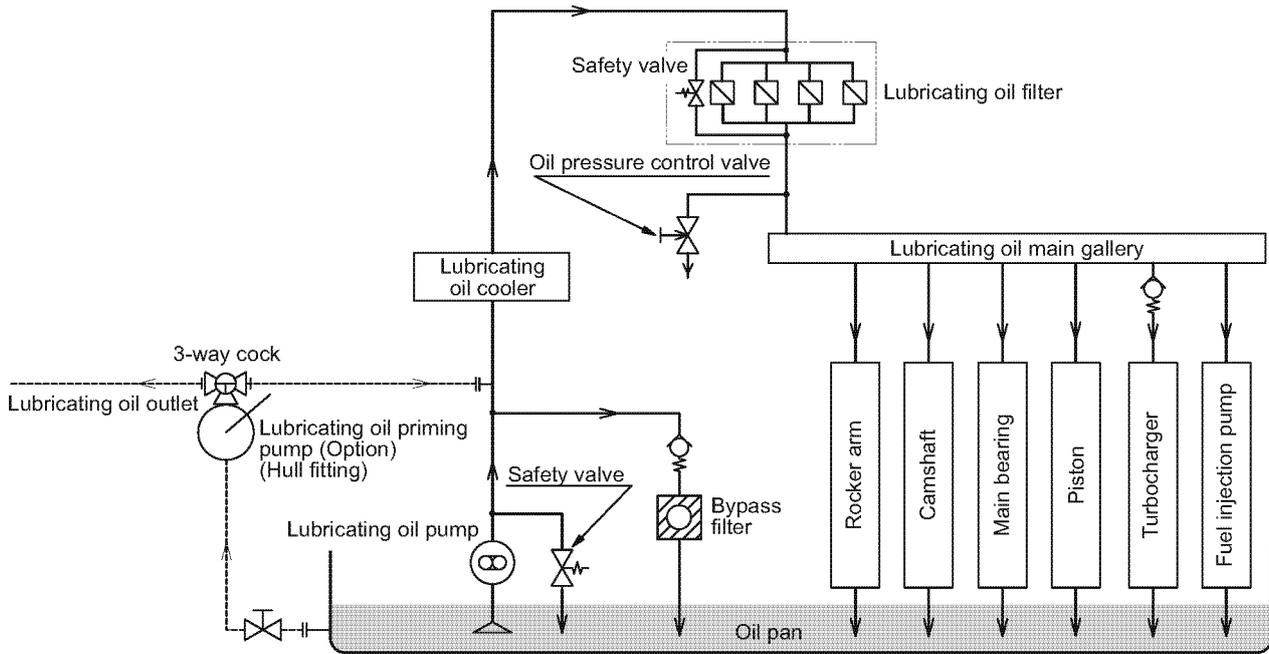


Lubricating oil system

The lubricating oil pump is a gear-type pump with a built-in safety valve.

The pump compresses the lubricating oil and sends it through the cooler and the filter to the oil gallery of the cylinder block. A pressure valve maintains the specified oil pressure. From the gallery, the oil lubricates and cools each part of the engine. Then it returns to the oil pan.

The lubricating oil filter have a paper filter and a centrifugal-type bypass filter.



• Pipes marked by a dashed line (-----) are installed by the shipyard.

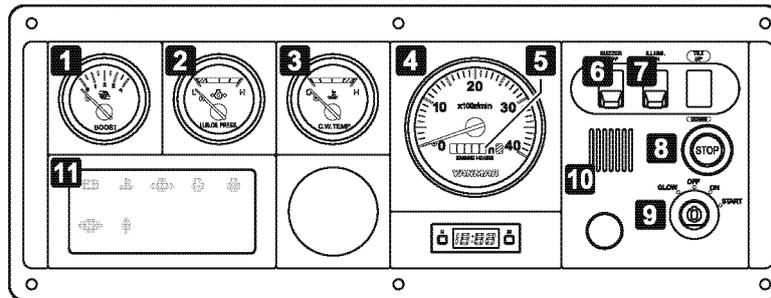
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Control System

The control system is the main control for engine operation.

Instrument panel

The gauge panel is in the control room, separate from the engine. You can remotely start and stop the engine and monitor its condition with the following instruments and alarm devices.



001.296-02X00

1 Boost air pressure gauge

The boost air pressure gauge indicates the boost pressure of the intake air that flows to the combustion chamber. Monitor the condition of the turbocharger to prevent accidents.



044066-00X00

2 Engine lubricating oil pressure gauge

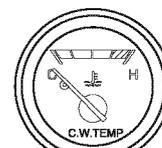
This gauge indicates the pressure of the engine lubricating oil. The red range on the scale indicates caution and dangerous conditions. Monitor the condition of engine lubrication to prevent accidents.



044065-00X00

3 Coolant temperature gauge

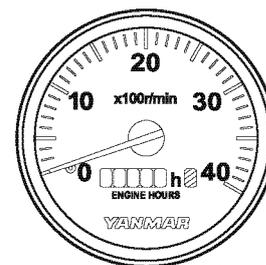
The coolant temperature gauge shows the coolant temperature. The red range on the scale indicates caution and dangerous conditions. Monitor the condition of the engine temperature to prevent defects.



044064-00X00

4 Tachometer

The tachometer indicates the rotation speed of the engine. You can monitor engine speed.



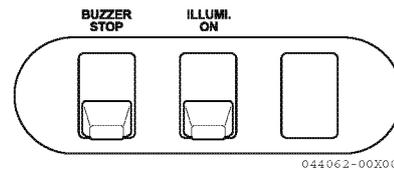
044063-00X00

5 Hourmeter

The hourmeter indicates the total time of engine operation. Use it to schedule periodic inspections and maintenance accordingly.

6 Buzzer stop switch

This switch temporarily stops the buzzer sound. Only turn off the buzzer when you investigate a defect.

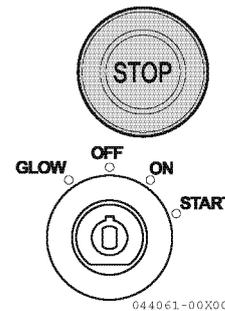


7 Illumination switch

This is the illumination switch for the instrument panel.

8 Engine stop button

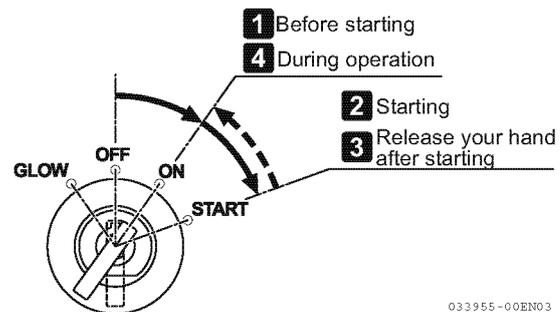
This red button stops the engine. It is above the starter switch. If you push the engine stop button, the stop device of the fuel injection pump actuates. It cuts off the fuel supply and the engine stops. Keep to press the button until the engine comes to complete stop.



9 Starter switch

This is a 3-step rotary-type switch. The key switch starts the engine.

- OFF : This is the position to insert and remove the key. All power is cut off.
- ON : This is the position during engine operation. The instruments and alarms are on.
- START : Start position. This starts the engine. After the engine starts and you release the key, it goes back to ON automatically.
- GLOW : This position turns on the air heater (option). The air heater warms the intake air and thus helps to start the engine in cold.



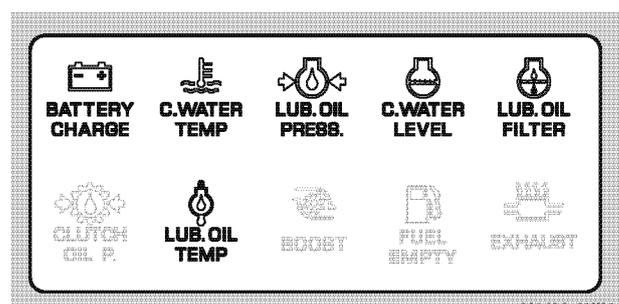
You cannot stop the engine with the starter switch.

10 Buzzer

The alarm buzzer repeatedly makes an alarm sound when an alarm lamp comes on. Only the charge lamp and the oil filter alarm lamp do not sound the alarm buzzer.

11 Alarm lamps

If a defect occurs, the alarm lamp will indicate the defective device.



Alarm devices



000092-01X

BATTERY CHARGE

Comes on if the charge is abnormal. The buzzer will not sound. Check for failures such as a slipped or broken V-belt in the alternator.



000094-01X

LUBRICATING OIL PRESSURE LOW ALARM LAMP

Comes on if the engine lubricating oil pressure drops below the lower level. Continuing operation with insufficient oil will result in damage and seizure. Check the oil level.



000097-01X

LUBRICATING OIL FILTER CLOGGED ALARM LAMP

Comes on if the lubricating oil filter is clogged. The buzzer will not sound. Replace the filter element (cartridge) as soon as possible.



000098-01X

ENGINE LUBRICATING OIL TEMPERATURE HIGH ALARM LAMP

Comes on if the engine lubricating oil temperature becomes abnormally high. Continuing operation at temperatures exceeding the maximum will result in damage and seizure. Check for failures in the cooling system.



000093-01X

COOLANT TEMPERATURE HIGH ALARM LAMP

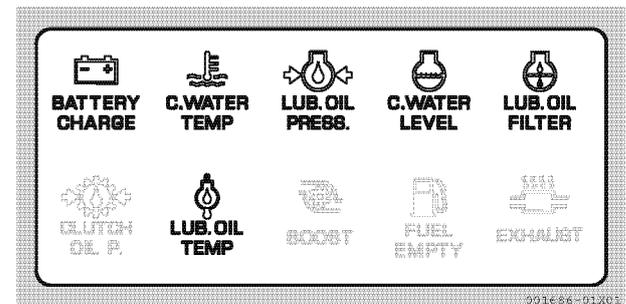
Comes on if the coolant temperature becomes abnormally high. Continuing operation at temperatures exceeding the maximum will result in damage and seizure. Check the load and the water cooling system for any abnormalities.



000096-01X

COOLANT LEVEL LOW ALARM LAMP

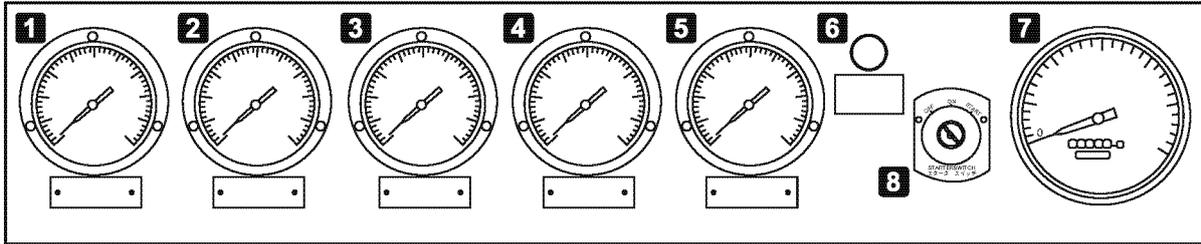
Comes on if the coolant level drops below the lower level. Continuing operation at temperatures exceeding the maximum will result in coolant temperature rise, damage and seizure. Check the coolant level. In addition, check that there is no leakage from the cooling system.



001686-01X01

Gauge panel (option)

The gauge panel located on the engine has the following instruments. Engines with an air starter do not have a starter switch and a charge lamp.



031058-01X00

1 Fuel pressure gauge

This shows the fuel pressure at the outlet of the fuel feed pump.

2 Coolant pressure gauge

This shows the coolant pressure at the outlet of the freshwater pump.

3 Seawater pressure gauge

This shows the cooling water pressure at the outlet of the seawater pump.

4 Boost air pressure gauge

This shows the boost air pressure of the turbocharger.

5 Lubricating oil pressure gauge

This shows the pressure of the engine lubricating oil.

6 Charge lamp

This lamp is off during charging operation. It comes on when the charge is insufficient.

7 Tachometer (with hourmeter)

This shows the rotational engine speed. The hourmeter calculates the total operating time.

8 Starter switch (when starting by electric start)

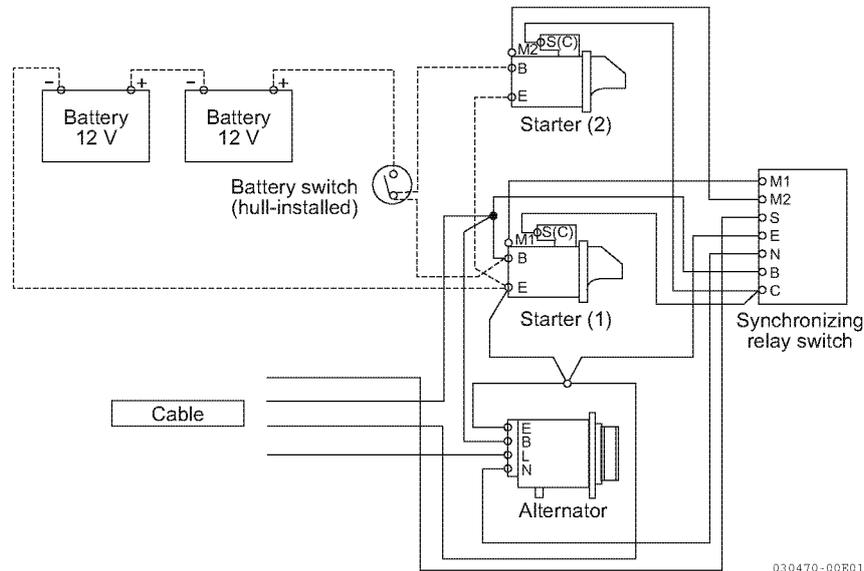
This is a 2-step rotary-type switch. The key switch starts the engine.

Starting devices

There are two starting devices: the electric starter and the air starter (option).

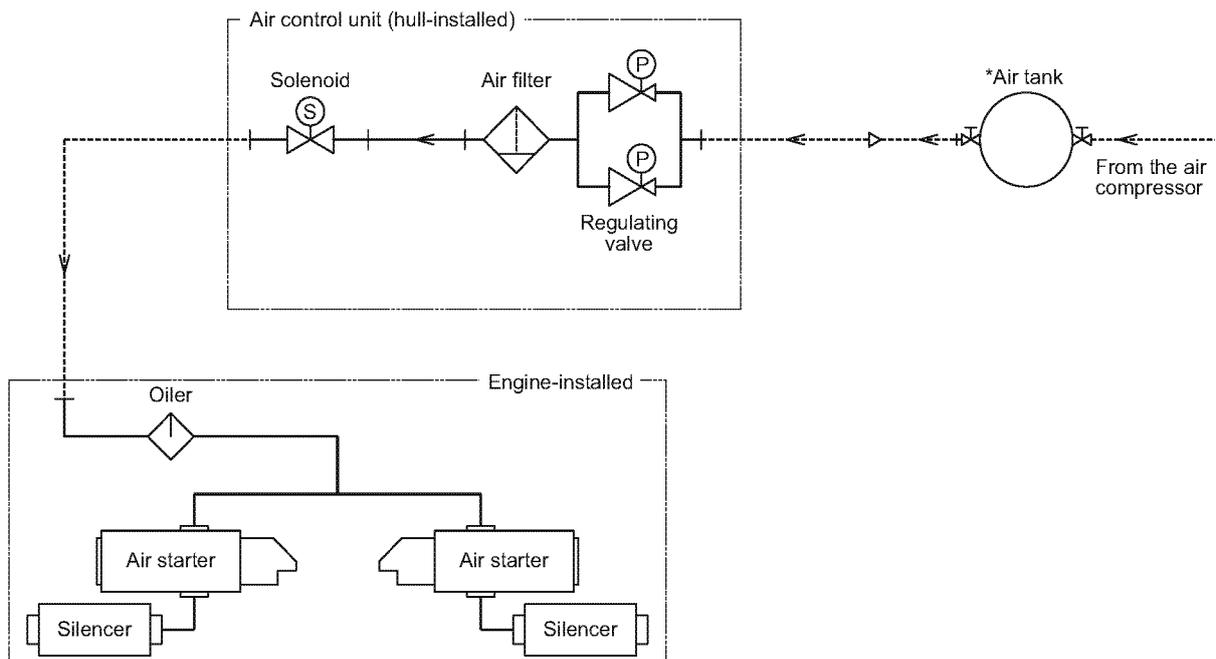
■ Electric start method

The electric start system has a battery, battery switch, starter and synchronizing relay switch. Turn the key to start the engine. It is on the gauge panel on the engine or on the control panel in the control cabin.



■ Air start method (option)

The air starting system has an air tank, pressure regulating valve, air filter, solenoid valve, oiler, air starter and silencer. Compressed air flows from the air tank. The pressure regulating valve decreases air pressure. The filter cleans the air. When the solenoid valve opens, the oiler mixes with lubricating oil into the low pressure air. The air actuates the air starter and discharges through the silencer.



Remark:

- Pipes marked by a dashed line (----) and devices marked with an asterisk (*) are prepared and installed by the shipyard.
- The air control unit is installed near the engine.

Control device

The governor lever and the marine gear shift lever (to shift from forward to reverse) are connected via the respective cables to the controller heads.

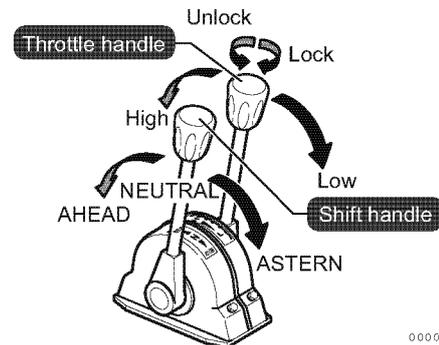
If you use a different type of remote controller that varies from the one below, obey all instructions in its operation manual.

Refer to the operation manual of the installed marine gear.

■ 2-handle controller head (option)

A handle is the throttle handle that it adjusts the engine speed.

The other handle is the shift handle. It shifts marine gear for ahead or astern of propeller shaft and changes the direction of movement of vessel.



000044-03E04

FUEL OIL, LUBRICATING OIL AND COOLANT

Fuel

The following table shows the fuel oil specifications for this engine model.

Fuel oil properties affect the smooth running of the engine, its maintenance intervals and the service life of its parts. They come in a broad range and can be uncertain. Thus, depending on the applied fuel oil, it might be necessary to add attachments or change the specifications of the engine.

■ Quality criteria of fuel oil

Viscosity at 50 °C	mm ² /s	3 - 8
Specific gravity at 15 °C	g/cm ³	< 0.86
Flash point	°C	> 60
Residual carbon	mass%	< 0.7
Sulfur content	mass%	< 1.0
Ash content	mass%	< 0.03
Moisture content	vol. %	< 0.1
Vanadium	ppm	–
Sodium	ppm	–
Aluminum	ppm	–
Diesel index		(Cetane no. of ≥ 45)
Quality criteria equivalent fuel oil	ASTM D975	2D
	BS-2869	Class A1 or A2
	ISO 8217	DMX
	EN	590

NOTICE

The fuel injection system consists of precision parts. For that reason, only use fuel that is free of water and dust. Contaminated fuel causes malfunctions. Thus, pay attention to the following when supplying fuel. Also, drain and do maintenance servicing of the fuel filter as described in P45 [PERIODIC MAINTENANCE].

When supplying fuel

- When supplying fuel stored in a drum, let the drum rest for one day or longer so that impurities can settle, and fill the top layer of oil to the engine.
- If supplying fuel from a storage tank to the service tank, wait one day or more after the fuel was filled to the storage tank before you supply the fuel to the service tank.

Lubricating Oil

Selection of lubricating oil is very important for a diesel engine. If improper lubricating oil is used or change of lubricating oil is neglected, it causes sticking of piston rings, seizure or early wear of pistons and cylinder liners and faster wear of bearings and various other moving parts that reduce the durability of the engine.

■ Selection of the lubricating oil

Service categories

Use an engine oil that meets or exceeds the following guidelines and classifications:

- A.P.I. Classification: Grade CD, CF
- SAE Viscosity grade: 40, 15W-40 (Only if the sulfur content of the used fuel is less than 0.5 %)
- T.B.N. [mgKOH/g]: 9 - 15

Viscosity (SAE)	Specific gravity	Flash point (°C) (open type)	Pour point (°C)	Kinetic viscosity (mm ² /s)		Viscosity index
				40 °C	100 °C	
40	0.893	> 240	< -7.5	140 - 155	14 - 15.5	96 - 110
15W-40	0.88	> 230	< -30	> 100	14 - 15.5	> 140

NOTICE

- Do not blend. (If you cannot avoid blending different brands of lubricating oil, consult your lubricating oil supplier.)
- If you use a lubricating oil with a high total base number (T.B.N.) and a fuel oil with low sulfur content, the additive (calcium carbonate) of the lubricating oil sticks to high-temperature areas and deposits with carbon residue. This causes the adverse effects mentioned below. Thus, use the proper lubricating oil. Accumulation of these deposits in the combustion chamber hinders the sliding of the piston rings and may cause scuffing on the rings, cylinder liners and other parts. Also, the deposits may cause bite-in and blow-by if they enter the exhaust valves.

■ Selection of the hydraulic oil for the hydraulic governor

We recommend an oil with a SAE viscosity 40 of API quality classification service grade CD or CF, or Mobil 1 Rally Formula SJ-grade 0W-40.

■ Selection of the oiler lubricating oil for the air starter (option)

For engines with an air starter, select a lubricating oil for the oiler based on the ambient temperature.

Temperature range	Lubricating oil type	
5 °C - 60 °C	E.g. Turbine oil, category 1, ISO VG 32	E.g. Turbine oil #90 (spindle oil not applicable)
-15 °C - 5 °C	For refrigerating machines, category 1, ISO VG 15	E.g. #90 refrigerating machine oil (spindle oil not applicable)

■ Selection of the marine gear oil

Refer to the Operation Manual of the marine gear.

Coolant

■ Coolant selection

Use clean water (tap water) as coolant.

Select water that has the properties shown in the following table.

Water quality for coolant	
pH (25 °C)	6.5 - 8.0
Total hardness (CaCO ₃)	< 100 ppm
M alkalinity	30 - 100 ppm
Ammonium ion (NH ₄ ⁺)	< 0.05 ppm
Chloride ion (Cl ⁻)	< 100 ppm
Sulfate ion (SO ₄ ²⁻)	< 100 ppm
Evaporation residue	< 400 ppm

■ Long Life Coolant (LLC) mixture selection

As a coolant, only use tap water mixed with Long Life Coolant (LLC).

YANMAR recommends the following Long Life Coolant (LLC):

- TEXACO LONG LIFE COOLANT/standard and premixed
Product Code 7997 and 7998
- HAVOLINE EXTENDED LIFE ANTIFREEZE/COOLANT
Product Code 7994
or products equivalent to the above LLC.

NOTICE

If you select an LLC different from the above, make sure that it does not have any adverse effects on the materials used in the engine's cooling system (cast iron, aluminum, copper, etc.).

Without this mixture, scale and rust develops inside the coolant system, thus deteriorating the cooling performance. Always use LLC in winter. If you do not use LLC, the cooling water freezes and expands inside the engine, causing parts of the coolant system to break.

The mixing ratio of LLC depends on the temperature. Be careful to use the mixing ratio specified by the LLC manufacturer.

NOTICE

- Too much LLC reduces the cooling effect of the coolant.
Too less LLC does not provide sufficient protection against the lowest temperatures. The cooling water system freezes and is damaged.
- Never mix different types or brands of LLC. Chemical reactions may make the LLC useless and engine trouble could result.

RUNNING-IN

Initial Operation

Make sure that you do the following checks before you operate the engine for the first time, after an overhaul or after a long rest.

Consult your YANMAR dealer or distributor for the details.

- Make sure that you do not forget any parts or tools.
- Check that all screws and bolts are tight.
- Check the deflection of the crankshaft.
- Check the starting device.

Electric starter: Check that the battery voltage is sufficient.

Air starter: Check the pressure of the air tank. Drain the air tank.
Fill lubricating oil to the oiler.

Filling oil to the fuel oil system

- Before fueling, clean the fuel tank, fuel oil pipes and other interior parts with kerosene or diesel oil.
- Fill the tank with clean fuel that is free of water and dirt.
- When you fill from a drum, let the drum rest for one day or more. This allows dirt to settle. Fill from the top layer of the drum.
- When you fill from a service tank, let the fuel oil rest for one day or more after filling it from the storage tank to the service tank.
- Fill fuel oil adequately to avoid running out of fuel oil during operation.
- Bleed air from the fuel system if the fuel oil has run out or you removed parts of the fuel system (e.g. the fuel filter).

Bleeding the fuel oil system

If air enters the fuel system, the fuel injection pump does not work correctly.

Bleed air in the fuel system and obey the following procedure when you fill fuel oil to the fuel tank for the first time, perform maintenance (such as replacing the fuel filter) of the fuel system, after the fuel oil has run out, and when there is a failure at startup.

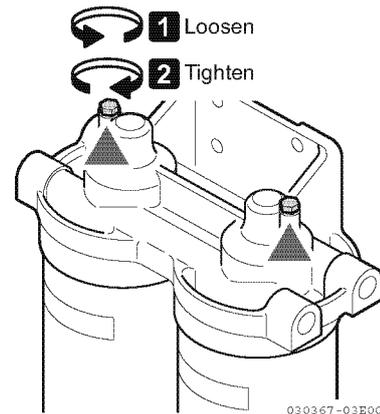
1. Check the fuel oil level in the fuel tank and open the fuel cock (or valve).

2. Loosen the air vent plug on the top of the water separator (option).

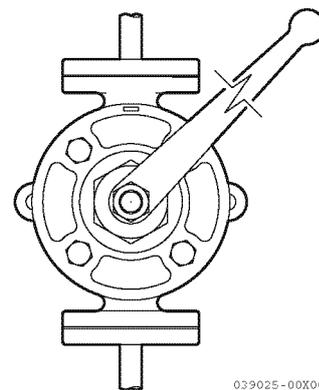
When fuel oil without air bubbles comes out of the air vent plug hole, tighten the air vent plug.



3. Loosen the air vent plug on the top of the fuel filter.



4. Open the stop valve on the inlet/outlet of the fuel priming pump (wing pump). Operate the pump and send the fuel oil.



5. When fuel oil without air bubbles comes out of the air vent plug hole, tighten the air vent plug.

6. After the air bleeding, close the stop valve on the inlet/outlet of the fuel priming pump.

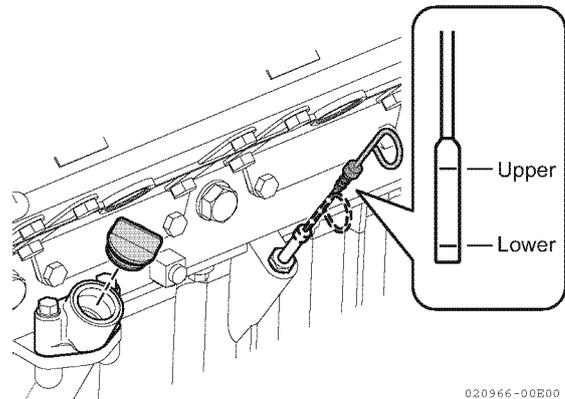
Filling lubricating oil

■ Filling the engine lubricating oil

Keeping the correct oil level is important. Obey the following procedures when you fill the engine lubricating oil.

1. Remove the oil filler cap.
2. Fill the recommended oil to the upper level mark on the dipstick while checking the level with the dipstick.

Engine lubricating oil capacity (oil pan)	170 ℓ
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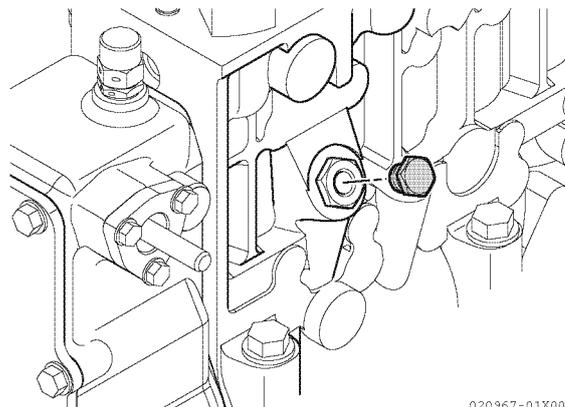
3. Install the oil filler cap.

NOTICE

- Be sure to stop the engine before refilling.
- When checking the oil level, insert the dipstick fully.
- Do not overfill with oil, as this may cause oil to be sprayed out from the breather and damage the engine.

4. Remove the oil filler plug attached to the fuel injection pump.
5. Fill the recommended oil.

Fuel injection pump lubricating oil capacity (A-bank and B-bank each pump)	1.5 ℓ
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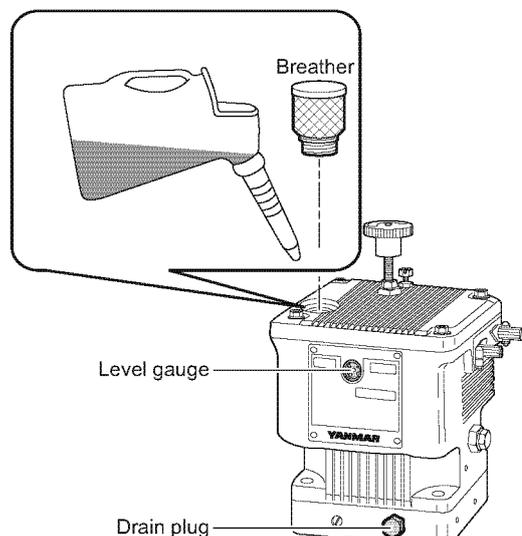


6. Install the oil filler plug.

■ Filling the lubricating oil of the hydraulic governor

Remove the breather of the hydraulic governor. Fill the lubricating oil for the hydraulic governor from the center of the oil level gauge almost up to the top.

Hydraulic governor lubricating oil capacity	Up to the center of the oil level gauge Approximately 0.8 ℓ
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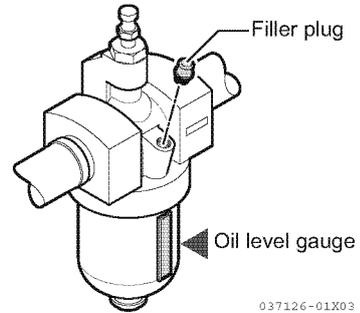


■ **Filling the lubricating oil of the marine gear**

Refer to the operation manual of the installed marine gear.

■ **Filling the lubricating oil of the air starter's oiler (option)**

Remove the filler plug on the oiler of the air starter. Fill the lubricating oil for the air starter up to the top of the oil level gauge.



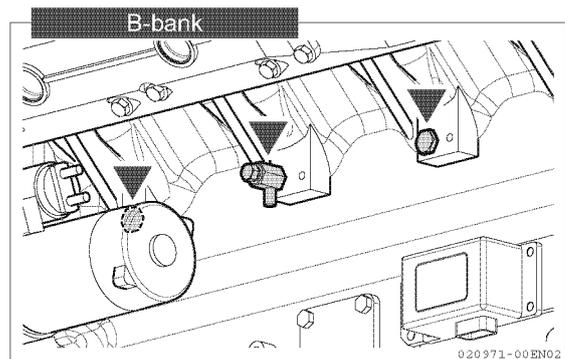
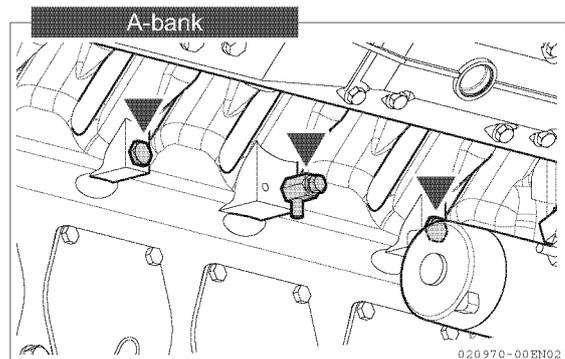
Filling coolant

Be sure to check the tightening condition of all coolant drain cocks before filling the coolant.

1. Make sure the 8 drain plugs and 2 drain cocks on the cylinder block are securely tightened.

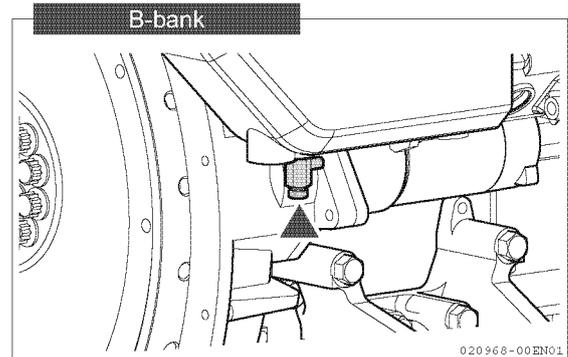
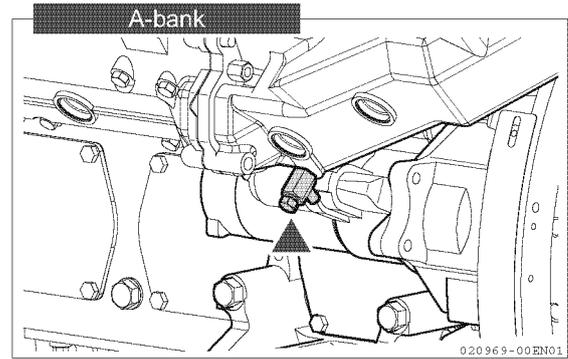
NOTICE

When you open or close the drain plug on the back of the starter, be careful that you do not spill water on the starter.

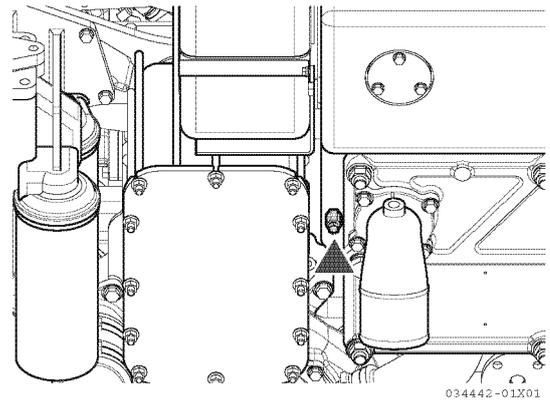


29 — RUNNING-IN

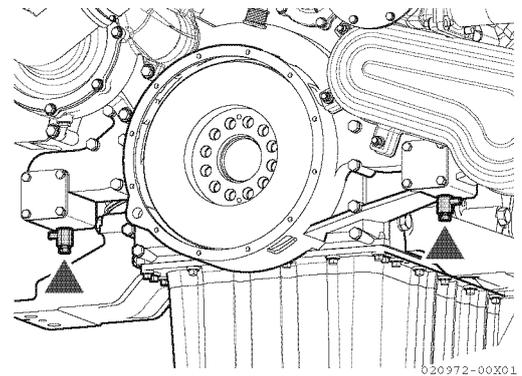
2. Make sure the 2 drain cocks on the exhaust connecting pipe (turbocharger inlet) are securely tightened.



3. Make sure the drain cock on the coolant tank is securely tightened.



4. Make sure the 2 drain cocks on the gear case on the opposite side of the flywheel are securely tightened.

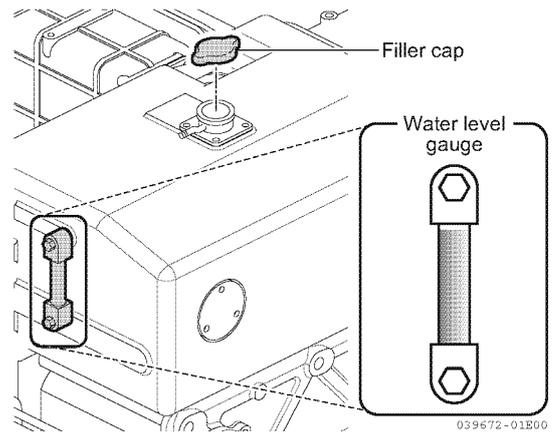


5. Remove the filler cap of the coolant tank.
6. Fill the coolant tank with coolant up to the top of the water level gauge.

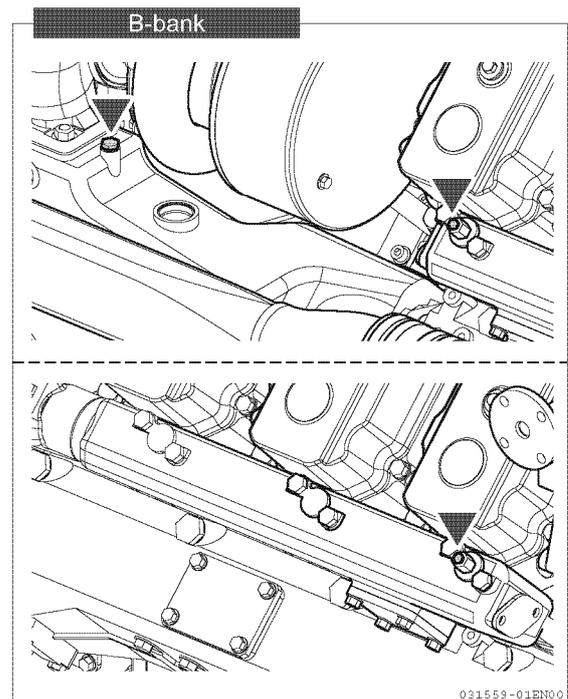
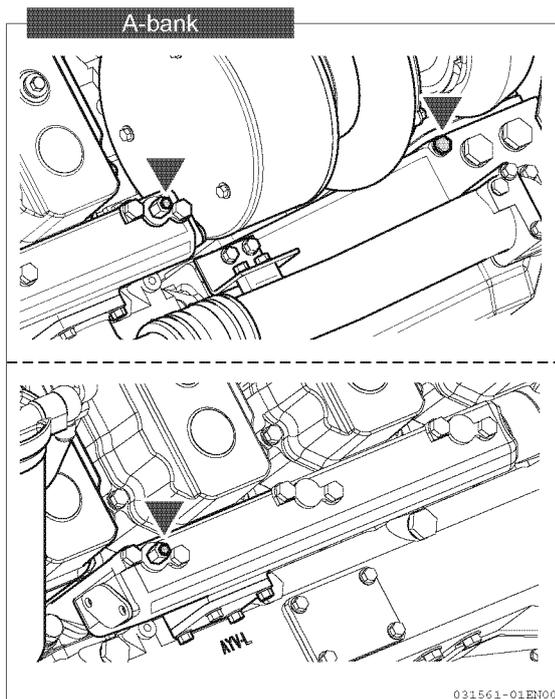
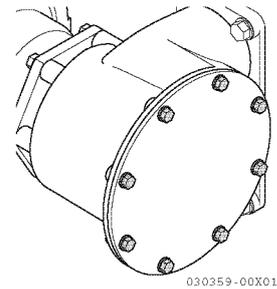
Coolant capacity	225 ℓ
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NOTICE

- Always fill with clean coolant.
- Always use coolant mixed with LLC.



7. Make sure the cover bolts of the seawater pump are securely tightened.
8. Make sure the drain cocks on marine gearside are securely tightened. Refer to the operation manual of the installed marine gear.
9. Remove the 6 air vent plugs from the coolant pipe as shown in the following illustrations.

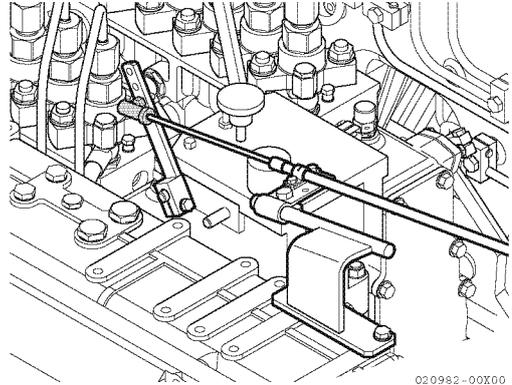


10. Start the engine the air vent plug and filler cap are opened, when first start engine or drain coolant. After engine start, do an idling operation without load.
11. While the engine is operating, fill coolant until it comes out of the hole of the air vent plugs.
12. Tighten the air vent plugs securely.
13. Stop the engine.
14. Tighten the filler cap securely.

Lubricating engine parts

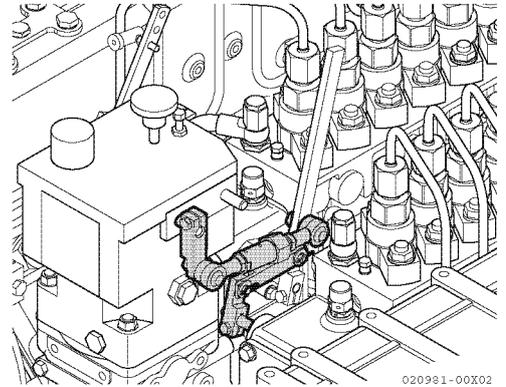
■ Governor lever

Apply grease to the ball joints of the remote control cables.



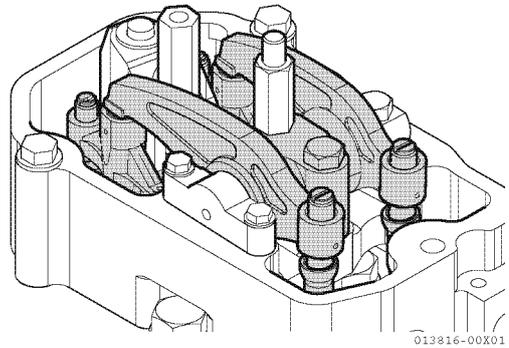
■ Hydraulic governor link

Apply grease to the link.



■ Rocker arm

Apply oil to the rocker arm.

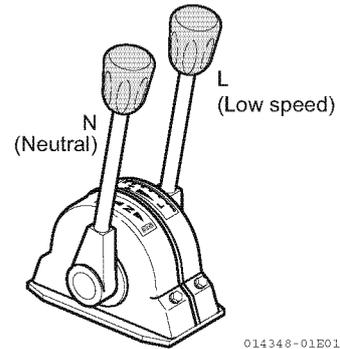


Cranking

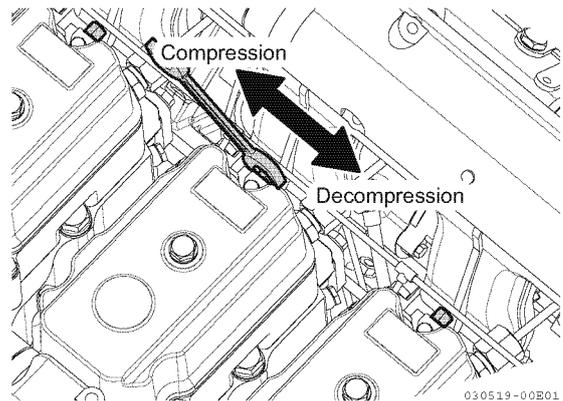
If you start the engine for the first time or after a long engine stop, moving parts are not correctly lubricated. Crank the engine so that a sufficient amount of oil reaches all moving parts of the engine. Obey the following procedure.

Before the cranking, make sure that you can operate the engine safely.

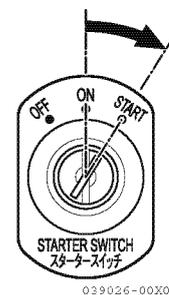
1. Open the sea cock (valve).
2. Set the shift handle into the "NEUTRAL" position.
3. Set the throttle handle into the "L" position.



4. Set the decompression shaft to DECOMPRESSION on all cylinders.



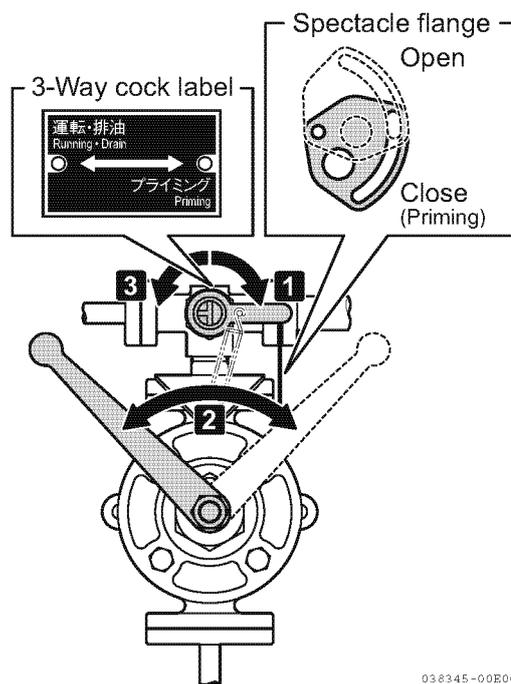
5. Turn the battery switch to "ON".
6. Put the key in the starter switch and turn it to the "ON" position.
7. Turn the key to the "START" position to start cranking.
8. Cranking time is 5 seconds: check for abnormal sounds during that time.
9. If you release the key, the engine stops.
10. After the engine stops fully, set the decompression shaft to COMPRESSION on all cylinders.



■ Lubricating oil priming (option)

Before the engine cranking, obey these instructions:

1. Remove the rocker cover and the crankcase side cover. Set the decompression shaft to DECOMPRESSION on all cylinders.
2. Make sure that the spectacle flange of the 3-way cock is closed.
3. Turn the engine flywheel. While turning, set the 3-way cock lever on the lubricating oil wing pump outlet to PRIMING. Operate the wing pump. Make sure that oil drips come out from the rocker arm of the intake/exhaust valves, the piston cooling nozzle and the crankpin on all cylinders.
4. After this check, set the 3-way cock lever to RUNNING.
5. After the lubricating oil priming, install the rocker cover and the crankcase side cover.



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Checking before Starting

Do these checks before engine start.

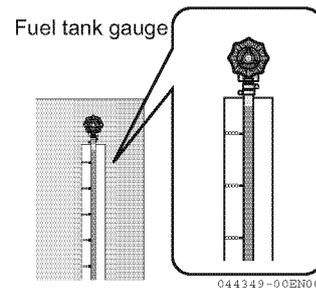
Visual inspection of the engine

Check the following and make sure that there are no defects. If you find a defect, do not start the engine. Consult your YANMAR dealer or distributor.

- Check for oil leaks from the lubricating oil system.
- Check for fuel oil leaks from the fuel system.
- Check for water leaks (seawater and coolant) from the cooling water system.
- Check for gas leaks from the exhaust pipe.
- Check parts for damage and chippings.
- Check for loose or missing bolts.
- Check for loose or missing wire ends.

Checking and refilling fuel oil

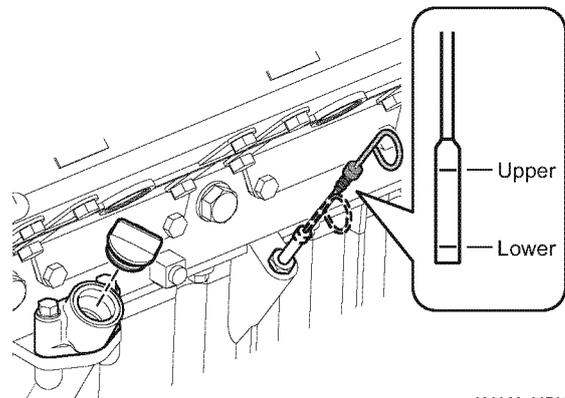
- Drain water of the fuel tank.
- Check the fuel level of the tank. If necessary, refill with a recommended fuel oil.
- Fill the tank with clean fuel that is free of water and dirt.
- Sufficiently refill fuel oil to avoid running out of fuel oil during operation.



Checking and refilling engine lubricating oil

Check and refill engine lubricating oil before engine start. Check the level of the engine lubricating oil with the dipstick.

- Make sure that the oil level is between the upper and lower lines of the dipstick. If necessary, fill with lubricating oil to the upper line on the dipstick.

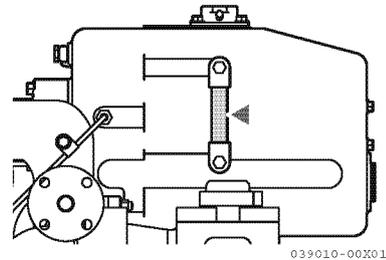


Checking and refilling marine gear lubricating oil

Refer to the operation manual of the installed marine gear.

Checking and refilling coolant

Always check and refill the coolant before engine start, when the engine is cold. Check the water level with the water level gauge on the coolant tank. If the water level is low or if you cannot see the water level gauge, fill coolant up to the top of the water level gauge.



Checking the instruments panel (electric start system)

If the engine runs out of water or lubricating oil and the instruments or alarms are defective, accidents can not be prevented.

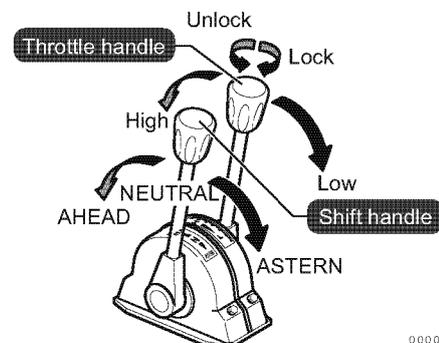
Check that the instruments panel operates correctly.

1. Turn the key to the "ON" position.
2. The needle of the oil pressure gauge should indicate "0".
3. Make sure that the coolant temperature gauge operates properly.
4. The hourmeter should be working.
5. If the illumination switch is turned on, the illumination lamps of the lubricating oil pressure gauge, the boost pressure gauge, the tachometer, and the coolant temperature gauge should all come on.

Checking the control device (option)

Check that the control handles and cables operate easily and correctly.

1. Operate the throttle handle from the position "L" to the (full) position "H" and check that the governor lever moves into the correct position. Adjust the control cable if necessary.
2. Operate the shift handle into "AHEAD", "NEUTRAL" and "ASTERN" and check that the marine gear control lever at the shift moves into the correct positions. Adjust the control cable if necessary.

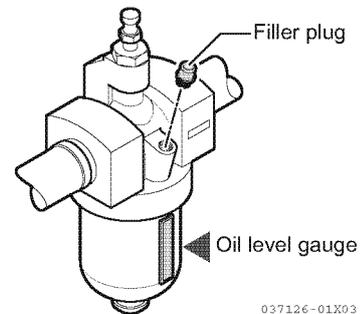


Checking the air starter (option)

Make sure that the air pressure in the air tank and the set pressure in the regulating valve are at the specified value.

Air tank pressure	2.45 MPa - 2.94 MPa
Set pressure in the regulating valve	0.69 MPa - 0.97 MPa

1. Make sure that the lubricating oil of the oiler is between the top and bottom lines on the scale of the oil level gauge.
2. If necessary, remove the filler plug and fill with the recommended lubricating oil to the top line.



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Rechecking after starting

When a new engine is operated for the first time, the oil level of the oil pan will drop because the engine oil is circulated to the oil cooler, oil filter, etc.

Therefore, stop the engine after operating for two to three minutes.

Wait for about five minutes and then check the following:

- Check the engine oil level with the dipstick, and add oil up to the upper level if necessary.
- Check the coolant level of the coolant tank. Add coolant to the upper level if necessary.

⚠ DANGER

Never remove the filler cap when the engine is hot (above 60 °C).

The coolant is under pressure and severe scalding could result.

- Check the marine gear oil level with the dipstick, and add oil up to the upper level if necessary.

OPERATION

Before starting, please pay attention to check if there is something near the engine, particularly its rotating parts, that may cause damage to the engine.

Starting

■ Start with the electric starter

1. Move the shift handle to the neutral position "N".
2. Move the throttle handle to the position "L".

- Before starting the engine

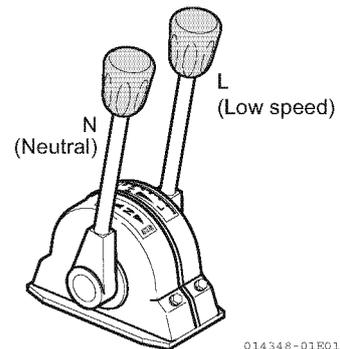
- 1- Turn on the battery switch.

- 2- Put the key in the starter switch.

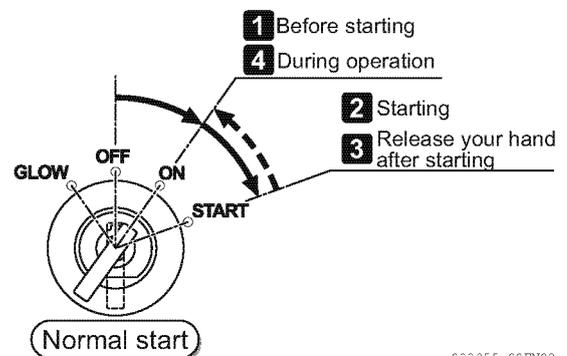
Turn the key from the OFF to ON position and check that the alarm device shown in the table P38 [Normal function of alarm devices] are working properly.

- The buzzer sounds briefly (for approximately 1 second).
- The battery charge lamp should turn on. The other alarm lamps should turn on for approximately 3 seconds and then turn off.

3. Turn the key to the "START" position. Once the engine starts, release the key. Then the key will return to the "ON" position automatically. While the key in the "ON" position, the instruments and warning devices are supplied with power.



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NOTICE

- If the engine did not start, do not continue cranking for longer than 15 seconds at any one attempt. Allow at least 30 seconds of rest between attempts. This will permit the battery to recover and prevent overheating of the starter.
- When restarting, turn the key only after the engine has completely stopped. If the key is turned on before the engine comes to a complete stop, serious damage to the starting motor pinion and ring gear of the flywheel may result.

4. Check the alarm devices after starting the engine.

- Turn the key from the START to the ON position and check that the alarm devices shown in the table “Normal function of alarm devices” below are working properly.
 - The buzzer stops.
 - All alarm lamps turn off.

By performing these procedures, it can be determined whether or not the electric circuit of the buzzer and alarm lamps is in good working order. If there is any problem, consult your YANMAR dealer or distributor for investigation and repair.

Normal function of alarm devices		
Starter switch operation	Before starting OFF → ON	After starting START → ON
Buzzers	ON	OFF
Alarm lamps		
Battery charge lamp	ON	OFF
Coolant temperature	ON briefly	OFF
Engine lubricating oil pressure	ON briefly	OFF
Marine gear lubricating oil pressure	ON briefly	OFF
Coolant level	ON briefly	OFF
Lubricating oil filter clogged	ON briefly	OFF
Engine lubricating oil temperature	ON briefly	OFF

■ Start with the air starter (option)

● Starting procedure

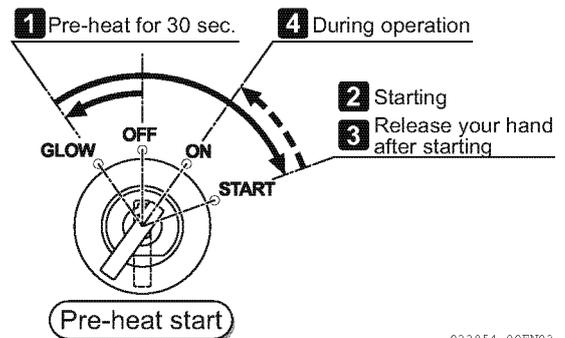
1. Move the shift handle to N (neutral).
2. Move the throttle handle to L (low speed).
3. Turn on the battery switch.
4. Open the valve of the start air tank.
5. Press the start button for the solenoid valve for 2 to 3 seconds.
 - 1- The engine starts.
 - 2- The solenoid valve automatically closes when the engine speed reaches 400 min⁻¹.
6. Close the valve of the start air tank.

Starting in cold by air heater (option)

1. Move the shift handle in N (neutral).
2. Move the throttle handle in a position that is slightly higher than the low idle position.
3. Turn the key in the starter switch on the instrument panel to the GLOW position.
4. Turn the key to the START position after approximately 30 seconds.

The engine starts.

If you cannot start the engine within 1 minute, start from the GLOW position again.
5. Release the key when the engine starts. The key returns automatically to the ON position.
6. Move the throttle handle in the low idle position.



Engine Warm-Up

After starting the engine, do an engine warm-up for approximately 5 to 10 minutes with no-load at 700 to 800 min⁻¹.

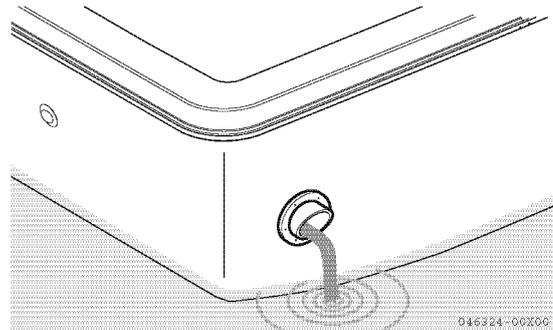
This sends lubricating oil to all moving parts, which also warms up the engine.

■ Check during warm-up operation

- Make sure that seawater is coming out from the cooling water (seawater) outlet.
- Check that the instruments and alarm lamps operate correctly.
- Check that the battery charge lamp turns off.
- Check that there are no oil, water and gas leaks from any parts of the engine.
- Check that there is no unusual noise or heat from any parts of the engine.

NOTICE

Do not turn off the key of the starter switch and the battery switch when operating the engine.



Notice while Running with Load

While running the engine, pay attention to the following.

If a problem occurs during operation, try to find the cause. If the cause cannot be found and the vessel is able to continue operation, return to port at a low speed. Consult your YANMAR dealer or distributor after return.

■ First running

Do not operate new engines at full load during the first 50 hours except for short periods.

■ Cooling water (seawater)

Make sure that water is coming out from the cooling water (seawater) outlet.

When water is coming out intermittently or in small volume, check for the following.

- Is air trapped in the cooling system?
- Is the cooling seawater pump impeller faulty?
- Is the cooling seawater pipe or the sea cock clogged?

NOTICE

Never operate the engine if the seawater pump is not taking in water. The seawater pump impeller will seize and becomes overheat of the engine in result.

■ Coolant

Normally, the coolant temperature while running with load is 70 - 80 °C.

If the temperature exceeds 85 °C, check the following.

- Water leakage (temperature and coolant level warning devices may activate)
- Faulty water pump (coolant) or clogged coolant passage
- Faulty seawater or clogged seawater passage
- Insufficient coolant volume
- Heat exchanger restriction

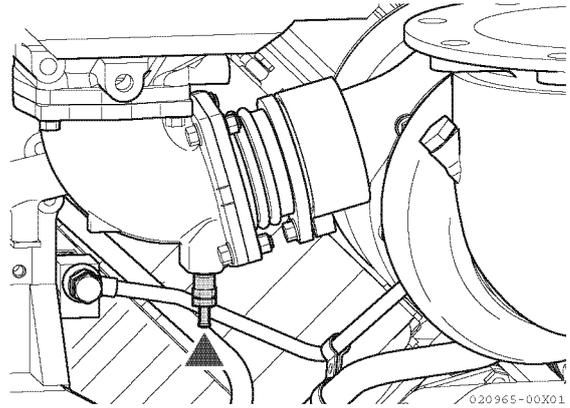
■ Color of exhaust gas

Black smoke is a sign that the engine is overloaded. Such operation will shorten the life of the intake and exhaust valves, piston rings, cylinder liners, turbo-charger and particularly fuel injection nozzles. Avoid continuing operation if black smoke is being emitted.

■ Water leakage, oil leakage and other operational conditions

Always check for the following conditions: water leaks, oil leaks, gas leaks, loose fasteners, abnormal noise, abnormal temperature, low oil pressure and vibration.

Note: The engine has an auto drain cock for condensed water at the bottom of the turbocharger inlet bend (both A-bank and B-bank). It is closed during operation and condensed water does not come out. But condensed water can come out when the engine is stopped. This is not a defect.



■ Avoid operating the engine at critical speed

Avoid operating the engine at a speed that produces resonance (critical speed). Depending on the construction of the hull, the engine and ship can resonate at a certain engine speed, making the vibrations suddenly surge.

■ Alarm devices

When the buzzer sounds during engine running, at first check which alarm lamp is on, immediately set the engine speed to low speed and stop the engine, and then try to find the cause.

■ Long time operation at low speed

When the engine is operated for more than 4 hours at low speed, set the shift handle to the "NEUTRAL" position, and increase the engine speed without load for 1 minute at about 1800 min^{-1} to discharge residue from cylinders every 4 hours of operation.

Do it every 4 hours of operation.

■ Operation of shift handle (Refer to the Operation Manual of your marine gear)

Be sure to operate the shift handle when throttle handle is at a low speed.

If the marine gear is engaged or disengaged during high-speed operation or if it is used under half-clutch, the marine gear can be damaged or its service-life shortened.

Stopping

To stop the engine, set the shift handle to the “NEUTRAL” position, and perform the after no-load running at a low speed ($600 - 700 \text{ min}^{-1}$) for approximately 5 to 10 minutes.

NOTICE

If the engine stops in a hot condition, the temperature of the coolant and various engine parts will rise quickly, and the engine may be damaged.

1. Press and hold the engine stop button or pull and hold the engine stop lever until the engine has stopped completely.
2. Set the starter key switch to the “OFF” position after stopping the engine.
3. Remove the key from the starter switch.
4. Close the fuel cock.
5. Close the sea cock.
6. While the engine is still warm, wipe off dust and dirt from the engine.
7. In cold temperatures or before long term storage, be sure to drain the seawater from cooling system.

NOTICE

- Storing the engine without draining may cause the seawater left inside the engine to freeze and damage to the parts (heat exchanger, lubricating oil cooler, seawater pump) in the cooling water passage.
 - Always use LLC in the coolant system.
 - If you leave the sea cock open, water can come into the vessel.
-

Long-Term Storage

■ Storing engine for a long time

When the engine is not used for a long period of time, consult your YANMAR dealer or distributor and do the following preparations.

- Choose a dry, dust-free location for storage.
- In cold, make sure that you fully drain coolant and seawater from both cooling systems.
- Loosen the V-belt.
- Disconnect the battery terminals from the engine, and store the battery fully charged. Charge the battery once a month to compensate for the battery's self discharge.
- Remove any dirt, grime, or oil on the exterior and wipe the engine clean, and apply a coat of antirust agent or clean oil.
- Cover the exhaust pipe, intake, and electric devices with vinyl sheets to guard against moisture and dust.

■ Operating after long-term storage

Follow the steps below when restarting an engine which has been stored for 6 months or longer.

- Install a fully charged battery.
- Refer to P25 [RUNNING-IN] before starting.
- Remove the rocker cover, and apply lubricating oil to the rocker arms.
- Check for cracks of the V-belt and adjust the V-belt tension.
- Check for damage of the impeller of the seawater pump.
- Perform cranking before operation to circulate lubricating oil to all parts. Refer to P32 [Cranking].

PERIODIC MAINTENANCE

- Periodical maintenance is an important factor in keeping the engine in the best condition. Perform periodic maintenance depending on the operating hours as described in the following maintenance time schedule.
- When the parts are disassembled for checking and/or servicing, reassemble them properly.
- Please contact a YANMAR dealer or distributor if you need assistance in inspecting your engine or replacing parts.
- Consult with your YANMAR dealer or distributor about scheduling the engine overhaul.

Periodic Maintenance Schedule

○: Check ⊙: Replace ●: Consult your YANMAR dealer or distributor.

Item		Service period						Remarks
		Daily	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 6 months	Every year	
Fuel system	Check fuel level and refill	○						
	Drain fuel tank deposit and water	○ (When replenished)						
	Drain fuel filter and water separator deposit and water	○						
	Replace fuel filter and water separator element				⊙			
Lubrication system	Check oil pressure	○						
	Check oil level and refill (oil pan)	○						
	Replace oil filter		⊙ (1st time)		⊙			
	Clean bypass filter		⊙ (1st time)	⊙				
	Clean oil cooler						●	
	Replace oil (Engine oil pan)		⊙ (1st time)	⊙ (Sulfur content 0.5 - 1.0 %)	⊙ (Sulfur content ≤ 0.5 %)			
	Check oil level and refill (Hydraulic governor)	○						
	Replace oil (Hydraulic governor)					⊙ (1st time)	⊙	1st time: 1000 h
Cooling seawater system	Check cooling seawater discharging condition	○						
	Check water leakage seawater pump	○						
	Replace seawater pump impeller						⊙	
	Check and replace zinc anode			○	⊙			
	Clean seawater strainer of heat exchanger				○			
Cooling coolant system	Check coolant temperature	○						
	Check coolant level	○						
	Check water leakage water pump (coolant)	○						
	Change coolant						⊙	
	Check and clean thermostat						●	

○: Check ⊙: Replace ●: Consult your YANMAR dealer or distributor.

Item		Service period						Remarks
		Daily	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 6 months	Every year	
Fuel injection pump and nozzle	Check injection timing			● (1st time)		●		Adjust if required
	Check injection pressure and spray form				● (1st time)	●		Replace if found troubling
	Check fuel injection pump major parts						●	Replace if found worn
	Replace injection nozzle						●	
Cylinder head	Check and adjust valve clearance		● (1st time)			●		
	Check and adjust valve spring, rotator and stem seal						●	
	Re-tightening cylinder head bolts						●	
Turbo charger	Check air and gas leakage	○						
	Cleaning pre-filter and wash the blower			○				
	Replace pre-filter						⊙	
	Disassemble and clean						●	
Disassemble and clean air cooler							●	
Check and adjust remote control head and cables			○ (1st time)		○			
Re-tighten hose clips (Fuel, lubricating oil, cooling water, breather and air line)			○ (1st time)		○			
Check rubber hoses (Fuel, lubricating oil, cooling water, breather and air line)							○	
Check and adjust governor link					●			
Electric device	Check alarm lamp	○						
	Check on indication gauges and tachometer	○						
	Check battery electrolyte level	○						
	Check battery electrolyte specific gravity			○				
	Check battery terminals						○	
	Check and replace alternator V-belt tension		○ (1st time)		○ (2nd time)		⊙	
	Check wire harness					○		per 1000 h
	Check temperature and pressure switch						●	
Exterior	Check looseness bolts and nuts	○						
	Check water, oil/gas and leakage at various parts	○						

Fuel System

■ Fuel level checking

Service period	Daily
----------------	-------

Refill as required.

■ Fuel tank deposit draining

Open the drain cock on the tank to drain out sediment and water at the tank bottom.

Service period	Daily
----------------	-------

■ Fuel filter and water separator (option) draining

Remove the drain plug to drain water from the fuel filter and water separator.

Service period	Every 50 hours
----------------	----------------

■ Replacement of fuel filter and water separator element

Service period	Every 500 hours
----------------	-----------------

Loosen the bolt in the center of the fuel filter and remove the filter case and element.

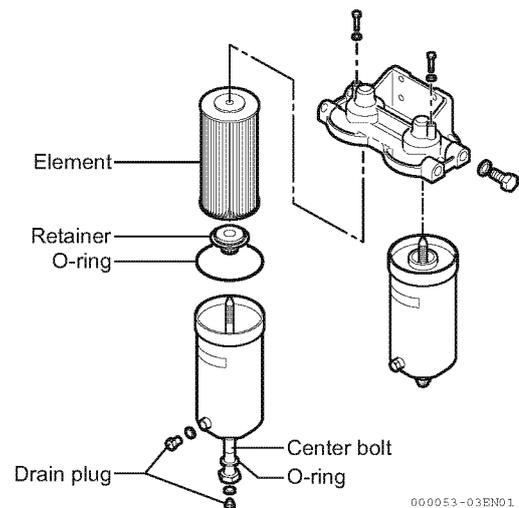
Replace the element with a new one.

When installing the new element and case, use new O-rings; tighten the center bolt securely.

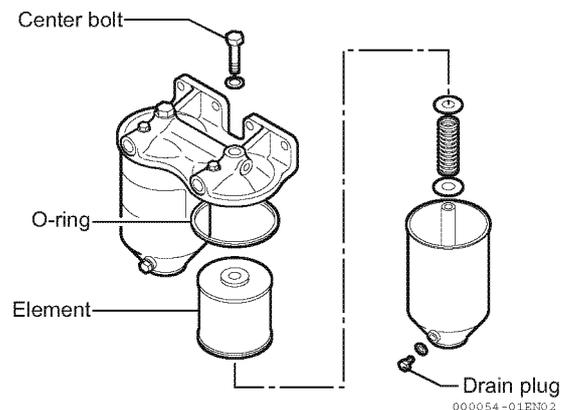
NOTICE

- Before installing the element, clean the inside of the filter case.
- Do not forget to install the spring, retainer and O-rings.
- After replacing the element, be sure to bleed air from the fuel system.

Fuel filter



Water separator



Lubricating Oil System

■ Oil level

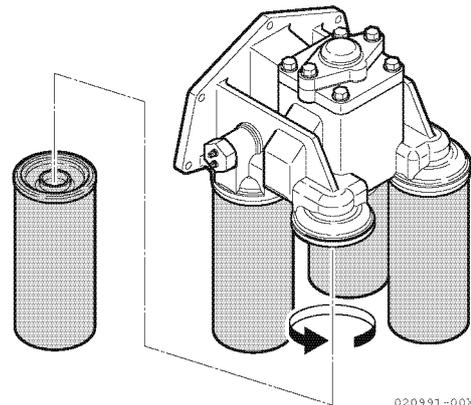
Check the oil level with the dipstick. The oil level must be maintained between the upper and lower level marks on the dipstick. Add the recommended oil up to the upper level mark, if necessary.

Service period	Daily (prior to operation)
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■ Replacement of oil filter

1. Remove the filter with the filter wrench. (Turn to the left.)
2. Before installing the filter, carefully wipe the installation side and apply lubricating oil to the packing surface.
3. Tighten the lubricating oil filter fully by hand, and then use a filter wrench to further tighten the filter. (Turn to the right.)
4. Check for oil leakage during operation.

Service period	1st time	50 hours
	2nd time and after	Every 500 hours



■ Engine oil changing

The lubricating oil drains easier if you replace the oil while the engine is still warm.

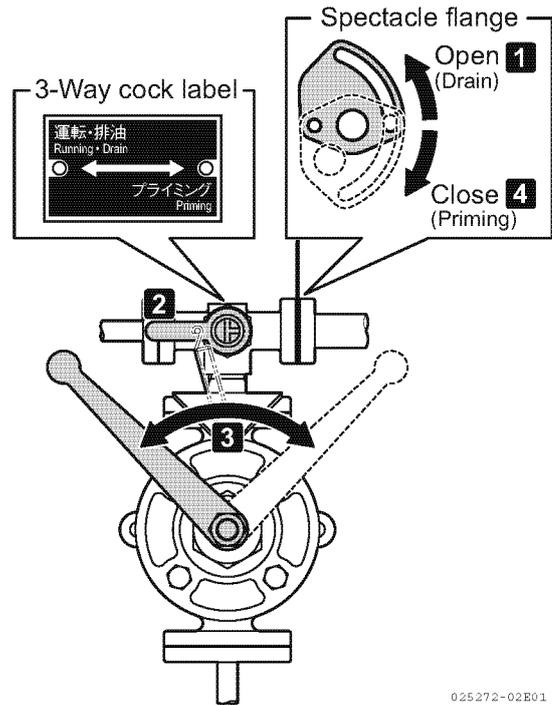
CAUTION

Be careful of burns from small oil drops.
Lubricating oil is hot.

● Priming pump (option)

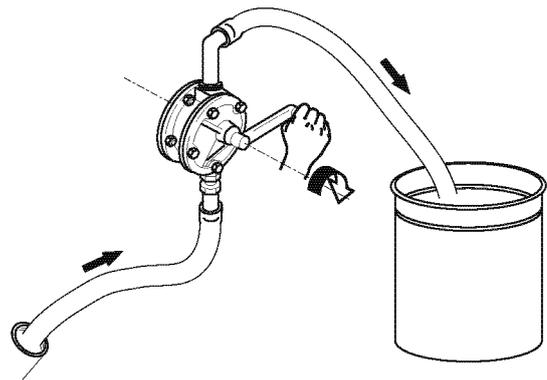
1. Set the spectacle flange of the 3-way cock to OPEN.
2. Check the 3-way cock lever on the top of the wing pump to RUNNING/DRAIN.
3. Drain the oil from the oil discharge port of the wing pump.
4. After you drain all oil, set the spectacle flange of the 3-way cock on the wing pump to CLOSED.
5. Fill new lubricating oil into the oil supply port.

Service period	1st time	After 50 hours		
	2nd time and after	Sulfur content	Every 250	hours
		0.5 - 1.0 %	hours	
Sulfur content	Every 500	hours		
≤ 0.5 %	hours			



● Oil discharge pump (option)

1. Insert the rubber hose of the oil discharge pump into the oil supply port. Drain the lubricating oil.
2. After you drain, fill new lubricating oil.



■ Cleaning of lubricating oil bypass filter

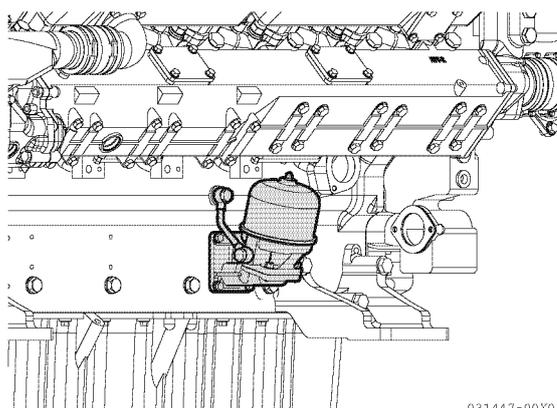
The lubricating oil system is equipped with a lubricating oil bypass filter.

NOTICE

Stop the engine before cleaning the bypass filter.
Do not disassemble while the engine is running.

Disassembly and cleaning

Service period	1st time	50 h
	2nd time and after	Every 250 hours



● Disassembly

Disassemble and clean the lubricating oil bypass filter according to the following procedures.

1. Loosen the cap nut and then remove the cover.
2. Loosen the nut and remove the rotor body.
3. Loosen the lock nut and remove the rotor cover, then remove the insulator and spring.
4. Remove sludge inside the rotor with a spatula.

NOTICE

Completely remove sludge. Otherwise, residual sludge may cause an unbalance in rotation, resulting in damage to the bearing of the spindle shaft.

5. Check for clogging of the nozzle and clean the nozzle with a brass wire brush.
6. Check each part. If any damage or excessive wear is found, replace the new part.

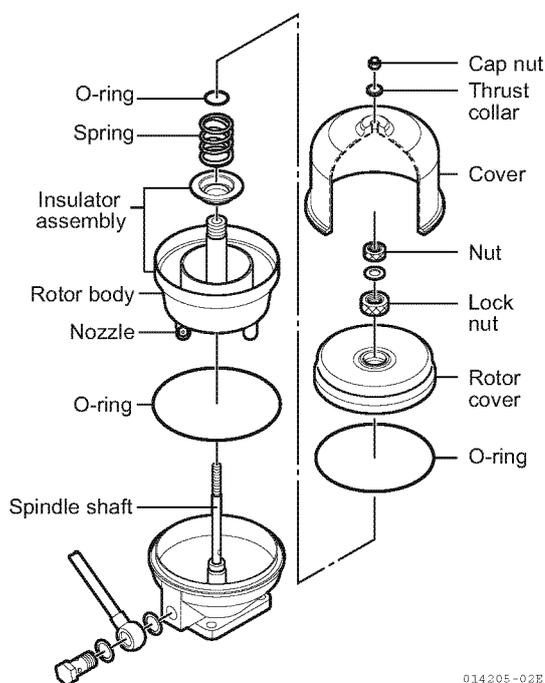
● Assembly

Assemble the filter in the sequence reverse to disassembly while observing the following precautions.

1. Install the insulator spring into the rotor body and cover the rotor body with the rotor cover.

NOTICE

Ensure that the rotor and rotor cover fit well. When the fitting is not aligned, the rotor becomes unbalanced and it may damage the equipment.



51 — PERIODIC MAINTENANCE

2. Tighten the rotor cover to the rotor body with a lock nut.

Lock nut tightening torque	Hand-tighten
-----------------------------------	---------------------

3. Insert the rotor to the spindle shaft and tighten the nut by hand.

Nut tightening torque	Hand-tighten
------------------------------	---------------------

4. Install the cover with the thrust collar (upper), and tighten the cap nut.

Cap nut tightening torque	9.8 N•m
----------------------------------	----------------

NOTICE

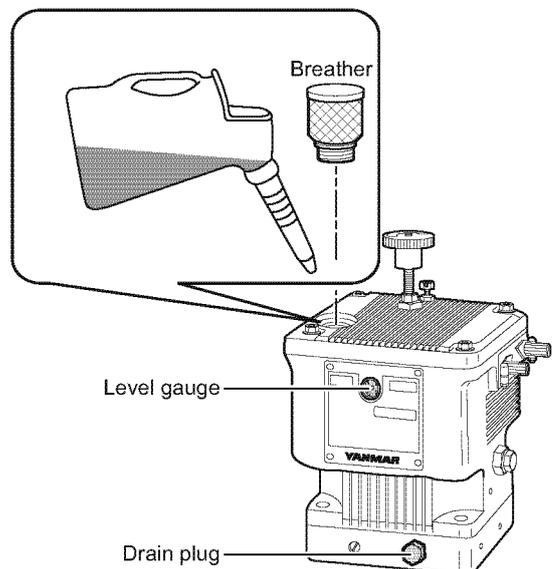
Do not tighten the nut and cap nut with too much torque, it loses its tightening power when it is loosened the next time and it can cause the spindle shaft to be loosen.

5. While operating the filter, make sure oil does not leak from connected sections. Also, make sure the filter is not vibrating abnormally.

■ Replacement of hydraulic governor oil

Service period		CD grade #40	SJ grade 0W-40
	1st time	After 1000 h	After 500 hours
	2nd time and after	Every year	Every 6 months

1. Remove the drain plug on the bottom of the governor and loosen breather.
2. Drain the oil.
3. Install the plug. Replace the gasket if necessary.
4. Fill new recommended oil until it is a little higher than center of the level gauge.



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■ Replacement of marine gear oil and filter

Refer to the operation manual of the installed marine gear.

Cooling Water System (Seawater and Coolant)

Seawater system

■ Discharging seawater

From time to time during operation, check if water is coming out of the seawater outlet. If water comes out intermittently or its volume is low during a high-speed run, stop the engine immediately, and check for the cause.

Service period	Daily (during operation)
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■ Replacement of zinc anodes

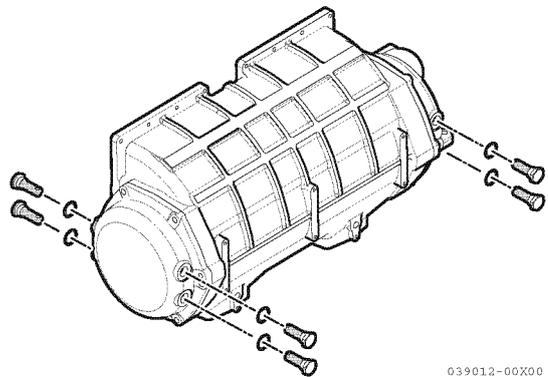
Remove the zinc anode and scrape the coating on the zincs with a wire brush. If more than 50 % of the zinc is corroded away, it should be replaced with a new zinc. There are 6 pieces zinc anode on air cooler.

Service period	Checking	Every 250 hours
	Replacement	Every 500 hours

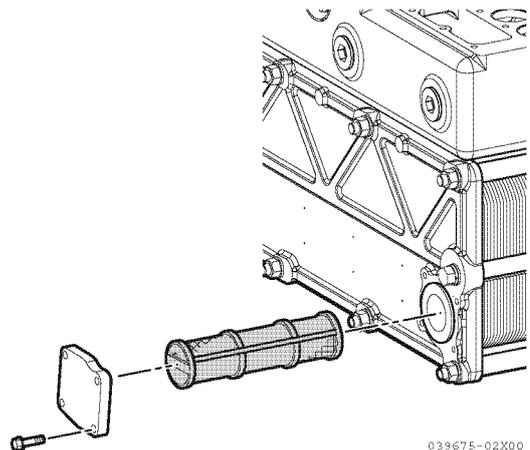
■ Cleaning seawater strainer of heat exchanger

Service period	Every 500 hours
-----------------------	------------------------

1. Remove the cover of the seawater pump and drain seawater.
2. Remove the cover (flange) of the heat exchanger.
3. Remove the seawater strainer and clean it.
4. Install the seawater strainer and the cover (flange) to the initial positions.
5. Check for water leaks during engine operation.



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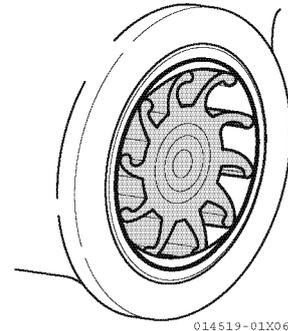
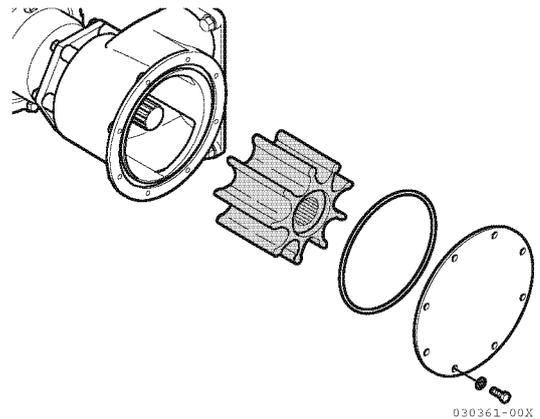


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■ Replacement of seawater pump impeller

1. Remove the seawater pump cover and pull out the impeller. Check the wear plate and cover for wear or damage.
2. If the wear plate and cover are excessively worn, replace them with new ones.
3. When reassembling the pump, apply grease to the fitting area of the pump shaft and impeller, both end faces of the impeller and the tip of the impeller blades.
4. When installing the impeller, make sure that the blades of the impeller point in the direction shown in the illustration on the right.

Service period	Every year
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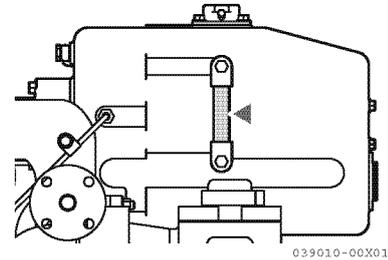
Coolant system

■ Coolant level

Check the coolant level before starting the engine in the cold condition.

1. Check the water level with the water level gauge on the coolant tank.
2. If necessary, add coolant up to the top of the water level gauge.

Service period	Daily
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■ Water pump (coolant) leakage

If there is a coolant leak and the amount of coolant decreases, serious problems such as seizure of the engine may occur.

If there is a water leak, consult your YANMAR dealer or distributor.

Service period	Daily
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■ Coolant change

Service period	Every year
----------------	------------

NOTICE

- Be sure to replace the coolant at the specified time.
- Be sure to obey the correct mixture ratio for the Long Life Coolant (LLC). (Refer to P24 [Coolant])

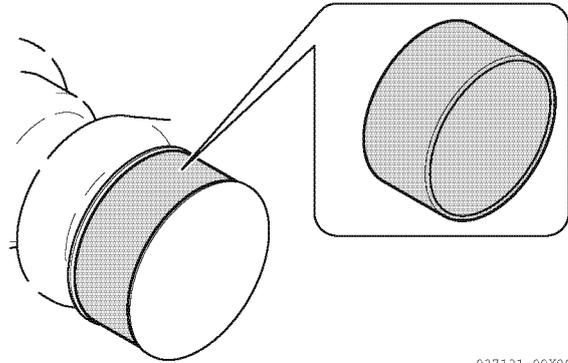
Turbocharger

Checking and servicing

■ Wash the pre-filter

A pre-filter removes contaminations in the air and keeps the engine output in good condition.

1. Wash the pre-filter with a neutral detergent.
2. Wash the pre-filter with tap water, dry it sufficiently, and install.



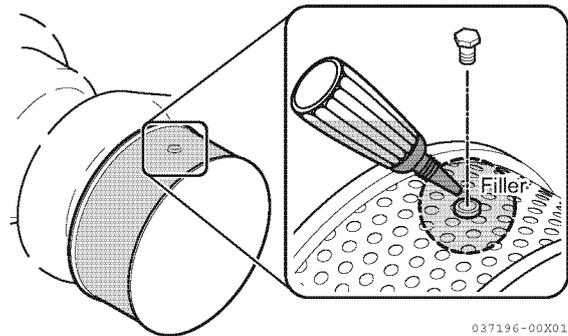
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■ Wash the blower

If the turbocharger blower is contaminated, the blower speed decreases, the boost pressure drops, and causing the engine output to fall. Wash the blower, if the boost pressure drops by approximately 10 % compared with normal condition.

The blower washing is according to following procedure.

1. Prepare the blower wash fluid, tap water, and oiler.
2. Remove the pre-filter from the intake silencer, and remove the water filler plug.
3. During a load operation at 1700 min⁻¹ or more, fill 150 cc of the blower wash fluid slowly (over approximately 10 seconds) from the filler.
4. Approx. 3 minutes after filling the blower wash fluid, fill 150 cc of tap water slowly (over approximately 10 seconds) from the filler.
5. Continue the load operation for approximately 15 minutes to dry and check the output recovery.
6. Repeat the above washing operation for 3 to 4 times if the prior performance is not recovered, consult your YANMAR dealer or distributor for repair.



037196-00X01

Service period	Pre-filter	When the boost pressure drops by 10 % in comparison with normal condition or every 250 hours.
	Blower	

NOTICE

Do not fill a large amount of the wash fluid and tap water at once. It may result in turbo charger damage and a water hammer accident.

■ The connections of parts

1. Check the exhaust gasket and the air connection pipe of the turbocharger for air and gas leaks.
2. Check all tightened parts for looseness.

Service period	Daily
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Rubber Hoses

■ Hoses and tightening hose clips

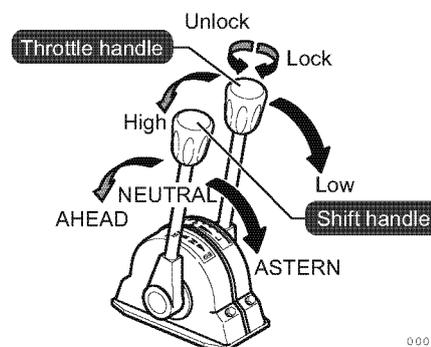
1. Check all rubber hoses for oil, water and air leaks. Tighten the hose clips if it is necessary.
2. Check all rubber hoses for the damage. Replace the rubber hoses if it is damaged.

Service period	Hose clips	1st time	50 hours
		2nd time	Every 500 hours
	Rubber hoses	Every year	

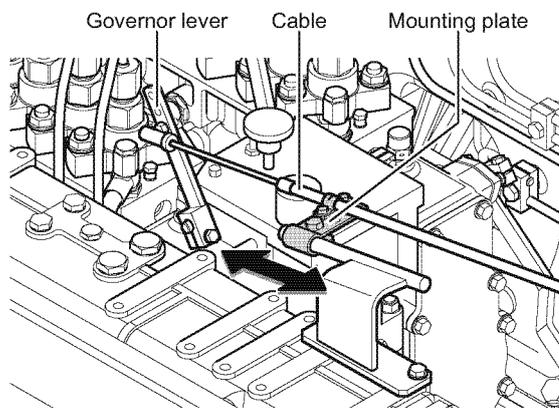
Control Handle and Cables

■ Checking throttle handle and cable

Operate the throttle handle from the position “L” to the position “H”, and check if the governor lever at the governor moves into the correct position. If there is disalignment between the throttle handle and the governor lever in their position, adjust the control cable by changing the clamping position of the bracket.



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■ The shift handle and cable

Refer to the operation manual of the installed marine gear.

Service period	1st time	50 hours
	2nd time	Every 500 hours

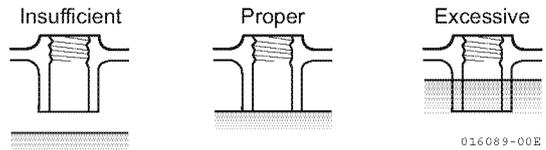
Electrical Parts

■ The alarm devices

Service period	Daily
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■ The battery fluid level

Battery electrolyte decreases as charging and discharging are repeated. Check that the normal electrolyte level. If the level is low, add distilled water. Refer to the illustration on the right.



Service period	Every 250 hours
----------------	-----------------

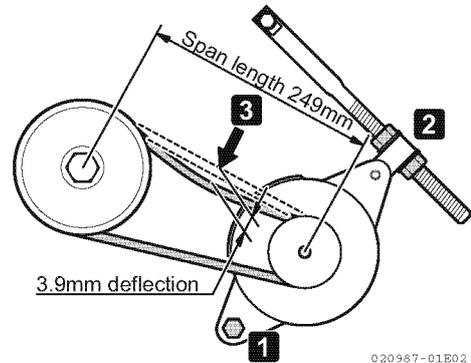
■ The alternator drive belt tension

Put load in a right angle on the center of the belt span. The span length is 249 mm, adjust until the deflection is 3.9 mm at 5 - 6 N load.

● Adjusting the V-Belt

1. Loosen the lock bolt of the alternator. Adjust the tension of the V-belt with the adjuster nut.
2. After you adjust, tighten the adjuster nut and the lock bolt of the alternator.

Replace the V-belt if it is damaged.



Service period	Checking	1st time	After 50 hours
		2nd time and after	Every 500 hours
	Replacement V-belt		Every year

Adjustment of Valve Clearance

Adjusting the valve clearance should be done while the engine is cold.

Service period	1st time	50 hours
	2nd time and after	Every 6 months

Valve bridge parallel adjustment

Adjustment procedures for the intake and exhaust valves are the same.

1. Set the decompression shaft to the RUN position (all cylinders).
2. Turn the flywheel until the No. 1 cylinder is at T.D.C. (Top Dead Center) on the combustion stroke.
3. Loosen the valve bridge lock nut and loosen the bridge adjusting screw 1 - 2 turns.
4. Loosen the rocker arm lock nut and screw in the adjusting screw until the rocker arm tip just touches to the bridge center.

NOTICE

Be careful not to screw in the adjusting screw since it will compress the valve spring.

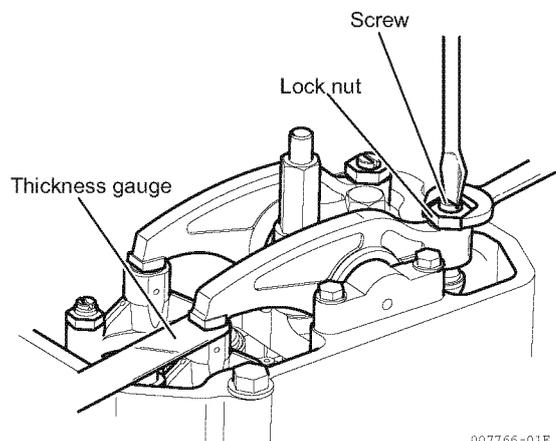
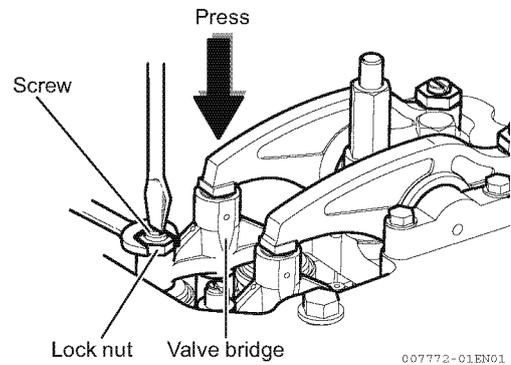
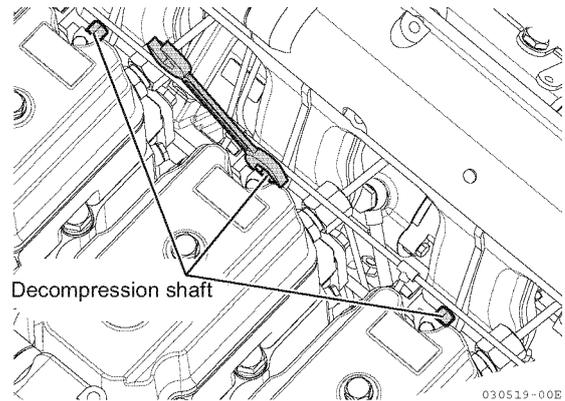
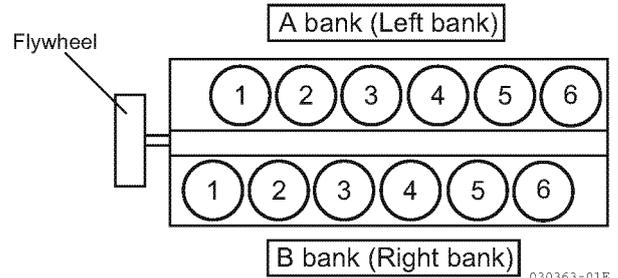
5. Screw in the valve bridge adjusting screw until it just touches the valve stem.
6. Keep the adjusting screw in this position and tighten the bridge lock nut with wrench.

Valve clearance adjustment

Valve clearance	Intake	0.3 mm
	Exhaust	0.5 mm

Insert a thickness gauge between the rocker arm and the center of the bridge and adjust valve clearance by turning the adjusting screw. Tighten the lock nut and reinspect the valve clearance.

Cylinder arrangement



TROUBLESHOOTING AND COUNTERMEASURES

There are many causes for abnormalities and defects, and they often play together.

Pay attention to changes in the operating performance, and refer to the maintenance records, servicing dates and history of part replacement. Locate the cause early and take the proper countermeasures.

- **Starting failure**

- **Flywheel does not turn**

- **Flywheel turns, but ignition does not occur**

- **Rotational speed drops spontaneously**
- **Lubricating oil pressure drops below the specified pressure**
- **Coolant temperature is too high**
- **Engine stops suddenly**
- **Exhaust temperatures of all the cylinders is too high**
- **Bad color of exhaust gas**
- **Unusual sounds (e.g. knocking) occur during operation**

NOTICE

- Although some failures can be solved by the user, others can not. For failures that require disassembly for repair and servicing or those that are not covered in this chapter, consult your YANMAR dealer or distributor.
 - If you decide after inspection that you can continue using the engine, return to port at a slow speed. At port, do or request the necessary repairs by consult your YANMAR dealer or distributor. If you cannot make a decision yourself, consult your YANMAR dealer or distributor.
 - Do not operate the engine if the alarm devices are not working properly. Doing so may lead to a severe accident in case of a failure because you will not receive any alarm notifications.
-

Starting failure

Flywheel does not turn

Cause	Countermeasure
1. Electric starting system <ul style="list-style-type: none"> • Battery voltage drop • Failure of synchronizing relay switch • Failure of starter motor 	Charge the battery Check and repair the switch Consult your YANMAR dealer or distributor
2. Air starting system <ul style="list-style-type: none"> • Clogging of air filter or silencer • Failure of air starter 	Check and clean the filter or silencer Consult your YANMAR dealer or distributor
3. Viscosity of lubricating oil too high	Change to the correct lubricating oil with appropriate viscosity
4. Seizure of moving part <ul style="list-style-type: none"> • Seizure of piston and cylinder liner • Seizure of main bearing and/or camshaft bearing 	Consult your YANMAR dealer or distributor Consult your YANMAR dealer or distributor

Flywheel turns, but ignition does not occur

Cause	Countermeasure
1. Fuel oil not sent under pressure to fuel injection pump <ul style="list-style-type: none"> • Fuel tank empty • Closing of fuel cock (valve) • Clogging of fuel filter • Failure of fuel feed pump • Air mixed in fuel system 	Fill the fuel to the fuel tank Open fuel cock (valve) Replace the filter element Consult your YANMAR dealer or distributor Check and repair the fuel system, then bleed air
2. Poor airtightness of intake/exhaust valve <ul style="list-style-type: none"> • Inadequate intake/exhaust valve clearance • Sticking of intake/exhaust valve • Damage of seat of intake/exhaust valve 	Consult your YANMAR dealer or distributor Consult your YANMAR dealer or distributor Consult your YANMAR dealer or distributor
3. Low cetane number of fuel oil	Use a appropriate quality fuel oil
4. Incorrect decompression shaft	Check and set to compression
5. Shortage of hydraulic governor oil	Check and refill governor oil

Rotational speed drops spontaneously

Cause	Countermeasure
1. Clogging of fuel filter	Replace the filter element
2. Seizure of moving part (piston, main bearing or turbocharger)	Consult your YANMAR dealer or distributor
3. Air mixed in fuel system	Check and repair the fuel system, then bleed air
4. Moisture content in fuel system	Drain the filter, tank, etc
5. Defect of hydraulic governor	Consult your YANMAR dealer of distributor

Lubricating oil pressure out of the specified pressure

Cause	Countermeasure
1. Looseness of lubricating oil pipe	Check and repair the lubricating oil pipe
2. Clogging of lubricating oil filter	Replace the lubricating oil filter element
3. Excessive oil clearance of crankshaft bearing	Consult your YANMAR dealer or distributor
4. Sticking of lubricating oil pressure regulating valve or loose adjusting bolt	Consult your YANMAR dealer or distributor
5. Sticking of lubricating oil safety valve	Consult your YANMAR dealer or distributor
6. Too high temperature of lubricating oil	
• Shortage of cooling water volume	Check the seawater pump
• Fouling of lubricating oil cooler	Consult your YANMAR dealer or distributor
• Excessive blow-by (gas leak) into the crankcase	Consult your YANMAR dealer or distributor
7. Air sucked in lubricating oil pump (shortage of lubricating oil volume)	Replenish the lubricating oil

Coolant temperature is too high

Cause	Countermeasure
1. Shortage of cooling water volume	
• Clogging of seawater inlet passage	Check and clean the seawater strainer, sea cock and pipes
• Failure of seawater pump impeller	Check and repair the impeller
• Failure of water pump (coolant)	Consult your YANMAR dealer or distributor
2. Clogging of seawater strainer of heat exchanger	Check and clean the seawater strainer
3. Coolant level is low	Refill with coolant
4. Coolant is leaking	Check and tighten the leaking part
5. Sticking of coolant thermostatic valve	Consult your YANMAR dealer or distributor

Engine stops suddenly

Cause	Countermeasure
1. Fuel tank empty	Replenish the fuel oil
2. Air mixed in fuel system	Bleed air from the fuel system
3. Clogging of fuel filter	Replace the filter element
4. Seizure of moving part (piston, main bearing, crank-pin bearing, timing gear, etc.)	Consult your YANMAR dealer or distributor

Exhaust temperature of all the cylinders is too high

Cause	Countermeasure
1. Charge air temperature is too high <ul style="list-style-type: none"> • Shortage of charge air cooler cooling water volume • Fouling of charge air cooler (cooling water side and air side) • Engine room temperature is too high 	Check and repair the seawater pump Consult your YANMAR dealer or distributor
2. Unsuitable properties of fuel oil	Check and service the engine room ventilation equipment Use a high-quality fuel oil
3. Overload	Reduce the load

Bad color of exhaust gas

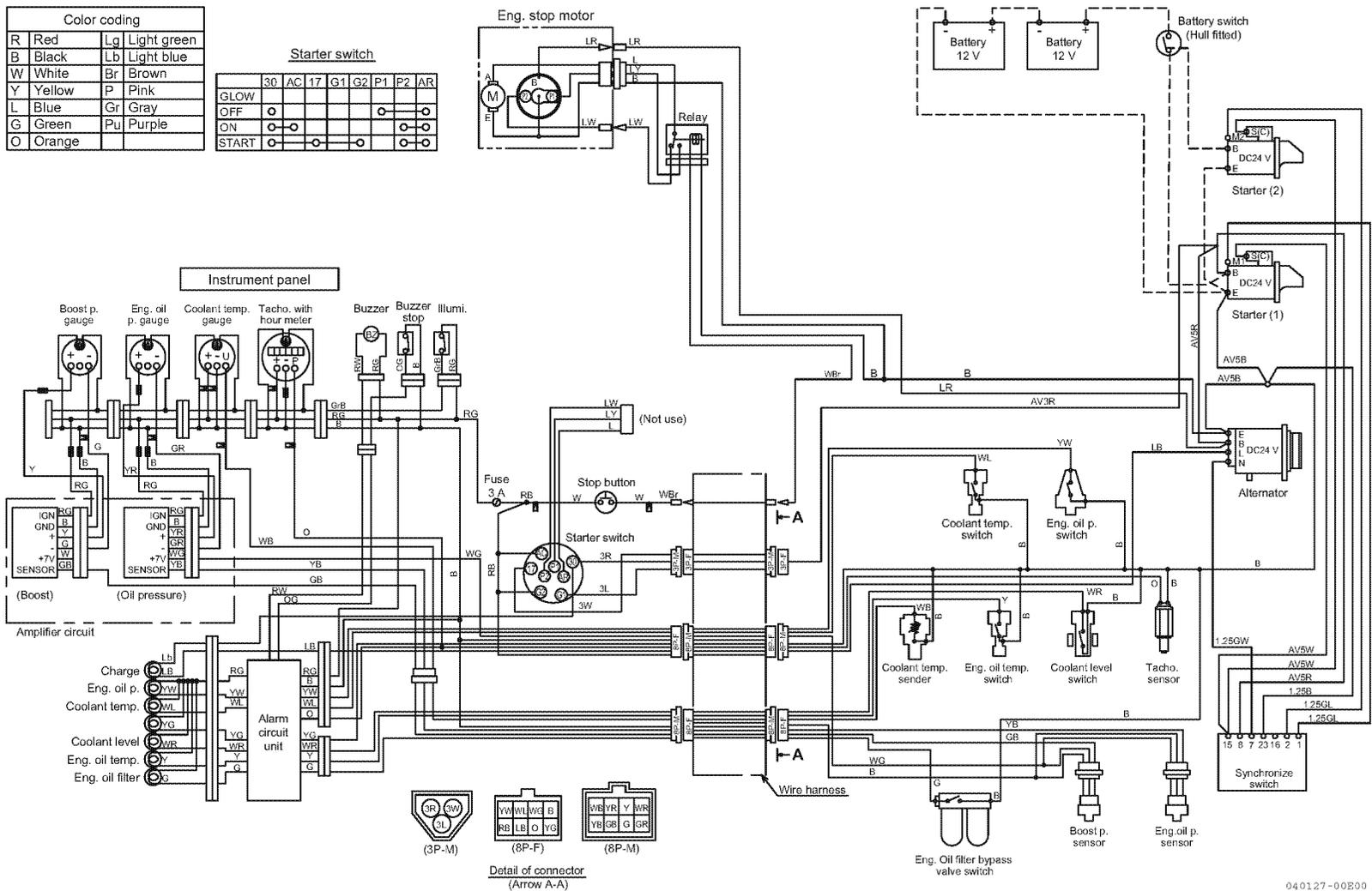
Cause	Countermeasure
1. Inadequate fuel injection timing	Consult your YANMAR dealer or distributor
2. Inadequate intake/exhaust valve clearance or damage of intake/exhaust valve seat	Consult your YANMAR dealer or distributor
3. Sticking of intake/exhaust valve	Consult your YANMAR dealer or distributor
4. Damage of intake/exhaust cam	Consult your YANMAR dealer or distributor
5. Defect of turbocharger <ul style="list-style-type: none"> • Clogging of pre-filter • Fouling of the blower side or turbine side 	Wash the pre-filter Wash the turbocharger/blower
6. Fouling of charge air cooler (too high temperature of boost air)	Consult your YANMAR dealer or distributor
7. Low quality of fuel oil	Use a high quality fuel oil
8. Overload	Reduce the load

Unusual sounds (e.g. knocking) occur during operation

Cause	Countermeasure
1. Inadequate intake/exhaust valve clearance	Consult your YANMAR dealer or distributor
2. Inadequate fuel injection timing	Consult your YANMAR dealer or distributor
3. Loosen some parts	Check and fasten

WIRING DIAGRAMS

■ Earth float without air heater



040127-00E00

Record of ownership

Take a few moments and record the information that is necessary when contacting YANMAR for service, parts or documentation.

Engine model: _____

Engine serial No.: _____

Date purchased: _____

Dealer: _____

Dealer phone: _____

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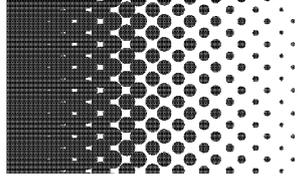
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OPERATION MANUAL

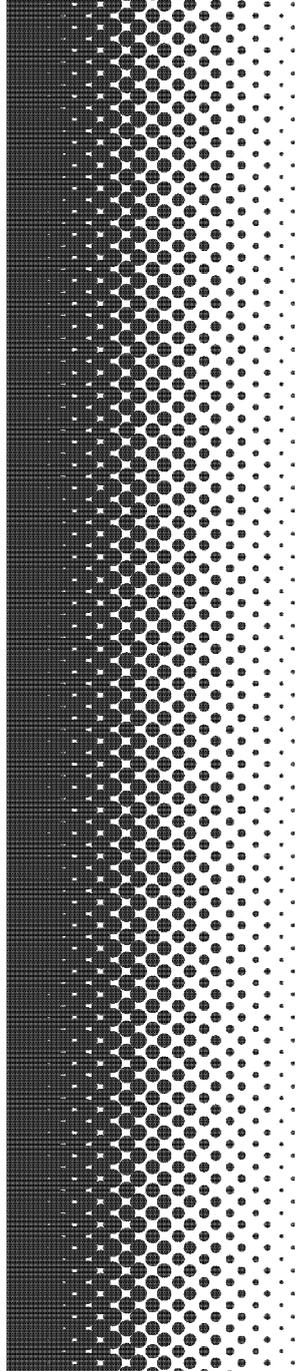
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