

YANMAR

OPERATION MANUAL

MARINE PROPULSION ENGINE

6EY17W

INTRODUCTION

Thank you for purchasing a YANMAR marine product.

This operation manual is for your safe and effective use of the product.

Before you use this product, carefully read and fully understand the instructions about operation, inspection and maintenance.

Keep this manual in a safe location. Make sure that the operator can always read it.

Because the inspection and maintenance instructions are for professional technicians, necessary but basic knowledge has been omitted.

■ Using this manual

- The text and illustrations of this operation manual can partly disagree with products of some specifications. In that case, refer to the separate Specification and Final Document.
- The contents of this operation manual can change without prior notification to improve the quality and performance of the product and to improve safety
- For some devices, refer to the separate operation manuals.
- If you lose or damage this operation manual, please contact YANMAR or your sales or service agent.
- If you transfer this product, also transfer this Operation Manual, Final Document and Records of Shop Trial with the product to the next owner.
- The numerical values in this manual are based on the SI system (International System of Units).

■ Inquiries

- Only use genuine YANMAR replacement parts or other specified parts. When you order a part, clearly give your YANMAR sales or service agent the product name (model) and serial number together with the part name (and its page in this manual) and part number.
- If you:
 - use the product differently from the intended usage purpose or conditions OR
 - operate the product differently from the contents of this operation manual,you can cause accidents and malfunctions. Before you make a modification to the product, contact YANMAR or your sales or service agent. Do not make a modification that is not approved by YANMAR.
- If you have questions or comments about this manual, please contact YANMAR or your sales or service agent.

ABOUT THIS OPERATION MANUAL

The major terms used in this operation manual are defined as follows:

The front of the engine: opposite side of the flywheel

The back of the engine: the flywheel side

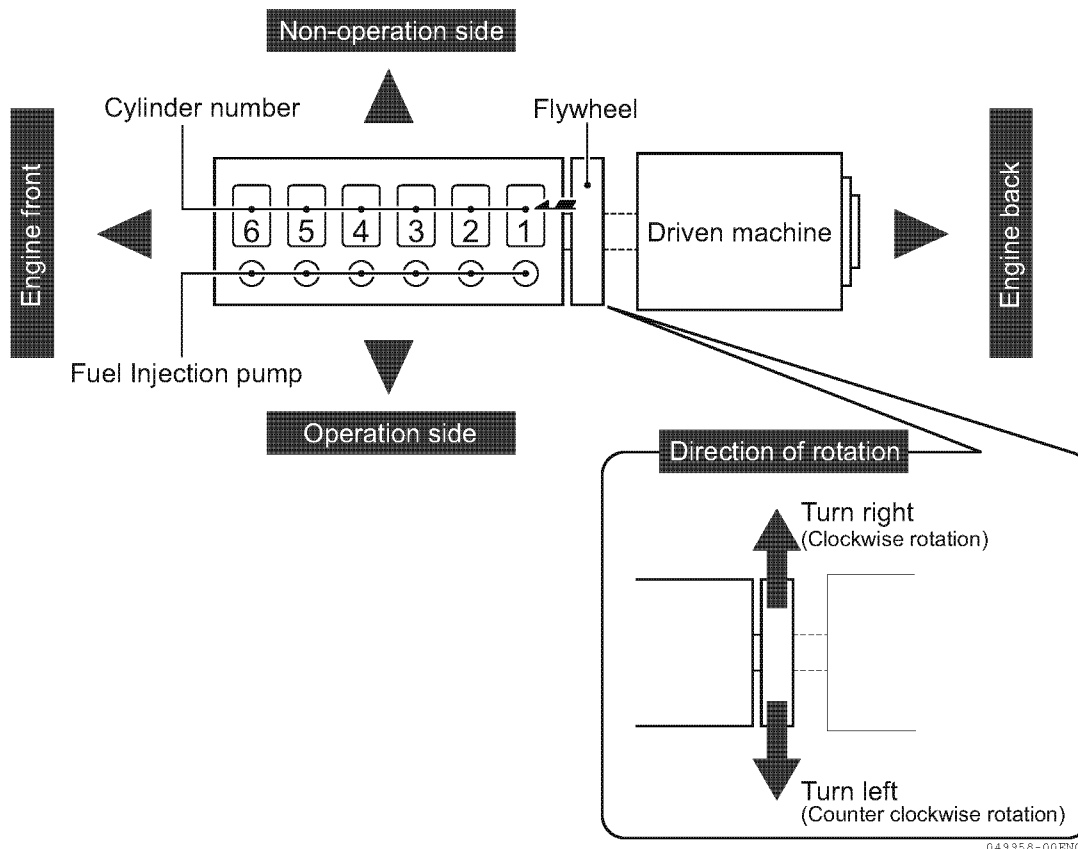
Operation side: on the left side as viewed from the flywheel side (fuel injection pump side)

Non-operation side: on the right side as viewed from the flywheel side (exhaust manifold side)

Turn right: clockwise rotation as viewed from the flywheel side

Turn left: counterclockwise rotation as viewed from the flywheel side

Cylinder number: counted from the flywheel side (1, 2, 3, ...)



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FOR YOUR SAFETY

We are confident that you will be fully satisfied with this product if you use it as described in this manual. But if you do not obey all instructions, dangerous accidents and damage (e.g. injuries, burn injuries and fire) can occur. Before you use the engine, carefully read and thoroughly understand all safety precautions.

About Safety Labels

This manual and the engine have safety indications. They are important symbols and warnings that are necessary to operate this product safely.

The safety labels tell you this:



This safety alert symbol is used with most safety warnings. It says: Attention! Warning! Your safety is involved! Carefully read and obey the safety instructions after 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 injury.

NOTICE

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

Precautions

DANGER



Burns from steam

- Never remove the filler cap from the freshwater tank while the engine is still hot. Steam and hot air will spurt out and seriously burn you.
- After engine stop, wait until the temperature decreases. 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 will come out during operation and cause burn injuries.



Ventilation of the battery area

- Make sure that the area around the battery is ventilated well and that no flammable materials are near. The battery makes hydrogen gas when it charges. The gas is very flammable.



Fires from oil ignition

- Make sure again that the type of fuel oil is correct before you refuel. The wrong fuel oils (e.g. gasoline) can cause a fire.
- Be sure to stop the engine before fueling. If you spill fuel oil, carefully wipe the spillage.
- Do not put oils or other flammable materials near the engine. They can burn and cause a 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.



Injury from rotating parts

- Keep your hands, other body parts and clothing away from rotating parts (e.g. the front drive shaft, V-belt or propeller shaft). If they are caught, injury can occur.
- Stop the engine before inspection, unless operation is absolutely necessary.
- Do not operate the engine without the cover of rotating parts.
- Before you start the engine, make sure that no tools or rags are near the engine.



Precautions against noise

- Put on ear protection (ear plugs) in the engine room to prevent hearing loss.

⚠ WARNING**Precautions against opening the cylinder block side cover**

- Do not open the cylinder block side cover when the engine is hot. Fresh air that flows into the engine can cause an explosion.

**Fires from electric short-circuits**

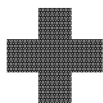
- Always turn off the battery switch or detach the earth cable (-) before you inspect the electrical system.
- A short-circuit can cause a fire.

**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. You may mishandle the engine, which could lead to a serious accident or injury.

**Ventilation of the battery area**

- Make sure that no flammable materials are near as the battery makes inflammable gas while charging.
- Make sure that the room has good airflow. It can explode.

**Precautions against starting the engine**

- Make sure that nobody is near the engine.
- If someone is present, give a signal and make sure that the person is safe before you start the engine.
- Make sure that you remove the turning bar. Put it in the specified place. There is a risk of injury.

⚠ CAUTION**Precautions against burn injury**

- Make sure that you (e.g. your hands, body and clothing) do not touch the exhaust manifold, exhaust pipes, turbocharger, air cooler or engine body. Be careful of burns. The entire engine and each part are very hot.

**Battery fluid**

- Be careful that the battery fluid does not get on your skin or in your eyes. 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.

NOTICE

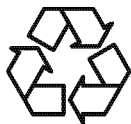
No modifications

To ensure safe engine operation, the fuel injection volume control and the engine speed control are sealed. If the seal is removed, the engine life decreases very much. This is because of deterioration and increased wear on the sliding and rotating parts of the engine. This can result in an increase of lubricating oil consumption and fuel consumption, seizure of all parts and damage. Never remove a seal.

Removing a seal voids warranty, even before the warranty is expired.

Regulation on NOx

Laws on maritime pollution and hazard prevention regulate the replacement of certain parts. The laws require that you keep a record and the signature of personnel who replaces them. Our professional service technicians have the expertise and skills to help you with the necessary tasks.



Waste disposal

- Never dispose of waste liquids such as lubricating oil by dumping them into a sewer, river, lake or ocean waters.
- Put a container to catch any waste oil (e.g. lubricating oil) so that it does not spill into the sea.
- Comply with relevant laws and/or regulations for the disposal of hazardous materials such coolant, lubricating oil, fuel, filters or batteries.

Use genuine parts

- Not using genuine parts may shorten the machine life or cause unexpected malfunction.



Maintenance Precautions

Be sure to obey the maintenance precautions for safe maintenance.

Maintenance locations

WARNING



Ventilate the room well.

- Ventilate the room well when you operate the engine, weld the parts, remove the paint with sandpaper and other works. Inhaling poisonous gas or dust is very harmful to the human body.

CAUTION



Light the room well

- Light the work area sufficiently and safely. When you work in a dim area, use a portable safety lamp. In such a case, use the lamp with the bulb covered with wire gauge. The bulb may accidentally break and ignite the leaked oil.



Work in a spacious, flat location

- The floor space of the workshop (location) where inspection and maintenance are conducted must be spacious and flat without any holes. An unexpected accident including falling may occur.



Work in a clean, tidy location

- Do not leave dust, oil, parts on the floor. An unexpected accident may occur.



Have fire extinguisher

- Work with a fire extinguisher nearby in case of fire. Make sure that the fire extinguisher is appropriately inspected.

Precautions against work

WARNING

Before you start work



- Disconnect the power source. You can get burned or suffer an electric shock.
When you check the battery system, make sure that you disconnect the earth cable (-) terminal.
You can cause a short circuit and a fire.



Do not get caught in the engine

- Be careful that your body does not touch any rotating parts when you turn the flywheel.
Never put your hand into the cylinder block.
- Make sure that you remove the turning bar from the flywheel after you finish your task. If you start the engine with the turning bar attached, it can come off and cause fatal accident.



Work with sufficient holding and lifting conditions

- Do not hold the engine with blocks or wood blocks. Never work while holding the engine only with the jack. Be sure to use the specified metal fittings to lift and hold the engine to the specified location. It can cause fatal accident.
- When you work with heavy parts, use the specified tools and a safe wire rope.

⚠ CAUTION**Work with safe equipment and clothing**

- Put on the correct protective equipment for your task (e.g. helmet, work uniform and safety shoes). Wear work uniform that fits your body. Wearing loose work uniform can cause fatal accident including getting caught in the machine.

**Battery fluid**

- Battery fluid is a strong acid and causes inflammation.
- If you get it on your skin or eyes, immediately flush the area with a lot of fresh water. Get medical aid.

**Work with correct tools**

- Use the appropriate tools for work. Use the tools with the correct size for loosening and tightening the machine. Using the tools with the incorrect size may cause serious injury or damage to the machine.

**For the specified parts in the manual, be sure to tighten the bolts to the specified torque.**

- Loosened or missing bolts may cause damage to the parts and accident.

**Do not work in an unnatural posture**

- An unexpected injury may occur.

**When you use organic solvents**

- Organic solvent can turn into a gas easily. It is dangerous to breathe the gas. Make sure that the area where you use this solvent has sufficient airflow.
- Highly-concentrated organic solvent can dissolve fats and oils and is absorbed by the skin. This is dangerous. Put on protective gear when you use such a solvent.

NOTICE**Checks after work**

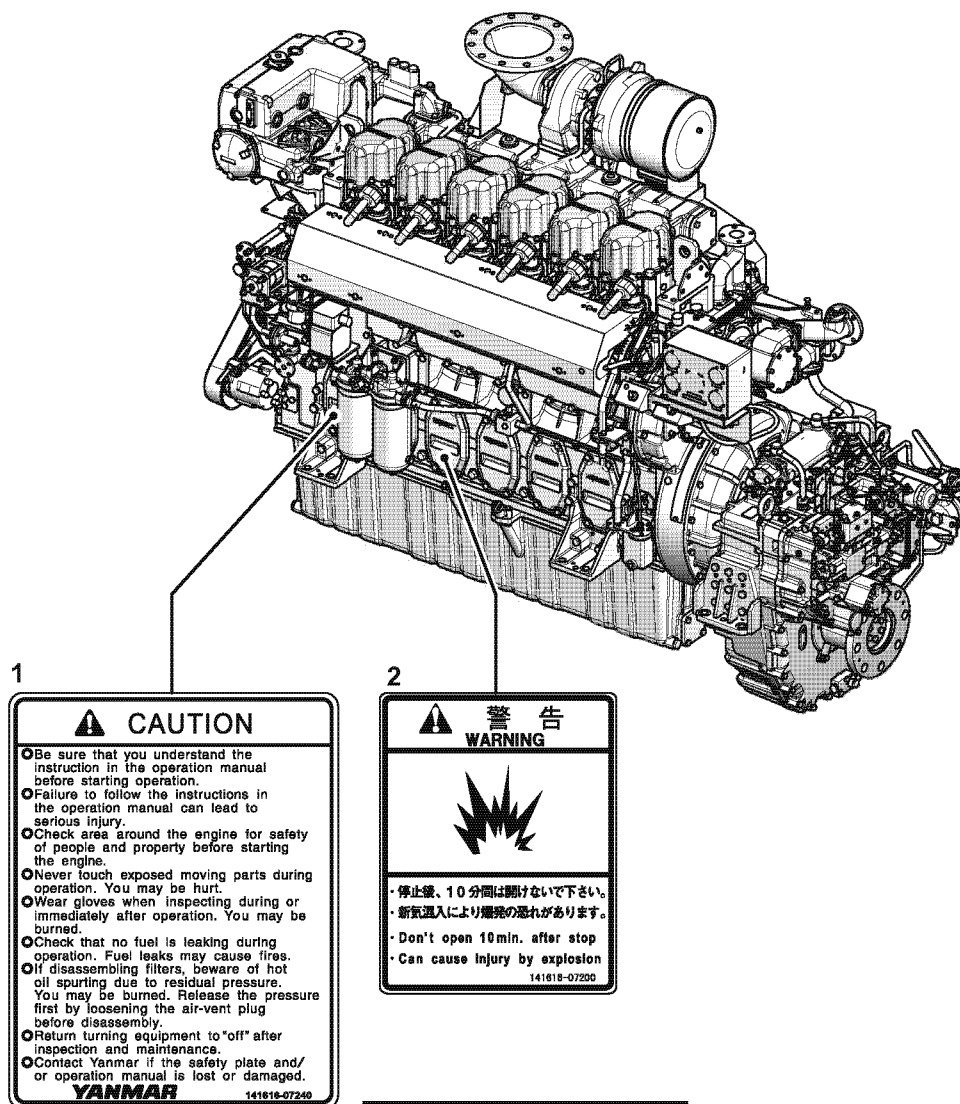
- All removed parts are installed again in their correct position.
- All damaged parts are replaced.
- Put back all tools (e.g. lifting gear and wires) to their correct location.
- All lubricating oil is removed from the engine room.
- The engine room is clean. Nothing prevents you from your routine work.
- Before you start the engine, make sure that all parts are in a good condition.
- Start the engine and look for leaks of fuel, lubricating oil, cooling water or air.
- Start a load run and check that the engine performance is the same as before servicing. If you find an unusual difference, immediately stop the engine. Adjust or repair the engine.
- When the load run is finished, record the performance values and the contents of your servicing in the engine log. (First finish the records, then report that you are finished with your work.)
- Remove standing signboards. Contact all related personnel that you are finished with your work.

Safety Labels (Warning Labels)

These are the locations of the safety labels (warning labels).

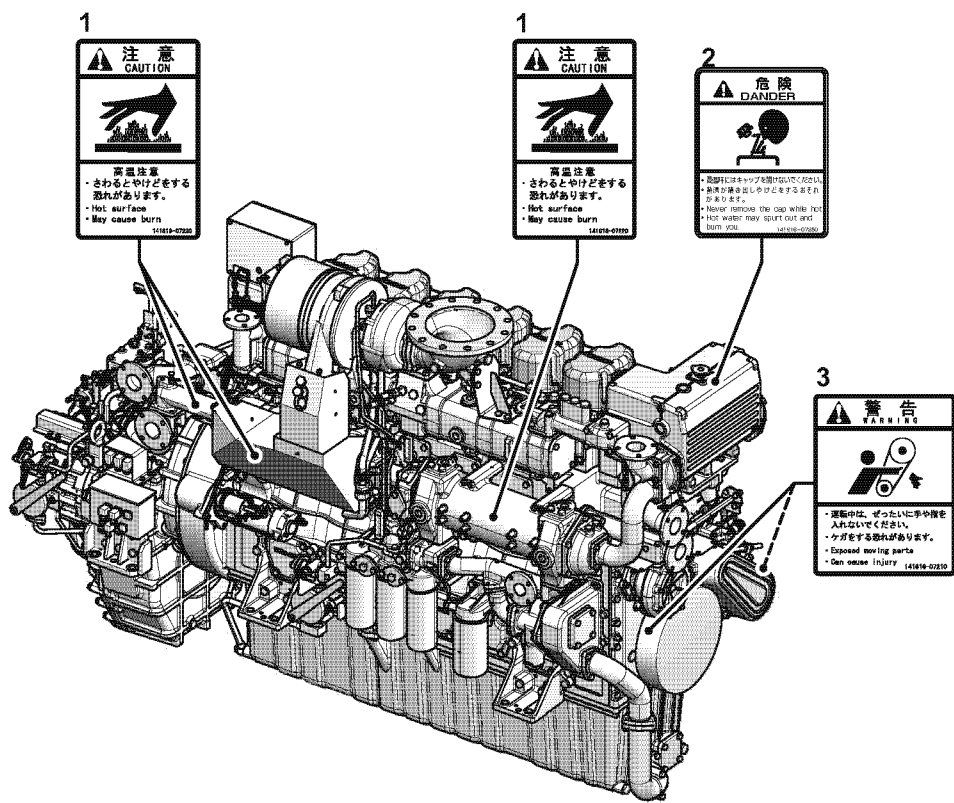
- Carefully read all safety labels to prevent accidents.
- Also, if you need to replace a part that has a label, make sure that you order the new part together with the label.
- If a safety label is dirty or missing: Find the part number and send an order for a new safety label to your YANMAR sales agent. Attach the new safety label.

■ Operation side



No.	Part No.
1	141616-07240
2	141616-07200

■ Non-operation side



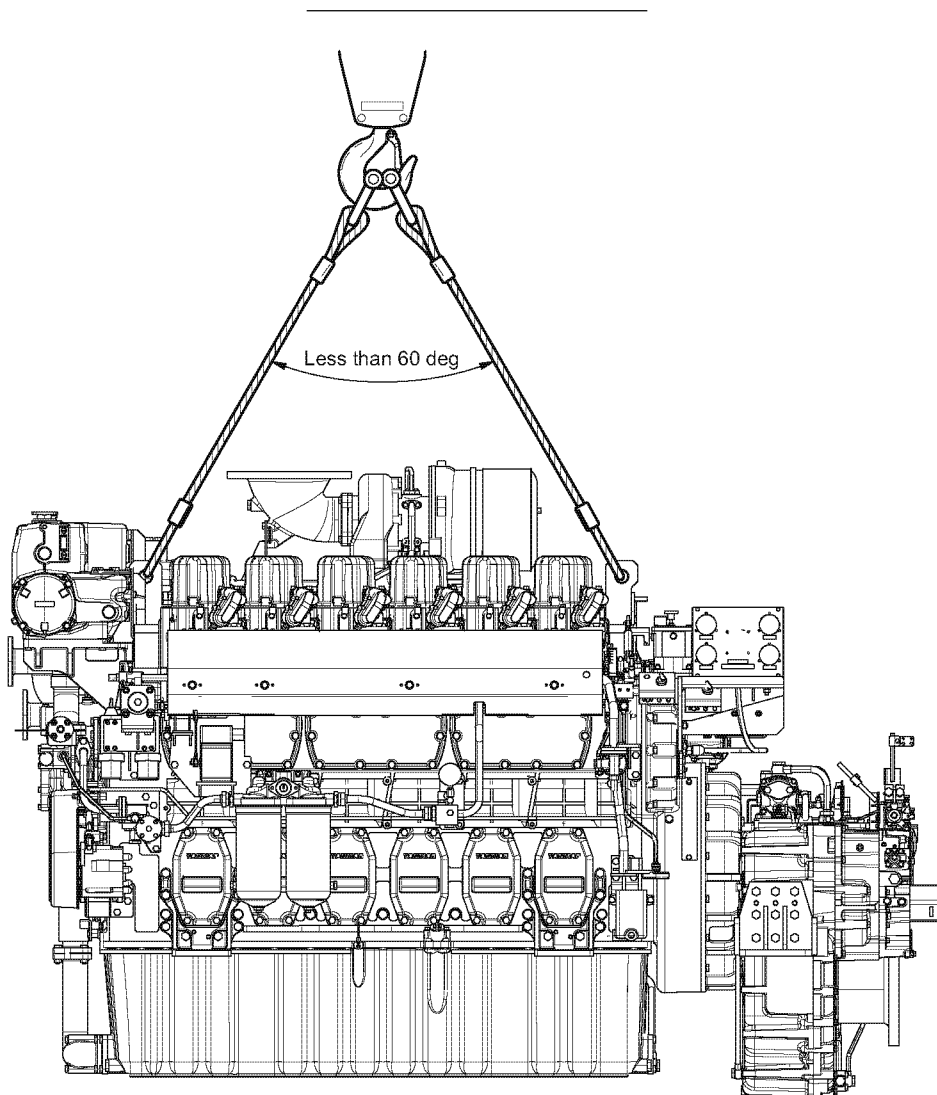
No.	Part No.
1	141616-07220
2	141616-07250
3	141616-07210

Precautions for Lifting the Engine

Falling of the engine during its lifting is very dangerous if so happened. When you lift, obey the following precautions to prevent an accident:

⚠ WARNING

- The specified license and certification are required for the lifting work depending on the lifting appliance and load. The engine lifting work must be performed by certified personnel.
- Check the engine lifting metal fittings and the mounting bolts for failure and damage before starting work. If any problems are found, stop the work immediately and consult your YANMAR dealer or distributor.
- Select the lifting tools including wire rope and shackle in accordance with the weight of heavy parts.
- Adjust the length of the wire rope so that the engine does not lean to one side.
- Inspect the lifting tools for failure and damage before starting work.
- Make sure that the wire rope does not directly touch the engine or driven machine. Use a wooden block as padding to protect them.
- The tension of the wire rope changes depending on the lifting angle. Make sure that the lifting angle of the wire rope is less than 60°.
- When you use the marine gear not described in this operation manual, separate the engine from the marine gear before lifting them.
- Do not stand under or near the engine while lifting or moving the engine.



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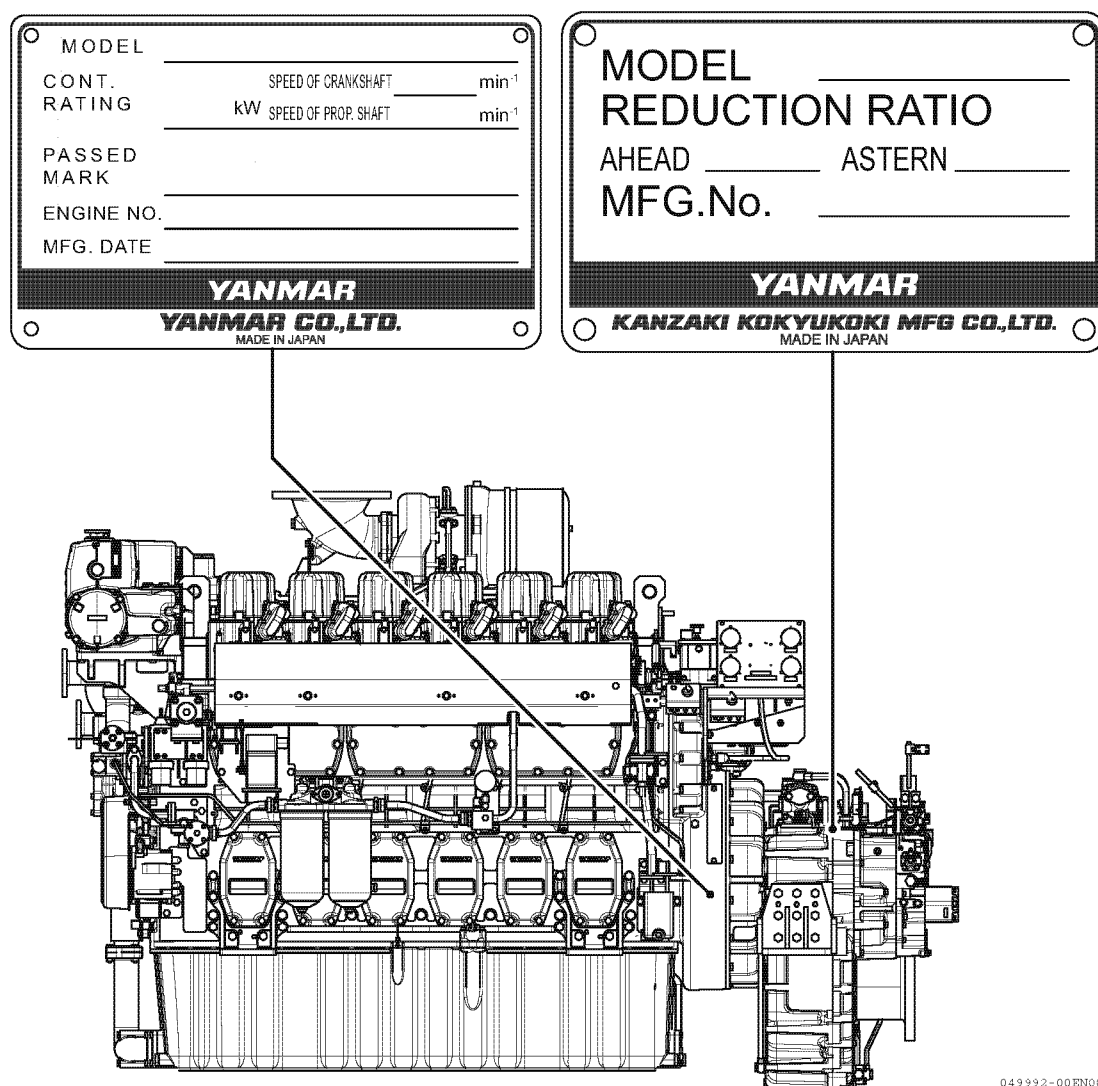
For mass, refer to the specifications of the approval drawings.

Engine Nameplate

The serial number of your engine is required when you request maintenance, repair or order a part. Have it ready beforehand.

■ Location of the engine nameplate

The engine nameplate is on the fuel injection pump side of the flywheel housing.



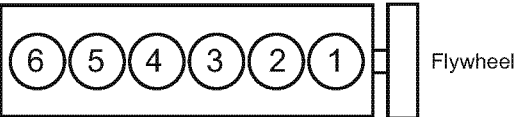
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PRODUCT OVERVIEW

Principal Engine Specifications

Model		Unit	6EY17W
Type		-	Vertical, water-cooled, 4-cycle diesel engine
Combustion chamber		-	Direct injection
No. of cylinders		-	6
Cylinder bore		mm	170
Stroke		mm	230
Displacement		ℓ	31.30
Compression ratio		-	15.2
Specified engine rotation speed		min ⁻¹	1450 or 1405 (refer to the separate paper)
Direction of crankshaft rotation		-	Counterclockwise as viewed from the flywheel
Operation side		-	Left as viewed from the flywheel
Firing order		-	1-4-2-6-3-5-1
Type of turbocharger		-	Exhaust gas turbocharger (with air cooler)
Type of cooling		-	Constant high temperature cooling (with freshwater cooler)
Lubricating oil		-	Lubrication: Self-lubricating by integrated oil pump
		-	Oil pan: wet sump
Type of starting		-	Electric start (cell motor)
Engine size	Overall length	mm	2908
	Overall width	mm	1305
	Overall height	mm	1882
Engine mass		kg	3880

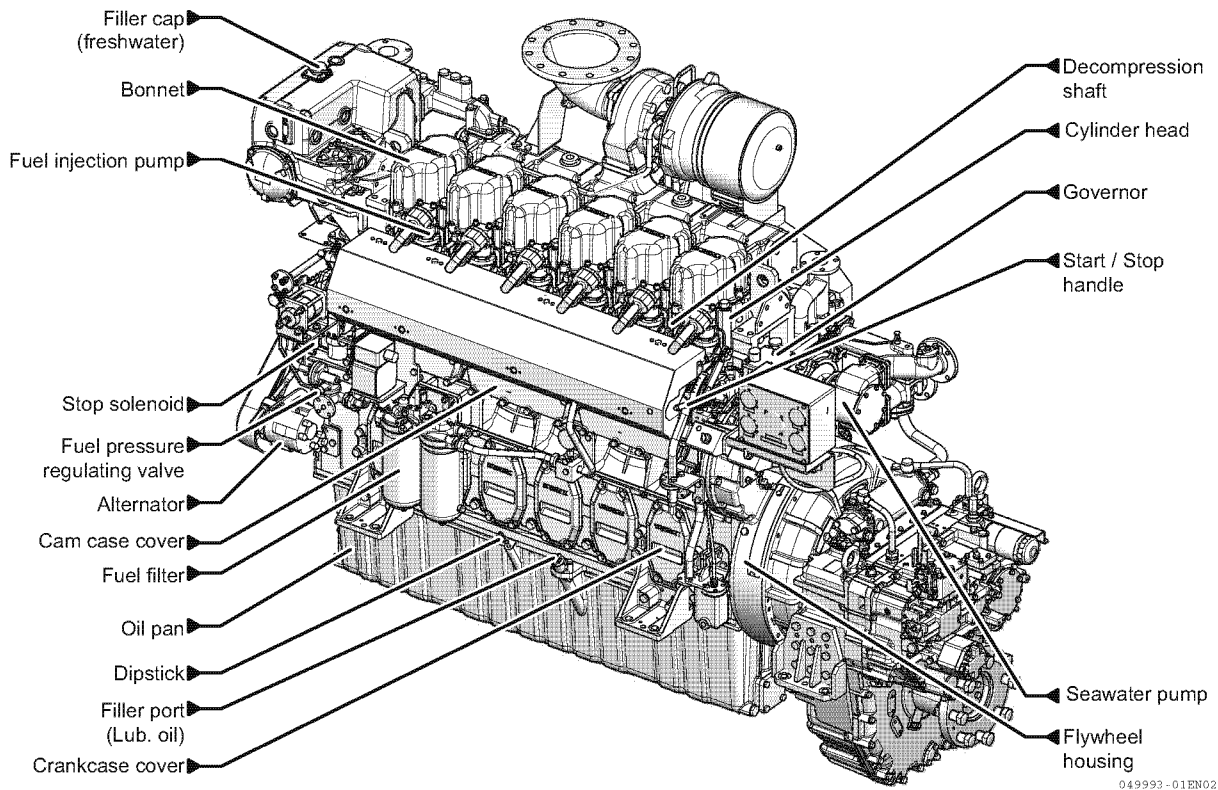
[Configuration of Cylinders]



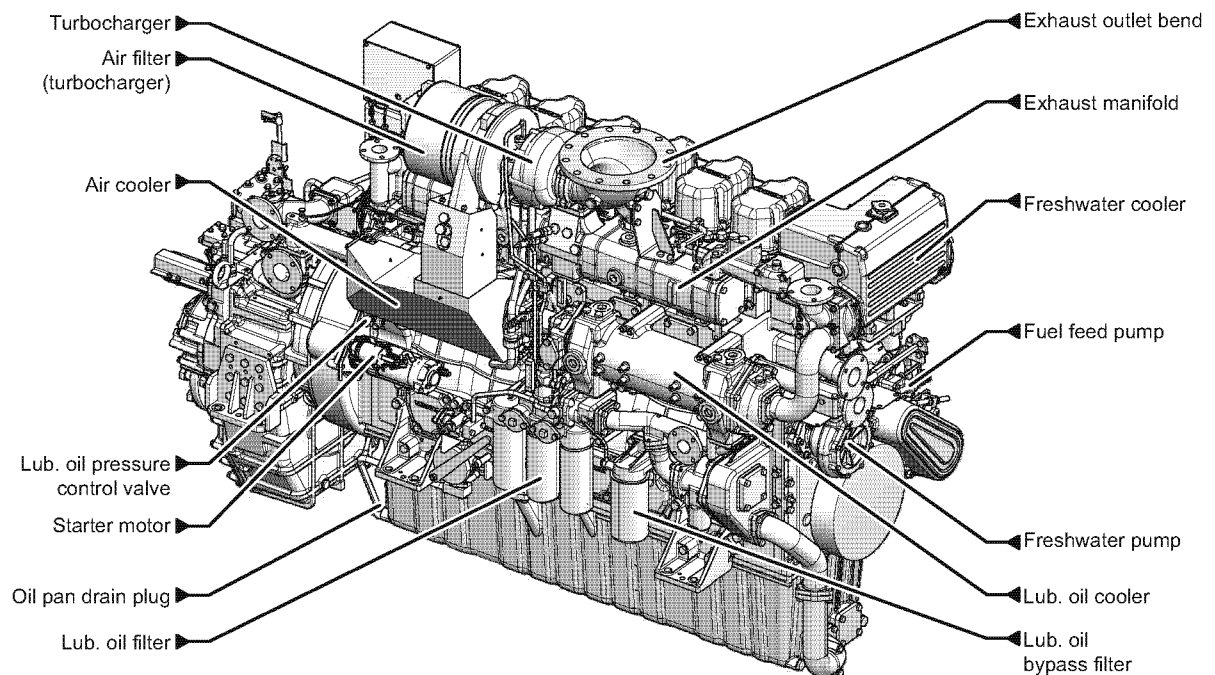
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Engine Component Names

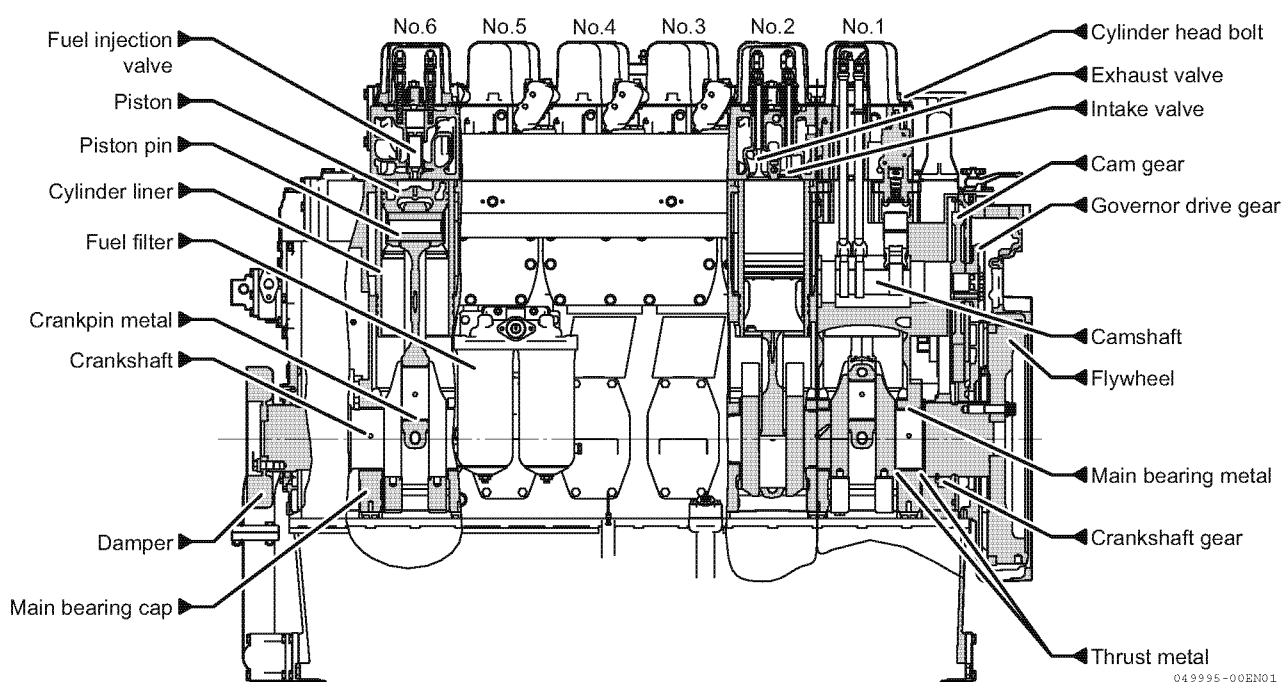
■ Operation side



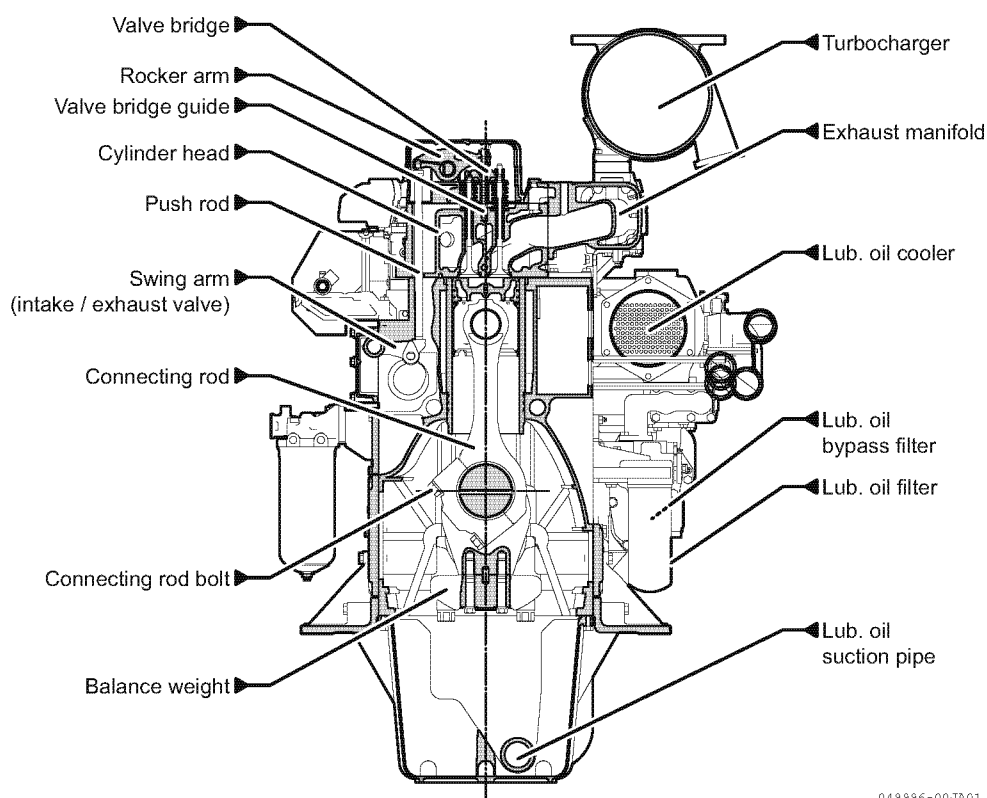
■ Non-operation side



■ Longitudinal view



■ Horizontal view

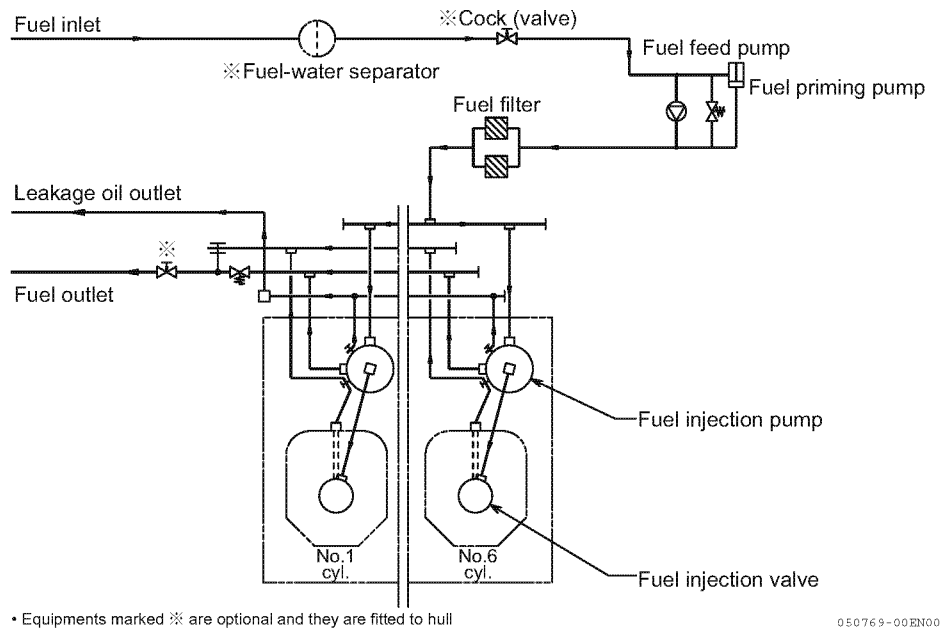


Functions of Major Components

Fuel system

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

The collection pipe returns excess fuel oil from the fuel injection valve and the fuel injection pump to the fuel tank.



● Fuel feed pump

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

● Fuel priming pump

This manual fuel pump sends fuel oil to the fuel injection pump. Use it when you release air from the fuel system. Move the piston to send the fuel oil.

● Fuel filter

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

● Fuel-water separator (option)

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

Cooling water system

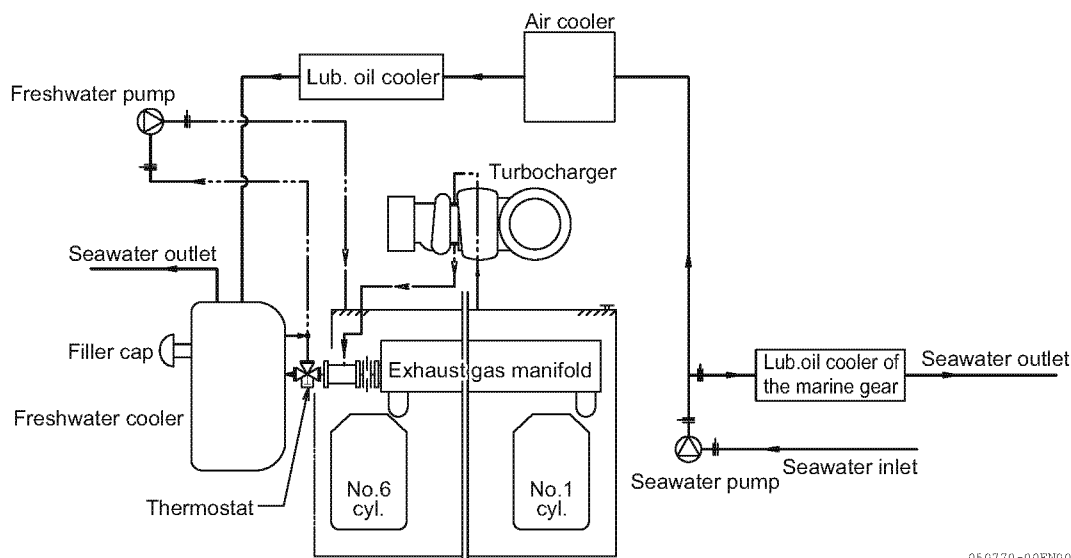
The cylinder and the cylinder head are cooled by a constant high-temperature freshwater cooling system (freshwater circulation with indirect seawater cooling). This keeps the temperature of the cooling water nearly constant at any engine load. Thus the engine performance is kept stable.

■ Seawater system

The seawater pump sends seawater to the air cooler, the lubricating oil cooler and the freshwater cooler. Then it discharges back into the sea. The seawater pump sends part of the seawater to the lubricating oil cooler for the marine gear.

■ Freshwater system

The freshwater pump sends freshwater to the cylinder block jacket. There it cools the cylinder, cylinder liner and cylinder head. Then it flows through the exhaust manifold into the cooling water thermostat and returns to the freshwater pump from the freshwater tank. If the freshwater is warmer than the specified temperature, the thermostat sends part of the freshwater to the freshwater cooler. This way, the freshwater temperature is automatically adjusted.



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● Freshwater tank

This freshwater storage tank has a built-in freshwater cooler. The cooler uses seawater to cool the freshwater.

● Filler cap

This is the cover of the water supply port on the top of the freshwater tank. It has a pressure valve.

● Freshwater pump

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

● Seawater pump

This rubber-impeller pump takes in seawater, sends it to all coolers and returns it to the sea.

● Seawater strainer (option)

This strainer separates and removes dirt from the seawater with a filter net. Do periodic inspections and clean the seawater strainer before its filter net gets clogged.

● Engine lubricating oil cooler

This cooler cools the lubricating oil of the engine with seawater.

● Lubricating oil cooler of the marine gear

This cooler cools the lubricating oil of the marine gear with seawater.

● Anti-corrosive zinc

Anti-corrosive zinc is attached to the pipes of the seawater passages and the cooler and prevents the electrical corrosion.

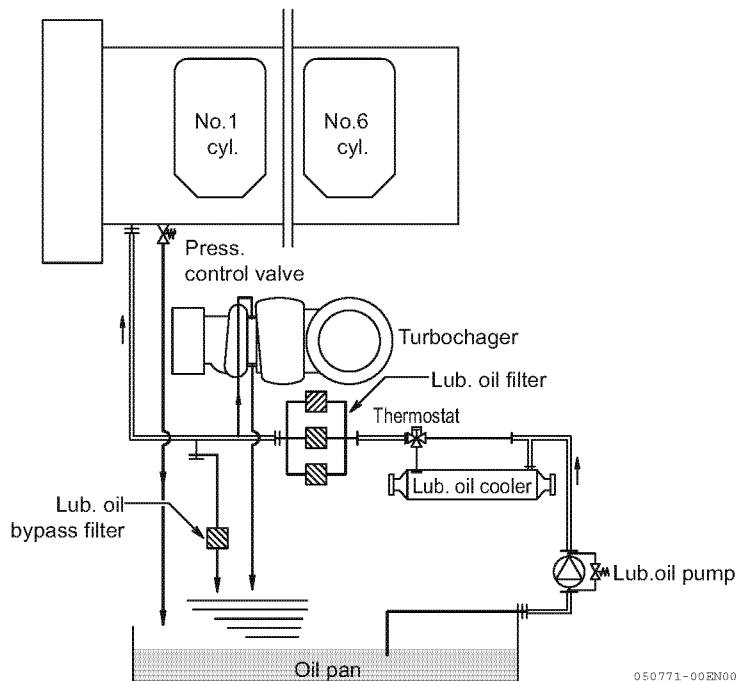
Check and replace the anti-corrosive zinc at regular intervals.

Lubricating device

The lubricating oil pump is a gear-type pump with a built-in relief valve. It is on the bottom of the cylinder block. The lubricating oil pump compresses the lubricating oil and sends it through the cooler and the filter to the inside of the engine.

A pressure control valve keeps the specified oil pressure. The oil cools all parts and returns to the oil gallery of the cylinder block.

The lubricating oil filter is a cartridge-type paper element with a main filter and a bypass filter.



● Engine lubricating oil filter

This filter removes small metal particles and carbon from the lubricating oil. Replace the filter (cartridge type) at regular intervals.

● Engine lubricating oil bypass filter

This filter removes sludge and metal powder with the use of centrifugal force by constantly bypassing a small quantity of lubricating oil. Replace the filter (cartridge type) at regular intervals.

● Lubricating oil filter of the marine gear

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

Intake/exhaust gas system

■ Turbocharger

This air-feed device sends air to the combustion chamber. Exhaust gas turns the turbine and the blower. The turbocharger compresses the supply air and sends it to the combustion chamber.

■ Air cooler

This cooler cools the air that comes from the turbocharger with seawater.

Electrical equipment

■ 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.

Marine gear

■ Marine gear

The marine gear uses the hydraulic multi-disc clutch to reduce the engine speed and transmits to the propeller shaft. The marine gear switches from forward gear to reverse gear. It reduces the engine speed, disengages the propeller shaft and switches its rotation into the desired direction (clockwise or counterclockwise).

■ Trolling device

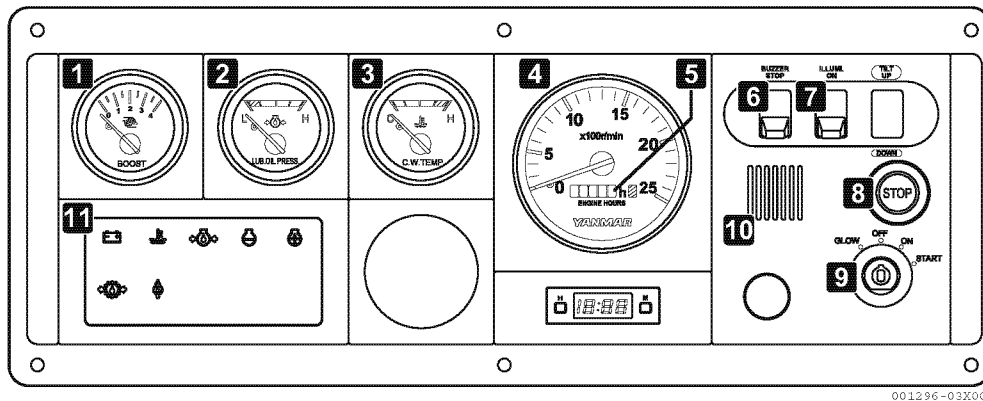
The trolling device slips the clutch to reduce the propeller speed.

Control System

The control system is the main control for engine operation.

Gauge panel (instrument panel specifications)

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.

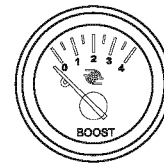


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1 Boost pressure meter

The boost pressure meter indicates the pressure of the air that flows to the combustion chamber.

Monitor the condition of the turbocharger to prevent accidents.



044066-00X00

2 Engine lubricating oil pressure meter

This meter indicates the pressure of the engine lubricating oil.

The red range on the scale indicates dangerous conditions.

Monitor the condition of engine lubrication to prevent accidents.



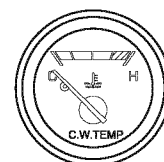
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3 Freshwater temperature meter

The cooling water temperature meter shows the fresh-water temperature.

The red range on the scale indicates dangerous conditions.

Monitor the condition of the engine temperature to prevent defects.

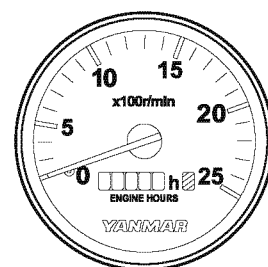


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4 Tachometer

The tachometer indicates the rotation speed of the engine.

You can monitor load conditions and speed.



044063-01X00

5 Hourmeter

The hourmeter indicates the total time of engine operation.

Use it to schedule periodic inspections accordingly.

6 Buzzer stop switch

This switch momentarily stops the buzzer sound.

Only turn off the buzzer when you investigate a defect.

7 Light switch

This is the light switch for the gauge panel.

8 Engine stop button

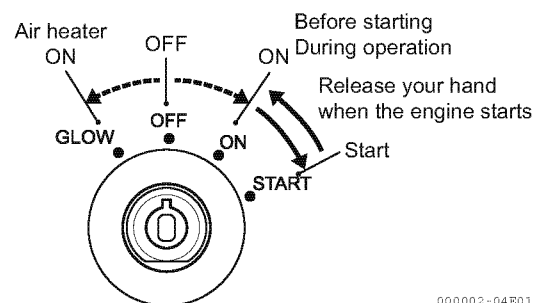
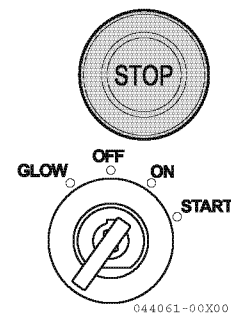
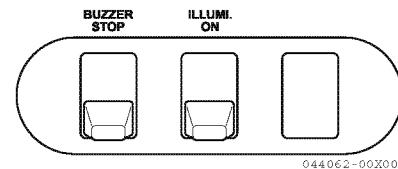
This red button stops the engine. It is above the starter switch. If you push the engine stop button, the stop device actuates and the engine stops.

Press down the button until the engine comes to a complete stop.

9 Starter switch

Three-step rotary switch The key switch starts the engine.

- OFF** : This is the stop position.
The electric system of the engine is cut off.
 - ON** : This is the position during engine operation.
The instruments and alarms are on.
 - START** : Start the engine.
This starts the engine. After the engine starts and you release the key, it goes back to ON automatically.
 - GLOW** : Turn on the air heater.
Increases the temperature of the intake air before engine start to assist an engine start in cold climate.
- You can only start the engine when the clutch lever is in neutral. A safety device prevents the engine from starting.
 - You cannot stop the engine with the starter switch.



- The air heater pre-heats the intake air warmer when in cold operating conditions. This makes the engine start easier.

Be sure to start the engine within 1 minute after switching to the GLOW position.

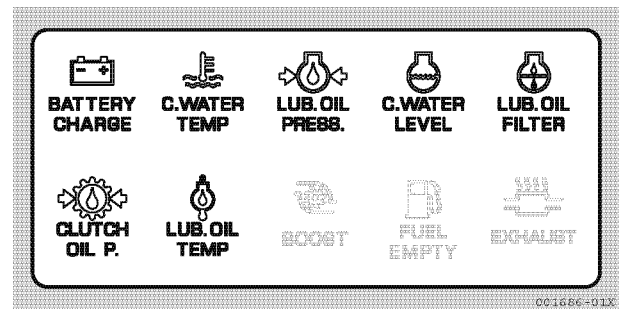
If you start the engine without switching to the GLOW position, the air heater will not turn on.

10 Alarm buzzers

The alarm buzzers repeatedly make an alarm sound when an alarm lamp comes on. Only the charge lamp and the oil filter clogging alarm lamp do not start the alarm buzzer.

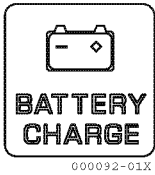
11 Alarm lamp

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



Alarm devices

If a defect occurs during operation, an alarm buzzer and alarm lamp operates.



Charge lamp

The lamp indicates a low battery charge. The alarm buzzer does not sound. Check the alternator for defects.



Freshwater temperature alarm lamp

This lamp indicates that the freshwater is too hot. If the engine continues to operate, it will overheat and seizure will occur. Check the load condition and the freshwater cooling system for defects.



Engine lubrication oil pressure alarm lamp

This lamp indicates that the pressure of the engine lubricating oil is low. If the engine continues to operate, it will run out of oil and seizure will occur. Check the level of the lubricating oil and refill if necessary.



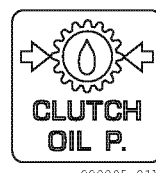
Freshwater quantity alarm lamp

This lamp indicates a low level of freshwater in the freshwater tank. If the engine continues to operate, it will overheat and damage will occur. Check the freshwater quantity. Check the freshwater system for defects.



Engine lubricating oil filter clogging alarm lamp

This lamp indicates clogging of the lubricating oil filter. The alarm buzzer does not sound. Replace the filter element.



Clutch lubricating oil pressure alarm lamp

This lamp indicates low lubricating oil pressure. If the engine continues to operate, it will run out of oil and seizure will occur. Check the level of the lubricating oil of the marine gear and refill if necessary.



Engine lubricating oil temperature alarm lamp

This lamp indicates that the temperature of the lubricating oil is too high. If the engine continues to operate, it will overheat and seizure will occur. Check the seawater cooling system for defects.

■ Normal operation of alarm devices

If the engine runs out of water or lubricating oil and the instruments or alarms are defective, it is not possible to prevent accidents. Apart from accidents, wrong operation or malfunctions can result.

Be sure to check that the alarm devices operate normally before and after you start the engine.

You can determine whether the electronic circuits for the buzzers and lamps operate normally.

If the alarm devices operate as follows, they operate correctly. If they do not operate correctly, consult your YANMAR dealer or distributor.

Operation of starter switch	Before starting OFF→ON	After starting START→ON
Alarm buzzers	Buzzer sounds	Buzzer stops
Alarm lamps		
Charge lamp	Continuously lit	OFF
Freshwater temperature	Temporarily lit	OFF
Engine lubricating oil pressure	Temporarily lit	OFF
Clutch lubricating oil pressure	Temporarily lit	OFF
Freshwater level	Temporarily lit	OFF
Clogged lubricating oil filter	Temporarily lit	OFF
Engine lubricating oil temperature	Temporarily lit	OFF

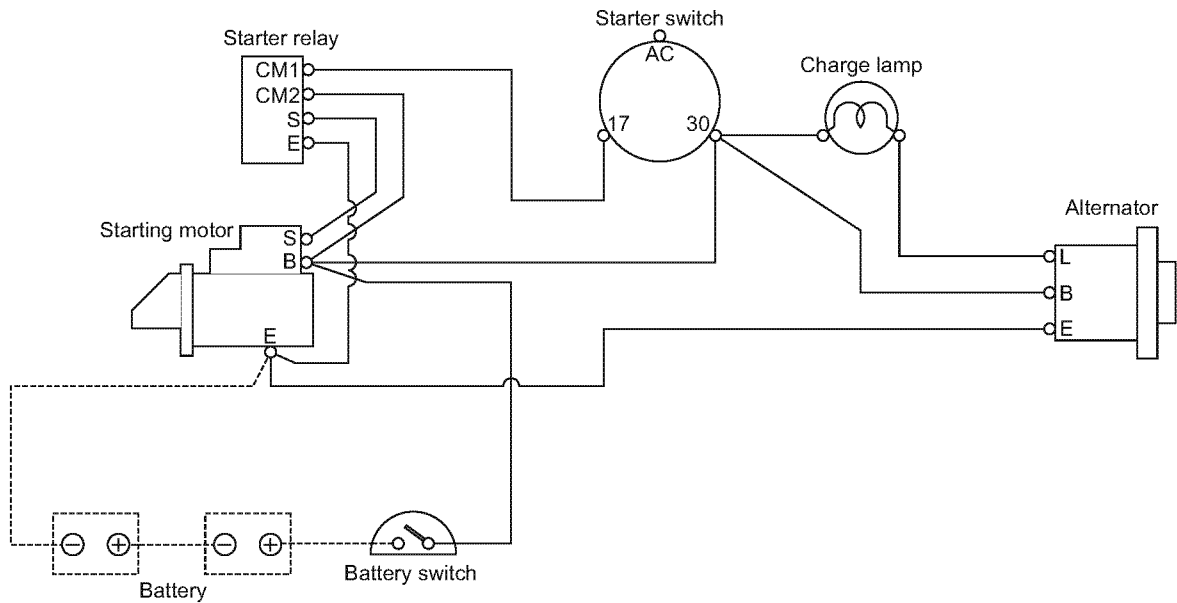
Starter

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

Both types can be operated locally, remotely or automatically (option).

■ Electric start

The electric start system has a battery, battery switch, starting motor and starter switch. Turn the starter switch on the instrument panel in the control cabin to start the motor. The alternator recharges the batteries.

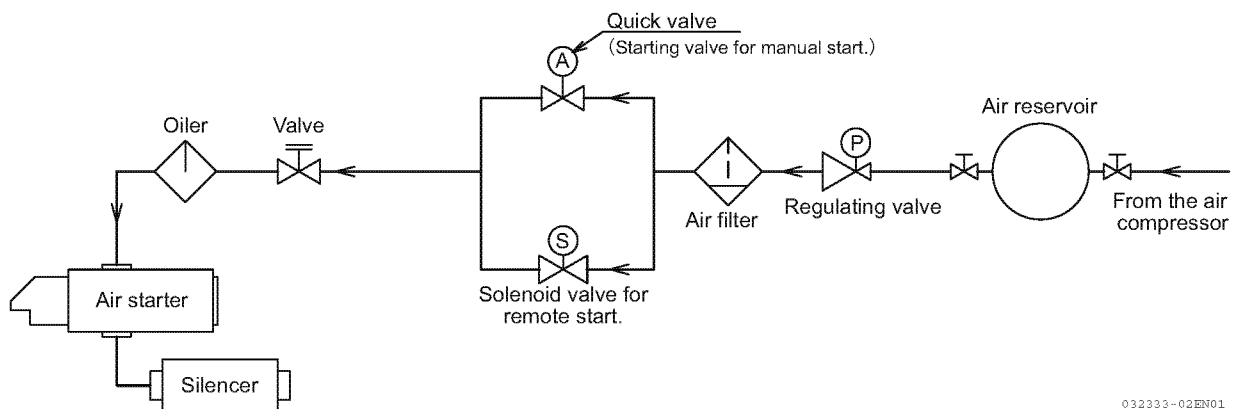


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■ Air start (option)

The air starting system has an air reservoir, pressure regulating valve, air filter, quick valve (starting valve), oiler, air starter and silencer. Compressed air flows from the air reservoir. The reducing valve decreases the pressure of the air. The filter cleans the air.

When the quick valve (starting valve) opens, the oiler mixes lubricating oil into the low pressure air. The air drives the air starter and discharges through the silencer.



032333-02EN01

Navigation control system

The governor lever and the clutch lever (to switch from forward to reverse) on the engine side are connected via the respective cables to the remote controller heads.

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

■ 2-handle remote controller head

The controller has one handle for the governor and one handle for the clutch. The right handle is the governor handle. It adjusts the engine speed.

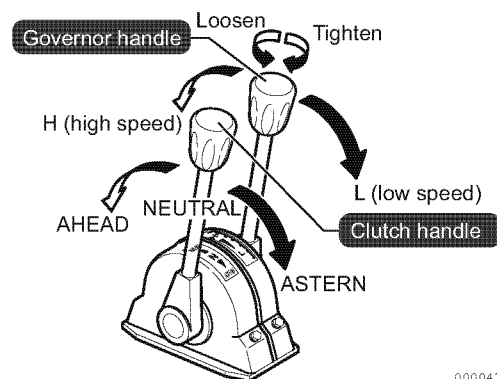
The left handle is the clutch handle. It disengages the propeller shaft and changes the direction of movement.

● Governor handle

On the handle, H is for high speed, L is for low speed. The movement of the handle from minimum speed to maximum speed is locked.

To unlock the handle, loosen the handle grip by turning it counterclockwise.

To lock the handle, tighten the handle grip by turning it clockwise.



000047-03E00

The governor lever can only move between a certain minimum and maximum engine speed. This range is limited by bolts.

The maximum speed bolt is sealed. Do not remove it.

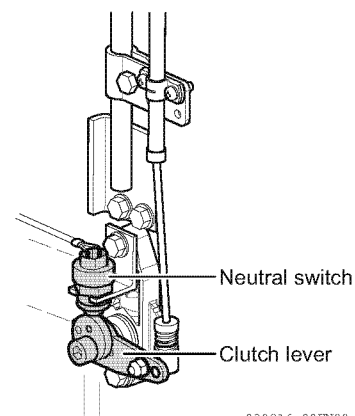
● Clutch handle

AHEAD is for forward movement, N is neutral, and ASTERN is for reverse movement.

When you start the engine, set it to N (neutral).

■ Clutch neutral switch

The clutch lever on the clutch side has the neutral switch as a safety device. It starts the engine with the clutch handle in the neutral position.



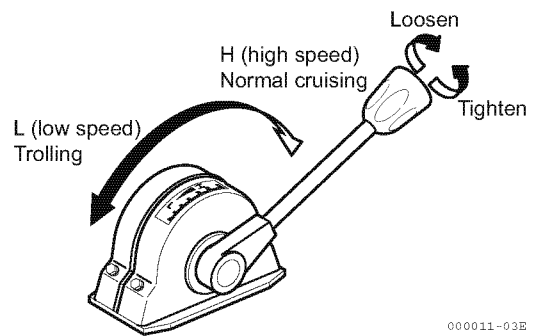
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■ Trolling handle (option)

The trolling handle is a 1-handle remote controller head.

On the handle, H is for high speed (regular cruise mode), L is for low speed (trolling mode).

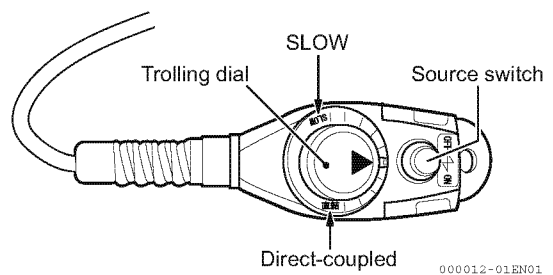
To unlock the trolling handle, turn the grip counter-clockwise. To lock the trolling handle, turn the grip clockwise.



■ Trolling dial (Electronic trolling available as an option)

The trolling dial adjusts the propeller speed during trolling.

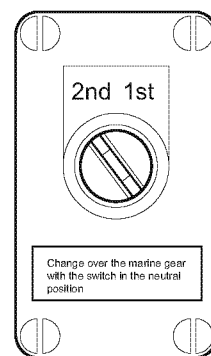
Direct-coupled is for direct-coupled operation, direct-coupled side is for high speed, SLOW side is for slow speed.



■ 1st/2nd gear switch (YXH2-500 marine gear option)

Use the 1st/2nd gear switch in the control room to operate the reduction ratio solenoid valve.

The 1st gear switch is for the high speed side (cruise mode), the 2nd gear switch is for the low speed side (trawl mode).



FUEL OIL, LUBRICATING OIL & COOLING WATER

Fuel Oil

■ Selection of the Fuel Oil

- Only use the specified fuel oils. Other fuel oils can cause bad performance and malfunctions.
- Do not use fuel oil that is contaminated with water or dirt. The fuel injection system has many precision parts. They can malfunction if contaminated.

Appropriate fuel oils are:

- M.D.O. (JIS K-2205 class 1, type 2 equivalent).
- Diesel fuel (JIS K-2204 type 2 equivalent).

Recommended properties of M.D.O. or equivalent fuel oils

Fuel properties are highly uncertain and the specifications cover a wide range. Refer to this table for the recommended properties of fuel oil.

Kinematic viscosity mm ² /s 40°C	Cetane number	Pour point	Residue carbon (Mass)	Ash content (Mass)	Sulfur content (Mass)	Water content (Capacity)	Flash point	Density
								15°C
2.0 to 11.0	45 or more	-10 °C or less	0.3 % or less	0.01 % or less	1.0 % or less	0.1 % or less	60 °C or more	900 or lower

Diesel fuel

Use diesel fuel of JIS K2204 or equivalent.

Diesel fuel is categorized into different types depending on the pour point.

It gets thicker and does not circulate well at low temperatures. Make sure that you choose a type that is appropriate for the outdoor air temperature.

Diesel fuel types and outdoor air temperature

- Outdoor air temperature: -5°C or higher: Diesel fuel No. 2
- 15°C or higher: Fuel oil No.3
- 25°C or higher: Fuel oil No.3 special

Lubricating Oil

- Only use the specified lubricating oil. A different oil results in seizure of engine parts and irregular wear, and shortens the engine life.
- Avoid using a lubricating oil with a high total base number (T.B.N.) together with a fuel oil with low sulfur content. The additives in the lubricating oil (calcium carbonate) cause carbon residue on the top of the piston and the combustion chamber. This results in shortening the engine life and causing the engine failures. Use the appropriate fuel oil.
- Do not mix different lubricating oils.

■ Selection of engine lubricating oil

Recommended lubricating oils: choose lubricating oil with an API quality classification service grade of CE or CD and an SAE viscosity of 40.

Viscosity (SAE)	Specific gravity	Flash point (open type)	Pour point	Kinematic viscosity mm ² /s		Viscosity index	Base number (mgKOH/g)
				40°C	100°C		
40	0.893	240 °C or more	-7.5 °C or less	140 to 155	14 to 15.5	96 to 110	9 to 15

The commonly sold lubricating oil brands with an API service grade of CE or CD are indicated.

Company name	Product name	Company name	Product name
Genuine YANMAR oil	YANMAR MARINE SUPER OIL oil 40	COSMO OIL	COSMO MARINE SUPER 40
IDEMITSU KOSAN	DAPHNE MARINE OIL SX40	SHOWA SHELL	GADINIA OIL 40
EXXON MOBIL	Mobilgard 412	BP	BP ENERGOL DS3-154
GYOREN OIL	TAIRYO SUPER 40	FUJI KOSAN	FUKKOL MARINE 412
JX Nippon Oil & Energy	MARINE T104	CHEVRON (CALTEX, TEXACO)	DELO 1000 MARINE 40 TARO 12 XD 40
TOTAL Lubmarine	DISOLA M4015	CASTROL	MCL40 CASTROL MHP154 SEAMAX EXTRA 40
KYGNUS OIL	KYGNUS MARINE DX40		

NOTICE

- To lubricate the governor, use an oil that is equivalent to the oils listed above. Do not mix it with oils by other manufacturers.
- When you replace the lubricating oil, carefully remove all unwanted material that collected in the filter, lubricating oil cooler and oil pan.
- Use the YANMAR marine gear lubricating oil with a viscosity of SAE 40 and API service grade of CE or CD.

■ Selection of 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.

Ambient temperature	Lubricating oil in use	
5 °C to 60 °C	Turbine oil, category 1, ISO VG 32	E.g. Turbine oil #90 (spindle oil not applicable)
-15 °C to +5 °C	Refrigerating machine oil, category 1, ISO VG15	E.g. Refrigerating machine oil class 90 (spindle oil not applicable)

■ Handling lubricating oil

- Be careful to avoid burns when you handle lubricating oil inside the engine immediately after engine stop.
- Wear safety goggles and rubber gloves if there is a risk that lubricating oil gets into your eyes or on your skin.
- If lubricating oil contacts the eyes or skin, flush the affected area with clean water. It can cause inflammation. If there are any irregular reactions, go to a doctor.
- The disposal of waste oil is regulated by law. Dispose waste oil correctly according to the law. If you are uncertain how to correctly dispose of oil, contact the seller.

Filling the lubricating oil (where and how much)

Where to fill the lubrication oil		Filling amount (ℓ)	
Oil pan	To the bottom line of the oil dipstick	132	total 200
	from bottom line to the top line of the oil dipstick	68	
Governor (before the first start and after disassembly)		0.8	
Lubricating oil cooler, filter and piping		Approx. 26	
Marine gear case		YXH(2)-500 : 22	
		YXH-500L : 45	

Locations for oil filling and oil check (P34 [Filling the engine lubricating oil])

Degradation check interval

Do the check approximately every 100 hours or if you think that the water or fuel is contaminated with a substance that can cause degradation of the lubricating oil. Adjust the analysis interval depending on the rate of degradation.

Measurement method (guideline)

Old lubricating oil suffers from contamination and degradation. Oil control and purifying methods may not be able to restore the oil to the correct condition.

In that case, fully replace the lubricating oil.

Make your own decision when you schedule and perform oil changes. Consider not only the time, but also the operating conditions of the engine. Ask your lubricating oil supplier to make an analysis of the lubricating oil. Ask for a decision whether you can continue to use the oil or not. Ask the lubricating oil maker for a spot test kit. Use it to find the remaining total base number, degree of contamination and cleaning dispersion.

If you cannot make a decision, replace the oil with new oil after approximately 250 hours.

If auxiliary lubricating oil tanks are installed (in addition to the oil pan) and a capacity of 1.36 ℓ/kW is kept, we recommend that you replace with new oil after approximately 1500 hours.

Oil control standards for the diesel engine crankcase

Item		Unit	Control standards	Usage limit
Flash point (PM method)		°C	> 180	140
Viscosity change (40 °C)		mm ² /s (cSt)	New oil within ±15 %	New oil ± 25 %
Water content		vol %	< 0.1	0.2
N-pentane insoluble content (A method)		mass %	< 1.5	2.0
Toluene insoluble matter (A method)		mass %	< 1.5	2.0
Difference between n-pentane insoluble content and toluene insoluble content		mass %	-	< 0.5
Total base number (T.B.N.)	HCl method	mgKOH/g	> 3.0	1.0
	HClO ₄ method		> 6.0	4.0

Freshwater Cooling Water

- Do not use hard water.

If you use hard water, scale collects in the water chambers such as cylinder head and cylinder water jackets and cause overheating.

- Using only freshwater causes scale and rust in the water system. This impedes cooling. Add Long Life Coolant.
- Long Life Coolant has an effect to prevent rust and can be used throughout the year.
Use Long Life Coolant in cold conditions. If you do not, the freshwater freezes, expands and causes damage to the water system of the engine.

■ Freshwater

Be sure to use clean, soft water (e.g. tap water) as freshwater.

Water quality for freshwater

pH (25°C)	6.5 to 8.0	Ammonium ion (NH_4^+)	0.05 ppm or less
Total hardness (CaCO_3)	< 100 ppm	Sulfate ion (SO_4^{2-})	< 100 ppm
Chloride ion (Cl^-) concentra-	< 100 ppm	Evaporation residue	< 400 ppm
M alkalinity	100 ppm or less		

■ Long Life Coolant (LLC)

Be sure to add a Long Life Coolant to the freshwater.

Recommended Long Life Coolant: Yanmar Genuine Long Life Coolant (Product Name: Royal Freeze)

- Yanmar Genuine Long Life Coolant has an effect to prevent rust and can be used throughout the year.
- The mixture ratio must be between 30% and 55% and is determined by the minimum air temperature.
- If the Long Life Coolant mixture is too thin, damage or rust can occur when the temperature decreases.
- If Long Life Coolant is too thick, the cooling becomes less effective.

Minimum temperature	-15 °C or more	-20 °C	-25°C	-30°C
Mixture ratio	30 %	35 %	40 %	45 %

Select a commercial Long Life Coolant with a quality that is equivalent to Yanmar Genuine Long Life Coolant or better.

NOTICE

- This engine has aluminum materials. Do not use Long Life Coolant with ingredients that cause corrosion on aluminum. They cause corrosion on the aluminum used in the engine.
- Do not mix different brands or types of Long Life Coolant. Mixing decreases the cooling effect and causes corrosion.
- If you use a commercial Long Life Coolant, obey the manufacturer's instruction manual for the mixture ratio and replacement periods.
- Do not use commercial corrosion inhibitors (including Royal Cabiruston). Their properties are uncertain and they can cause corrosion of the aluminum material.

■ Rust inhibitor

Use a rust inhibitor that does not cause damage to aluminum and copper materials and that is environmentally compliant.

This engine has aluminum materials. Use the following rust inhibitor or equivalent.

Product brands

Brand	Seller	Remarks
YANMAR Royal Freeze	YANMAR SANGYO	Contact the sales agent of the rust inhibitor for information on use and handling.
Olgard C-601	Organo Co., Ltd.	
Kurilex L-501	Kurita Industries Co., Ltd.	
Nalfleet 9-111	NALCO Japan Co., Ltd.	

- Obey the operation manual of the rust inhibitor when you use it.
- We recommend that you fully replace the cooling water (with rust inhibitor) at regular intervals. This is a simple method to control the concentration of the cooling water.

⚠ CAUTION

- **Rust inhibitors are water treatment chemicals for industrial use. Do not use them in the drinking water system.**
- **When you work with rust inhibitors, put on rubber gloves and a gauze mask. Avoid contact with your hands or other body parts.**
- **If rust inhibitor comes in contact with your skin or eyes, wash the area thoroughly with fresh water. If the area has an irregular reaction after you wash it, get medical aid.**

NOTICE

- Do not discharge cooling water with rust inhibitor into the sea or rivers. This can cause environmental pollution. How to discharge waste liquids is stipulated by law. Treat the rust inhibitor according to the instructions by the manufacturer.
- Do not mix different brands. (If you must mix different brands of rust inhibitor, consult your rust inhibitor supplier.)

OPERATION

Operation Preparation

Before you operate the engine for the first time after installation, a scheduled inspection and maintenance, or a long rest, do the checks that follow.

Regarding details, consult your YANMAR dealer or distributor.

- Make sure that there are no unwanted parts or tools inside or near the engine.
- Make sure that all parts are correctly tightened.
- Measure the deflection of the crankshaft.
- Check the starter.

Electric starter: Make sure that the battery for starting has enough voltage.

Air starter: Check the pressure of the air reservoir. Drain the air reservoir.
Fill the oiler.

Refilling the fuel oil

- Fill the tank with clean fuel that is free of water and dirt.
- When you fill from a barrel, let the barrel rest for one day or more. This allows dirt to settle. Fill from the top of the barrel.
- When you fill from a daily tank, let the fuel oil rest for one day or more after filling it from the storage tank to the daily tank.
- Refill fuel oil sufficiently to avoid running out of fuel oil during operation.

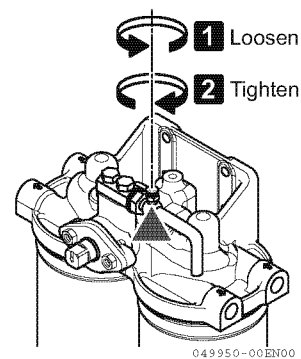
Bleeding the fuel system

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

Bleed the fuel system and obey the procedure that follows when:

- You fill fuel oil to the fuel tank for the first time.
- You do maintenance of the fuel system (e.g. servicing the fuel filter).
- The fuel oil has run out.
- The engine does not start.

1. Check the oil level in the fuel tank and open the hull-mounted fuel cock (or valve).
2. Loosen the air vent plug (or valve) on the top of the fuel filter for 2 to 3 turns.

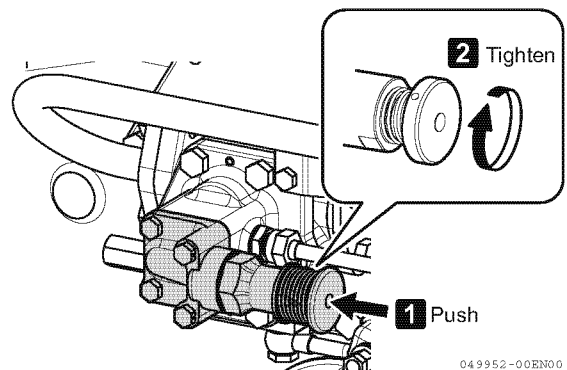
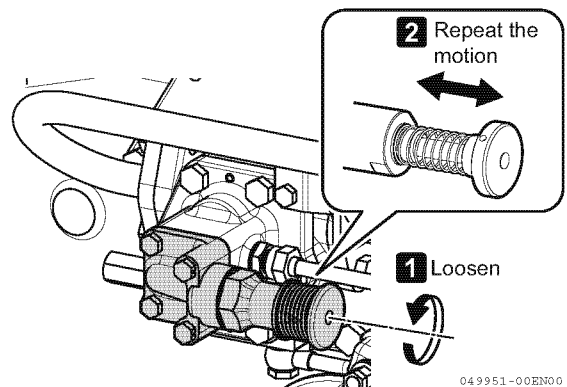


3. Fill the fuel with the fuel priming pump.

1- The knob of the priming pump rises when you turn it counterclockwise.

2- Press the knob manually. Repeat the motion.

4. Fuel oil with air bubbles comes out of the air vent bolt plug hole on the top of the fuel filter. When air bubbles disappear, tighten the air vent plug.



5. Bleed the fuel main pipe and the fuel injection pump in the same manner. Bleed all cylinders of the fuel injection pump.

1- Loosen the air vent plug 3 of the fuel main pipe for 2 to 3 turns.

2- Operate the fuel priming pump to send the fuel oil. Fuel oil with air bubbles will come out of the air vent bolt plug hole.

3- When air bubbles disappear, tighten the air vent plug.

4- Loosen the air vent plug 4 of the fuel injection pump for 2 to 3 turns. Bleed all cylinders in the same procedure as the fuel main pipe.

6. Obey this procedure to check that the air is released from the fuel injection pump.

1- Set the start/stop handle to RUN.

2- Remove the stopper 1. Set the decompression shaft 2 to the DECOMP position with a wrench.

3- Loosen the cap nut (on the fuel injection pump side) of the fuel injection pipe.

4- Turn the flywheel. Make sure that fuel oil comes out of all cylinders.

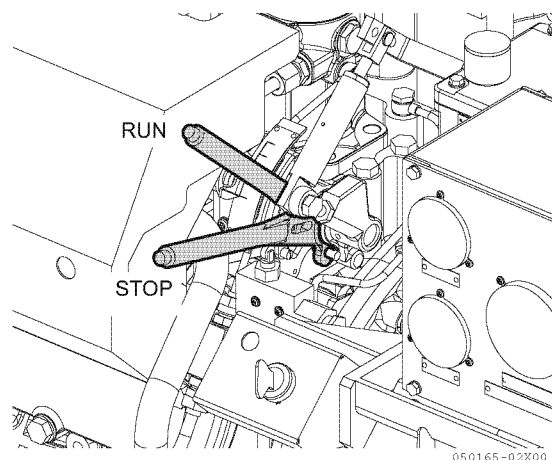
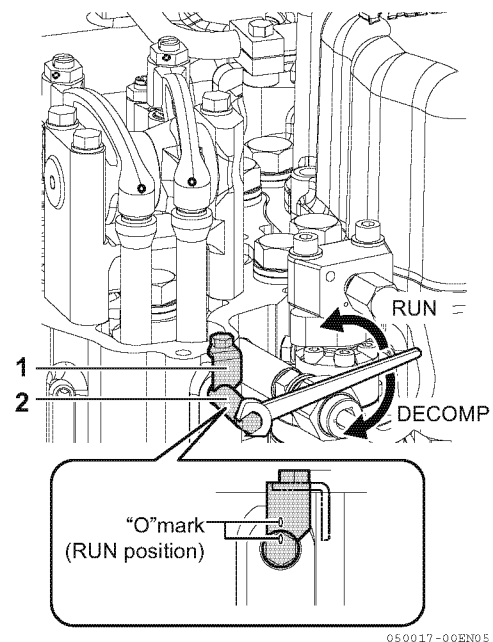
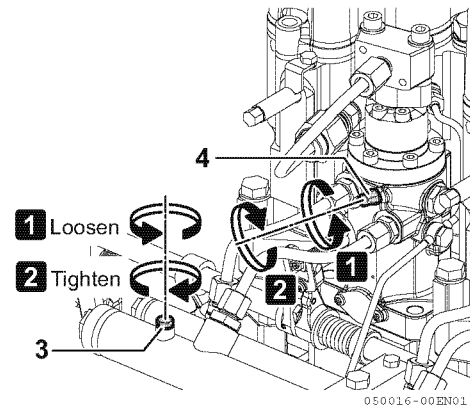
5- If there is a fuel injection pump that does not release fuel oil, the air is not released. Loosen the air vent plug of the fuel injection pump of that cylinder again. Operate the fuel priming pump to send the fuel oil. Fuel oil with air bubbles comes out of the air vent bolt plug hole. When air bubbles no longer come out, tighten the air vent plug.

7. Tighten the cap nut of the fuel injection pipe. Turn the flywheel for 3 to 5 turns.

8. Move the start/stop handle to STOP. Turn the flywheel for 5 to 6 turns. Make sure that the fuel injection valves make no injection sound.

9. After you discharge air from the tank, screw the fuel priming pump knob tight clockwise while pressing it down.

10. Set the decompression shaft 2 to the RUN position with a wrench. Install the stopper 1.



Filling the engine lubricating oil

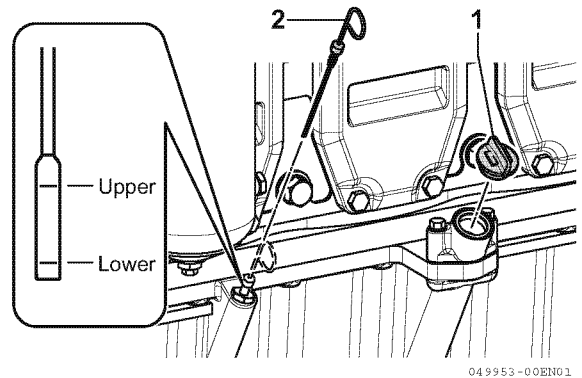
Obey this procedure when you fill the engine lubricating oil.

1. Check that the engine is at a complete stop.
2. Remove the cap 1 on the yellow filler port attached to the oil pan.
3. Fill with lubricating oil to the upper line of the dipstick 2.
- 1- Remove the dipstick.
- 2- Wipe off the oil on the gauge with a clean cloth.
- 3- Fully insert and remove the dipstick again.
- 4- Make sure that the oil level is between the upper and lower lines on the dipstick. If necessary, fill with lubricating oil to the upper line on the dipstick.

Do not fill oil over the upper line of the dipstick.

Engine lubricating oil capacity	200 l
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- 5- Fully insert the dipstick.
- 6- Install the cap of the filler port.



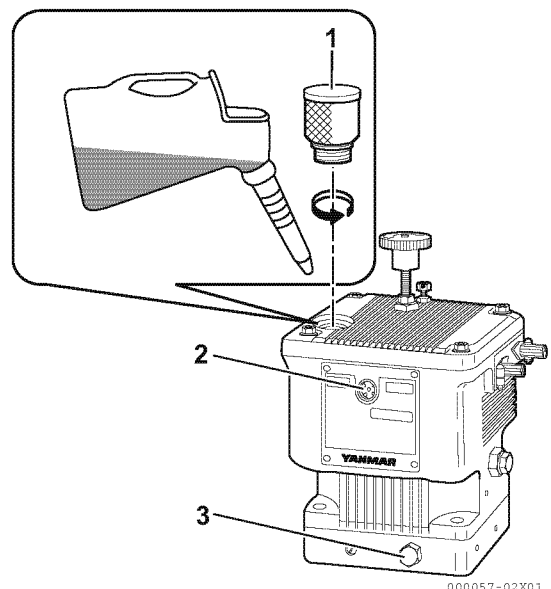
Filling the lubricating oil of the hydraulic governor

Obey this procedure when you fill the lubricating oil to the governor.

1. Check that the engine is at a complete stop.
2. Remove the breather 1 as shown in the figure on the right and fill the lubricating oil.
3. Check that the oil level is a littler higher than the center of the level gauge 2.

Lubricating oil capacity	0.8 l
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4. Install the breather.
5. You can drain the overfilled lubricating oil from the drain plug 3.

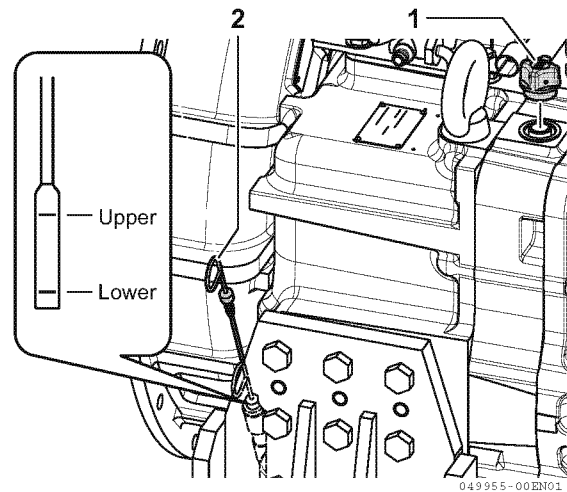


Filling the lubricating oil of the marine gear

Obey this procedure when you fill the lubricating oil of the marine gear.

1. Check that the engine is at a complete stop.
2. Remove the breather cap 1 of the filler port on the top of the marine gear.
3. Fill with lubricating oil to the upper line of the dipstick 2.
- 1- Remove the dipstick.
- 2- Wipe off the oil on the gauge with a clean cloth.
- 3- Fully insert and remove the dipstick again.
- 4- Make sure that the oil level is between the upper and lower lines on the dipstick. If necessary, fill with lubricating oil to the upper line on the dipstick.

Do not fill oil over the upper line of the dipstick.



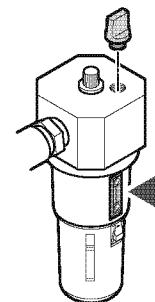
Marine gear Lubricating oil capacity	YXH-500	22 ℓ
	YXH2-500	22 ℓ
	YXH-500L	45 ℓ

4. Fully insert the dipstick 2.
5. Install the breather cap of the filler port.

Filling the oiler lubricating oil for the air starter (option)

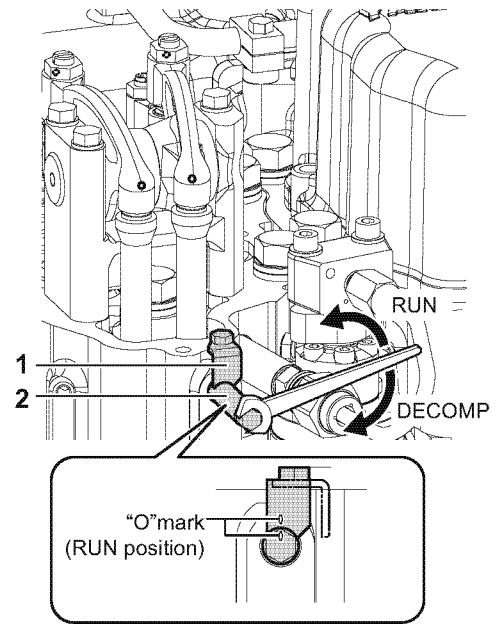
Obey these instructions when you fill the oiler lubricating oil for the air starter.

1. Remove the filler plug.
2. Fill with lubricating oil to the top line (full) on the oil level meter.
3. Install the filler plug.



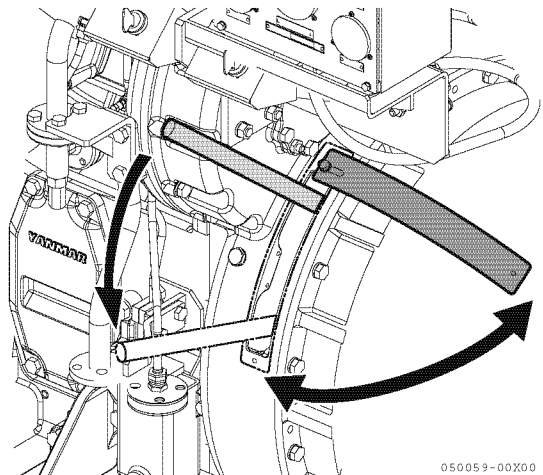
Priming of the lubricating oil

1. Remove the bonnet and cylinder block side cover.
2. Remove the stopper 1 from all cylinders. Set the decompression shaft 2 to the DECOMP position. Use a wrench to operate the decompression shaft.

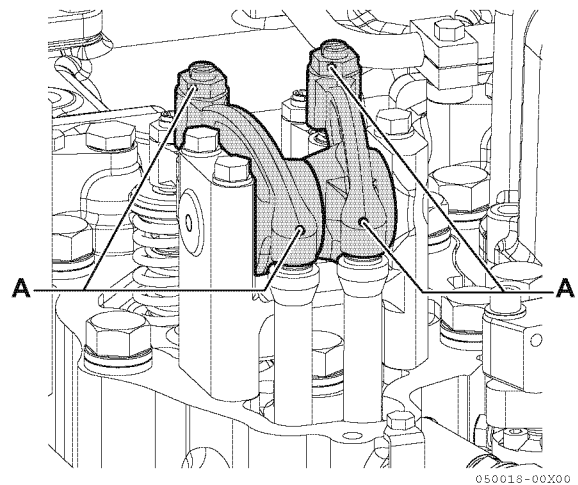


050017-00EN05

3. Turn the flywheel of the engine. Make sure that these parts have enough oil: part A of the rocker arm of the intake/exhaust valves, piston cooling nozzle and crank pin.
4. After you prime the lubricating oil, install and tighten the bonnet and cylinder block side cover.
5. Return the decompression shaft 2 of all cylinders to the DRIVE position.
6. Install the stopper 1. Check that the O mark position is aligned with the decompression shaft 2.



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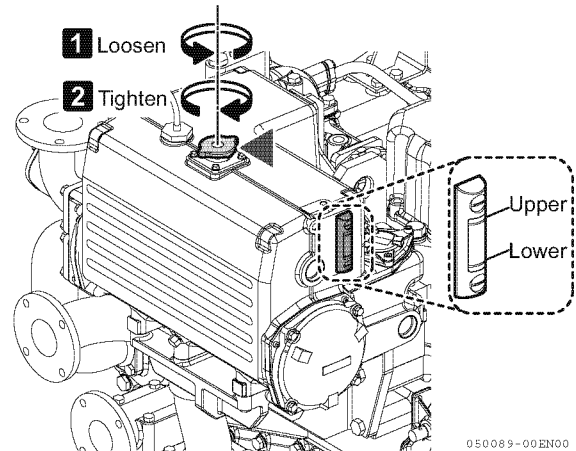
050018-00X00

Filling freshwater

Obey these instructions when you fill the freshwater.

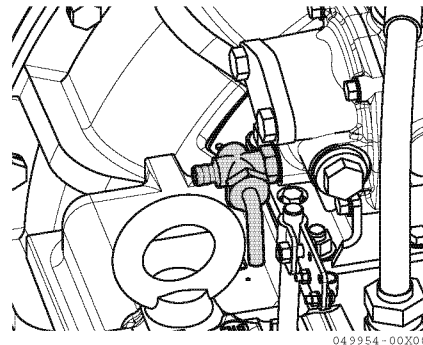
1. Check that the engine is at a complete stop.
2. Remove the filler cap of the freshwater cooler. Fill it with water to the upper line of the level gauge.
3. Check for leaks in all parts.
4. After you fill the water, close the filler cap in the clockwise direction. Make sure that you fully close it.

Freshwater capacity	85 l
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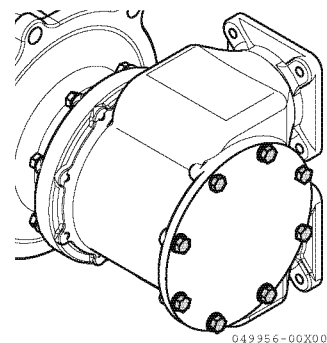


Closing the drain cock of the seawater channel

1. Close the seawater drain cock of the lubricating oil cooler of the marine gear.



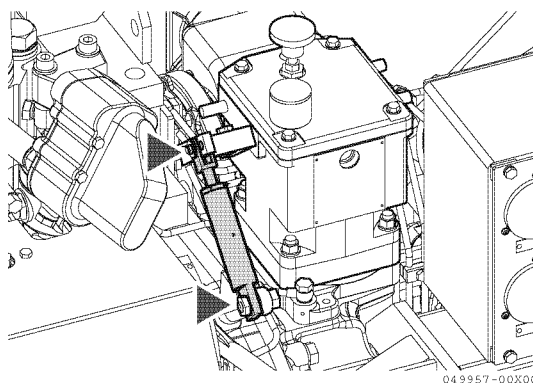
2. Check that the bolts on the side cover of the seawater pump are tight.



Lubricating engine components

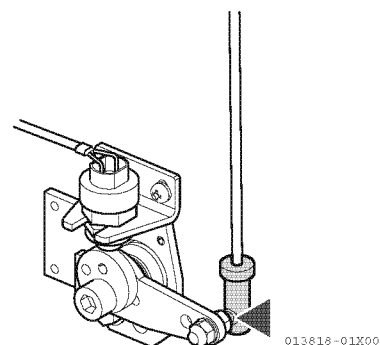
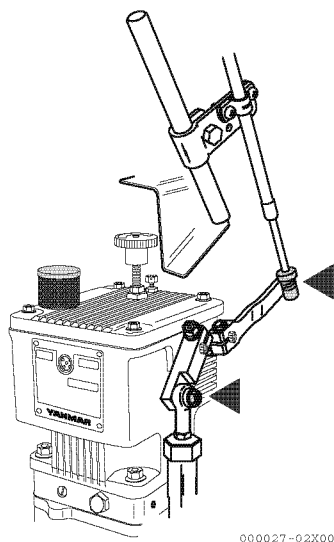
■ Governor link

Manually lubricate the area around the governor link.
Make sure that it moves easily.



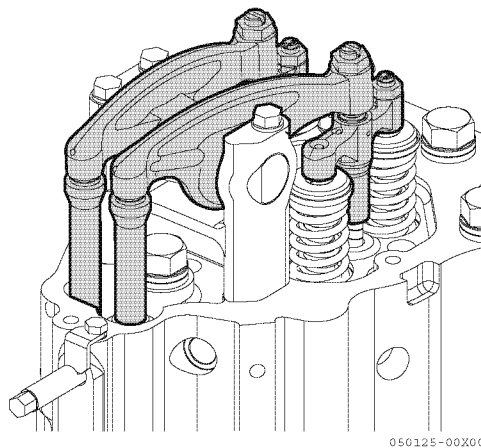
■ Remote control lever

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



■ Rocker arm

Apply oil to the rocker arm.



Rechecking the Quantity of Lubricating Oil and Freshwater

Do a test run of the engine when: You fill the engine with engine lubricating oil, marine gear lubricating oil or freshwater for the first time. You change or refill any of these liquids.

Stop the engine and wait for approximately 5 minutes. Then check the lubricating oil level and cooling water level again.

During the test run of the engine, lubricating oil and freshwater flow through the engine. Thus oil and water levels decrease. Refill lubricating oil and freshwater to the original levels.

- Refill the engine lubricating oil (P34 [Filling the engine lubricating oil])
- Refill the lubricating oil of the marine gear (P35 [Filling the lubricating oil of the marine gear])
- Fill freshwater (P37 [Filling freshwater])

Inspection before Engine Start

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 freshwater) 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.

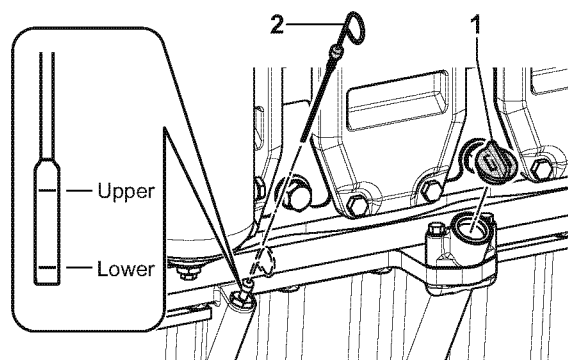
Checking and refilling the fuel oil

- Drain the fuel tank.
- Open the drain cock (or plug) of the fuel filter No.1 (hull-mounted) and drain them.
- Check the fuel level inside the tank. If necessary, refill with fuel oil.
- Refill fuel oil sufficiently to avoid running out of fuel oil during operation.
- Open the fuel cock (valve) on the fuel tank.
- Bleed air from the fuel system if: You removed parts of the fuel system, e.g. the fuel filter. Refer to P32 [Bleeding the fuel system] for instructions on how to bleed air from the fuel system.

Checking and refilling the engine lubricating oil

Check and refill engine lubricating oil before engine start. The lubricating oil level fluctuates after engine start. This makes it difficult to read the correct oil level. Check the level of the engine lubricating oil with the dipstick 2.

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

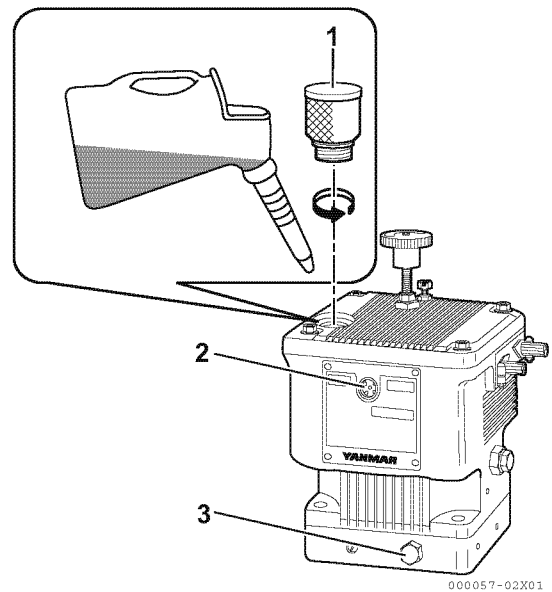


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Checking and refilling the hydraulic governor lubricating oil

Check and refill the hydraulic governor lubricating oil before engine start. The lubricating oil level fluctuates after engine start. This makes it difficult to read the correct oil level.

Check that the oil level is a littler higher than the center of the level gauge 2. If necessary, remove the breather 1 and fill the lubricating oil.

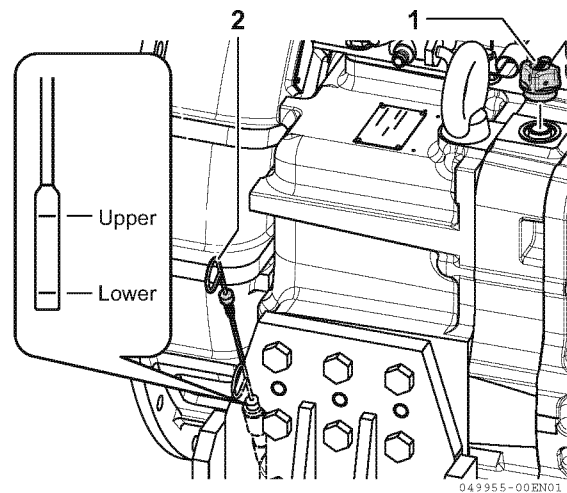


Checking and refilling the marine gear lubricating oil

Check and refill the marine gear lubricating oil before engine start. The lubricating oil level fluctuates after engine start. This makes it difficult to read the correct oil level.

Check the level of the marine gear lubricating oil with the dipstick 2.

Make sure that the oil level is between the upper and lower lines on the dipstick. If necessary, fill the lubricating oil from the breather cap 1 of the filler port to the upper line on the dipstick.

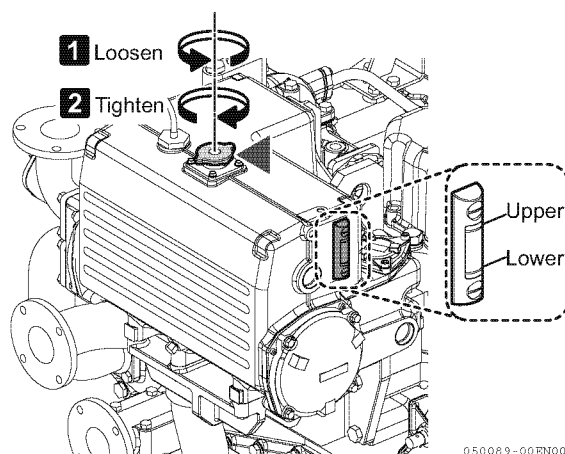


Checking and refilling the freshwater

Always check and refill the freshwater before engine start, when the engine is cold.

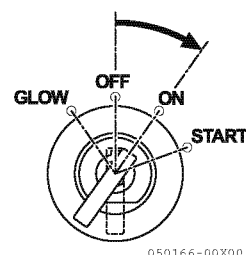
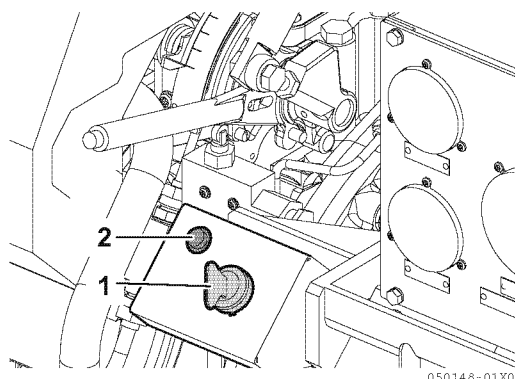
1. Inspect the water level of the freshwater cooler.
Make sure that the water level is between the upper and lower lines.
2. If necessary, remove the filler cap of the freshwater cooler. Fill it with water to the upper line.
3. After you fill the water, close the filler cap in the clockwise direction. Make sure that you fully close it.

If freshwater is frequently insufficient or a defect occurs in the freshwater system with the water level of the freshwater cooler unchanged, consult your YANMAR dealer or distributor.



Inspecting the starting system

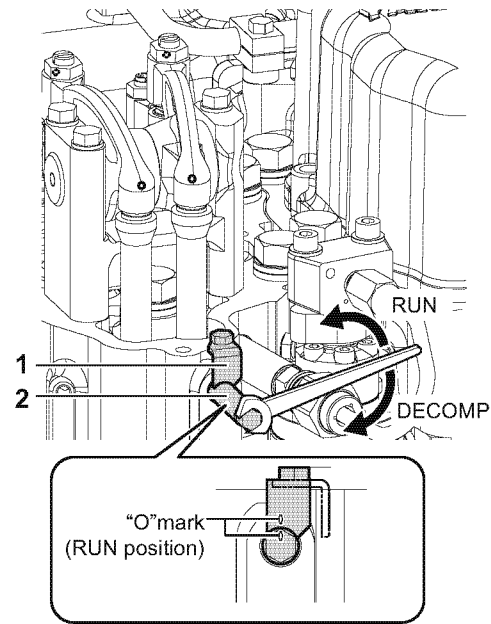
1. Make sure that the terminals of all electric wiring are correctly connected. Make sure that they are tight.
2. Make sure that the battery is charged. Charge it if necessary.
3. Move the starter switch 1 to ON (turn it one step clockwise). Make sure that the charging lamp 2 comes on (standard wiring).
4. Move the starter switch of the remote instrument panel to ON. Make sure that the charging lamp comes on.



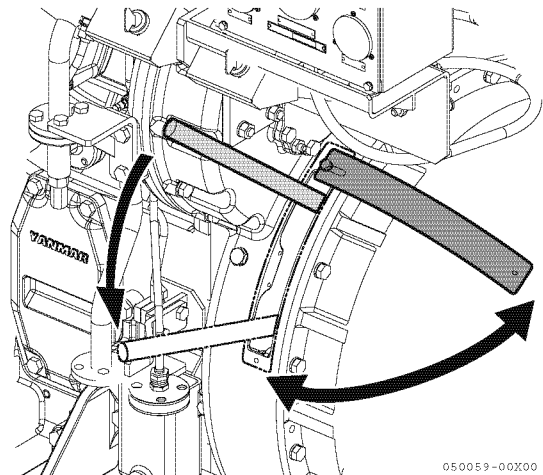
Water hammer prevention inspection

Before the first engine start after installation or a long engine stop, examine the inside of the cylinder for water or fuel. Obey the instructions that follow.

1. Remove the stopper 1 from all cylinders. Turn the decompression shaft 2 to the DECOMP side. Turn the flywheel until cylinder No. 1 is in a position of 25° before the top of compression.
2. Move only the decompression shaft of cylinder No. 1 in the RUN position. Slowly turn the flywheel. If you can turn to the top of the compression without feeling a bump, the cylinder is not defective.
3. Do the same check on all cylinders in firing order.
4. If you feel a bump and cannot turn to the top of compression, that cylinder is defective. Disassemble the cylinder head, find the cause and repair it.
5. Return the decompression shaft 2 of all cylinders to the RUN side. Install the stopper 1.



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Inspecting the remote control devices

Check, adjust (P83 [Inspecting and adjusting the remote control cables])

1. Fully move the speed control lever of the machine side governor to INCREASE.
2. Fully move the handle of the remote control head (box side) to INCREASE.
3. Connect the remote control cable.
4. Screw in the stroke adjustment screw of the control head by approximately 1 turn.

NOTICE

If the stopper on the machine side governor is controlled first and the remote control head lever is actuated, the shaft of the governor speed control lever will bend. This causes a malfunction.

5. Connect the remote control cable of the clutch to the most outward position inside the control head.
6. Check that the clutch lever on the machine side moves correctly to the corresponding position when you put the clutch handle to AHEAD (forward), N (neutral) or ASTERN (reverse).

Make sure that the lights for AHEAD (forward), N (neutral) and ASTERN (reverse) come on (only if the engine has a lamp display).

⚠ WARNING

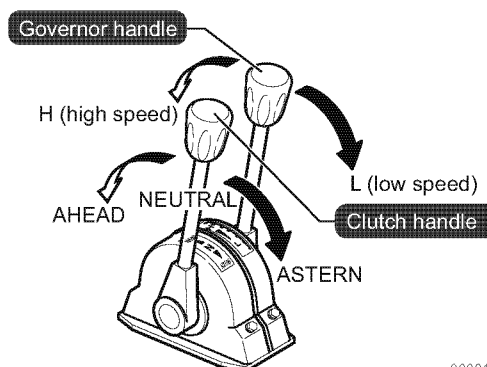
After you adjust the remote control, move:

- The governor handle in the L (low speed) position
- The clutch handle in the N (neutral) position.

If you do not do this, the vessel can move suddenly at engine start.

7. Inspect that the governor handle, the clutch handle and the trolling handle (option) move easily.

If not, lubricate the ball joint of the remote control cable and the shaft of the remote control lever.

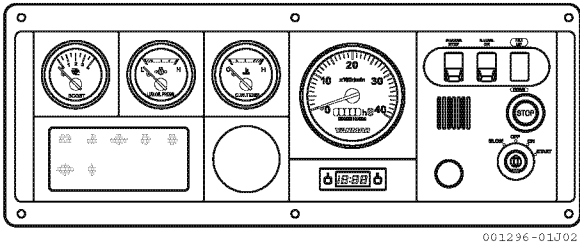


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Checking the instruments and alarm devices

Be sure to check that the instruments and alarm devices operate normally before and after you start the engine.

It is not possible to prevent accidents if the instruments or alarms are defective. Apart from accidents, wrong operation or malfunctions can result. If they do not operate correctly, consult your YANMAR dealer or distributor.



Preparing fuel oil, lubricating oil and freshwater in reserve

Prepare fuel for the day's operation. Always keep an reserve of lubricating oil and freshwater on board (at least one refill), for the case of an emergency.

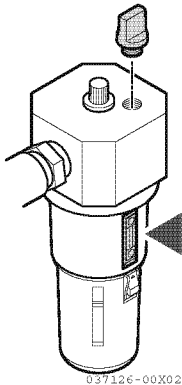
Inspecting the air starting system (option)

Make sure that the air pressure in the air reservoir and the set pressure in the reducing valve are at the specified value.

Air pressure in the air reservoir:	2.45 MPa to 2.94 MPa
Set pressure in the reducing valve	0.69 MPa to 0.97 MPa

Make sure that the lubricating oil of the oiler for air starter is between the top and bottom lines on the scale of the oil level gauge.

If necessary, remove the filler plug and fill with lubricating oil to the top line.



Starting the Engine

When you start the engine after overhaul or a long engine stop, do it from the engine side (even on remote control engines).

Running-in operation

Do a run-in operation when you start the engine for the first time after installation or after overhaul. This operation is not necessary in normal starting.

1. Start at approximately 600 min^{-1} . Increase to the rated engine speed in steps of 100 min^{-1} every 10 minutes. Do it without load.
2. After the no-load operation, do load operations in the sequence of 25 %, 50 %, 75 % and 100 %.

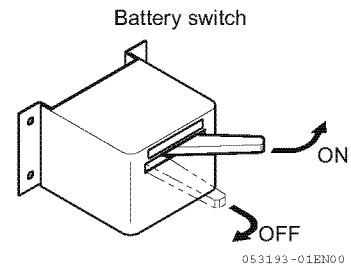
NOTICE

Quickly increase the engine speed if torsional vibration occurs.

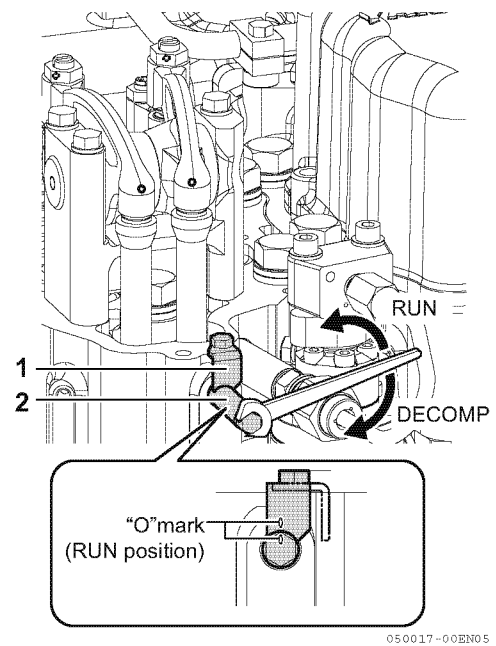
Engine side start operation

■ Electric start

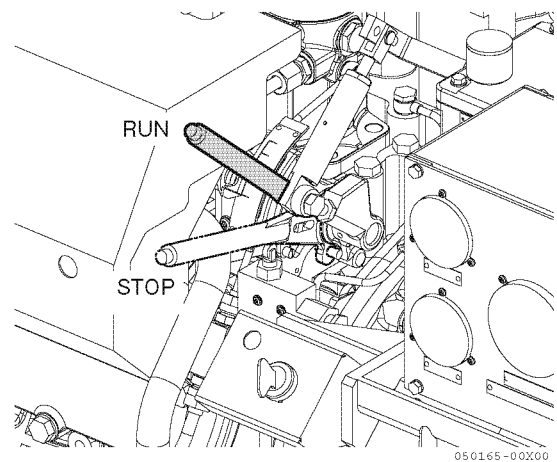
1. Move the battery switch to ON.



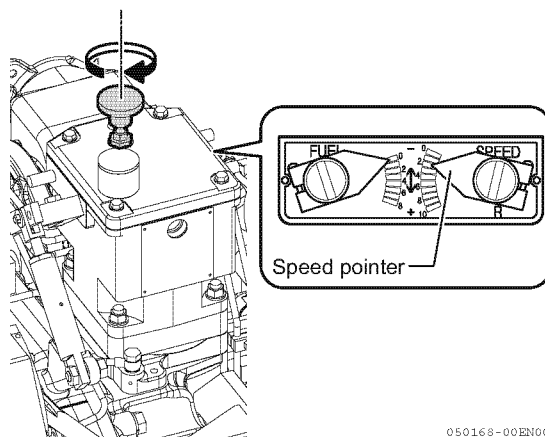
2. Check that the stopper 1 is installed in all cylinders and the decompression shaft 2 is in the RUN position.



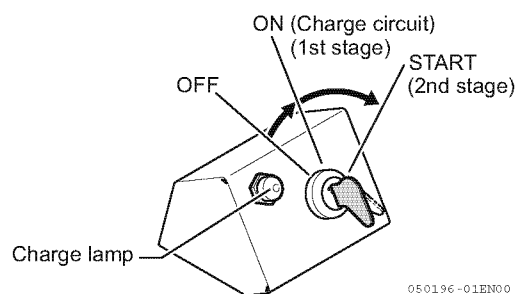
3. Make sure that the start/stop handle is set to RUN.



4. Move the governor handle until the pointer on the speed control shaft of the governor points to "2" on the scale.
5. Before you operate the starter switch, make sure that the clutch lever of the marine gear is set to NEUTRAL.



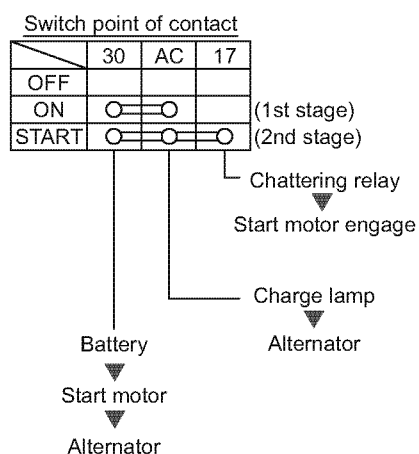
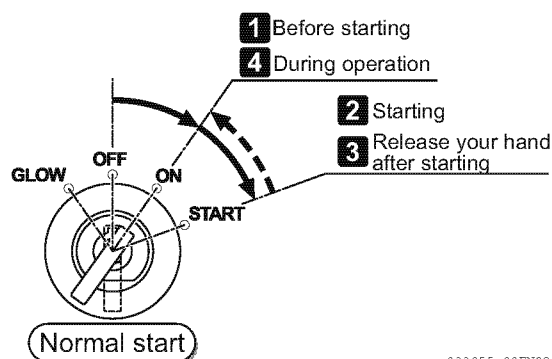
6. Move the key of the starter switch (optional engine installation) to START (2 steps in clockwise direction).



7. After the engine turns and ignition occurs (rotation increases), release the starter key. The starter switch key then moves back to the ON position.

NOTICE

- Do not operate the starter switch for longer than 15 seconds. If you operate it longer, the starter motor becomes hot and can have a malfunction.
- Release the key before the engine speed is at 500 min⁻¹.
- If the engine does not start: After the engine stops fully, wait for 10 seconds. Then start again. If you do not wait, the starter motor can be damaged.



8. Turn the governor handle and set the idle rotation.

Idle rotation: approx. 600 to 700 min⁻¹

The type of shaft is different for all vessels. Adjust the range so that the ship can be operated without problems (e.g. noise from the gears, shocks when the clutch engages).

NOTICE

- If the rotation of the idle gear is too high, shocks can occur when the clutch engages.
- If the rotation of the idle gear is too low, the engine can stall when the clutch engages.
- When you operate the trolling device of the marine gear, keep the engine speed under 725 min⁻¹.

NOTICE

When you start the engine from the engine side, you cannot see the alarm devices located in the control room. Monitor the mounted instruments and operate the engine carefully.

9. Measure the water level of the freshwater cooler with the water level gauge.

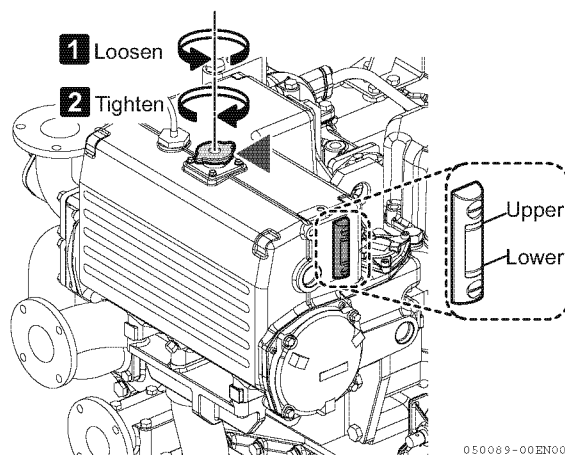
Fill with water if the water level is low. Fill to the upper level of the water level gauge.

Obey these instructions when you fill water.

- 1- Stop the engine. Wait for the engine to cool down.
- 2- Turn the filler cap one step in the counterclockwise direction. Release the pressure. Then remove the filler cap.
- 3- Fill to the upper level of the water level gauge.

NOTICE

If a clogging alarm is installed, the lamp of the lubricating oil filter clogging alarm comes on for approximately 1 minute after engine start. This is normal, because the viscosity of lubricating oil is high when the engine is cold. If the lamp stays on, replace the filter element.



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■ Air start (option)

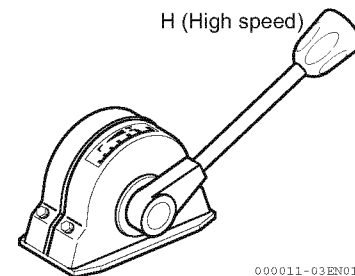
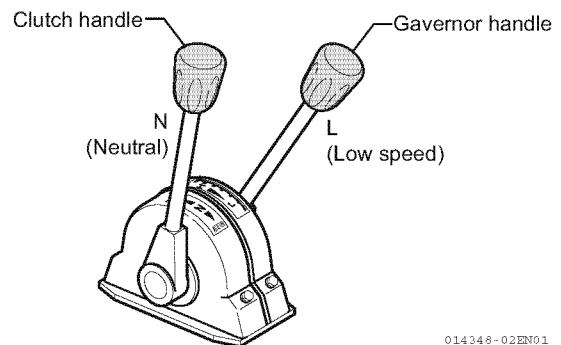
1. Open the quick valve and the engine operates.
2. Close the quick valve when you are sure that the engine operates.
3. When the engine operates, do the same operation as electric start.

Remote start operation

ObeY these instructions when you start the engine.

■ Electric start

1. Open the hull-mounted fuel cock (valve).
2. Open the Kingston cock (valve).
3. Check that the decompression shaft is in the DRIVE position and the start/stop handle is in the RUN position.
4. Move the battery switch to ON.
5. Shut off all loads for the inboard equipment used in the front drive system.
6. Move the clutch handle to N (neutral).
Put the engine in N (neutral). If not, the safety devices will prevent an engine start.
7. Move the governor handle to L (low speed).
8. Move the trolling handle (option) to H (high speed).



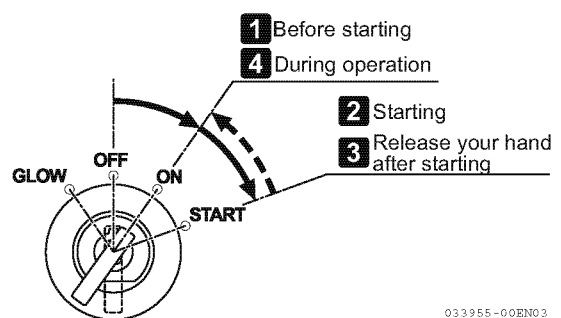
9. Put the key in the starter switch and turn it to the ON position. **1**

The alarm devices operate correctly if the buzzer operates momentarily and all alarm lamps turn on at the same time. The charge lamp stays on.

10. Move the key to START to start the engine. **2**

11. Release the key when the engine starts. **3**

The key returns automatically to the ON position. The alarm devices operate correctly if the alarm buzzer and the alarm lamps turn off. Leave the key in the ON position. **4**



NOTICE

- Do not operate the starter switch for longer than 15 seconds. If you operate it longer, the starter motor becomes hot and can have a malfunction.
 - Release the key before the engine speed is at 500 min^{-1} .
 - If the engine does not start: After the engine stops fully, wait for 10 seconds. Then start again. If you do not wait, the starter motor can be damaged.
-

■ Air start (option)

1. Push the engine start button on the control panel. The solenoid valve opens and the engine starts. Check that the oil in the adjusting dome overflows while the air starter turns.
2. Release the start button when you are sure that the engine operates.
3. To start the engine manually, press the start button of the solenoid valve.
 - The solenoid valve automatically closes when the engine speed reaches 400 min^{-1} .

Restarting after a start failure

After a start failure, make sure that the engine is at a complete stop before you turn the key in the starter switch again.

- Do not press the starter switch for more than 15 seconds at a time. If the engine does not start: After the engine stops fully, wait for 10 seconds. Then start again.
- If the engine does not start after you try several times, air in the fuel system can be the cause. Check the fuel system and release the air from the fuel system.

Air heater (for cold regions/option)

The air heater pre-heats the intake air warmer when in cold operating conditions. This makes the engine start easier.

1. Move the clutch lever to N (neutral).
2. Tilt the governor handle from L (low speed) to H (high speed) a little.
3. Turn the starter switch key to the GLOW position. If you release the key, it will automatically return to OFF. The heater operates. **1**

The heater operates for a maximum of 1 minute.

4. Hold the starter switch in either ON or OFF position for 20 to 30 seconds. **2**
5. Turn the starter switch key to the START position

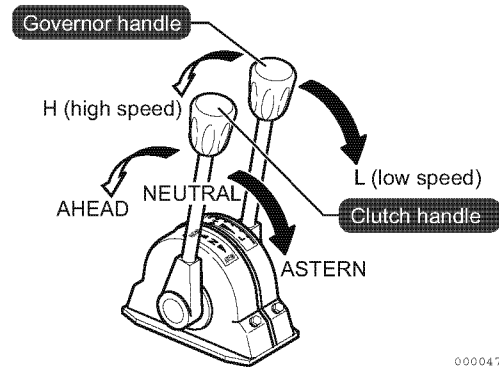
to start the engine. **3**

Release the key when the engine starts. The key returns to the ON position.

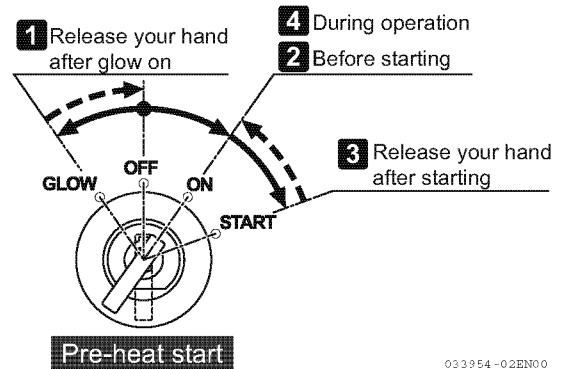
Leave the key in the ON position during operation. **4**

If the engine does not start, restart from the procedure 3.

6. When the engine operates, move the governor handle to L (low speed).



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Warm-up operation

Run the engine at the idling speed to warm it up for 5 to 10 minutes right after engine start.

1. Make sure that all pressure gauges indicate the specified value.
2. Make sure that equipment on the outside of the engine (e.g. turbocharger) does not have unusual heat or gas leaks.
3. Measure the water level of the freshwater cooler. If the water level is low, stop the engine and fill water.

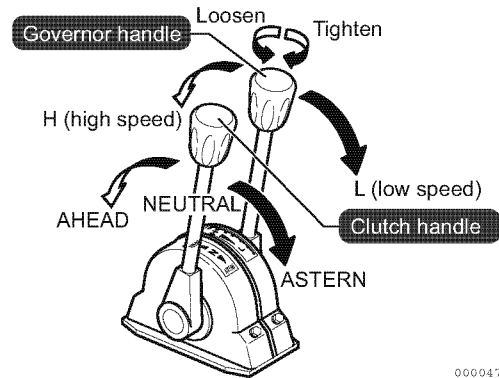
NOTICE

- Quickly increase the engine speed if torsional vibration occurs.
 - After you fill water, tighten the filler cap. Make sure that it is tight. If it is not tight and you operate the engine, the cooling water pressure does not increase to the standard value.
 - The cooler expands when the cooling water temperature increases. Water can come out the overflow pipe of the filler cap.
-

Load Operation

Changing from Neutral to Ahead or Astern

1. The clutch handle changes from neutral gear to forward (ahead) or reverse (astern) movement. Set the engine to the lowest speed before you change the clutch to Ahead or Astern. Return the handle to N (neutral) first and move it carefully. Never change the clutch position suddenly. Put the clutch handle securely in the desired position of AHEAD (forward), N (neutral) or ASTERN (reverse).
 - 1- To unlock the governor handle, turn the grip counterclockwise.
 - 2- Put the governor handle to L (low speed).
 - 3- The engine speed slows down to the lowest speed.
 - 4- Put the clutch handle in the intended position.
 - To stop the ship: Move the clutch handle to N (neutral).
 - To move ahead: Move the clutch handle to AHEAD (forward).
 - To move astern: Move the clutch handle to ASTERN (reverse).
 - 5- Put the governor handle to H (high speed) to accelerate the engine.



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NOTICE

Do not move the clutch while the engine operates at high speeds. Do not use the clutch with the shift handle in an incorrect position (half-engaged). It can cause clutch failures because of wear or damage to internal engine parts.

- If the rotation range in which engine vibration and gear noise occurs has become lower since the ship was built, replace the viscous damper on the crankshaft end with a new one.
- Quickly increase the engine speed if torsional vibration occurs.

2. Measure the temperature of the lubricating oil at the lubricating oil cooler outlet.

Lubricating oil temperature at cooler outlet: 70 °C or less

3. Make a record of the cooling water temperature.

Cooling water temperature at cylinder outlet: 75 °C to 85 °C.

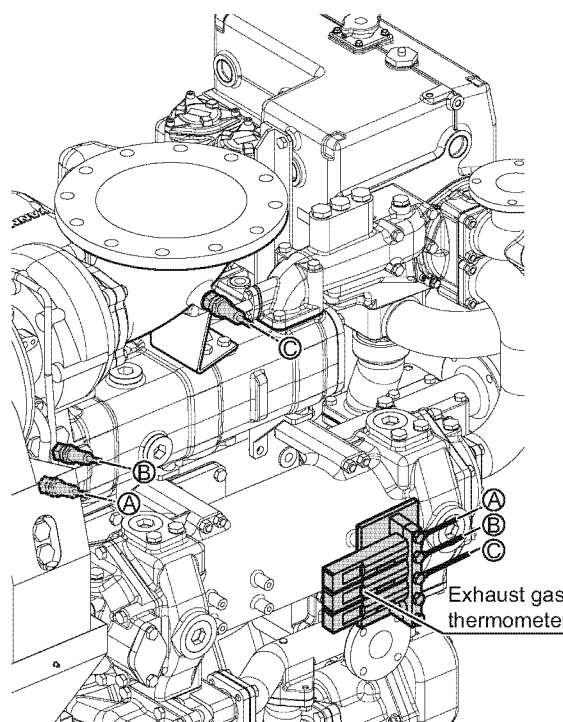
- If water continuously flows from the overflow pipe of the freshwater cooler filler cap during operation, examine the inside of the cooler for seawater intrusion.
- If anti-freezing fluid is added to the cooling water, the cooling water temperature can suddenly increase during operation.

In that case, decrease the load (speed).

4. Monitor the exhaust gas temperature during load operation.

Exhaust gas temperature limit at turbocharger inlet: 660 °C

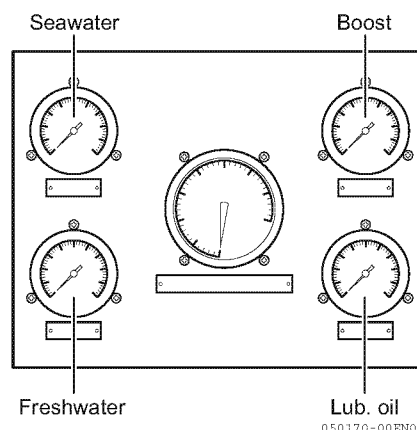
- If the exhaust gas temperature reaches its upper limit, decrease the engine speed (load). Find the cause and repair the engine.



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5. Make a record of the values on all pressure gauges.

- Adjust them to the standard values.
P163 [Standard Adjustment Value]
- Adjust the lubricating oil pressure after you clean the filter.



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6. Check of the charging lamp

The charging lamp is off during engine operation. If the charging lamp is not off, the battery may not be charging for these reasons. Inspect and repair it immediately.

- Loose wiring
- Alternator defect
- Damaged alternator V-belt

NOTICE

- Stay within the limits when you continuously operate the engine at maximum output.

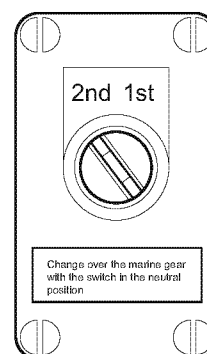
Model	Application	Yearly usage (hours)	Engine maximum output (kW)		Limits for continuous operation at maximum output (hours)
			at flywheel	at m./gear output-shaft	
6EY17W-G	· Fishing boat	2000	–	889	Less than 2
6EY17W-E		3000	–	809	Less than 10
6EY17W	· Commercial vessel	3000	Overload 921	(889)	Less than 1 /every 12
	· Work boat	4000	Overload 838	(809)	Less than 1 /every 12

Switching the reduction ratio

■ Two-speed operation (YXH2-500 marine gear option)

If the marine gear is equipped with a forward two-speed clutch, you can switch the reduction ratio at forward travel with the clutch 1st/2nd gear switch to 1st or 2nd gear. When the engine operates at heavy load (e.g. when tugging), switch to the 1st gear (cruise).

1. Move the governor handle to L (low speed).
2. Move the clutch handle to N (neutral).
3. Use the 1st/2nd gear switch to change the reduction ratio.



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NOTICE

Set the engine to the lowest speed before you change the reduction ratio. If you switch at a higher speed, a malfunction of the marine gear can occur because of wear or damage to its internal parts.

Switching to trolling mode

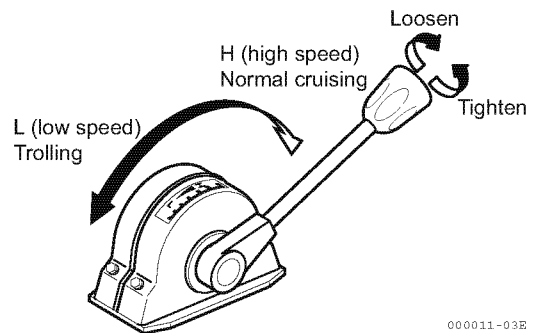
The trolling mode lets the clutch slip and slows the propeller. Do not use trolling mode for trawling or bottom trawling.

■ Trolling handle (option)

Make sure to lock the trolling handle to H (high speed) during normal operation.

Switch to the trolling mode during low speed cruising.

1. Adjust the engine speed below 700 min^{-1} with the governor handle.
2. Set the clutch handle to AHEAD.
3. Unlock the grip of the trolling handle.
4. Move the handle from H (high speed) to L (low speed) to adjust the propeller speed.
5. Lock the grip of the trolling handle to the trolling mode.
6. Before you resume normal cruising from the trolling mode, lock the handle into H (high speed).



NOTICE

Keep the engine speed at or below 725 min^{-1} when in trolling mode.

When the engine speed exceeds 725 min^{-1} , a malfunction of the marine gear can occur because of wear or damage to its internal parts.

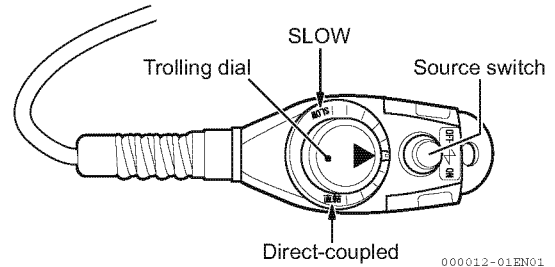
■ Trolling dial

(Electronic trolling available as an option)

Make sure to turn off the power switch of the trolling dial during normal operation.

Do not use trolling mode during cruising with the clutch connected.

1. Move the clutch handle to N (neutral).
2. Adjust the engine speed below 700 min^{-1} with the governor handle.
3. Set the trolling dial to the "direct-coupled" position.
4. Turn on the power switch of the trolling dial.
5. Put the clutch handle to AHEAD or ASTERN.
6. Adjust the propeller speed with the dial to the trolling mode.
 - Turn the dial to SLOW to decrease the propeller speed.
 - Turn the dial to the "direct-coupled" side to increase the propeller speed.
 - When the scale is "direct-coupled", the mode is direct-coupled mode.
7. To stop trolling, set the dial to the "direct-coupled" position and turn off the power switch.



● When the engine speed exceeds 725 min^{-1}

- in the electronic trolling, the clutch is automatically set to the direct-coupled mode when the engine speed exceeds 725 min^{-1} .
- To resume trolling, set the dial to the "direct-coupled" position and decrease the engine speed to the idling speed.

NOTICE

Never turn on the power switch with the clutch engaged.

It causes an electrical shock and is dangerous.

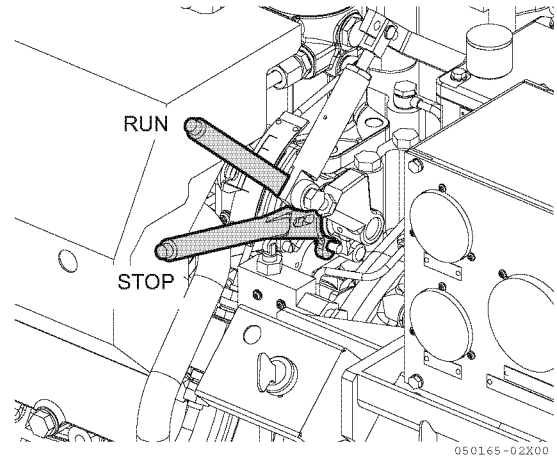
For details, refer to this separate document "Electronic Trolling Operation Manual."

Stopping the Engine

■ Stop in the machine side

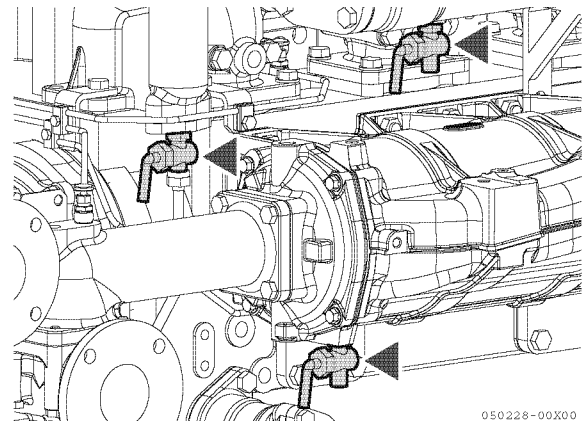
Unless in case of an emergency, reduce the engine speed and start a cooling operation in less than 10 minutes.

1. Set the start/stop handle to STOP.
2. Open the drain cock on the bottom of the intake air duct. Drain all water. Close the drain cock.
3. Open the drain cock on the breather pipe. Drain all water and other unwanted material. Close the drain cock.
4. Repair any defects of the running engine.

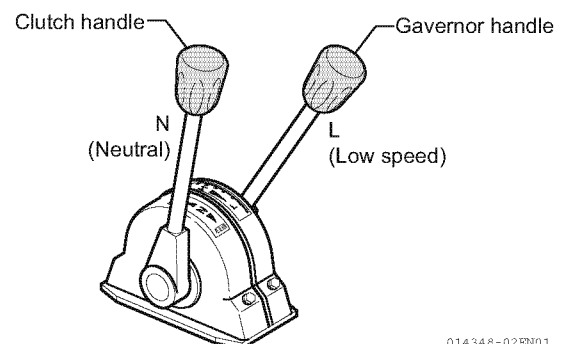


5. Close the Kingston cock after engine stop.
6. If the cooling water can freeze in cold weather, release it from the engine when the engine is cool.
 Freshwater: cylinder, exhaust manifold, freshwater cooler, freshwater pump
 Seawater: seawater pump, lubricating oil cooler, air cooler, lubricating oil cooler of the marine gear, pipe between the seawater pump and the freshwater cooler

* For the seawater pump (rubber impeller type), remove the pump cover to drain the water.



7. Make sure to turn off the battery switch after engine stop.
8. For the remote controller, set the clutch handle to N (neutral) and the governor handle to L (low speed).



■ Remote control stop

Reduce the engine speed and start a cooling operation in less than 10 minutes.

1. While the starter switch on the gauge panel is in the ON position, press the engine stop button until engine stops. **1**

If you stop pressing the engine stop button, the engine may operate again.

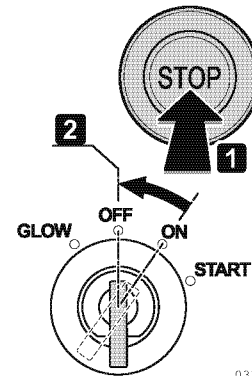
2. Turn the key in the starter switch to OFF.
Remove the key from the starter switch and keep it in a safe place to prevent unauthorized use.

3. Turn off the battery switch. **2**
Turn off the switch when the engine is not used.

4. Close the fuel cock (valve).

5. Close the Kingston cock (valve).

6. Check that the governor handle is set to L (low speed), the clutch handle is set to N (neutral), and the trolling handle is set to H (high speed) after engine stop.



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NOTICE

Do not continue to press the engine stop button for 30 seconds or more. The engine stop solenoid can cause seizure as the specification does not allow continuous energization.

Special Operation (No-Charge Operation)

If the turbocharger is defective and you do not have the necessary spare parts for repair, install the no-charge operation tool to the turbocharger and operate the engine with decreased load.

- Make sure that there are no exhaust gas leaks, lubricating oil leaks, and cooling water leaks during operation.
- Further decrease the engine speed if the exhaust temperature at the turbocharger inlet is more than the temperature recorded in the Records of Shop Trial at 100% load.
- Do not operate the engine in the critical rotation range where torsional vibration occurs.

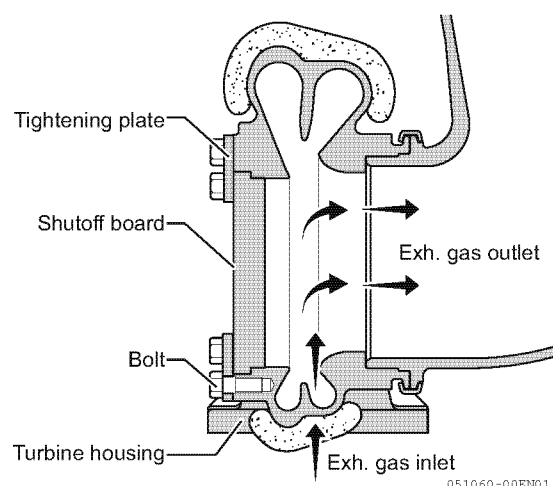
■ Disassembling the turbocharger

Disassemble the turbocharger when the engine is cold.

1. Remove the lubricating oil pipe and the return pipe. Install the plug or the shutoff flange. It stops the lubricating oil flow.
2. Remove the cooling freshwater pipe and the return pipe. Install the plug or the shutoff flange. It stops the cooling freshwater flow.
3. Remove the turbine shaft, bearing gear case and compressor gear case together as an assembly. Do not remove the turbine housing at the exhaust gas inlet.

■ Installing the tool

1. Install the shutoff board to the turbine housing as shown in the illustration.
2. Lock the shutoff board with the tightening plate.
3. Install a metal mesh to the air inlet. This prevent unwanted material from coming in.

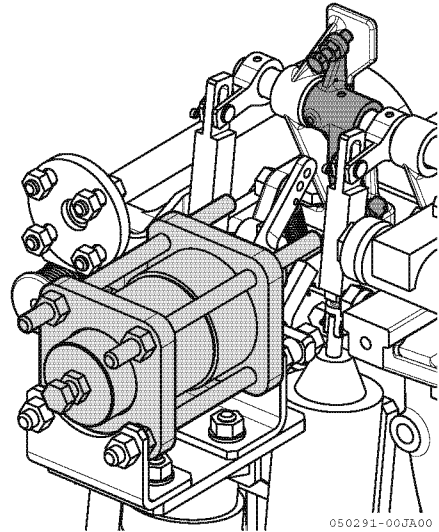


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Adjusting the Boost Compensator

When the clutch engages (changing from forward to reverse), the boost compensator uses the boost pressure of the turbocharger to control the fuel injection quantity. This reduces incomplete combustion (black exhaust smoke) caused by excessive fuel.

The engine is pre-set to standard conditions, but measure the performance at sea and adjust accordingly. Obey the instructions that follow to adjust the boost compensator.



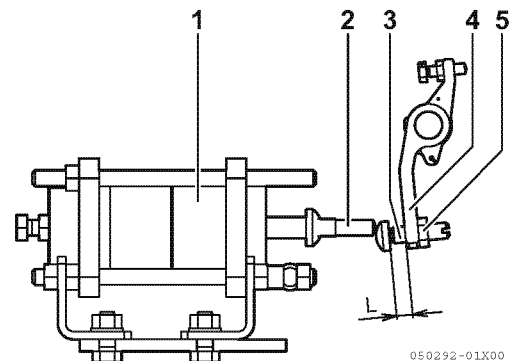
■ How to adjust the boost compensator

- Loosen the lock nut 5 with the boost compensator body 1 installed to the engine. Turn the adjustment screw 3 to adjust the dimension L.

If you make L larger, the fuel injection amount becomes smaller.

If you make L smaller, the fuel injection amount becomes larger.

- In the factory setting, the adjustment screw 3 touches the boost compensator rod 2 at fuel rack scale 14 during engine stop.



L in the factory setting	7 mm
---------------------------------	-------------

■ Adjusting in test operation at sea

Do a fine-tuning of the adjustment screw and consider:

- The acceleration performance
- Engine stalls during crash astern
- The amount of black exhaust smoke during acceleration and crash astern

PERIODIC INSPECTIONS

Precautions for Inspections

■ Periodic inspections are for your safety

Depending on the operating conditions and duration, the functionality of engine parts decreases and engine performance decreases.

Do not ignore bad engine performance. The engine can have an unexpected malfunction at sea. This is dangerous and also interferes with your activities.

It also causes greater consumption of fuel and lubricating oil, bad exhaust gas and more noise. It shortens the engine's service life.

Through daily and periodic inspections and maintenance you can find defects early and prevent failures and accidents.

■ Inspections when you begin work

The inspections when you begin work are the basis of the daily checks. Make it a habit of doing them before the start of each operating day.

■ Observe periodic inspection interval

We recommend that you keep a log of the engine's operating hours for each day and your daily inspections and maintenance. Do the inspection when the engine operation hours and the hourmeter indicate that a periodic inspection is due.

Replace all parts that are damaged or reached their usage limit. Also replace all parts that will reach their usage limit before the next scheduled inspection.

■ Genuine YANMAR parts

Make sure that you use genuine YANMAR parts when you replace engine parts. Other parts can decrease engine performance and shorten the engine's service life.

■ Preparing the necessary tools for inspection and maintenance is recommended

Make sure that you have all the tools on board that you need to inspect the engine.

■ Service agreement

Our professional service technicians have the expertise and skills to help you with all inspections and maintenance. For information on this service agreement, ask your YANMAR dealer or distributor.

■ Engine maintenance record accompanied with NOx regulations

Laws on maritime pollution and hazard prevention regulate the replacement of certain parts. The laws require that you keep a record and the signature of personnel who replaces them.

Our professional service technicians have the expertise and skills to help you with the necessary tasks. Consult your YANMAR dealer or distributor.

■ Waste disposal

Never dispose of waste liquids such as lubricating oil by dumping them into a sewer, river, lake or ocean waters. Comply with relevant laws and/or regulations for the disposal of hazardous materials such coolant, lubricating oil, fuel, filters or batteries.

Scheduled Inspections

Daily and periodic inspection is important to keep the engine in good condition.

This is a summary of maintenance items by periodic maintenance intervals. Schedule your own periodic inspections according to the operation conditions and do not miss an inspection.

- The column "Inspection Interval" shows intervals measured in operating hours and time intervals. Use whichever comes earlier.
- If the inspection interval includes the previous inspection interval, perform the inspection for the included item at the same time.
- Periodic maintenance intervals are inspection and replacement standards. The intervals may differ in the usage, load and handling conditions of the engine.

Inspection category

Inspection A: Every day (includes weekly)

Inspection B: Twice a month (150 to 200 hours)

Inspection C: Every month (400 hours)

Inspection D: Every 3 months (1000 hours)

Inspection E: Every 6 months (2000 hours)

Inspection F: Every year (4000 hours)

Inspection G: Every 2 to 3 years (8000 to 10000 hours)

○: Inspection, cleaning, washing, adjustment

⊙: Part replacement △: Analysis

Inspection and servicing items			Inspection intervals (per inspection)							Remark
Sys tem	Part	Maintenance task	A	B	C	D	E	F	G	
Fuel system	Injection pump	Inspect the rack scale position				○				
		Inspect the injection timing				First ○		○		Adjust if necessary
		Inspect the deflector						○		Replace if worn
		Overhauling major parts							○	
		Replace the plunger and delivery valve								Replace after 15000 hours
	Injection valve	Inspect the injection pressure and injection spray				First ○	○			If defective, replace the nozzle
		Remove carbon				First ○	○			
		Disassemble, clean and inspect / Replace the nozzle						⊙		
		Replace the nozzle spring							⊙	
	Filter	Drain	○							Every 50 hours
		Disassemble and clean / Replace the element			⊙					Every 500 hours
	Fuel tank	Inspect the oil level	○							
		Draining	○							
Lubricating oil system	Feed pump	Overhaul major parts							○	
		Replace the oil seal							⊙	
		Inspect for leaks from oil seal	○							
	Pump	Overhaul major parts							○	
		Replace the pump								Every 15000 hours
	Oil pan	Check the lubricating oil level and refill	○							Engine or marine gear
		Change the lubricating oil	First ⊙		⊙					1st time: 50 hours Every 250 hours
		(Analyze the lubricating oil)		△						
	Filter	Replace the cartridge	First ⊙		⊙					1st time: 50 hours At changing the lubricating oil every 250 hours

Inspection category**Inspection A:** Every day (includes weekly)**Inspection B:** Twice a month (150 to 200 hours)**Inspection C:** Every month (400 hours)**Inspection D:** Every 3 months (1000 hours)**Inspection E:** Every 6 months (2000 hours)**Inspection F:** Every year (4000 hours)**Inspection G:** Every 2 to 3 years (8000 to 10000 hours)

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Inspection and servicing items			Inspection intervals (per inspection)							Remark
Sys tem	Part	Maintenance task	A	B	C	D	E	F	G	
Lubricating oil system	Lubricating oil Bypass filter	Replace the cartridge	First ⊙		⊙					1st time: 50 hours At changing the lubricating oil every 250 hours
	Cooler	Disassemble, clean and inspect							○	Do a hydraulic test (necessary)
	Intake/exhaust valve rocker arm	Inspect the oil supply			○					
Reciprocating parts	Piston, Piston pin	Remove the piston and clean and measure the carbon							○	Do a color-check (necessary)
		Inspect the piston ring and oil ring groove							○	
		Inspect and measure the piston pin hole							○	
		Replace the piston ring and oil ring							⊙	
		Inspect and measure the piston pin							○	
	Connecting rod	Inspect and replace the piston pin bearing							○	Replace every 15000 hours
		Inspect and replace the crank pin bearing							⊙	
		Overhaul the connecting rod bolt							○	
		Replace the rod bolt								Every 15000 hours
	Cylinder liner	Measure the inner diameter of the cylinder liner							○	
		Remove and check the water jacket							○	
	Cylinder block	Inspect the liner hole								Every 15000 hours Do a color-check
Crankshaft	Main bearing	Inspect the main bearing							○	
		Inspect the main bearing bolt							○	
		Inspect the main bearing side bolt							○	
		Replace the main bearing								Every 15000 hours Replace
	Crankshaft	Measure the journal and the outer diameter of the pin							○	
		Measure and adjust the deflection					○			
	Viscous damper	Inspect and replace				○ Inspect			○	Replace every 10000 hours

Inspection category

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○: Inspection, cleaning, washing, adjustment

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Inspection and servicing items			Inspection intervals (per inspection)							Remark
Sys tem	Part	Maintenance task	A	B	C	D	E	F	G	
Cooling water system	Pump (freshwater)	Inspect the mechanical seal for water leaks	○							
		Replace the mechanical seal							⊙	
		Overhaul major parts							○	
		Replace the ball bearing							⊙	
		Replace the impeller and shaft							⊙	
	Pump (seawater)	Check for water leaks	○							
		Replace the mechanical seal							⊙	
		Replace the oil seal							⊙	
		Replace the rubber impeller				○	⊙			Replace if defective
		Replace the ball bearing							⊙	
	Freshwater cooler	Disassemble, clean and inspect							○	Do a test on the freshwater side with water pressure up to 0.1 MPa
	Anti-corrosive zinc	Inspect and replace			⊙					Every 500 hours Replace if worn
	Thermostat	Disassemble, inspect and clean						○		
		Replace the thermostat							⊙	
	Cooling water	Inspect the water level	○							
		Replace						○		Add antifreeze or rust inhibitor
Governor gear	Governor	Replace the hydraulic oil				⊙	⊙			1st time: 1000 hours
		Overhauling major parts							○	
	Linkage	Inspect, adjust and fill oil				○				
	Boost compensator	Apply grease between lever and reamer bolt				○				
		Replace the lubricating oil inside the boost compensator				○				Every 500 hours
Start system	Starter	Inspect							○	
	Alternator	Inspect							○	
		Inspect the V-belt and adjust the tension	First ○		○					1st time: 50 hours
	Battery	Inspect the specific gravity of the electrolyte			○					
		Inspect the electrolyte level	○							
		Inspect the terminal						○		
		Replace								Expected service life: 3 years

Inspection category**Inspection A:** Every day (includes weekly)**Inspection B:** Twice a month (150 to 200 hours)**Inspection C:** Every month (400 hours)**Inspection D:** Every 3 months (1000 hours)**Inspection E:** Every 6 months (2000 hours)**Inspection F:** Every year (4000 hours)**Inspection G:** Every 2 to 3 years (8000 to 10000 hours)

○: Inspection, cleaning, washing, adjustment

⊙: Part replacement △: Analysis

Inspection and servicing items			Inspection intervals (per inspection)							Remark
Sys tem	Part	Maintenance task	A	B	C	D	E	F	G	
Cylinder head / Valve mechanism	Cylinder head and Intake/exhaust valves	Inspect and adjust the valve head clearance					○			
		Inspect the valve spring and rotator speed					○			
		Overhaul and replace the rotator						○	⊙	
		Remove the carbon in the combustion chamber							○	
		Grind or replace the intake/exhaust valves seat							○	Replace the valve and valve seat Every 16000 hours
		Inspect the valve bridge, valve guide and push rod							○	
		Remove the scale in the water chamber							○	
		Replace the valve spring							⊙	
Turbocharger system	Turbocharger	Clean the blower (fill with water)			○					Every 250 hours
		Clean or replace the air filter			○			⊙		Every 250 hours
		Disassemble and clean						○		Every 4800 hours or every 2 years (whichever is sooner)
		Replace the bearing							⊙	Every 2 years
	Air cooler	Clean the air side (core)						○		
		Disassemble, clean and do a hydraulic test							○	
Camshaft / gear	Camshaft	Inspect the fuel and intake/exhaust cam							○	
		Inspect the camshaft bush								Every 15000 hours
	Intake/exhaust valves Swing lever	Inspect the roller contact							○	
		Replace the swing arm								Every 15000 hours
	All gears	Inspect the tooth contact and backlash							○	

Inspection category

Inspection A: Every day (includes weekly)

Inspection B: Twice a month (150 to 200 hours)

Inspection C: Every month (400 hours)

Inspection D: Every 3 months (1000 hours)

Inspection E: Every 6 months (2000 hours)

Inspection F: Every year (4000 hours)

Inspection G: Every 2 to 3 years (8000 to 10000 hours)

○: Inspection, cleaning, washing, adjustment

⊙: Part replacement △: Analysis

Inspection and servicing items			Inspection intervals (per inspection)							Remark
Sys tem	Part	Maintenance task	A	B	C	D	E	F	G	
Marine gear	Lubricating oil filter	Clean the strainer (mesh)	First ○				○			First time: 50 hours
		Replace the cartridge	First ⊙				⊙			1st time: 50 hours
	Inspect and clean the magnet plug	Inspect and clean	First ○				○			First time: 50 hours
	Disassemble, clean and inspect the lubricating oil cooler	Disassemble, clean and inspect						○		
		Inspect and replace the anti-corrosive zinc			○	⊙				Replace if worn
	Gears	Inspect the roller contact							○	
	Inspect the clutch	Friction plate, steel plate spline							○	Replace every 4 years
	All bearings	Part							○	Replace every 4 years
	Replace the lubricating oil	Replace	First ○				⊙			1st time: 50 hours Every 2000 hours
	Other	Other inspections and servicing								Refer to the separate operation manual of the marine gear.
Other	Stop solenoid	Part							○	
	Battery switch	Inspect							○	
	Temperature switch	Inspect and replace						○	⊙	
	Pressure switch	Inspect and replace						○	⊙	
	Wire harness	Check for disconnection and loose terminals				○				
	Tachometer	Inspect and replace the scale					○		⊙	
	All pressure gauges	Replace							⊙	
	All pipe system and rubber hose	Inspect for leaks	○						⊙	Replace the rubber hose
	Engine appearance	Inspect for loose bolts and nuts	○							
		Inspect all parts for water, oil and gas leaks	○							
	Remote control cables	Inspect, adjust			○				⊙	Phase shift daily Every 250 hours
		Inspect the ball joint			○				⊙	Fill oil

Periodic Inspections

Inspecting and servicing the fuel system

■ Draining the fuel filter

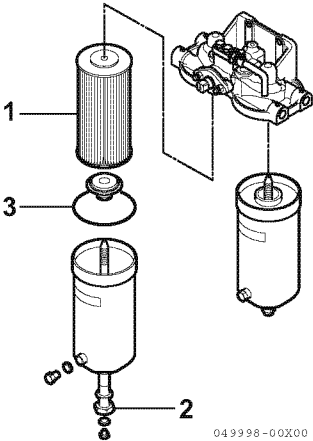
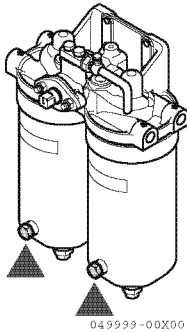
- 1. Remove the drain plug at the bottom of the fuel filter. Drain water, dirt and other unwanted material into a waste oil container.
- 2. Close the drain plug.
- 3. Release the air from the fuel system.

Interval	Every 50 hours (or every week)
----------	--------------------------------

■ Replacing the fuel filter element

- 1. Close the fuel cock (valve).
- 2. Loosen the center bolt 2 of the fuel filter.
- 3. Remove the lower case and the internal element 1.
- 4. Clean the inside of the filter case.
- 5. Install the spring, washer and O-ring 3.
Replace the washer and O-ring 3 if they are damaged.
- 6. Install the new element 1. Lock the element with the center bolt 2.
- 7. Obey P32 [Bleeding the fuel system] and release the air from the fuel system.

Replace- ment interval	Marine diesel oil	Every 500 hours (or every 1 to 2 months)
	Diesel oil	Every 1000 hours (or every 3 months)



Inspecting and servicing the lubricating device

The engine lubricating oil filter is triple cartridge type paper elements. All elements are used during operation.

■ Replacing the lubricating oil filter element (cartridge type)

- 1. Remove the cartridge.
 - 1- Put an oil container that fits the cartridge to prevent oil spillage.
 - 2- Remove the cartridge with a filter wrench.
- 2. Install a new cartridge.
 - 1- Apply lubricating oil to the surface of the rubber gasket.
 - 2- Turn it manually approximately 3/4 to 1 turn from the rubber gasket seat.

NOTICE

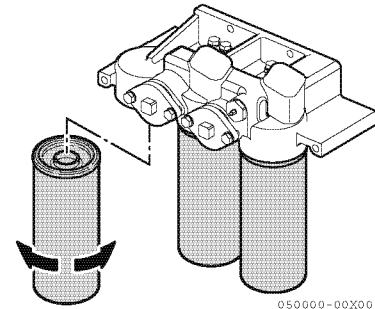
Do not use the filter wrench in the cartridge installation part. You can cause damage to the cartridge.

Replace- ment interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 250 hours (or every 1 month)

■ Replacing the duplex changeover lubricating oil filter element (cartridge type) (option)

NOTICE

If the filter is very dirty and only one side is used, the pressure decreases and the lubricating oil pressure drop alarm operates. Check the oil pressure. Operate the switch cock slowly.



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Replace both filters, one at a time, and obey these instructions:

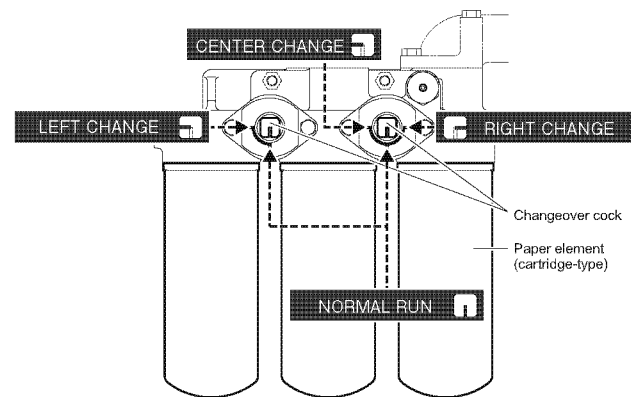
1. Move the red mark of the switch cock to EXCHANGE.
2. Remove the cartridge.
 - 1- Put an oil container that fits the cartridge to prevent oil spillage.
 - 2- Remove the cartridge with a filter wrench.
3. Install a new cartridge.
 - 1- Apply lubricating oil to the surface of the rubber gasket.
 - 2- Turn it manually approximately 3/4 to 1 turn from the rubber gasket seat.

NOTICE

Do not use the filter wrench in the cartridge installation part. You can cause damage to the cartridge.

NOTICE

When you set the switch cock to NORMAL RUN, shift it slowly. If shifted rapidly, the oil pressure can decrease temporarily until the case fills with lubricating oil. This may cause the lubricating oil pressure drop alarm to operate.



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4. Check for oil leaks during engine operation.
5. When you replace the cartridge during engine stop, it is not necessary to operate the switch cock. After restoration, do a priming as instructed in P36 [Priming of the lubricating oil] to fill lubricating oil inside the cartridge.

Replace- ment interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 250 hours (or every 1 month)

■ Replacing the engine lubricating oil bypass filter element (cartridge type)

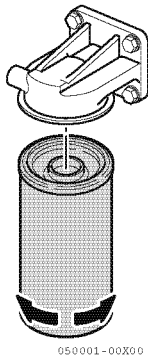
Remove the cartridge with a filter wrench.

NOTICE

Do not use the filter wrench in the cartridge installation part. You can cause damage to the cartridge.

- When you remove the cartridge, put an oil container that fits the cartridge to prevent oil spillage.
- When you install a new cartridge, apply lubricating oil to the rubber gasket. Turn it manually approximately 3/4 to 1 turn from the rubber gasket seat.
- After restoration, do a priming as instructed in P36 [Priming of the lubricating oil].

Replace- ment interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 250 hours (or every 1 month)



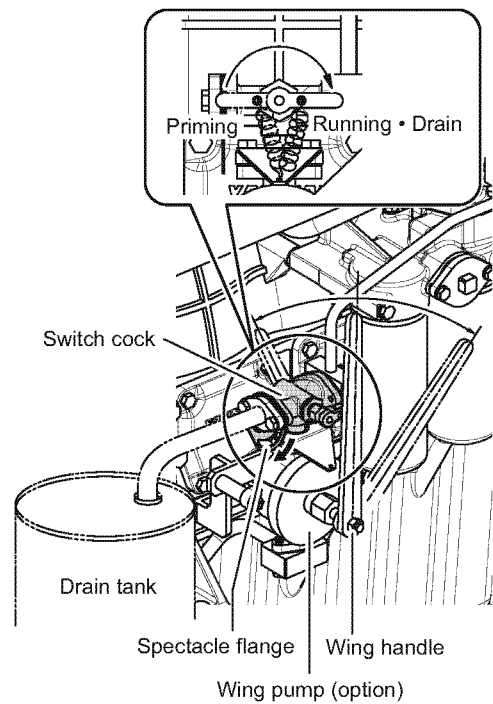
■ Replacing the lubricating oil

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

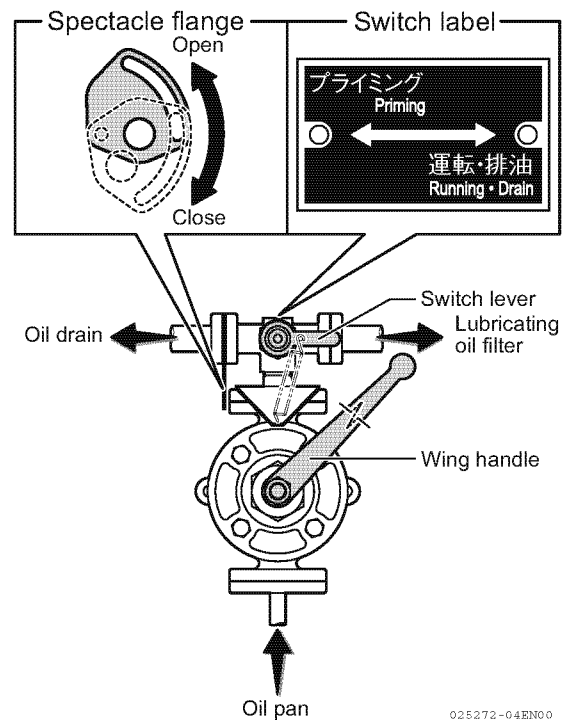
● Replacing the engine lubricating oil

Replace- ment interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 250 hours (or every 1 month)

1. Push in the rubber hose of the oil discharge pump (option) into the filler port attached to the oil pan and drain oil with the oil discharge pump.
2. If the engine is equipped with a lubricating oil wing pump, drain oil as follows:
 - 1- Set the spectacle flange of the switch cock to OPEN.
 - 2- Set the switch lever on the top of the wing pump to RUNNING / DRAIN.
 - 3- Drain oil from the oil discharge port of the wing pump.
 - 4- After approximately 2 hours, drain oil again. (The oil that remained on all engine parts returns almost completely to the oil pan.)
 - 5- After you drain all oil, set the spectacle flange of the switch cock on the wing pump to CLOSE.
3. Fill new lubricating oil into the oil filler port.



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● Replacing the lubricating oil of the marine gear

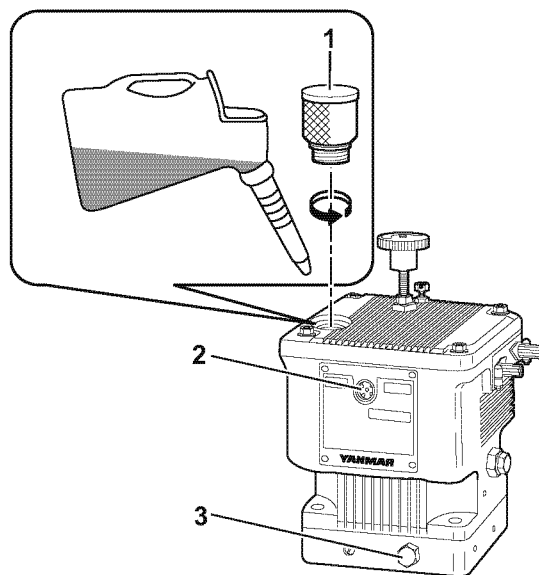
Replace- ment interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 2000 hours (or every 6 month)

1. Push in the rubber hose of the oil discharge pump into the dipstick collecting sewer and drain oil with the oil discharge pump.
2. If the engine is equipped with a lubricating oil wing pump, drain oil as follows:
 - 1- Set the spectacle flange of the switch cock to OPEN.
 - 2- Set the switch cock on the top of the wing pump to RUN / OIL DRAIN.
 - 3- Drain the oil of the wing pump from the oil discharge port.
 - 4- After you drain all oil, set the spectacle flange of the switch cock on the wing pump to CLOSED.
3. Fill new lubricating oil into the oil supply port.

■ Replacing the hydraulic oil of the hydraulic governor

		Grade CD #40
Replace- ment interval	1st time	After 1000 hours (or after 3 month)
	2nd time and after	Every 2000 hours (or every 6 month)

Remove the drain plug 3 on the bottom of the governor. Drain the oil. Install the plug. Fill new oil from the breather 1. Fill until it is a littler higher than the center of the level gauge 2.



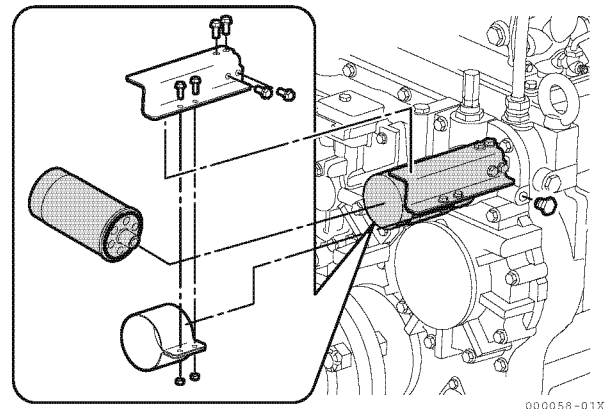
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■ Replacing or cleaning the marine gear lubricating oil filter element, replace or clean the magnet plug (YXH-500, YXH-2-500, YXH-500L)

Interval	Replace the lubricating oil filter element. Clean the strainer.	1st time	After 50 hours (or after 1 week)
		2nd time and after	Every 2000 hours (or every 6 month)
	Check and clean the magnet plug	1st time	After 50 hours (or after 1 week)
		2nd time and after	Every 2000 hours (or every 6 month)

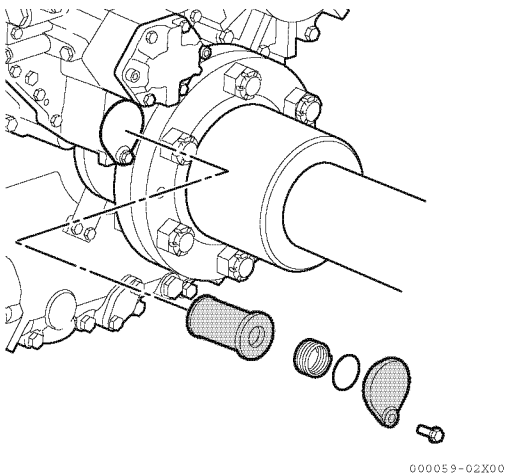
● Replacing the lubricating oil filter element (cartridge type)

1. Remove the element with a filter wrench. (Counter-clockwise)
2. Do the following tasks before you install the new element.
 - 1-Carefully clean the mounting surface.
 - 2-Apply lubricating oil to the surface of the rubber gasket.
3. Turn the element manually (clockwise) until it contacts the mounting surface and tighten after the O-ring is in contact with the mounting surface.
4. Check for oil leaks during engine operation.



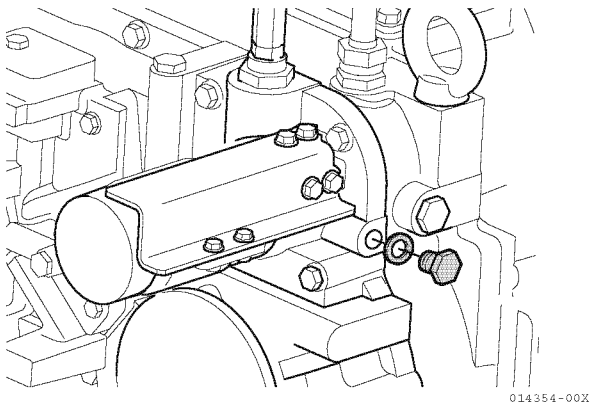
● **Cleaning the lubricating oil strainer**

- 1. Remove the strainer cover.
- 2. Remove and clean the strainer screen inside with kerosene.
- 3. Replace the O-ring with a new one at installation.
- 4. Check for oil leaks during engine operation.



● **Checking and cleaning the magnet plug**

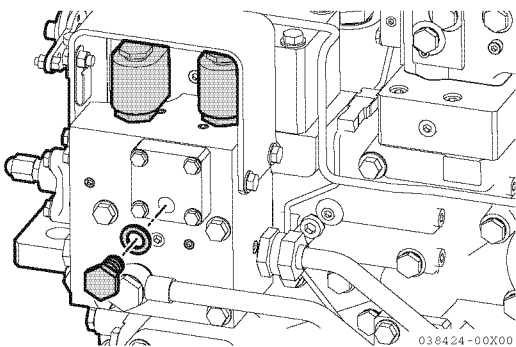
- 1. Remove and clean the magnet plug.
- 2. Tighten the magnet plug.
- 3. Check for oil leaks during engine operation.



■ **Inspecting and cleaning the 1st/2nd gear switch solenoid valve lubricating oil magnet plug (YXH2-500 Option)**

Interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 1000 hours (or every 3 month)

- 1. Remove and clean the magnet plug of the gear switch solenoid valve.
- 2. Tighten the magnet plug.
- 3. Check for oil leaks during engine operation.



Inspecting and servicing the cooling system

■ Inspecting and replacing the anti-corrosive zinc

Check the anti-corrosive zinc at regular intervals. The interval for replacement of the anti-corrosive zinc depends on the composition of the seawater and operating conditions.

The anti-corrosive zinc is at the back of the flange or the plug for anti-corrosive zincs.

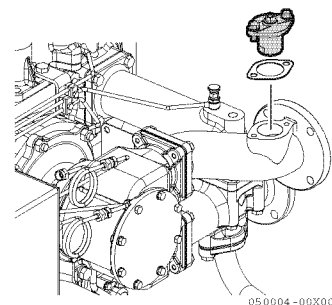
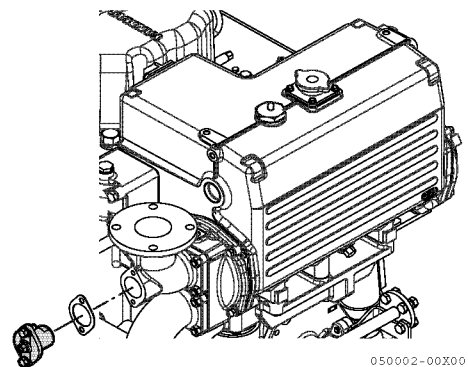
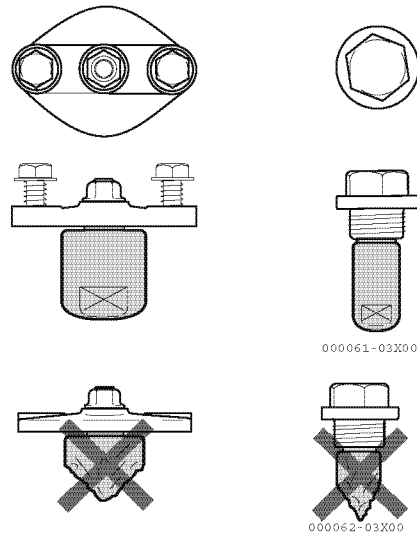
- Replace the anti-corrosive zinc with a new one when it becomes about half or less of its original size.
- To continue using the anti-corrosive zinc after inspection, remove all corrosion with a brush until the zinc layer is exposed.

NOTICE

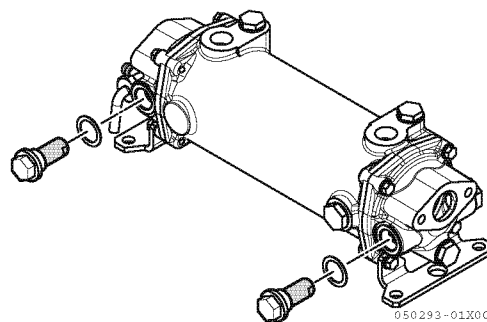
If the anti-corrosive zinc becomes too small, pipes and other parts in the seawater cooling system start to corrode. This results in water leaks and damage.

Replacement interval	Every 500 hours (or every 1 to 2 months)
----------------------	---

1. Close the Kingston cock (valve).
2. Drain seawater from the seawater drain cock of the marine gear lubricating oil cooler.
3. Inspect and replace the anti-corrosive zinc (2 pieces) for the engine inlet/outlet.



4. Inspect and replace the anti-corrosive zinc (2 pieces) for the marine gear lubricating oil cooler of the marine gear.
5. Restore all plug screws and flanges.
6. Check for water leaks during engine operation.



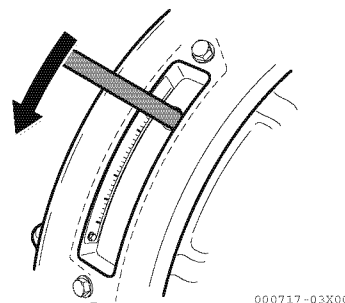
■ Inspecting the impeller of the seawater pump

Inspection interval	Every 1000 hours (or every 3 months)
---------------------	---

1. Remove the side cover of the seawater pump.
2. Check the end face of the impeller.
3. Turn the flywheel by hand and check that the impeller slides smoothly.
4. If you find any damage, replace the impeller with a new one.

NOTICE

Make sure that you do not turn the shaft in the reverse direction. This results in deformation and damage of the blades of the rubber impeller.

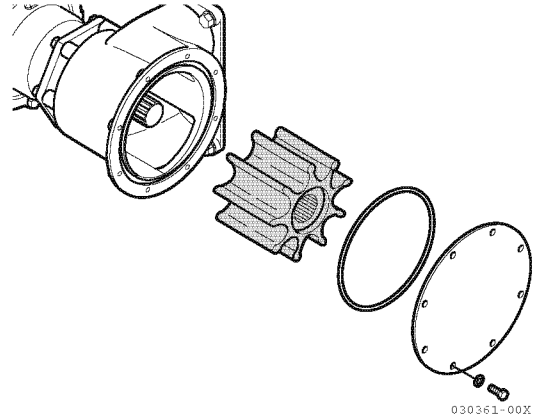
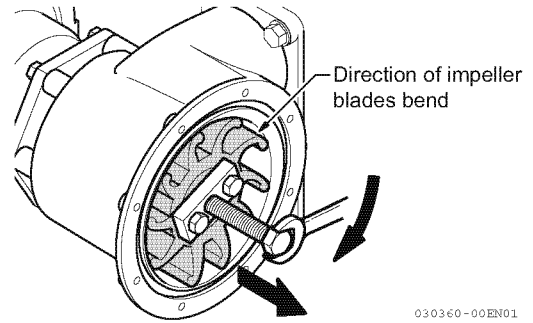


5. Install the side cover of the seawater pump to its initial positions.
6. Check for water leaks during engine operation.
Check the seawater discharge quantity.

■ Replacing the seawater pump impeller

Replacement interval	Every 2500 hours (or every 6 months)
-----------------------------	---

1. Remove the old impeller with the impeller removal tool (option).
2. Apply lithium grease to the shaft hole portion (seriation portion) of the new impeller.
3. Apply white Vaseline to both end faces and the outer diameter of the impeller.
4. The seawater pump rotates counter-clockwise. When you install the impeller, make sure that the tip of the blades bends to the right. Install impeller with turning to the left.

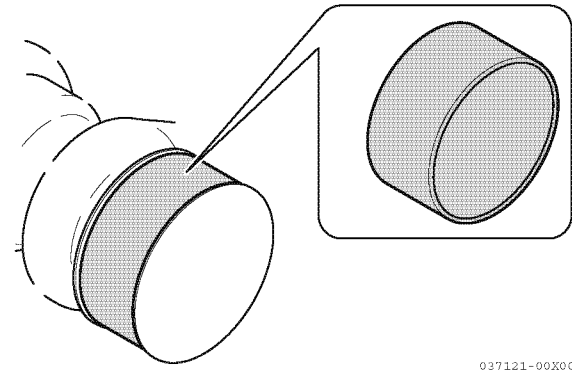


Inspecting and servicing the turbocharger

Cleaning interval	Air filter	When the intake air pressure is 10 % less than recorded in the factory trial run, or every 250 hours (every month)
	Blower	

■ Cleaning the air filter

1. Remove the air filter from the air supply silencer.
2. Clean the air filter with a neutral detergent.
3. Flush the air filter with tap water.
4. Dry the air filter well. Then install it.



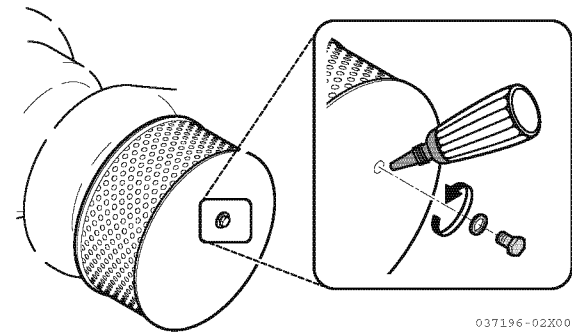
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■ Cleaning the blower

If the blower (blast fan) of the turbocharger is dirty, the boost pressure decreases and causes the engine output to decrease. If you find that the pressure decreases (by approximately 10 %), clean the blower.

1. Prepare the blower wash fluid, freshwater and a jug.
2. Remove the plug from the water supply port.
3. Sail with a load operation of 75% or more.
4. Fill approximately 150 mL of blower wash fluid into the turbocharger water supply port. Fill gradually over 10 seconds.
5. Wait approximately 3 minutes.
6. Fill approximately 150 mL of freshwater into the turbocharger water supply port. Fill gradually over 10 seconds.
7. Continue the load operation for approximately 15 minutes to dry.
8. Check if the engine output improved.

If the engine output is still low, repeat the cleaning operation 3 or 4 times. If the engine output does not improve, ask your YANMAR dealer or distributor for maintenance.



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NOTICE

Do not fill a large quantity of cleaning fluid or freshwater. Cleaning fluid or freshwater remains inside the cylinder and causes an water hammer accident. This results in the engine damage.

Inspecting and servicing the electric parts

■ Inspecting the battery fluid level

If you continuously use the battery with only a small quantity of battery fluid, the battery becomes unusable. Check the fluid level periodically. If the fluid is less than the specified level, refill with commercial distilled water. In hot conditions (e.g. during summer), check the fluid level earlier than specified. This is because the battery fluid evaporates faster.

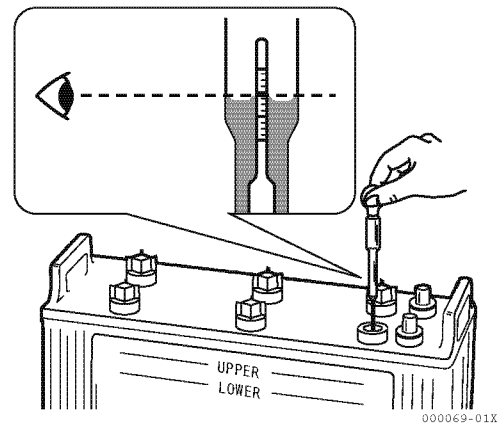
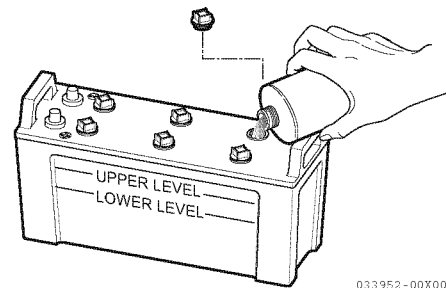
Inspection interval	Every 250 hours (or every 1 month)
Battery fluid standard specific gravity	1.28 (at 20 °C)

Note: Recharge when at 1.22 or less.

NOTICE

If the engine rotation does not increase and the engine does not start, measure the specific gravity of the battery fluid.

Recharge the battery if the measured specific gravity value is lower than the specified value. If the specific gravity does not increase, replace the battery.



■ Inspecting and adjusting the alternator (generator) V-belt tension

The alternator does not charge the battery if the V-belt tension is low and the belt slips.

Interval	1st time	After 50 hours (or after 1 week)
	2nd time and after	Every 500 hours (or every 1 to 2 months)

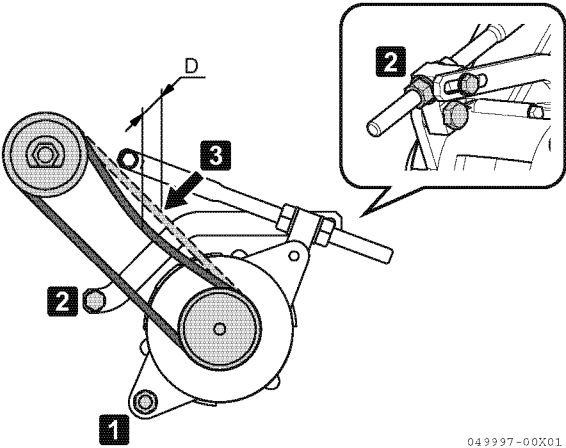
● Inspecting the V-belt tension

1. Press down in the middle of the V-belt with your thumb to check the tension of the belt.
 - The appropriate deflection D of the V-belt is approximately 4 mm when pressed at approximately 6.5 N.

● Adjusting the V-belt tension

1. Loosen the lock bolt of the alternator. **1**
2. Loosen the adjuster bolt. **2**
3. Move the alternator to adjust the belt tension. **3**
4. Tighten the adjuster bolt.
5. Tighten the lock bolt of the alternator.

Be careful not to get any oil on the V-belt.
Replace the V-belt if it is adhered with oil or damaged.



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■ Inspecting the wire harness

Inspection interval	Every 1000 hours (or every 3 months)
---------------------	---

Stop the engine. Turn off the starter switch and the battery switch. Then, inspect the electric equipment including wire harness.

- Breakage, friction and thermal hardening of the harness sheath causes burnouts in the electrical system and other malfunctions. Inspect the wire harness for defects.
- Loose connector terminals cause malfunctions in the electric instrument. Check all connector terminals and tighten if necessary.
- Check the contact terminal on the connector for corrosion and bad conduction. Replace the contact terminal if it is irregular.

Inspecting and adjusting the remote control cables

The operation levers on the engine and the head of the remote control are connected by cables. Over time, they become dislocated because the cables stretch and the cable brackets loosen. This is dangerous and can result in malfunction. Check and adjust the remote control cables at regular intervals. If the remote control handles are still difficult to operate, consult your YANMAR dealer or distributor.

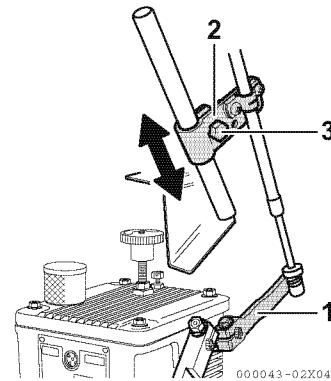
Inspection interval	Every 250 hours (or every 1 month)
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■ Governor remote control cable

Check the cable for damage.

Check that the governor lever 1 moves correctly to L (low speed) or H (high speed) when you put the governor handle to L or H. If the lever does not move to the correct position, adjust the mounting plate of the remote control cable.

1. Loosen the lock bolt 3 on the mounting plate of the remote control cable 2.
2. Move and adjust the mounting plate of the remote control cable 2.
3. After you adjust, tighten the lock bolt 3.

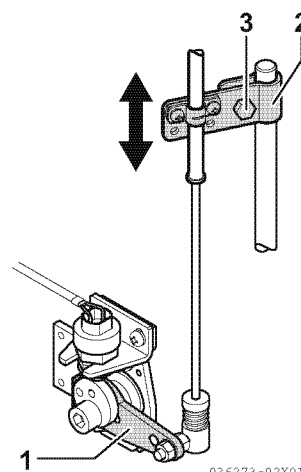


■ Marine gear remote control cable

Check the cable for damage.

Check that the clutch lever 1 moves correctly to the corresponding position when you put the clutch handle to AHEAD, N (neutral) or ASTERN. If the lever does not move to the correct position, adjust the mounting plate of the remote control cable.

1. Loosen the lock bolt 3 on the mounting plate of the remote control cable 2.
2. Move and adjust the mounting plate of the remote control cable 2.
3. After you adjust, tighten the lock bolt 3.

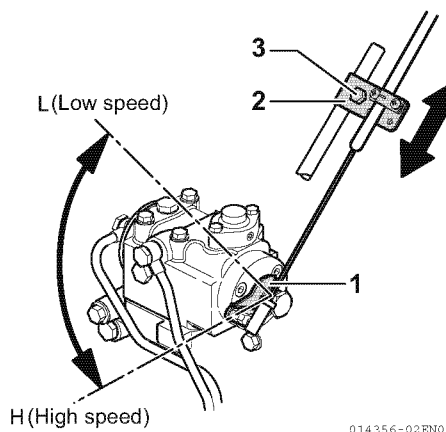


■ Trolling remote control cable (Option)

Check the cable for damage.

Check that the trolling lever 1 moves correctly to L (low speed) or H (high speed) when you put the trolling handle to L or H. If the lever does not move to the correct position, adjust the mounting plate 2 of the remote control cable.

1. Loosen the lock bolt 3 on the mounting plate of the remote control cable 2.
2. Move and adjust the mounting plate of the remote control cable 2.
3. After you adjust, tighten the lock bolt 3.



Inspecting the turbocharger connections

■ Inspect all connections of the turbocharger for air and gas leaks Inspect all clamps

Do these inspections every day before engine start:

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

Inspection interval	Every day (right after engine start)
---------------------	---

LONG-TERM STORAGE

Storing the Engine for a Long Time

Lift the vessel out of the water as far as possible. This prevents accidental flooding during mooring.

Before storing the engine for a long time, consult your YANMAR dealer or distributor and obey the following instructions.

- Before you put the engine in long-term storage, do all periodic inspections and maintenance that are soon due.
- Drain the cooling water. It can freeze in cold conditions.
- Loosen the V-belt.
- Remove the battery cable from the negative terminal side.
Fully charge the battery before storage. Charge the battery at least once a month to prevent a decrease in voltage.
- Carefully remove dust and oily dirt from the outside of the engine. Apply rust inhibitor or clean oil.
- Provide vinyl covering for the exhaust pipe, intake port, and electric parts to protect against humidity.
- To prevent condensation in the fuel tank, either drain or fill up the fuel oil.
- Close the fuel cock (valve) and the Kingston cock (valve).

Draining water from the cooling water channel

If you put the engine in long-term storage in cold climate, make sure that you fully drain all water from the cooling water system. Drain cooling water from both the seawater and freshwater system.

You do not need to drain the freshwater cooling water if it is mixed with Long Life Coolant.

NOTICE

Storing the engine without draining may cause the water left inside the engine to freeze and damage to parts (cooler, seawater pump, etc.) in the cooling water channel.

■ Draining water from the seawater system

Open the drain cock (1 position) of the marine gear lubricating oil cooler to drain the water from inside.
(For drain locations, refer to P59 [Stopping the Engine].)

■ Draining water from the freshwater system

If you do not use Long Life Coolant, open the drain cock of the freshwater system. Drain the water from the inside.
(For drain locations, refer to P59 [Stopping the Engine].)

Restarting the Engine after Long-Term Storage

If the engine was in storage for 6 months or more, consult your YANMAR dealer or distributor and obey the following instructions before you start the engine again. If the engine was in storage for 1 year or more, request inspection and servicing from your YANMAR dealer or distributor.

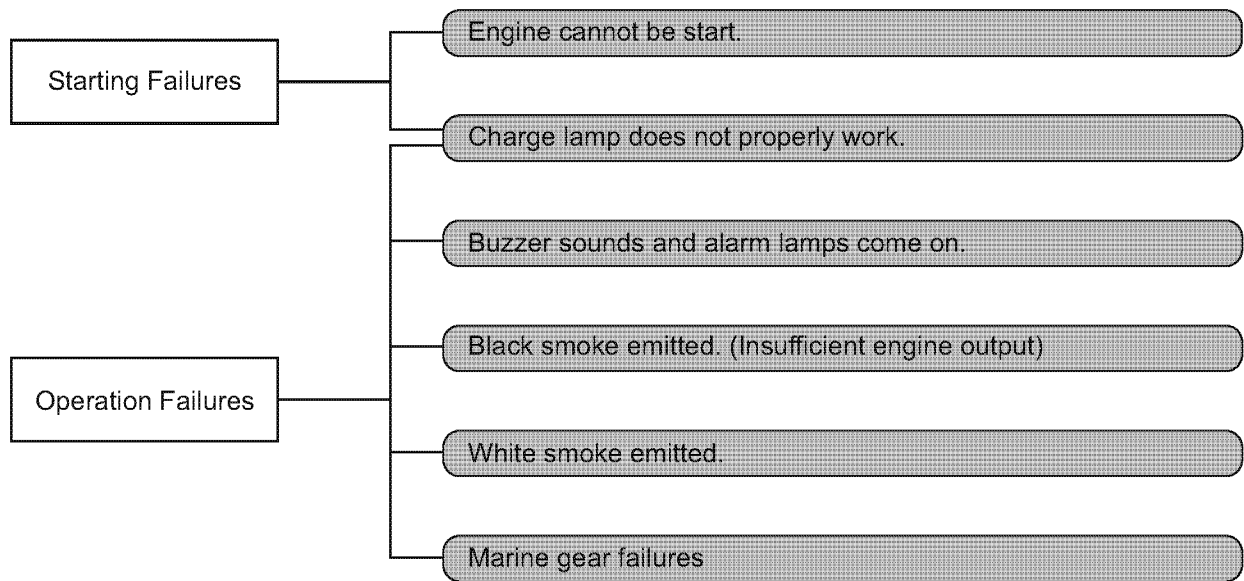
- Do the same start preparations as for the initial start of a new engine.
- Remove the turbocharger lubricating oil pipe (lubricating side) and fill oil to the turbocharger.
- Remove the turbocharger intake silencer and manually rotate the impeller of the blower a lot.
- Check the impeller of the seawater pump for damage and apply white Vaseline to both ends and the outer surface of the impeller
- Check the V-belt for cracks and move the alternator to adjust the V-belt tension.
- Install the battery cable from the positive terminal side.
- Make sure that the freshwater is drained. With the water drain cock open, let water flow through the freshwater system to clean it. Then close the water drain cock. Fill water. Replace the freshwater cooling water after the warm-up operation.
- Before you start the engine, make sure that you turn the flywheel. This sends lubricating oil to all lubrication points. If the engine is equipped with a lubricating oil wing pump, perform priming with the pump handle.
- Perform the inspections before engine start. Do a warm-up operation after starting the engine. Make sure that lubricating oil is coming out from the rocker arm.

TROUBLESHOOTING

Troubleshooting Chart

If you encounter some difficulty during operation, try to identify what kind of failure has occurred and stop the engine. Then, you can check and troubleshoot the engine for that failure.

Find the cause and take the correct countermeasures as indicated below.

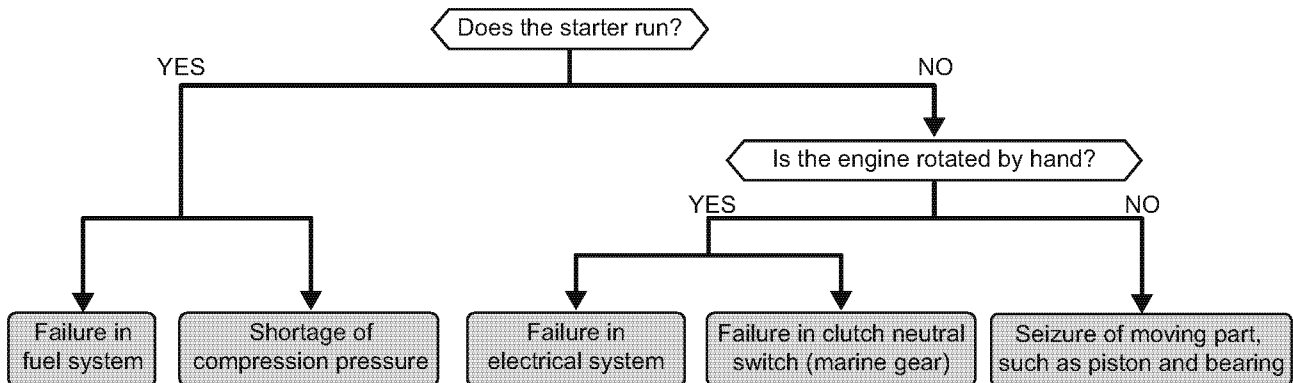


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NOTICE

- Although some failures can be solved by the user, others are 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. Be sure to P98 [Troubleshooting Information] provide your dealer or distributor with the information listed in.
- If you judge that you can continue using the engine after inspection, cruise at a slow speed to return to port and, when landed, ask for repairs. If you cannot judge on your own, ask your YANMAR dealer or distributor.
- Do not operate the engine if 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.

The engine cannot be started



050392-00EN00

● Failure in fuel system

No.	Failure Content	Countermeasure	Reference Page
1	The fuel cock (valve) is closed	Open the fuel cock (valve)	-
2	No fuel is left in fuel tank	Refill with fuel	31, 40
3	Air is trapped in fuel system	Bleed air	32
4	Fuel filter is clogged	Replace the filter element	69
5	Water separator is clogged	Replace the filter element	69
6	Fuel injection valve spray condition is abnormal	Check the injection valve. If necessary, replace the nozzle	-
7	Failure in control device	Check for the fuel cut-off. Adjust to the Drive position	-
8	Fuel piping is clogged with foreign substances	Clean the interior of piping	-

● Shortage of compression pressure

No.	Failure Content	Countermeasure	Reference Page
1	Decompression shaft is not in the Drive (Compression) position	Check the shaft and set it in the Drive (compression) position	-
2	An intake/exhaust valve is not adjusted	Re-adjust the valve clearance in accordance with the adjustment table	163

● Failure in electrical system

No.	Failure Content	Countermeasure	Reference Page
1	Battery switch is not turned on	Turn the battery switch to ON	47
2	Insufficient battery charge	Recharge the battery	81
3	Battery fluid level is low	Refill with battery fluid	81
4	Starter or starter relay is defective	Check and repair or replace it	-
5	Connection coupler has a bad connection	Remove and reinstall the coupler	82
6	Harness terminal is not tightened sufficiently	Re-tighten it	82
7	Harness wire is broken	Connect the disconnected part as a countermeasure or replace the wire harness	82

● Failure in clutch neutral switch

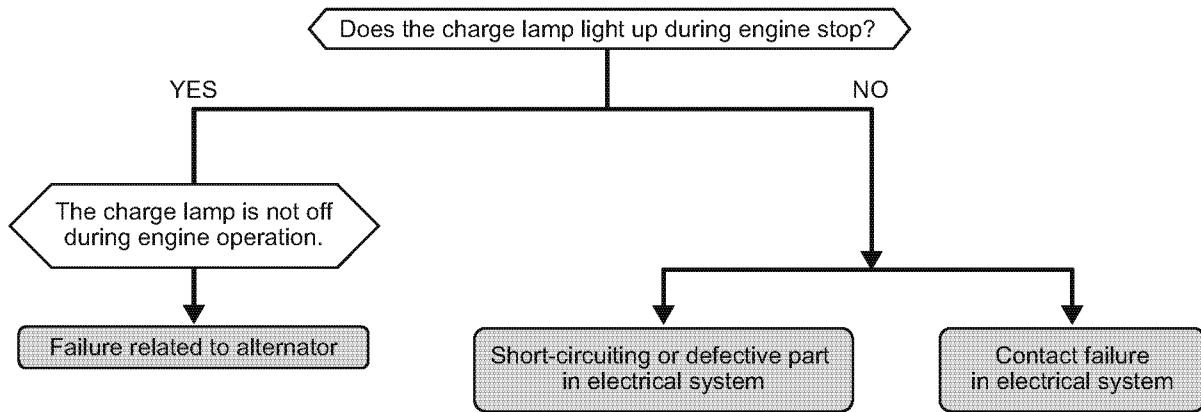
No.	Failure Content	Countermeasure	Reference Page
1	Clutch is not put in Neutral	Put the clutch lever in Neutral position	24
2	Clutch neutral switch is defective	Short circuit between the switch terminals to start the engine as a countermeasure or replace the switch	24

● Seizure of moving part

No.	Failure Content	Countermeasure	Reference Page
1	Moving part is seized up	Check and repair it. Or consult your YANMAR dealer or distributor	-

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

The charge lamp does not properly work



● Failure related to alternator

No.	Failure Content	Countermeasure	Reference Page
1	Engine speed is low	Increase engine speed	50
2	Alternator drive V-belt is loosened	Adjust the V-belt tension	82
3	Alternator defect	Repair or replace	-

● Short-circuiting or defective part in electrical system

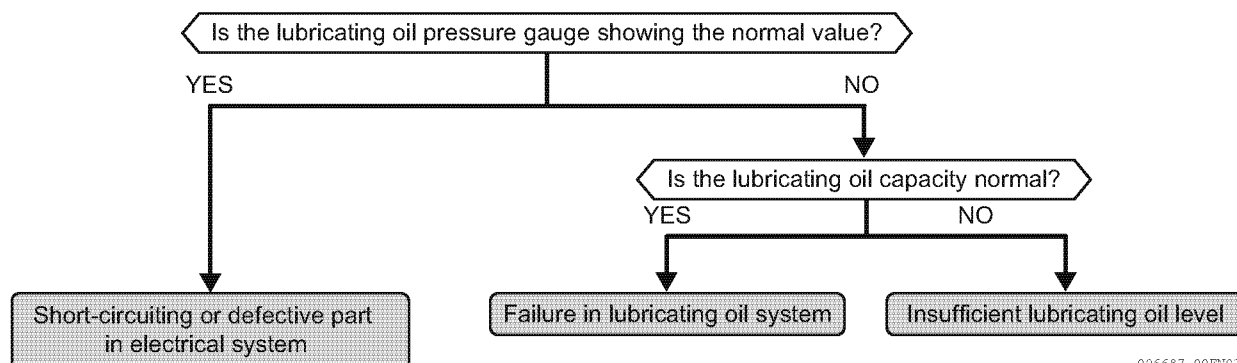
No.	Failure Content	Countermeasure	Reference Page
1	Lamp is defective	Replace	-
2	Instrument panel is defective	Check and repair it. Or consult your YANMAR dealer or distributor	19, 45

● Contact failure in electrical system

No.	Failure Content	Countermeasure	Reference Page
1	Harness terminal is loosened or has bad contact	Retighten the terminal	82
2	Harness terminals are corroded	Replace	82
3	Harness wire is broken	Connect the disconnected part as a countermeasure or replace the wire harness	82

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

The lubricating oil pressure alarm lamp lights up (engine/marine gear)



006687-00B103

● Short-circuiting or defective part in electrical system

No.	Failure Content	Countermeasure	Reference Page
1	Harness sheath is broken, causing short-circuiting	Use the vinyl tape as a countermeasure. Replace	82
2	Terminal is loosened, causing short-circuiting	Retighten the terminal	82
3	Instrument panel is defective	Check and repair it. Or consult your YANMAR dealer or distributor	19, 45
4	Pressure switch is defective	Replace	-

● Failure in lubricating oil system

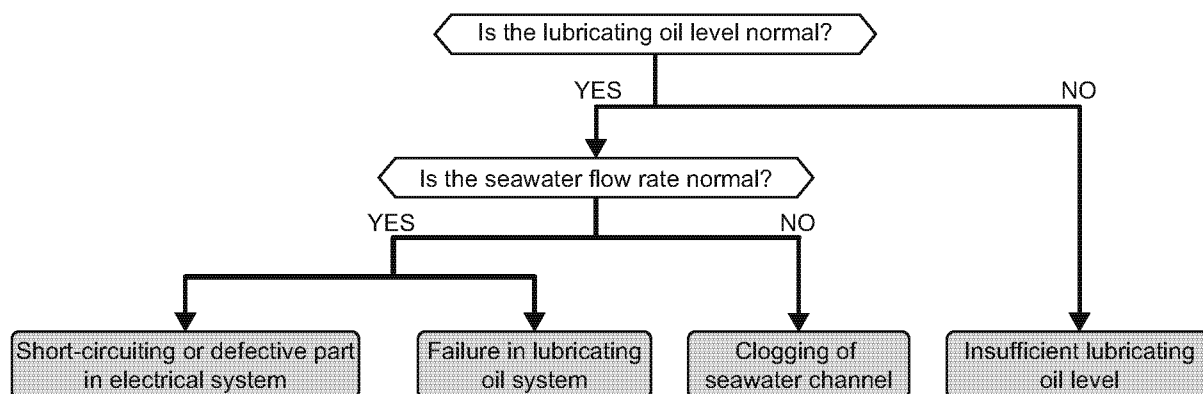
No.	Failure Content	Countermeasure	Reference Page
1	Lubricating oil filter is clogged (Engine or marine gear)	Replace the filter element (Engine or marine gear)	70
2	Lubricating oil pressure regulating valve failed.	Consult your YANMAR dealer or distributor	-
3	Lubricating oil is contaminated severely (Engine or marine gear)	Replace the lubricating oil (Engine or marine gear)	70
4	Defective lubricating oil pump	Check the part, then disassemble and clean it	138

● Insufficient lubricating oil level

No.	Failure Content	Countermeasure	Reference Page
1	Lubricating oil level is low (Engine or marine gear)	Refill with lubricating oil (Engine or marine gear)	34, 35
2	Lubricating oil is leaking	Locate where leakage is present and take corrective measure	-

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

Lubricating oil temperature alarm lamp lights up



006688-02EN100

● Short-circuiting or defective part in electrical system

No.	Failure Content	Countermeasure	Reference Page
1	Harness sheath is broken, causing short-circuiting	Use the vinyl tape as a countermeasure. Replace	82
2	Terminal is loosened, causing short-circuiting	Retighten the terminal	82
3	Instrument panel is defective	Check and repair it. Or consult your YANMAR dealer or distributor	19, 45
4	Temperature switch is defective	Replace	-

● Failure in lubricating oil system

No.	Failure Content	Countermeasure	Reference Page
1	Defective lubricating oil pump	Check the part, then disassemble and clean it	138
2	Defective thermostat	Check and replace it	141

● Clogging of seawater channel

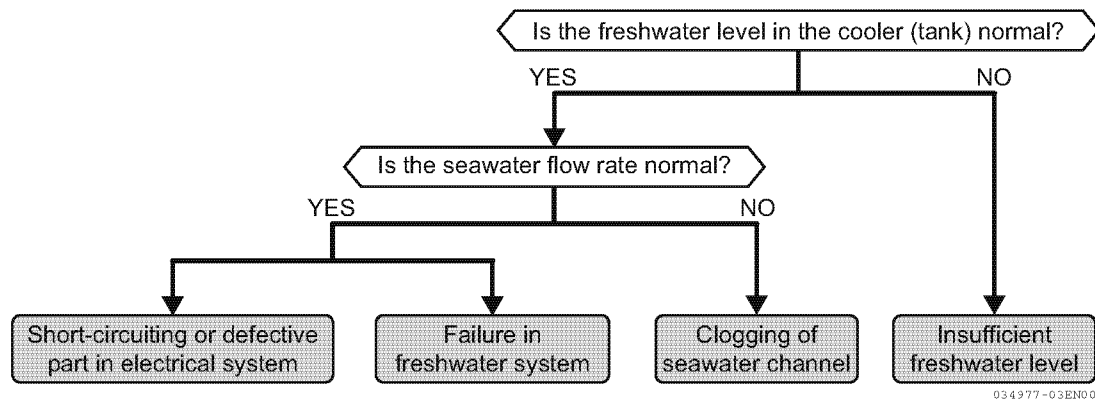
No.	Failure Content	Countermeasure	Reference Page
1	Kingston cock is not fully opened	Open the Kingston cock fully	-
2	Kingston is clogged	Remove anything that is clogged (inside boat or on bottom)	-
3	Seawater strainer is clogged.	Clean the seawater strainer	-
4	Seawater channel side of cooler is clogged or contaminated	Check and clean it	-
5	Seawater pump rubber impeller is broken	Replace the impeller	78

● Insufficient lubricating oil level

No.	Failure Content	Countermeasure	Reference Page
1	Lubricating oil level is low	Refill with lubricating oil	40
2	Lubricating oil is leaking	Locate where leakage is present and take corrective measure	-

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

Cooling freshwater temperature alarm lamp lights up



● Short-circuiting or defective part in electrical system

No.	Failure Content	Countermeasure	Reference Page
1	Harness sheath is broken, causing short-circuiting	Use the vinyl tape as a countermeasure Replace	82
2	Terminal is loosened, causing short-circuiting	Retighten the terminal	82
3	Instrument panel is defective	Check and repair it Or consult your YANMAR dealer or distributor	19, 45
4	Temperature switch is defective	Replace	152

● Failure in freshwater system

No.	Failure Content	Countermeasure	Reference Page
1	Freshwater pump is defective	Check the part, then disassemble and clean it	142
2	Thermostat is defective	Check and replace it	151

● Clogging of seawater channel

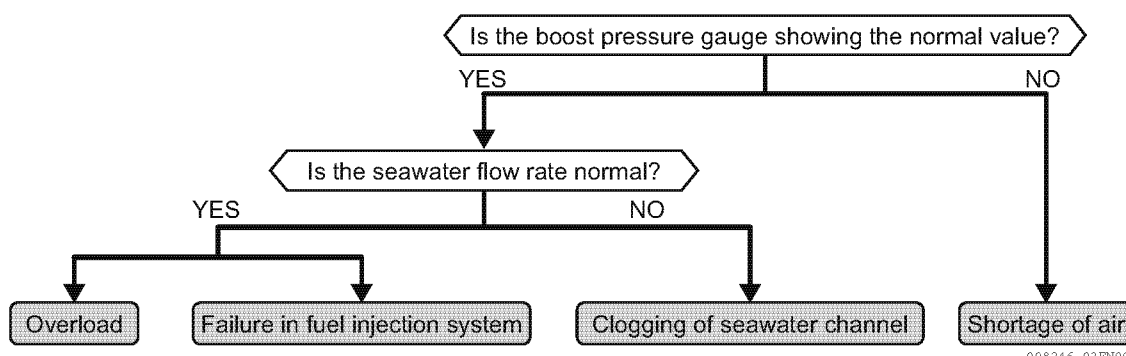
No.	Failure Content	Countermeasure	Reference Page
1	Kingston cock is not fully opened	Open the Kingston cock fully	-
2	Kingston cock is clogged	Remove anything that is clogged (inside boat or on bottom)	-
3	Seawater strainer is clogged	Clean the seawater strainer	-
4	Seawater channel side of cooler is clogged or contaminated	Check and clean it	150
5	Seawater pump rubber impeller is broken	Replace the impeller	79

● Insufficient freshwater level

No.	Failure Content	Countermeasure	Reference Page
1	Freshwater water level is low	Refill with freshwater.	42
2	Freshwater is leaking • Drain cock is not fully closed • Piping is not sealed properly • Filler cap is defective	Locate where leakage is present and take corrective measure such as tightening and replacing part	29, 37

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

Black Smoke Emitted (Insufficient Engine Output)



● Overload

No.	Failure Content	Countermeasure	Reference Page
1	Propeller is damaged or contaminated	Repair, replace, or clean the propeller	-
2	Hull is noticeably contaminated	Clean the hull	-
3	Attitude of hull is not good	Change the load position	-
4	Boat is overloaded	Respect the load capacity	-
5	Propeller shaft is not centered to engine	Adjust the shaft center	168

● Failure in fuel injection system

No.	Failure Content	Countermeasure	Reference Page
1	Fuel injection valve spray condition is abnormal	Check the injection valve. If necessary, replace the nozzle	-
2	Incorrect or uneven fuel injection timing	Check the injection timing and re-adjust it	131
3	The fuel injection volume of the cylinders is irregular	Check the rack scale of the injection pump and re-adjust it	131

● Clogging of seawater channel

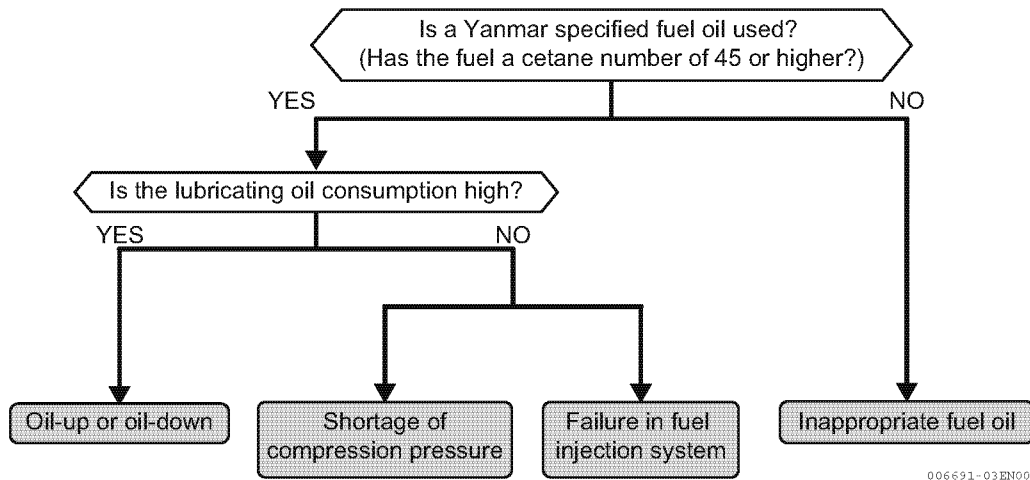
No.	Failure Content	Countermeasure	Reference Page
1	Kingston cock is not fully opened	Open the Kingston cock fully	-
2	Kingston cock is clogged	Remove anything that is clogged (inside boat or on bottom)	-
3	Seawater strainer is clogged	Clean the seawater strainer	-
4	Seawater channel side of air cooler is clogged or contaminated	Check and clean it	-
5	Seawater pump rubber impeller is broken	Replace the impeller	79

● Shortage of air

No.	Failure Content	Countermeasure	Reference Page
1	Ventilator switch is not turned on	Turn the switch to ON	-
2	Ventilator is defective	Replace the ventilator	-
3	Ventilating hole is blocked	Remove anything that blocks the ventilating hole	-
4	Turbocharger air filter is clogged	Clean the air filter	80
5	Turbocharger blower is contaminated	Clean the blower	80
6	Air cooler is contaminated	Check and clean it	149

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

White smoke comes out of the exhaust line



● Oil-up or oil-down

No.	Failure Content	Countermeasure	Reference Page
1	Lubricating oil level is high	Reduce the lubricating oil to a proper quantity	34
2	Failure in valve stem seal and valve guide	Check the valve stem seal and valve guide If necessary, replace	-
3	Wear in cylinder liner, oil ring and piston ring	Check the cylinder liner, oil ring and piston ring If necessary, replace	109, 116, 160

● Shortage of compression pressure

No.	Failure Content	Countermeasure	Reference Page
1	An intake/exhaust valve is not adjusted	Re-adjust the valve clearance in accordance with the adjustment table	163
2	Wear in cylinder liner and piston ring	Check the cylinder liner and piston ring If necessary, replace	109, 116, 160

● Failure in fuel injection system

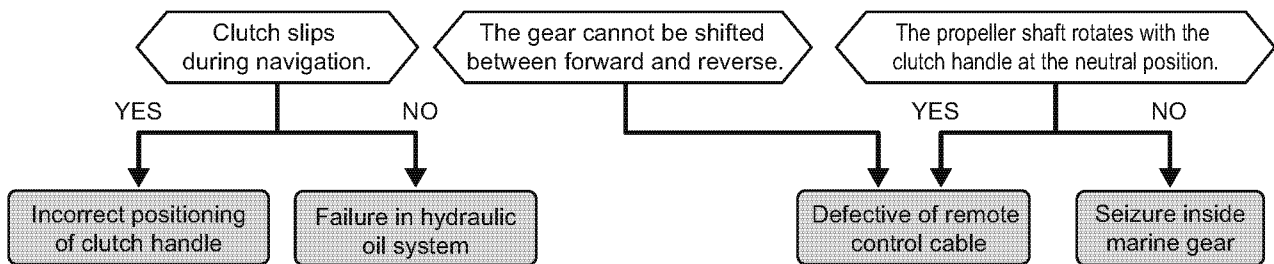
No.	Failure Content	Countermeasure	Reference Page
1	Fuel injection valve spray condition is abnormal	Check the injection valve. If necessary, replace the nozzle	-
2	Incorrect or uneven fuel injection timing	Check the injection timing and re-adjust it	131
3	The fuel injection volume of the cylinders is irregular	Check the rack scale of the injection pump and re-adjust it	131

● Inappropriate fuel oil

No.	Failure Content	Countermeasure	Reference Page
1	Fuel oil does not provide properties recommended by YANMAR	Replace with the fuel oil recommended by YANMAR	26

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

Marine gear failure



● Incorrect positioning of clutch handle

No.	Failure Content	Countermeasure	Reference Page
1	The trolling handle is in the trolling position	Move the handle out of the trolling position	57
2	There is phase difference between clutch handle and clutch lever	Adjust the remote control cable clamp position and correct the phase between clutch handle and clutch lever	83

● Failure in hydraulic oil system

No.	Failure Content	Countermeasure	Reference Page
1	Lubricating oil filter is clogged	Replace the element Clean the strainer	75
2	Insufficient lubricating oil level	Refill with lubricating oil	41
3	Hydraulic oil pump is defective	Check the part, then disassemble and clean it	-

● Defective remote control cable

No.	Failure Content	Countermeasure	Reference Page
1	Cable stroke is not adjusted properly	Re-adjust the cable	83
2	Cable is broken	Replace the cable	-

● Seizure inside marine gear

No.	Failure Content	Countermeasure	Reference Page
1	Friction plate, or plate, is seized up	Check the part, then disassemble and clean it Or contact your YANMAR dealer or distributor	-
2	Pinion gear or bushing is seized up	Check the part, then disassemble and clean it Or contact your YANMAR dealer or distributor	-

If you cannot take the correct countermeasures, consult your YANMAR dealer or distributor

Emergency Procedure for Marine Gear Failure

If the marine gear fails to operate during navigation, you will no longer be able to navigate the boat. In such an emergency, use the emergency bolts for the marine gear as follows to return to port.

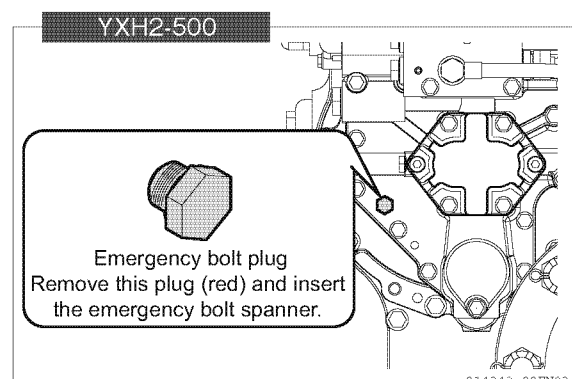
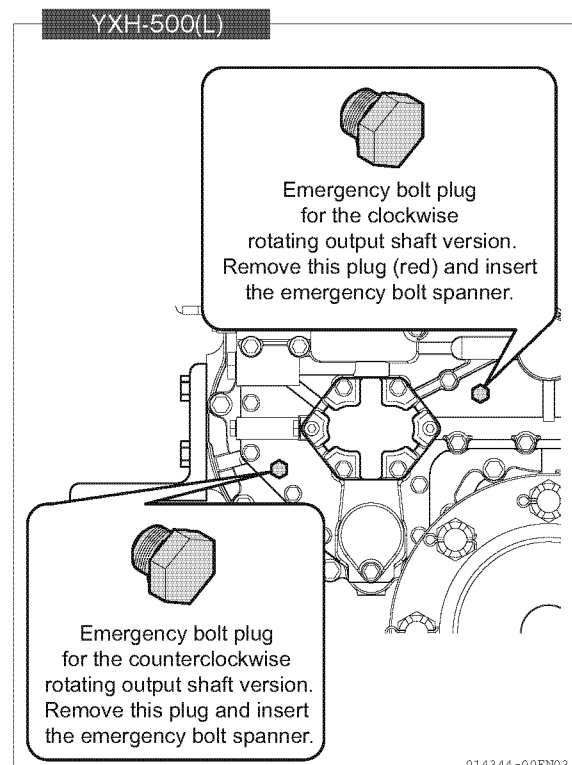
WARNING

- If you use the emergency bolt to engage the clutch, be sure to remove the starter key to prevent the engine from starting.
- Should the engine be started when the emergency bolt is used, internal marine gear parts such as shafts and gear will rotate, possibly catching your hand.
- When the clutch is engaged with the emergency bolt, the boat will start moving ahead immediately when you start the engine. Before starting the engine, be fully sure that there are no hazards ahead. Attention must be paid also when cruising the boat that you are not able to put the clutch in Neutral or Astern.
- Keep the engine speed at 700 min⁻¹ or lower until arriving at the port. As soon as returning to the port, request your authorized YANMAR dealer or distributor to repair the marine gear.

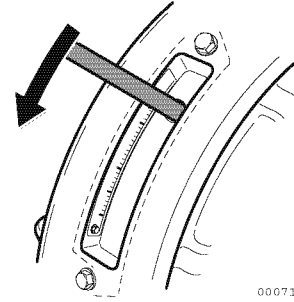
Using Emergency Bolts

If an emergency defect in the marine gear (e.g. the propeller does not rotate) occurs, stop the engine and take the correct countermeasure.

1. Remove the emergency bolt plug (red colored) of the marine gear with an emergency bolt wrench.



2. Turn the flywheel and stop it when one of the emergency stop bolts is visible in the plug hole of the marine gear.

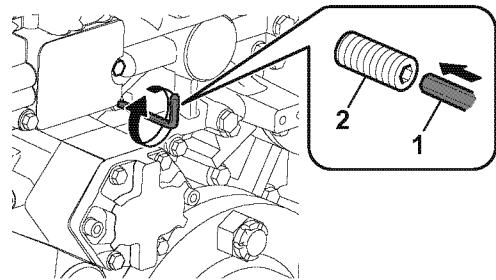


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3. Insert the supplied emergency bolt wrench 1 into the bolt hole.
4. Turn it clockwise to tighten the emergency bolt 2.
5. There are 4 emergency bolts. Tighten them with equal torque while turning the flywheel.
6. Pour lubricating oil through the oil filler until it overflows from the removed plug hole.
You need to refill with oil because the engine may not be lubricated if the hydraulic oil pump is at fault.

7. Replace the plug in position.
8. Move the clutch handle to the N (Neutral) position and start the engine.

For YXH2-500 (option), set the 1st/2nd marine gear ratio changeover switch to the 1st position, and cruise with the shift lever in the forward 1st position.



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Troubleshooting Information

If you have any questions about the troubleshooting and repair of the engine, consult your YANMAR dealer or distributor after checking the following items.

- Engine name and engine number (model number)
- Boat name, hull material, and boat size (in tons)
- Use, type of work, number of hours run
- Total number of operation hours (indicated in hour meter), duration of use
- Condition immediately before trouble (engine rpm, type of operation, load condition, etc.)
- Operating conditions when problem occurs:
- Exhaust color, sound of engine, whether or not engine can be started or turned manually
- Fuel oil in use, brand and viscosity number of lubricating oil
- Engine maintenance history and previous problems

DISASSEMBLY, ASSEMBLY, ADJUSTMENT

Precautions for Disassembly and Assembly

Precautions for disassembly

- Prepare disassembly tools, measuring instruments, and data sheets.
- Prepare the equipment and containers for cleaning.
- Prepare a temporary stocking area and containers for removed parts.
- Prepare new gaskets, copper gasket, and other gasket as required.
- Before you disassemble the engine, make sure that you thoroughly understand its structure. Think about the sequence of your tasks.
- Drain cooling water and lubricating oil from the engine.
- The materials and dimensions of bolts and nuts differ, so to prevent them from being mixed, assemble them loosely into position after disassembling.
- If the engine malfunctions, determine the exact cause to avoid unnecessary disassembly.

NOTICE

- Prepare the specified tools.
 - Put a cover (e.g. tape or clean cloth) on all openings to prevent unwanted material from entering.
Do not forget to remove the tape or cloth when you reassemble the part.
 - Keep the removed parts clean and tidy, so to prevent them from being damaged and lost.
-

Precautions for assembly

- Completely clean the parts and check their condition before assembling. Apply new engine lubricating oil or specified lubricant to sliding parts or moving parts before assembling.
- Replace all gaskets, copper gasket, and other gasket with new ones.
- To prevent water and oil leaks, use liquid gasket where required.
- Fit each part while checking oil clearances and thrust clearances.
- For parts having matchmarks, fit them by aligning the matchmarks. For parts to be selectively fitted, note how they are to be combined.
- Be sure to use the specified bolts, nuts, and washers. Tighten the main bolts and nuts to the specified torque. Be sure to carefully tighten aluminum alloy parts.
- Apply Protec oil or engine oil to the threaded parts and bearing surfaces of the main bolts before tightening them to the specified torque.

NOTICE

- Only use genuine YANMAR replacement parts or other specified parts.
- The parts with a position mark and match mark with the cylinder number and the bearing number must be installed in the original positions. If you replace these parts, make the same marks on the new ones.
- Install the removed protective covers and heat shielding covers in the original positions.
- If the cooling water system is equipped with a gasket, apply spray adhesive to the gasket. Make sure that it does not adhere to the engine. If you apply spray adhesive directly to the engine, the viscous bond in the cooling water fluid adheres to the mechanical seal sliding surface of the pump. It results in water leaks caused by catching unwanted material in the cooling fluid.

Disassembling and Assembling the Cylinder Head and Accessories

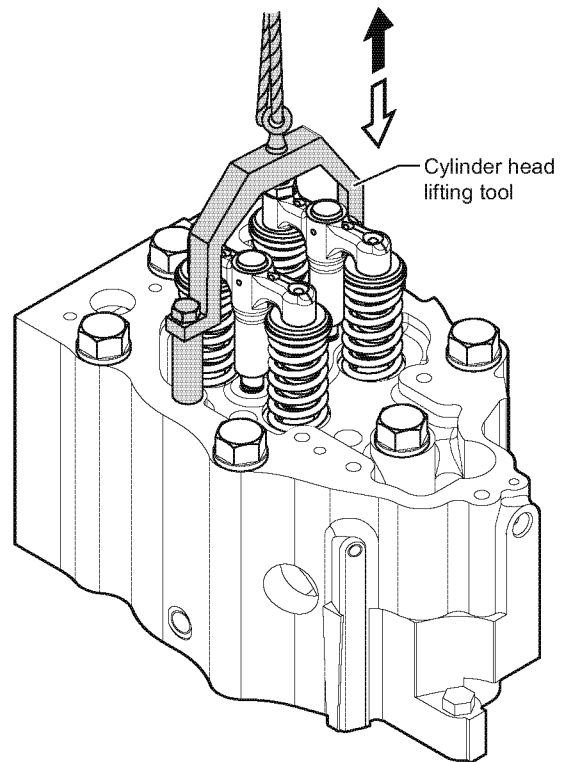
NOTICE

Disassemble the cylinder head at regular intervals and remove all collected carbon on the surface that is exposed to combustion gas. This has a negative effect on combustion. If scale collects in the cooling water passages, this has a negative effect on cooling. Also, thermal load can cause cracks.

■ Cylinder head

● How to disassemble

1. Remove the bonnet. Remove the piping around the cylinder head.
2. Remove the fuel injection pipe and injection valve.
3. Remove the rocker arm for the intake/exhaust valves.
4. Remove the exhaust manifold.
If you do not disassemble the engine fully, remove the head bolts only as needed.
5. Remove the push rod.
6. Remove the exhaust thermometer (optional part).
7. Loosen and remove the cylinder head bolts.
8. Remove the cylinder head.



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● Precautions for overhaul and assembly

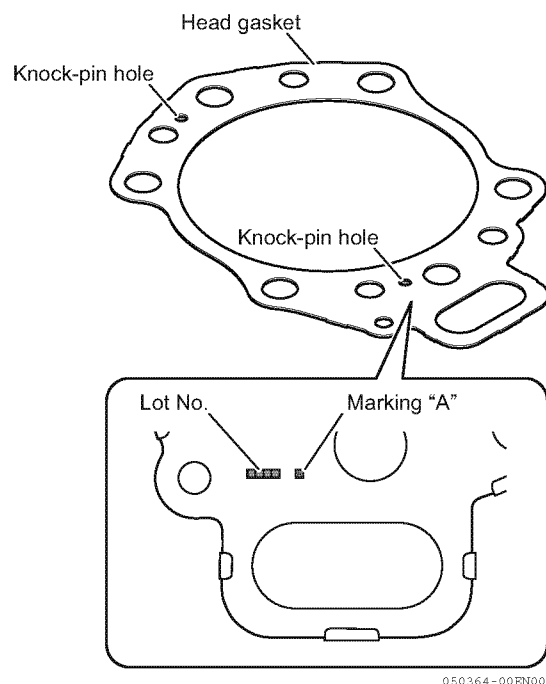
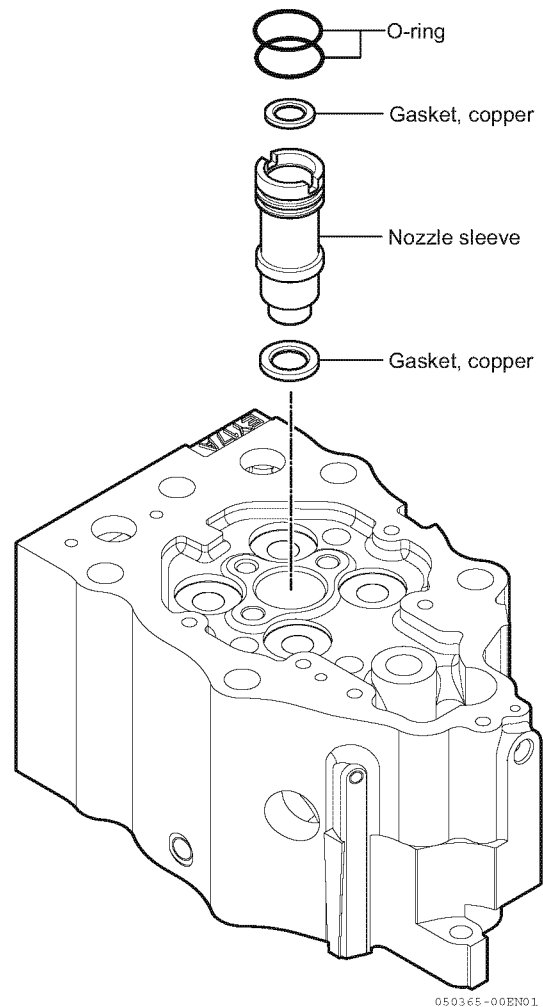
- Look for carbon buildup in the combustion chamber and the intake and exhaust passage. (It can be used as a reference to decide the maintenance intervals in the future).

After cleaning, carefully look for cracks and other damage.

- Check the water jacket for scale. Clean with a descaling agent.

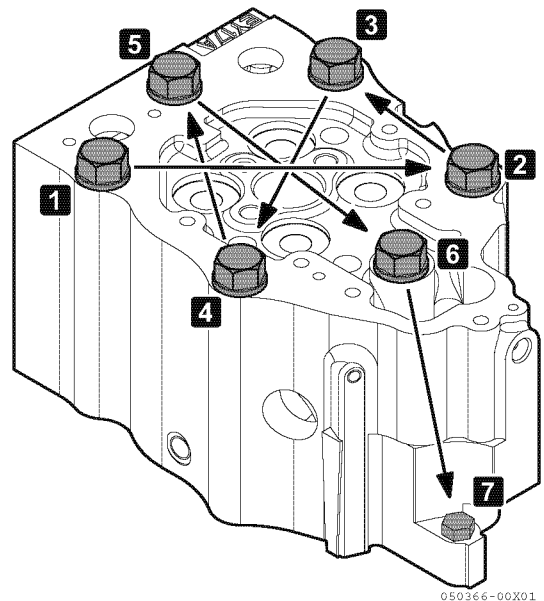
Clean the water jacket at intervals of 2 to 3 years or shorter. A lot of scale can collect depending on the water quality.

- If the fitting surface of the cylinder head is damaged, blowby can occur during operation. Examine these parts very carefully.
- If you use a head gasket of the initial dimensions, the standard top clearance is the same and adjustment is not necessary.
- Make sure that the holes are free from dirt and unwanted material after you clean all parts. Put a cover on the entire parts to keep dirt and unwanted material out of the parts when you store them.



- After you remove the nozzle sleeve, replace the copper gasket and O-rings with new, genuine parts. Apply a screw lock agent to the threads. Tighten to a torque of 235 N·m to 245 N·m.
- When you install the cylinder head, apply Protec grease to the threaded parts and bearing surfaces of the cylinder head bolts. Follow the tightening order and tighten the cylinder bolts in a few steps alternately.
- Tighten the cylinder head with a torque wrench to the specified torque.

How to tighten the cylinder head bolt and tightening torque (P166 [Cylinder head bolt tightening method (Tightening in 3 steps)])



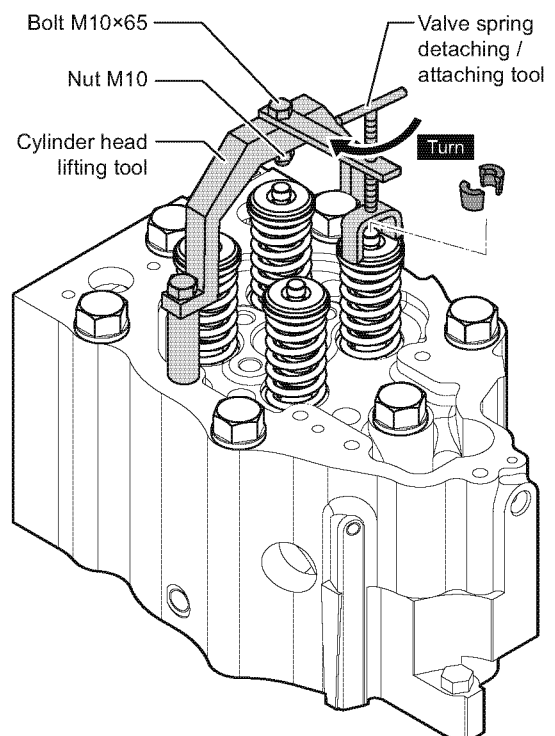
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■ Intake/exhaust valves

● How to disassemble

1. Install the valve spring detaching/attaching tool to the cylinder heads.
2. Move the handle of the valve spring tool in the direction of the arrow. Remove the cotter (stop metal).

When you remove the valve spring or the valve rotator with the cylinder head installed, set the piston to top dead center. This makes sure that the intake/exhaust valves do not fall down.



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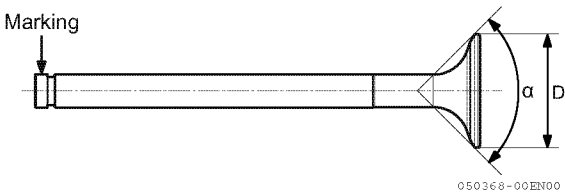
● Important considerations for overhaul and assembly

- When you disassemble the engine, carefully inspect the valve spring for cracks and corrosion.
- There are 2 cotters on every intake/exhaust valve. When re-assembling, install them together to the same valve.
If you install different cotters, bad contact can cause damage to the valve stem.

● How to differentiate intake and exhaust valves

The intake/exhaust valves have stamps with the marks, numbers (manufacturing date) and symbols on the shank. The exhaust valves have stamps with the identification mark "E" after the numbers and symbols.

	α (degree)	D (mm)	Identification mark
Intake valve	120	57	-
Exhaust valve	90	57	E



NOTICE

Handling the stem seal (during assembly)

- During assembly, make sure that you apply lubricating oil to the seal lip, valve stem and inner circumference of the valve guide.
- When you tap the stem seal into the valve guide, do not apply too much force to the lip. Make sure that you do not cause damage to the lip.

● Grinding the intake/exhaust valves

- Do the first valve grinding early. Examine the state of the valve and schedule the subsequent maintenance accordingly.

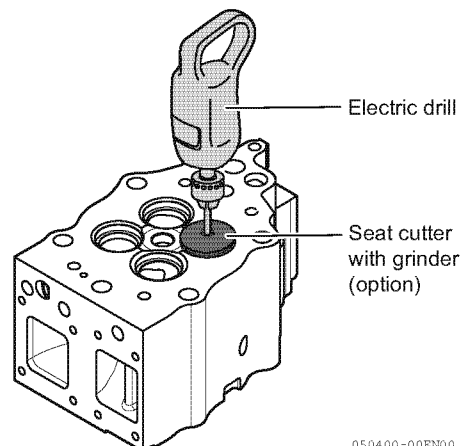
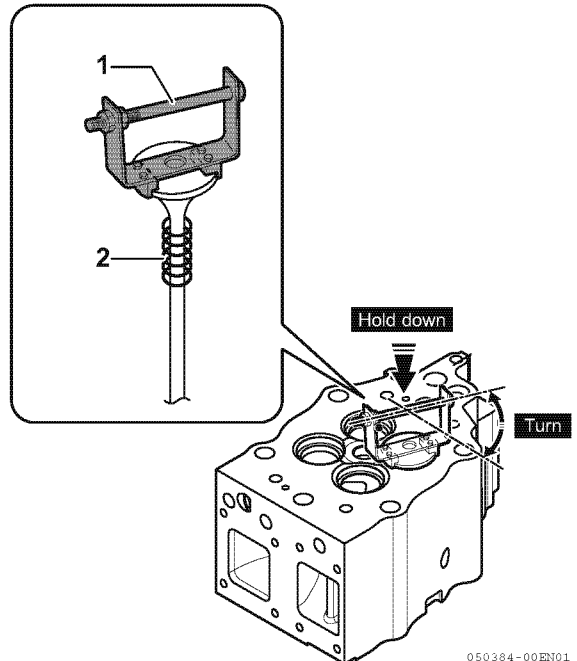
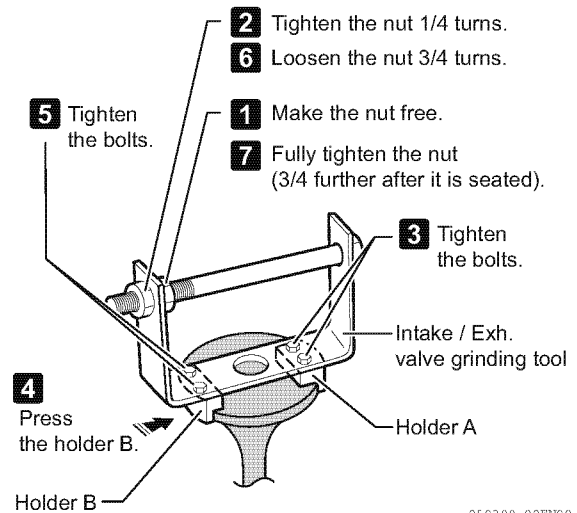
Periodic inspections (P64 [Scheduled Inspections])

- Before grinding, examine the wear on the valve guide and the clearance of the valve stem. Refer to table P160 [Standard Maintenance Table] and replace parts as necessary.
- The valve seat face (seat ring) has a stellite welding. When you correct a deep flaw, grind the valve seat with a rough correction seat cutter (with grinder). (The seat cutter is optional.)
- Measure the dimensions of the valve seat and seat ring. If the wear is more than the wear limit (see P160 [Standard Maintenance Table]), replace the parts.

NOTICE

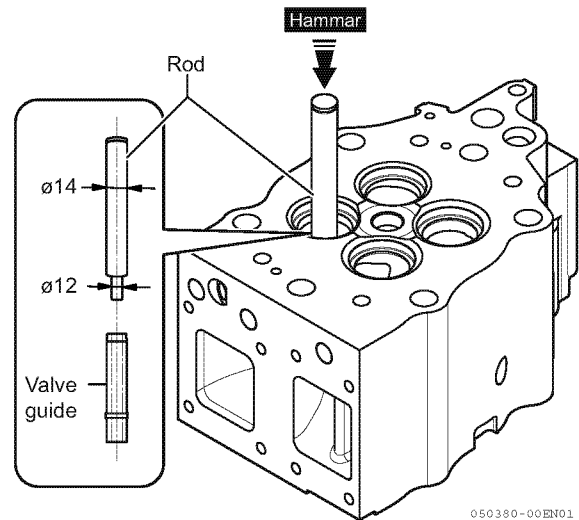
Carefully examine the valve head end. If it is too thin, it can break and pieces cause secondary damage in the combustion chamber and the turbocharger. Adjust the end of the valve head if necessary. Do not grind the combustion surface side of the valve head to correct this.

- Apply the correct quantity of grinding compound to the valve. Grind with the grinding tool 1 and spring 2. Do the last grind with oil.

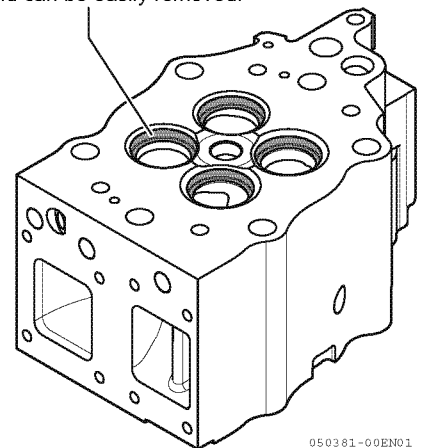


● How to replace the valve guide and valve seat (seat ring)

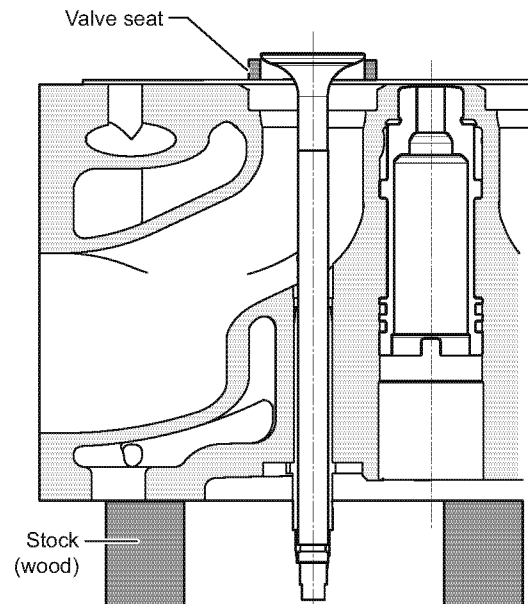
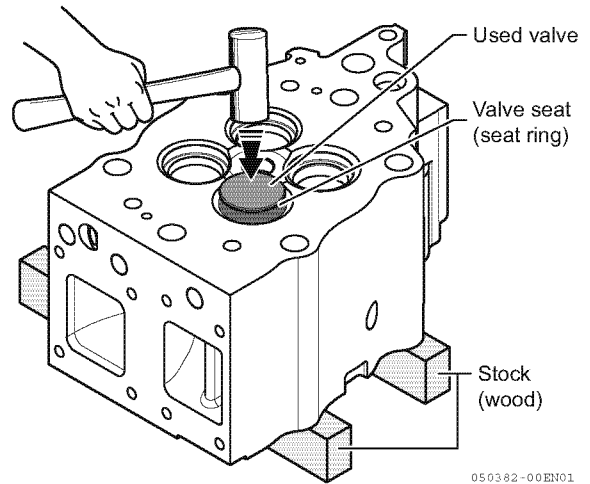
- Make sure that you do not cause damage to the mating surface. The valve guide and valve seat are shrink-fitted at installation.
If you apply liquid nitrogen, the insertion is easier.



If the entire circumference of valve seat part is built up by arc welding, the valve seat shrinks due to welding distortion and can be easily removed.



- When you insert the seat ring, measure the outer diameter of the seat ring and the inner diameter of the insertion hole. Make sure that the interference is between 0.047 mm and 0.085 mm.
- If you use liquid nitrogen to insert the valve guide and valve seat (outside diameter 58 mm), put the valve guide or the valve seat into the liquid nitrogen. Just after defoaming, quickly take the parts out of the liquid nitrogen and insert them. After insertion, you can lightly tap the parts to fit them into the correct location.
If you cannot use liquid nitrogen: Fill approximately 1.5 ℓ of alcohol and 10 kg of dry ice (in chunks of 10 mm to 30 mm) into a thermos bottle (with a stainless internal). Cover the parts in dry ice and decrease their temperature for approximately 1 hour. Insert the cooled valve guide or the valve seat.
- To make sure that the seat ring is straight (and not inclined), cool it sufficiently and tap it lightly with a used valve.



■ Valve bridge and valve bridge guide

Examine the valve bridge and valve bridge guide. Do the same check as for the guide of the intake/exhaust valves. If necessary, replace them with new ones.

NOTICE

Too much clearance between the valve bridge and the valve bridge guide can cause them to fall when operated. This can cause a defect and damage to the intake/exhaust cam because of uneven stress.

■ Valve rotator (intake/exhaust)

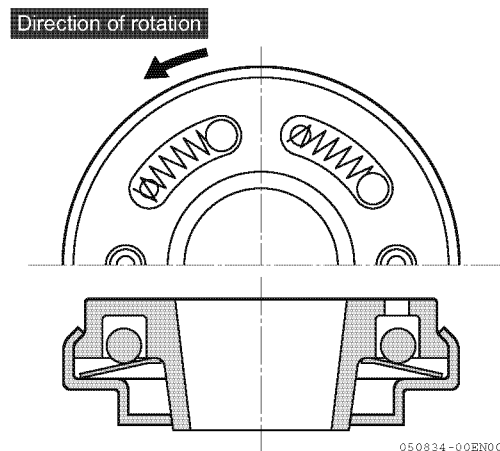
If the valve rotator stops turning, chances of valve blow-by are more.

Replace the valve rotator assembly when incorrect rotation occurs.

- Remove the cylinder head cover during operation to inspect the rotation conditions of the valve.
- Visually inspect the contact between the rocker arm and the valve head in the disassembled valve rotator. Replace the valve rotator assembly if there is a defect.

You can remove the valve rotator without disassembling the cylinder head.

How to disassemble (P103 [Intake/exhaust valves])

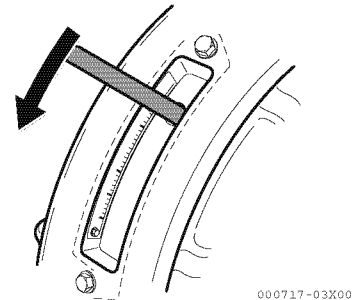


Disassembling and Assembling the Piston and the Connecting Rod

How often you remove and examine the piston depends on the daily maintenance, especially the control of lubricating oil and load (i.e. overload and very low load). The supervisor must decide the correct frequency. Do the first disassembly and inspection as shown in P63 [Periodic Inspections]. Examine the results of that inspection (e.g. the increase of blowby and the increase in consumption of lubricating oil). Accordingly, do subsequent inspections earlier or later. When the consumption of lubricating oil becomes twice the initial value, disassemble and clean the piston and replace the piston rings.

■ Removing the piston

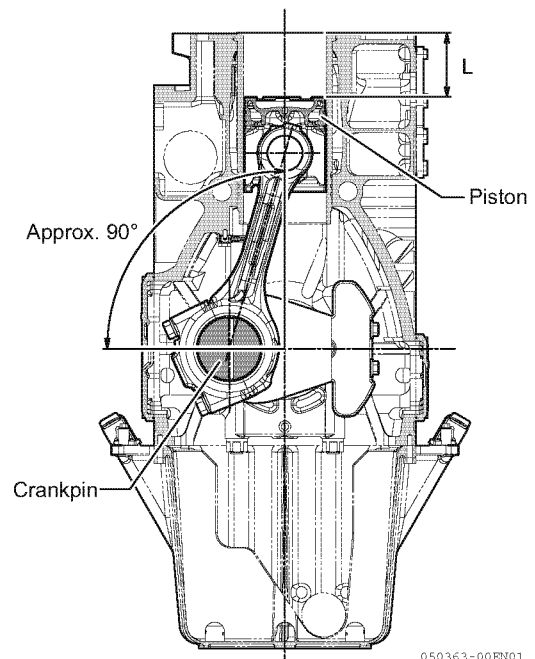
1. Remove the carbon from the combustion chamber on the top of the cylinder liner.
2. Turn the flywheel in the direction of engine rotation. Set the piston to approximately 90° after top dead center.
The piston top will be approximately $L = 130$ mm below the top face of the liner.
3. Lock the flywheel.



⚠ CAUTION

If you do not lock the flywheel, the crankshaft can turn suddenly because of unbalance when you remove a piston. This is dangerous.

4. Loosen the 2 connecting rod bolts with the specified special box wrench. Remove the bottom bolt first.
5. Remove the top connecting rod bolt together with the cap.
6. Turn the flywheel in the direction of engine rotation. Set the piston to approximately 30° after top dead center (the piston top will be approximately $L = 20$ mm from the top face of the liner).
Slowly turn the flywheel. Make sure that the large end of the connecting rod does not come off from the crankpin. If it comes off, the large end may damage the crankpin.
7. Install the piston lifting tool to the piston head.
8. Remove the piston and the connecting rod.
9. Make sure that the connecting rod does not touch the piston cooling nozzle.



Inserting the piston

1. Move the crank pin to approximately 30° after top dead center. Lock the flywheel.
2. Install the piston in the reverse sequence of disassembly.

Observe these instructions:

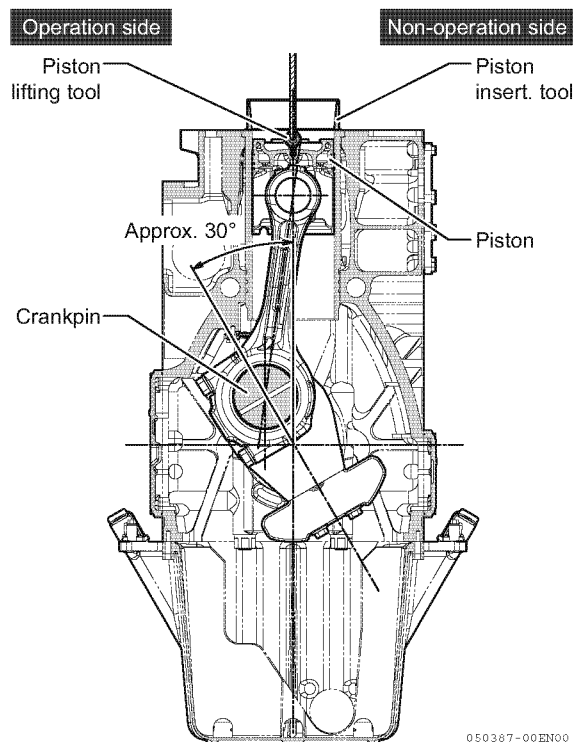
- Use the piston insertion tool.
- Attach the piston rings and make sure that their openings are 180° apart.
- Turn the connecting rod until the cap and opening of the large end point to the operation side.
- Apply lubricating oil to the sliding parts of the ring and the liner.
- When you insert the piston, make sure that the large end of the connecting rod does not touch the piston cooling nozzle at the bottom of the cylinder liner.

Be careful that the insertion tool does not get caught in the oil rings. Apply lubricating oil to the sliding surface of the bearing. Do not apply lubricating oil to the back of the bearing.

- Replace the connecting rod bolts with new ones at regular intervals.

Periodic inspections (P63 [Periodic Inspections])

- If you find seizure on the piston, replace all bolts of that cylinder. A lot of force can be exerted on the bolts.



050367-00EN00

Tightening the connecting rod bolt (angle tightening)

When you reuse the bolt

1. Apply Protec grease to the thread and seating face of the connecting rod bolt.
2. With the crank pin bearing not installed, tighten the 2 connecting rod bolts to a seating torque of $50 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$ with a torque meter. Make sure that the match mark (line) on the outer circumference of the bolt head is aligned with the match mark (A) on the cap.
 - If they are aligned, loosen the connecting rod bolt and remove the cap.
 - If they are not aligned, make a new match mark (A) on the cap that is aligned to the match mark (line) of the bolt.
3. Insert the crank pin bearing. Tighten the 2 bolts until the match mark (line) of the connecting rod bolt aligns with the match mark (A) on the cap side.

4. Tighten the 2 connecting rod bolts to the specified tightening angle of 110° . Do it alternatively in 3 turns (tighten the first bolt to 40° and the second bolt to 80°). Finally, align the match mark "B" on the cap side to the match mark line.

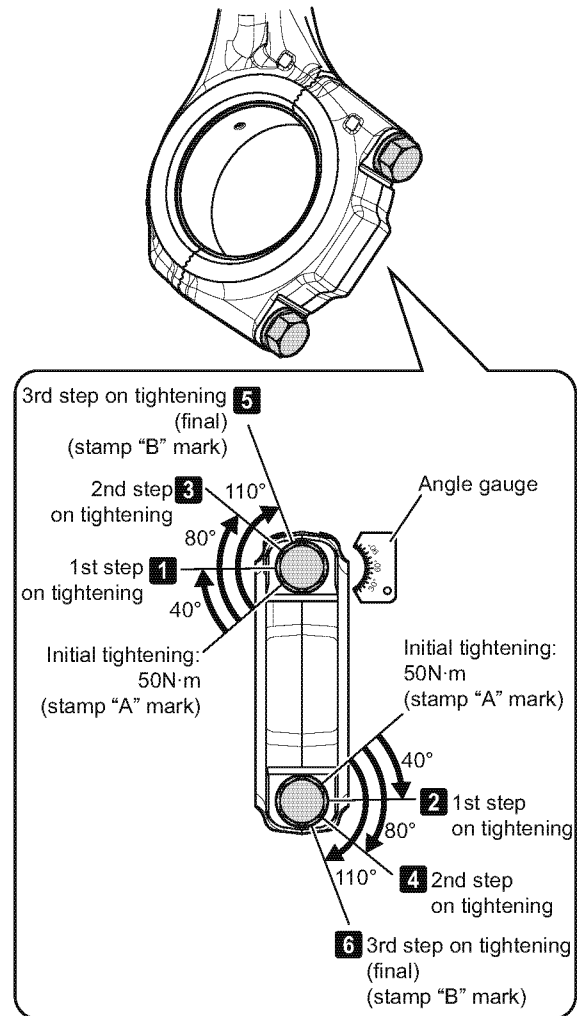
Make sure that the match mark on the rod bolt is 0 mm to 2 mm ahead of the match mark on the cap in the direction of tightening.

● When replacing the bolt with a new one

1. Apply Protec grease to the thread and seating face of the connecting rod bolt.
2. With the crank pin bearing not installed, tighten the 2 connecting rod bolts to a seating torque of $50 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$ with a torque meter.
3. Tighten the connecting rod bolt to an angle of approximately 110° (the specified tightening angle) as a break-in. Remove the connecting rod bolt.
4. With the crank pin bearing not installed, tighten the 2 connecting rod bolts to a seating torque of $50 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$ with a torque meter. Make sure that the match mark (line) on the outer circumference of the bolt head is aligned with the match mark (A) on the cap.
5. Make an identification mark (e.g. cylinder number and installation side).
6. Loosen the connecting rod bolt and remove the cap.
7. Insert the connecting rod into the engine. Insert the crank pin bearing. Tighten the 2 bolts until the match mark (line) of the connecting rod bolts align with the match mark (A) on the cap side.
8. Tighten the 2 connecting rod bolts to the specified tightening angle of 110° . Do it alternatively in 3 turns (intermediate angles: 40° and 80°).

Use an "angle gauge" for tightening angle.

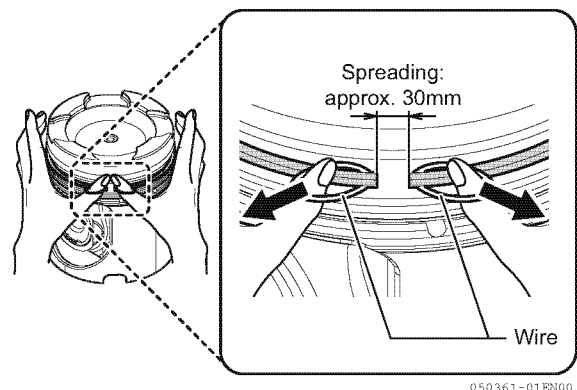
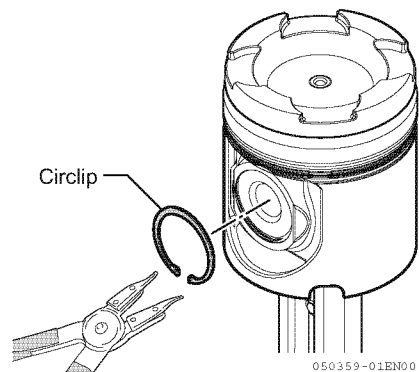
9. Finally, align the match mark (B) on the cap side to the match mark (line) on the connecting rod bolt. Make sure that the match mark on the rod bolt is 0 mm to 2 mm ahead of the match mark on the cap in the direction of tightening.



● Disassembling and assembling the piston and the connecting rod

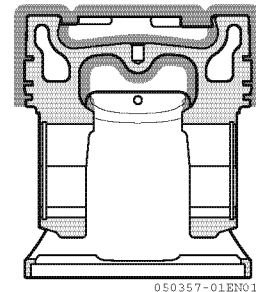
1. Remove the piston pin circlip.
2. Remove the piston pin and disassemble the piston and the connecting rod.
3. Remove the piston rings and oil ring.
4. To install and remove the rings, make loops from wire. Use them to make the ring openings wider.
5. Examine the cooling chamber on the back of the piston head for scale. If you find scale, clean the chamber thoroughly. For example, soak it in cleaning oil and then blow it with compressed air.

We recommend cleaning with Emocon 1 E-55 (Kurita Water Industries Ltd.) or One-1 (NEOS Co., Ltd.).

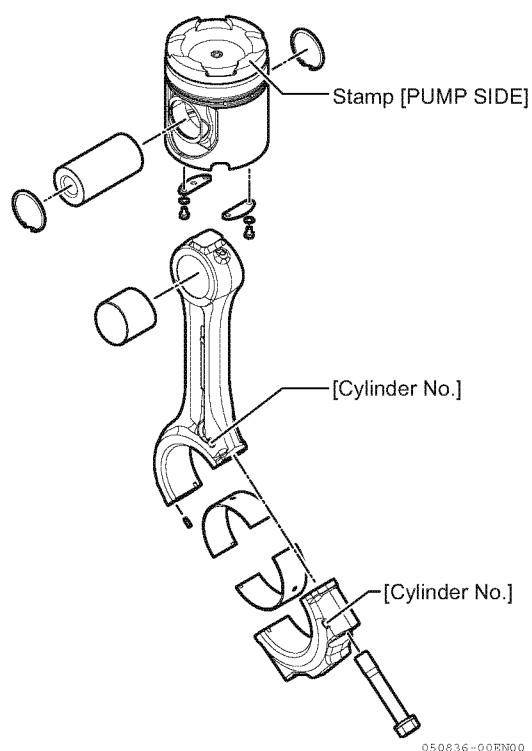


6. When you measure the piston, do a color-check and look for cracks in the piston head (inner and outer surface) and the ring grooves.

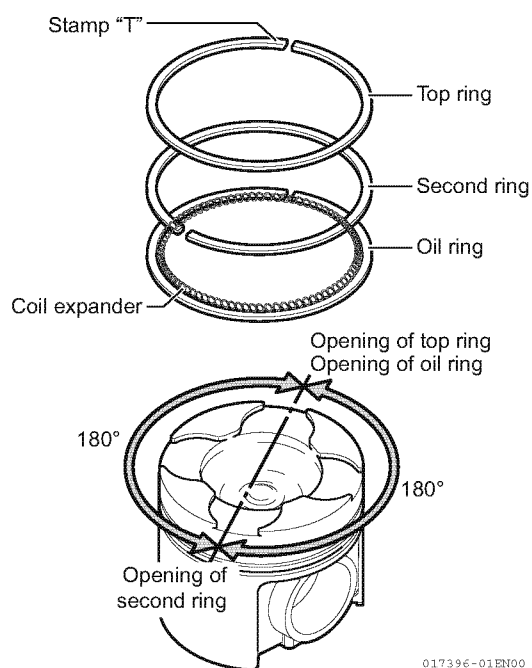
Color-check area



7. When you install the connecting rod to the piston, align the direction of the piston and the cylinder No. of the connecting rod.



8. When installing the piston ring, turn the rings until the match marks point up.
9. The oil ring has a coil expander. Make sure that its coil joint is shifted 180° apart from the oil ring opening.
10. Make sure that each ring is shifted 180° apart from the opening as shown in the figure.

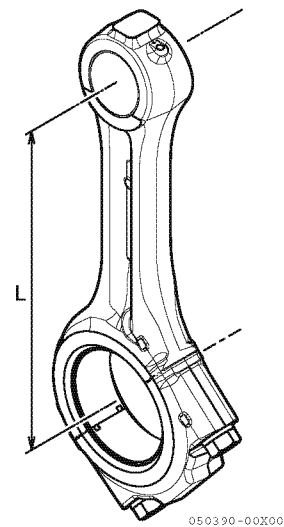


■ Inspecting and servicing the connecting rod

- The mating surface of the large end cap of the connecting rod has serrations.
- During scheduled inspections, examine the mating surfaces for cracks and wear caused by loose bolts.
- Examine the mating parts of the small end of the connecting rod and the piston pin bearing for looseness and cracks.
- Measure the inner diameter of the piston pin bearing. If the measurement is more than the wear limit (See P160 [Standard Maintenance Table]), replace the piston pin bearing.
 - The piston pin bearings are press-fitted. To remove them, use an applicable metal piece and hit it with a hammer or push them out with a press.
 - After you insert the piston pin bearings, measure their inside diameter.

Evaluation standards for bending of the connecting rod:	pitch between the large and small end $L = 420 \text{ mm} \pm 0.05 \text{ mm}$
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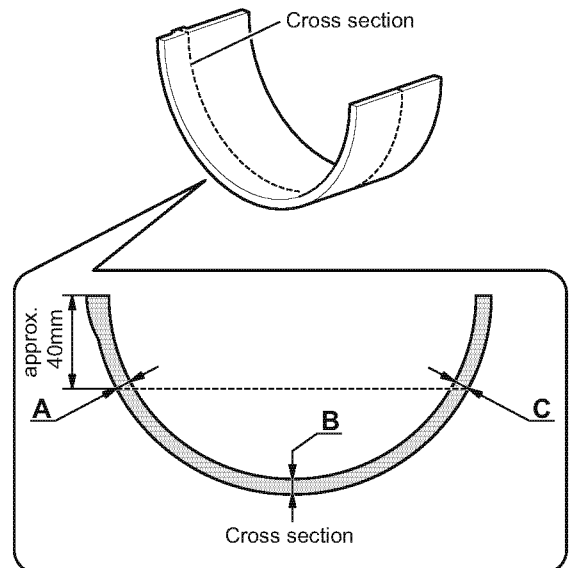
- If the roundness is larger, replace the piston pin bearing with a new one.
- If water-hammering occurred or the piston has a lot of burns, measure the bend and inclination of the connecting rod.



■ Crankpin bearing

● Inspection and servicing of the crank pin bearing

- Check the sliding surface of the crank pin bearing for cracks.
- Install the crank pin bearing to the connecting rod. Tighten the connecting rod bolt to the match mark. Measure the inner diameter of the bearing. If the wear is more than the wear limit, replace the bearing.
- Replace the crank pin bearing if the sliding surface of the overlay is worn by approximately 30 % and the kelmet alloy becomes visible. This reduces wear on the crank pin.
- Measure the thickness of A, B and C. If the difference is less than 0.04 mm, you can continue to use the bearing (even if the overlay of the bearing is worn by more than 30 %).
- Be sure to replace both the top and bottom bearings as a pair.
- Install the bearings.
 - Clean the back of the bearing. Do not apply oil.
 - Make sure that the mating surface of the bearing pawl has no burrs. Make sure that the bearings are installed correctly.



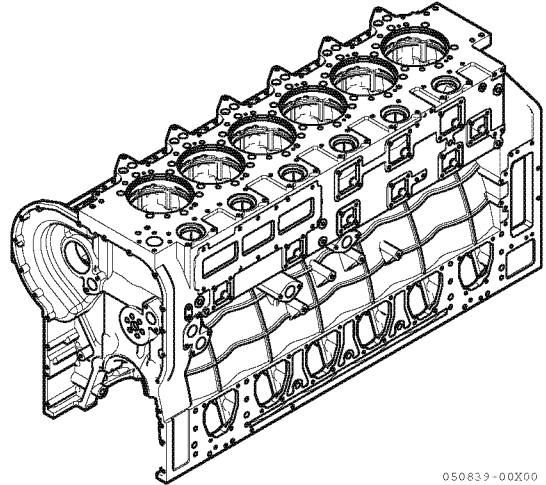
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Disassembling and Assembling the Cylinder and Cylinder Liner

■ Cylinder block

It is not necessary to remove the cylinder block during scheduled inspection, unless you remove the crankshaft. Do nevertheless, examine the inside of the jacket every 2 to 3 years.

- Examine the water jacket and water chamber for corrosion. Examine the condition of the cylinder liner fitting surface.
- Examine the cylinder liner fitting mating surface for cracks. Do a color-check.
- When you remove the cylinder block, make sure that you align the match mark of the timing gear when you re-assemble.

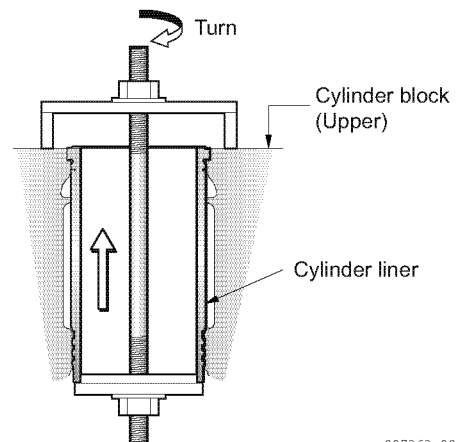


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■ Cylinder liner

- Remove the liner at regular intervals and examine it for corrosion. Cooling water can cause cavitation on the cylinder liner jacket. This results in erosion from the outer surface of cylinder liner.
- Measure the inner diameter of the liner every 2 to 3 years. The wear on the inner surface depends on:
 - The control of the lubricating oil
 - The temperature of the cooling water
 - The regular working load.

Make the measurement with the liner inside the cylinder block.



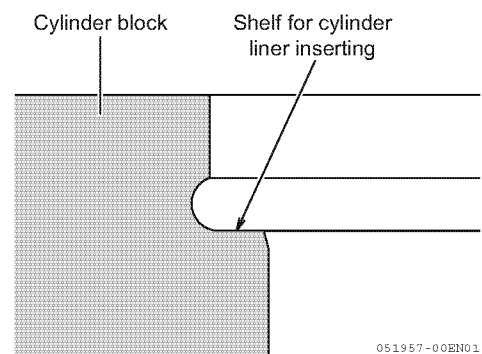
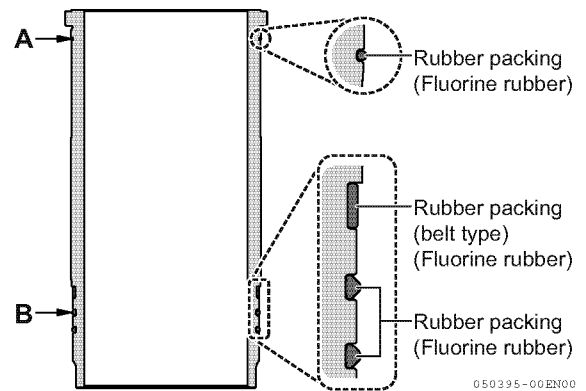
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● Removing the cylinder liner

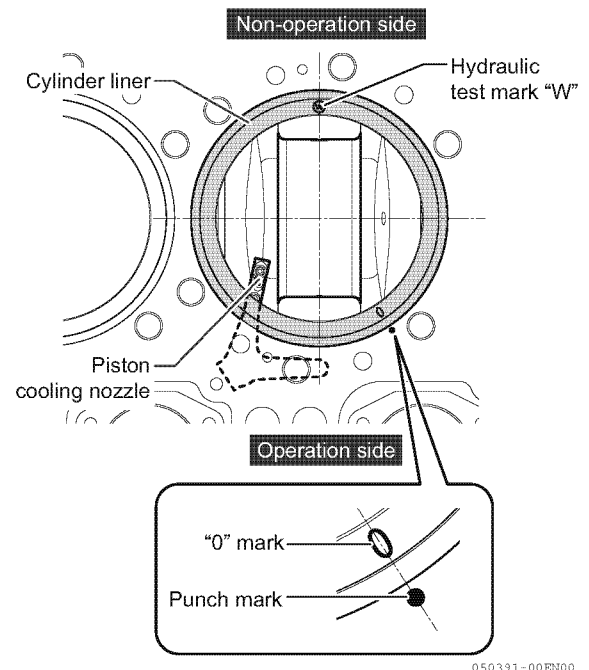
When you remove the liner, put the bottom part of the special tool in a right angle to the crank. Make sure that it does not touch the piston cooling nozzle.

● Cylinder liner assembly

1. Clean the liner hole of the cylinder block and the deck surfaces.
 - If a repair (cutting) of the deck surfaces is necessary, do the processing with a repair liner packing (genuine part) of the correct size.
 - Use the correct packing for the repair.
2. Replace the liner packing with a new one.
3. Stretch the rubber packing and check for cracks.
4. Long storage can cause damage to the rubber.
5. Install the liner rubber packing in the order shown in the figure on the right.
6. Install a rubber packing to the liner. Make sure that there are no twists.
7. Apply silicone oil or lubricating oil to area A and B. Apply silicone-type liquid gasket to shelves for cylinder liner inserting.



8. Align the match marks of the cylinder liner and the cylinder block.



Disassembling and Assembling the Main Bearing and Crankshaft

■ Main bearing and oil pan

● Inspection and servicing

- This engine has an oil pan. It is not possible to clean oil pan completely during regular oil changes.
Remove the oil pan at intervals of 4 to 5 years and clean the inside.
- If the paint on the inside is damaged, clean it with thinner, degrease and re-apply the paint.
- If the crankshaft has unexpected burns, measure the dimensions of the main bearing hole of the cylinder block.
Straightness: 0.03 mm or less in 1 m of length,
roundness: 0.02 mm or less
- During overhaul inspections:
 - Examine the main bearing cap for knocking.
 - Examine the oil hole of the cylinder block for cracks.
- Make sure that the bolt of the main bearing cap is tight. If necessary, apply a screw lock agent and tighten it.
The stud torque for the main bearing tightening bolt is $530 \text{ N}\cdot\text{m} \pm 30 \text{ N}\cdot\text{m}$.

■ Main bearing and thrust bearing

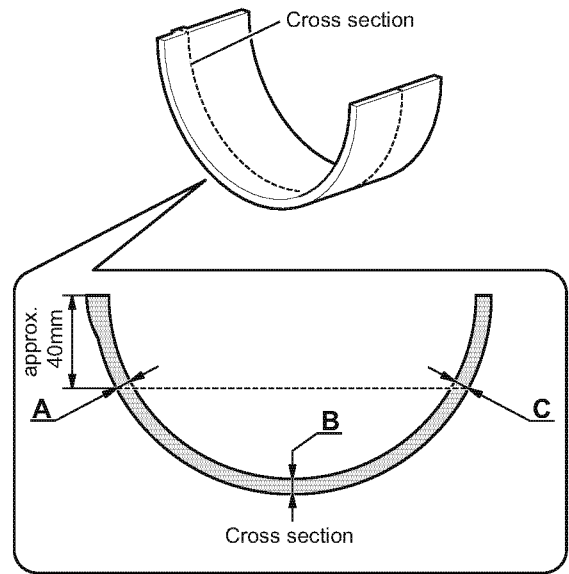
● Inspection

- Measure the clearance between the main bearings and the crankshaft at regular intervals. If the clearance is too large, a lot of lubricating oil escapes and the lubricating oil pressure decreases. This causes damage and cracks.
- Remove the main bearings. Examine the sliding surface for cracks.
- This is the correct method to measure the dimensions: Remove the crankshaft from the cylinder block. Tighten the main bearing cap to the specified torque. Measure the inside diameter of the bearing.
- If the clearance is too large because of wear on the bearing, replace the bearing with a new one.
- If you replace the bearing with a new one, but the clearance stays too large, use a genuine undersized bearing (inner diameter).

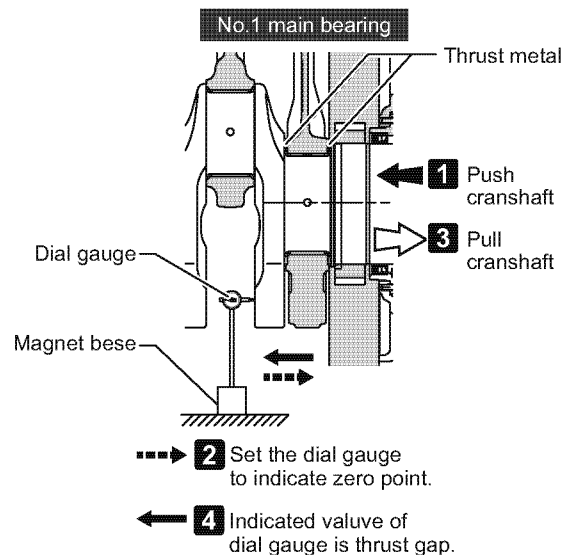
In that case, it is necessary to polish the crankshaft so that it fits the undersized bearings.

- Measure the thickness of the main bearings. If the difference between A, B and C (as shown in the figure) is 0.04 mm or more, replace the bearings.
- Examine the thrust bearings for wear and burns. The thrust bearings are installed to the bearing that is nearest to the flywheel.
- When you replace the main bearings or thrust bearings, replace the top and bottom bearings in as a pair.

Measure the clearance of the thrust bearing.



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How to remove and install main bearings

Removing

1. Loosen the tightening nuts of the main bearing cap bolt.
2. Loosen the side bolts of the main bearing caps.
The side bolts are on both sides of each bearing.
3. Install the main bearing cap drawing-out tool to the clamping bolt.

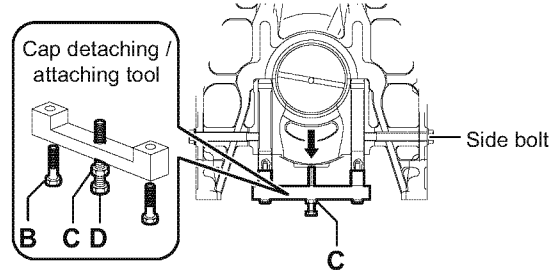
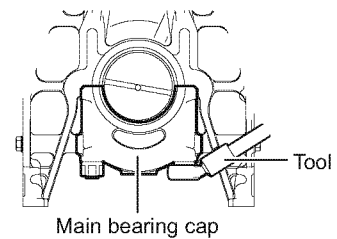
CAUTION

Do not remove the tightening nuts on both sides at the same time. The main bearing cap can fall and cause injury.

4. Fully screw the drawing-out bolt D to the main bearing cap. Turn the nut C. Draw out the main bearing cap until it is free.
5. Remove bolt B. Remove the main bearing cap and the main bearing together with the tool from the engine.

Removing the top main bearings

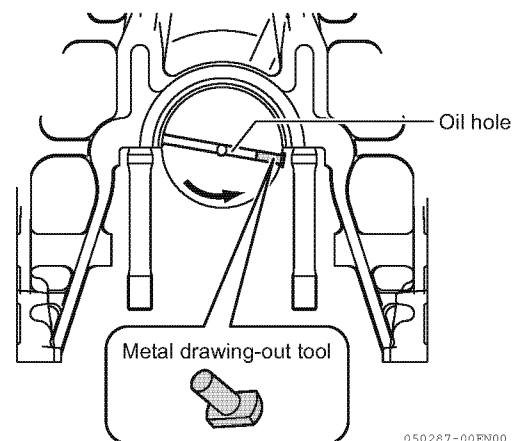
1. Put the drawing-out tool into the oil hole of the crankshaft.
2. Slowly turn the flywheel counterclockwise as seen from the flywheel side. Stop turning when the top bearing is completely out the housing. Remove the bearing.



050286-00EN00

Operation side

Non-operation side



050287-00EN00

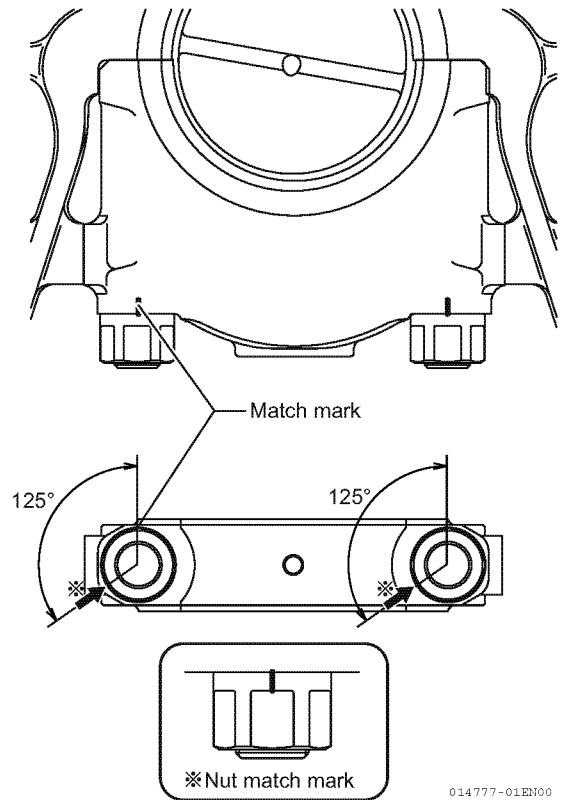
■ How to make a nut match mark

NOTICE

When you replace a bearing or a tightening nut or during disassembly, make sure that you apply a new match mark. The bolts have a factory match mark, but the tightening force of a bolt changes after it is tightened to a seat.

Make a match mark on each nut with the main bearings not installed. Obey the instructions that follow.

1. Apply lubricating oil to the bolt. Apply Protec grease to the nut seating face.
2. Tighten the bolt with a torque wrench to the seating torque.
Seating torque: $50 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$
3. Align the 0° position of an angle gauge to the match mark of the main bearing cap. Make a match mark on the side of the nut collar at 125° .



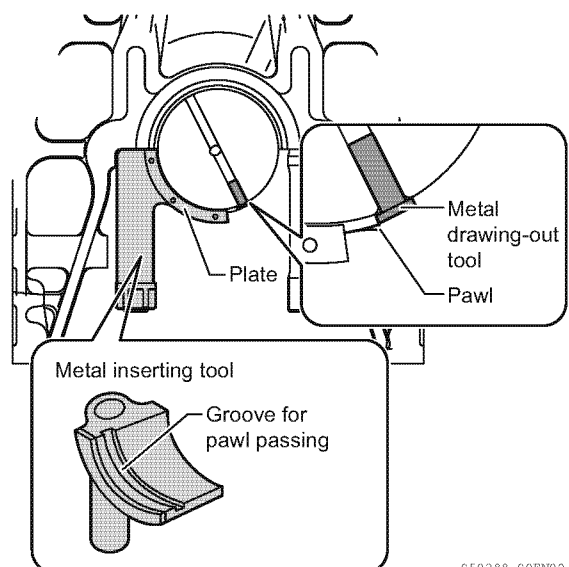
■ Installing the main bearings

1. Inspect the bearings for damage and buildup of dirt.
Look for hit marks and plucking on the bearing surface and thread of each nut. Repair all defects.

NOTICE

Do not mistake the top and bottom bearings. The top bearing has an oil groove.

2. Insert the bearing removal tool into the oil hole of the crankshaft. Turn the crankshaft until the tool disappears in the housing.
3. Carefully check the relationship of the fitting position between the top bearing pawl and the housing pawl. Insert the one without a pawl into the housing first. (Push in manually by approximately $1/4$.)
4. Install the bearing insertion tool (guide).
5. Slowly and carefully turn the crankshaft to the right. Insert the bearing. (Make sure that the bearing pawl and the insertion tool guide are aligned.)



6. Turn until the bearing and the housing match and the bearing is completely settled. Then stop turning.
7. Turn the crankshaft back a little. Remove the bearing insertion tool and the bearing removal tool.

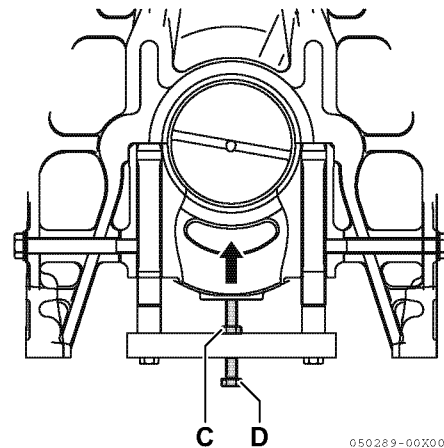
■ Installing the main bearing cap

1. Align the bearing pawl to the main bearing cap pawl groove position.
2. Align the match marks of the main bearing cap and the cylinder block and install.
3. Install the removal tool to the main bearing cap. (Refer to the figure)
4. Screw the bolt D into the main bearing cap. Turn the nut C. When the main bearing cap is settled in the specified position (when the mating surfaces are aligned), remove the special tools.
5. Tighten the main bearing nuts to a seating torque of $50 \text{ N}\cdot\text{m} \pm 5 \text{ N}\cdot\text{m}$.
6. Obey the P166 [Tightening method for the main bearing nut (angular tightening)] order to tighten the bolt.
7. After you tighten them, check the match marks.

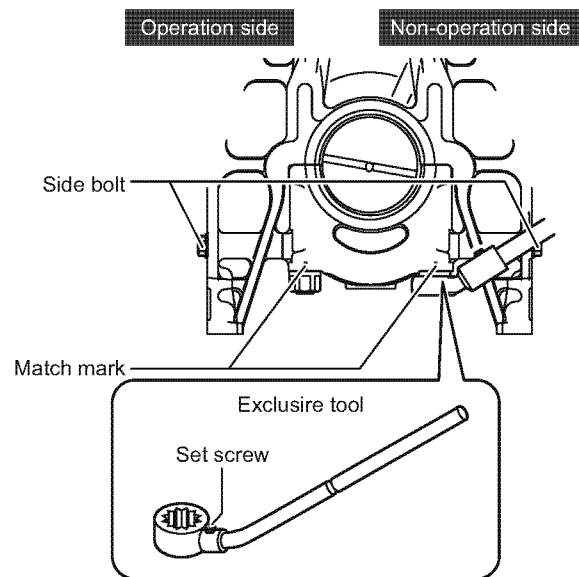
⚠ CAUTION

Install the tightening nuts on one side, then on the other side. The main bearing cap can fall and cause injury.

8. Tighten the side bolts on the operation side and non-operation side alternately.
9. Obey the P167 [Tightening method for the main bearing side bolt (tighten the side bolt after tightening the main bearing nut)] order to tighten the bolt.



050289-00X00



050290-00EN00

■ Crankshaft

Disassemble and examine the crankshaft at regular intervals. The following malfunctions may occur:

- Uneven wear of the crankshaft
- Too much clearance of the main bearing (because of wear of the crankshaft)
- Cracks caused by too much crankshaft deflection
- Hair cracks caused by crankshaft seizure due to lack of oil
- Cracks caused by torsional vibration at normal speeds

If the crankshaft or the main bearings have burns, replace the bearings. Also, look for hair cracks of the crankshaft:

- Measure the surface hardness.
- Do a magnetic check for deep flaws.

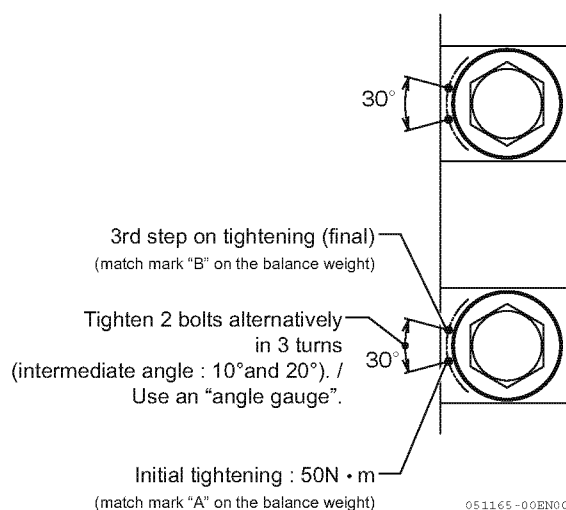
	Evaluation
Crankshaft surface hardness	Between 56 HRC and 65 HRC (Rockwell hardness)
Hair cracks	Not permitted

● Important considerations for disassembly and assembly

- Clean carefully including the oil hole during disassembly.
- During maintenance, protect the engine from seawater and other materials that cause rust.
- Rust can cause cracks.
- When you install, align the knock pin of the crankshaft and the flywheel. Install it by hitting it lightly.
- Before you install the flywheel clamping bolt, examine the bolt thread for defects. Apply seizure inhibitor (e.g. Molycote) to the bolt thread.
- Measure the crankshaft deflection during installation.

Tightening the balance weight bolt (angle tightening)

1. Apply lubricating oil to the thread. Apply Protec grease to the bolt seating surface.
2. Tighten the balance weight bolt.
3. Tighten the 2 balance weight bolts to a seating torque of $50 \text{ N} \cdot \text{m} \pm 5 \text{ N} \cdot \text{m}$. Align the bolts to the match mark A on the balance weight side and stamp the match mark (punch mark) on the balance weight bolt.
4. Tighten the 2 balance weight bolts to the specified tightening angle of 30° . Do it alternatively in 3 turns (intermediate angles: 10° and 20°). Finally, align the match mark (line) of the bolt to the match mark B on the balance weight side. Make sure that the match mark on the bolt is 0 mm to 1 mm ahead of the match mark on the balance weight in the direction of tightening.



Disassembling and assembling the crankshaft oil seal on the flywheel side

During crankshaft removal or when oil leaks from the oil seal, disassemble and assemble the oil seal according to these instructions.

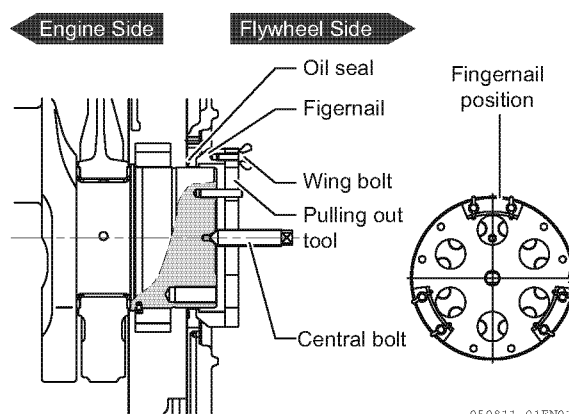
How to remove the oil seal

The oil seal is a slinger (end face seal) type. Make sure that you use the drawing-out tools and obey the instructions that follow.

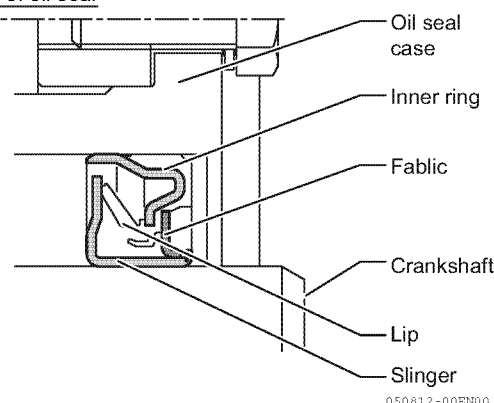
NOTICE

- Stop the engine and wait for the engine temperature to decrease.
- When you remove the oil seal, make sure that you do not cause damage to the crankshaft and the inner surface of the oil seal case.
- Replace the oil seals with new ones.

1. Remove the fabric with a screwdriver.
2. Remove the lip and the inner ring with pliers. Only the slinger stays.
3. Remove the oil seal case.
4. Set the drawing-out tool, the center bolt, and the drawing-put pawl.
5. Lock the pawl to the drawing-out tool. Attach the pawl in three locations as shown in the figure. The end of the pawl must touch the return part in front of the slinger.
6. Slowly tighten the center bolt and remove the slinger. If the return part of the slinger turns upside down, change the position of the pawls and do the task again.



Detail of oil seal



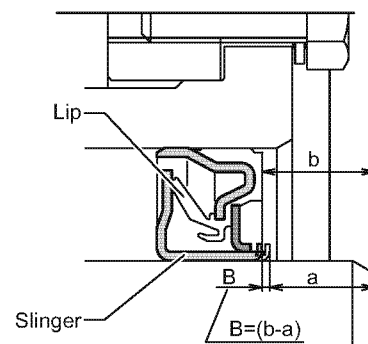
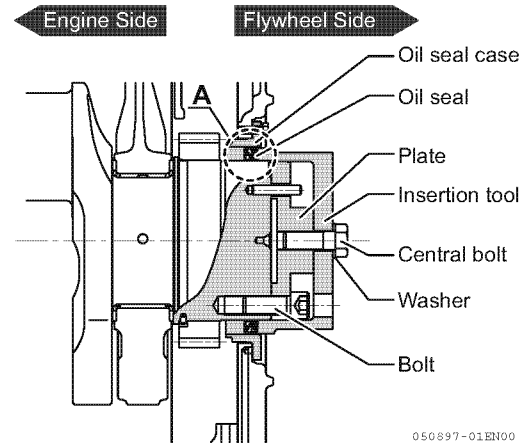
● Important considerations for installing

Make sure that you use the drawing-out tools and obey the instructions that follow.

NOTICE

- Replace the oil seals with new ones. Do not use the removed oil seal again.
- There are different oil seals depending on the direction of engine rotation. Use the correct oil seal.
- Refer to the figure and make sure that the oil seal faces in the right direction. Insert it.
- When you install the oil seal, make sure that you do not cause damage to the crankshaft and the inner surface of the oil seal case.

1. Apply lubricating oil to the oil seal lip.
2. Temporarily install the bolt to the plate at 3 locations.
3. Insert the insertion tool up to the crankshaft. Align the center of the crankshaft and the plate. Tighten the bolt through the window of the insertion tool with a hexagonal wrench.
4. Insert the oil seal in the plate. Attach the insertion tool.
5. Tighten the center bolt to the insertion tool. Press-fit the oil seal.
6. Tighten the center bolt until the insertion tool touches the plate.
7. After insertion, make sure that the installation location (size B) of the oil seal end and the slinger is within ± 0.3 mm. If it is larger than ± 0.3 mm, failure of the sealing can occur. Repeat the task and install a new oil seal.



Detail A

050898-00EN00

■ **Replacing the crankshaft oil seal on the opposite side of the flywheel (front side)**

1. If a front power take-off shaft is attached to the front, remove it and its coupling.
2. To replace the oil seal, obey the same instructions as "Disassembling and assembling the crankshaft oil seal on the flywheel side".

NOTICE

The oil seal is a slinger (end face seal) type. It is the same seal as the one on the flywheel side.

However, its size is smaller. Use a different jig.

Replace the oil seals with new ones.

Disassembling and Assembling the Timing Gear, Camshaft, and Intake/Exhaust Swing Arm

■ Timing gear

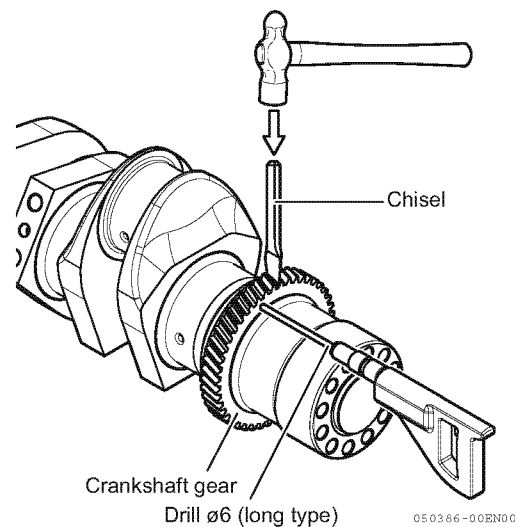
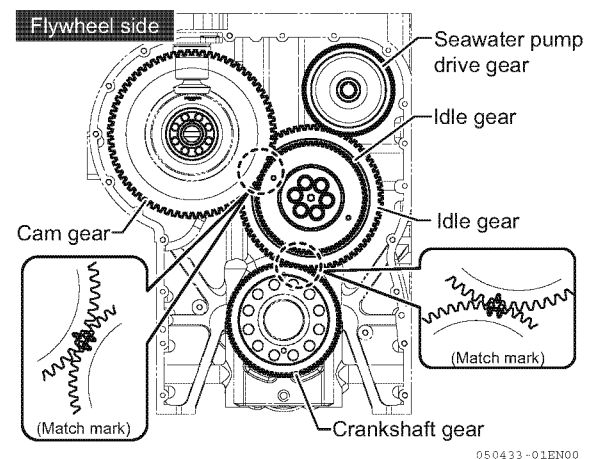
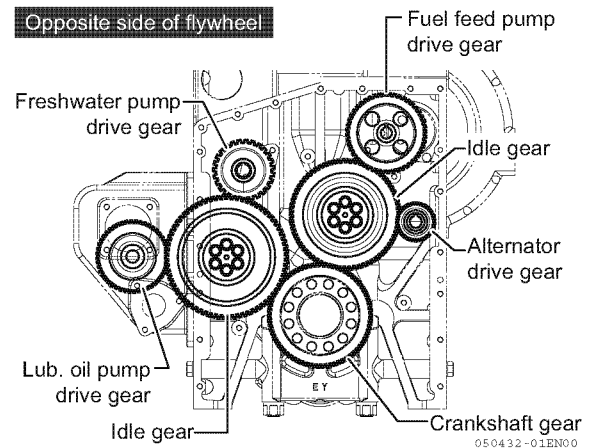
Normal operation also causes backlash and wear on the gear. Even at normal speeds, torsional vibration can cause hair cracks and pitting wear of the gear. Measure the backlash of the gears. Examine the condition of the teeth surface.

● Precautions during disassembly and assembly

- Be careful. All these parts have match marks on their alignment tooth: the cam gear, the camshaft idle gear and the crankshaft gear on the flywheel side.
- When you loosen the cam gear tightening nut, put a wood piece into the gear alignment.
- Do not put a screwdriver or a metal piece.
- When you remove the crankshaft gear: Drill a hole into the bottom land of the gear. Put a chisel into the hole. Lightly hit the chisel to loosen the gear alignment.
- Inserting the crankshaft gear
 1. Put the crankshaft gear in an oil bath of approximately 150 °C to 180 °C.
 2. Soak it for approximately 30 minutes. Take the crankshaft gear out of the oil bath. Quickly insert it into the crankshaft.

Do not increase the temperature of the crankshaft gear with a gas burner. Too much temperature will weaken its material and strength. Use an oil bath instead.

	Flywheel side	Opposite side of the flywheel
Crankshaft/gear Interference (mm)	0.136 to 0.211	0.120 to 0.185



Crankshaft gear
Drill ø6 (long type)

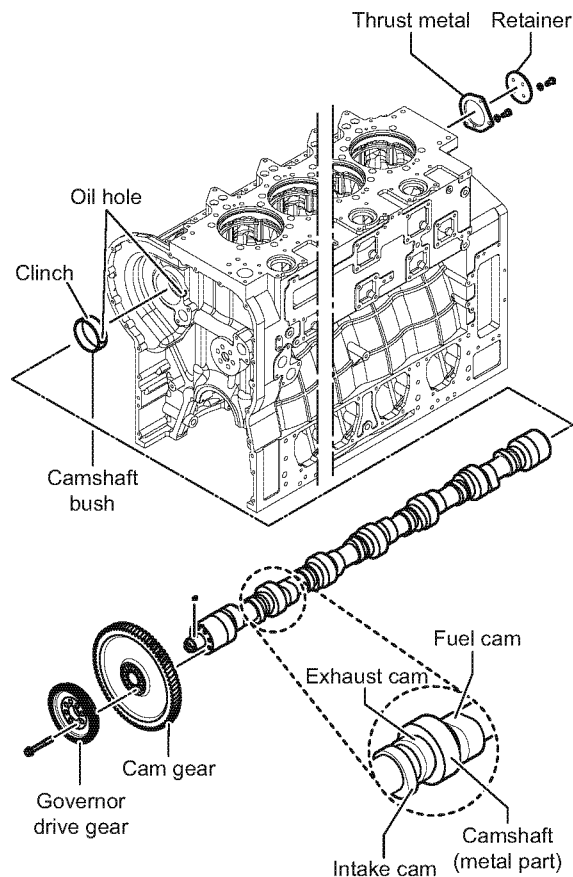
■ Camshaft

Remove the camshaft and obey the steps that follow if:

- The wear on the cam, metal part of camshaft, bush and fuel cam is more than the wear limit.
- These parts are damaged.

● Important considerations for disassembly and assembly

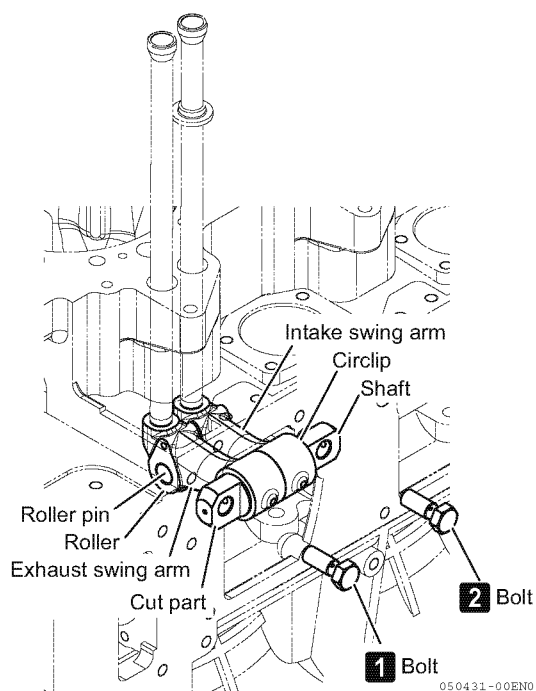
- The intake/exhaust cam and the fuel cam are integrated into the shaft. But the outer diameter of metal part of camshaft is very large. If you remove the fuel pump, drive unit, cam gear and thrust metal, you can easily remove the camshaft.
- When you replace the camshaft bush:
 - Press-fit the bush.
 - Measure the roundness.
 - Examine the clinch of the bush for defects.
- Before you press-fit, correctly align the oil holes of the bush and the cylinder block.



050375-01EN00

■ Swing arm

1. First tighten the left tightening bolt of the swing arm shaft. Then tighten the right bolt.
2. Inspect the mating surfaces of the sliding parts with the cam and push rod. Inspect the roller.



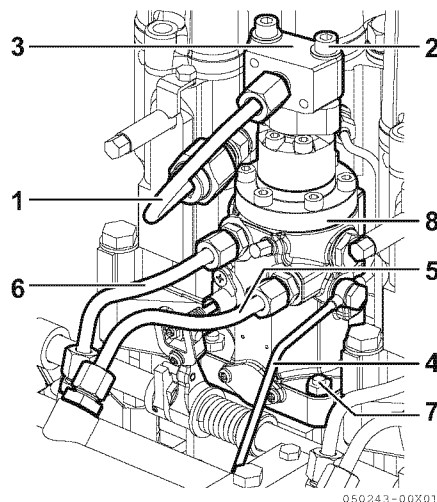
050431-00EN00

Disassembling and Assembling the Fuel Injection Pump

It is a precision instrument and any defect will have a bad effect on combustion performance and engine output. Be careful with the fuel injection pump during disassembly and assembly.

■ Removal procedure

1. Remove the fuel injection pipe 1.
2. Loosen the clamping bolts on the pump side 2 with a hexagonal wrench key. Remove the fuel injection pipe joint 3.
3. Remove the overflow oil pipe 4.
4. Remove the fuel oil inlet pipe 5.
5. Remove the fuel oil outlet pipe 6.
6. Loosen the tightening nuts 7 of the fuel injection pump with the special box wrench.
7. Remove the pump 8.



050243-00X01

Disassembly

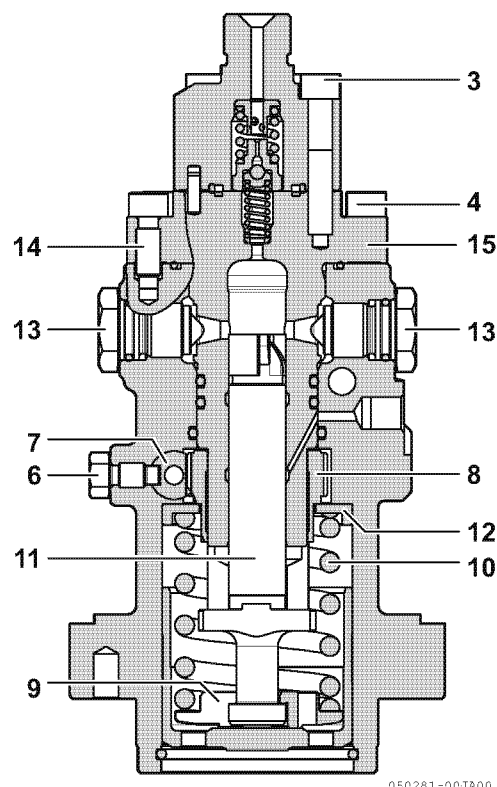
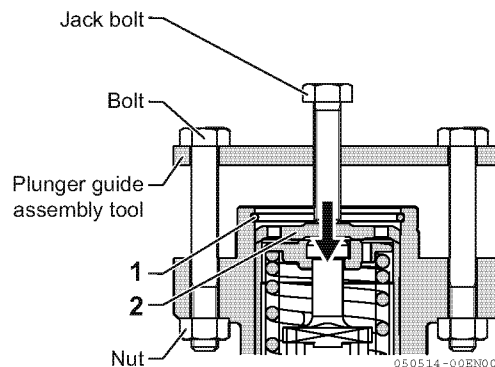
CAUTION

When you remove the retainer 1 from the groove, it can suddenly come off and cause injury. To prevent this, cover it with a cloth.

1. Turn the pump in the opposite direction of operation and install the assembly tool.
2. Screw in the jack bolt. Push in the plunger guide
 2. Make the opening of the retainer larger.
3. Remove the retainer.
4. Remove the plunger guide.
5. Remove the plunger spring retainer 9.
6. Remove the plunger 11.
7. Remove the plunger spring 10.
8. Remove the spring seat 12.
9. Remove the pinion 8.
10. Loosen the bolt of the rack guide 6.
11. Remove the rack 7.
12. Remove the two deflectors 13.
13. Loosen the clamping bolt of the two-way delivery valve 3.
14. Loosen the barrel clamping bolt 4.
15. Loosen the lock bolt 14.
16. Remove the barrel 15.

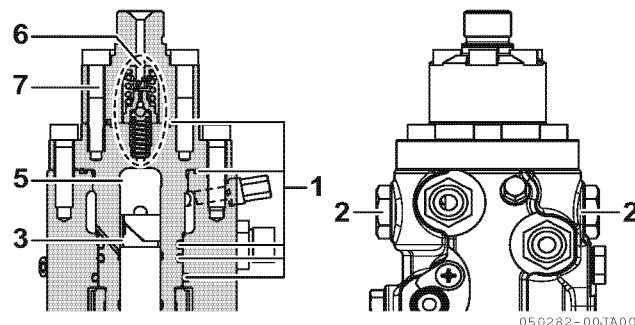
NOTICE

Handle the plunger and the barrel together as a pair.



Inspection

1. Clean all parts. Make sure that there is no rust.
2. Examine the spring of the two-way delivery valve 6 for breakage.
3. Inspect the mating surfaces of the two-way delivery valve body 7 and the barrel 5 for blowby from fuel oil.
4. Clean the oil hole of the barrel 3.
5. If the tip of the deflector 2 has dents from corrosion, replace it.
6. Replace all O-rings 1 with new ones.



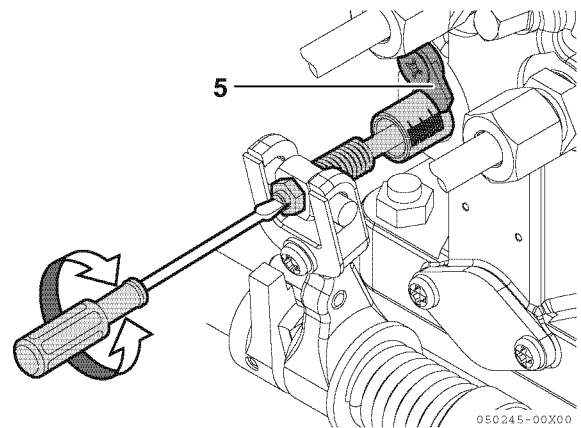
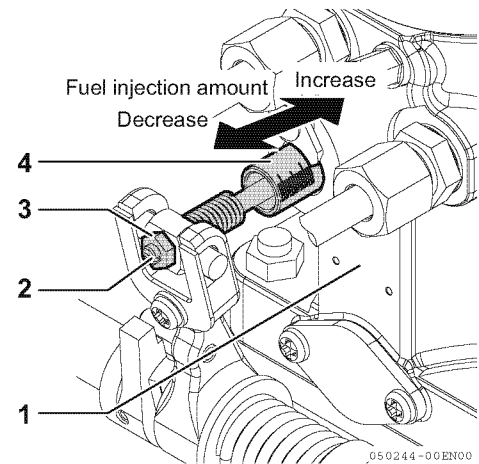
■ Adjustment

● Adjusting the fuel injection amount (fuel injection pump rack scale)

If the difference in exhaust temperatures between the cylinders is more than 40 °C (and you serviced the fuel injection valve), adjust the rack 4 of the relevant cylinder's fuel injection pump 1.

Keep the difference between cylinders within one mark of the rack index on the indicator board 5.

1. Loosen the locknut 3.
2. To adjust the injection amount, turn the rack-adjuster bolt 2 as follows:
Turn right (clockwise): increase the injection quantity (exhaust temperature increases)
Turn left (counterclockwise): Decrease the injection quantity (exhaust temperature decreases)
3. Tighten the locknut.



● How to check the injection timing

1. Open the cover of the marking line check window of the injection pump drive unit.
2. Turn the flywheel and align the marking lines on the pump body and on the plunger guide.
When aligned, the flywheel pointer shows the fuel injection time on the flywheel scale.
(In the range of 0° to 30° before and after top dead center, one mark indicates 2°. Outside this range, one mark indicates 5°.)

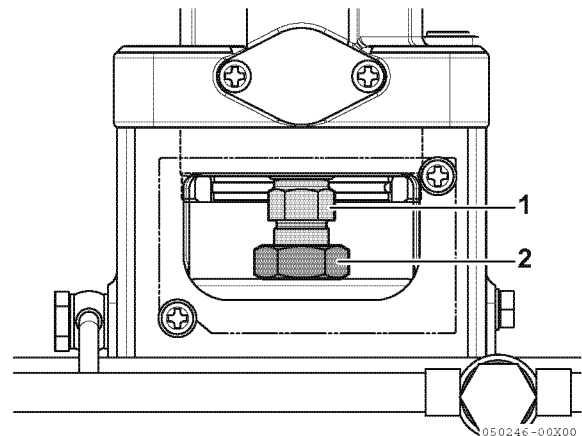
● How to check the injection timing

⚠ CAUTION

When you turn the flywheel, do not let your fingers come near the locknut 2 or the oil shield plate. Your fingers can get caught, resulting in injury.

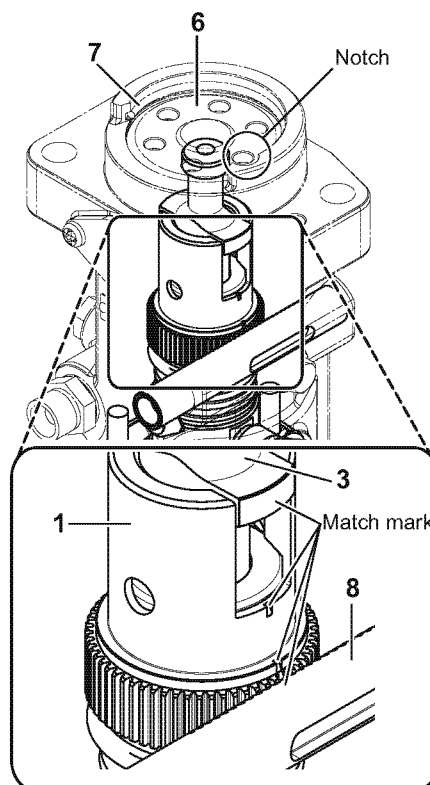
1. Open the cover of the marking line check window.
2. Turn the flywheel and move the moving part of the drive unit (the adjusting bolt 1 and the locknut 2) to the lowest position.
3. Loosen the locknut 2.
4. Turn the flywheel in the direction of engine rotation.
Align the flywheel pointer with the injection time mark (on the flywheel scale) for the cylinder that you want to adjust.
 - Make the injection timing faster: Pmax increases
 - Make the injection timing slower: Pmax decreases
5. Turn the adjusting bolt and align the marking line on the pump body with the line on the plunger guide.
6. Turn the flywheel and move the drive unit moving part to the lowest position.
7. Tighten the locknut to the specified torque. To prevent the adjusting bolt from turning with the locknut, lock it with a wrench.

P164 [Tightening Torque for Major Bolts and Nuts]
Make sure that the plunger is not pushed up. After the adjustment, turn the flywheel and make sure that it turns easily.
8. Install the cover of the marking line check window.

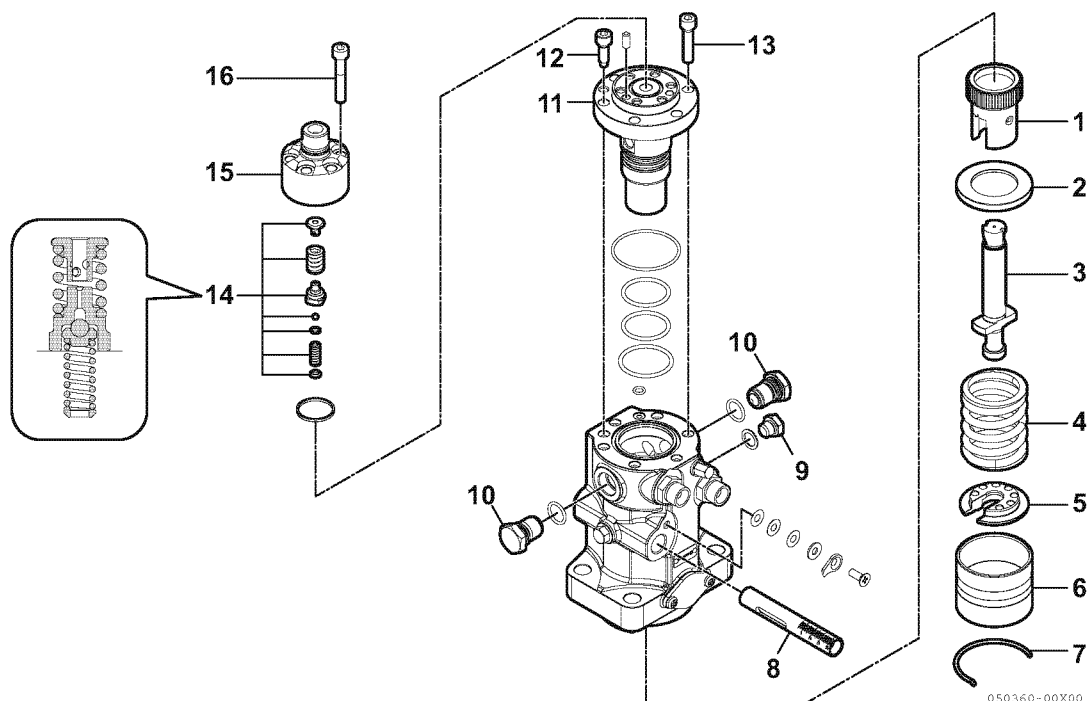


■ Assembly

1. Replace the O-rings and the gaskets with new ones.
2. Install the O-rings. Make sure that they are not twisted.
3. Apply lubricating oil to the barrel 11.
4. Install the barrel to the fuel injection pump body.
5. Install the two-way delivery valve 14.
6. Tighten the barrel clamping bolt 13 and the clamping bolt 16 of the two-way delivery valve body. Tighten them gradually in 3 steps to the specified torque.
P164 [Tightening Torque for Major Bolts and Nuts]
7. Align the match marks of the rack 8, pinion 1 and plunger 3.
8. When you install the retainer 7, be careful that you do not damage the guide of the pinion by the collar of the plunger. To avoid damage, adjust the movement of the rack while you push in the plunger guide 6.
9. Align the opening of the retainer with the notch of the body.
10. After you assemble the fuel injection pump, make sure that the rack moves easily.



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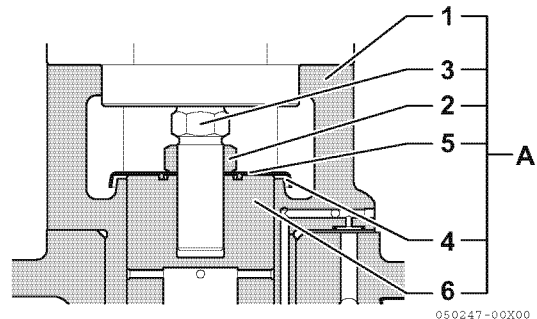


050360-00X00

Disassembling and Assembling the Fuel Injection Pump Drive Unit

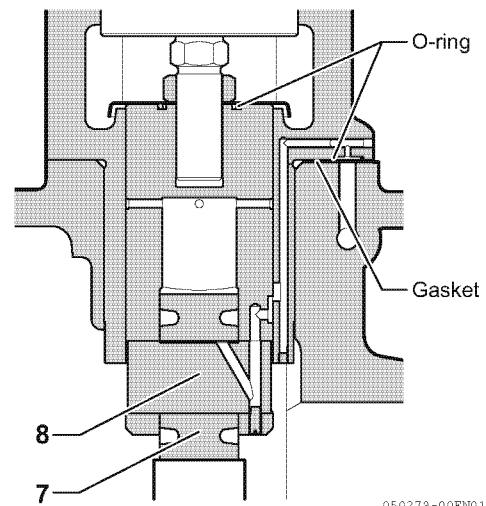
■ Disassembly

1. Remove the fuel injection pump.
P129 [Removal procedure]
2. Remove the drive unit assembly A from the cylinder block.
3. Loosen the locknut 2.
4. Loosen the injection-timing adjusting bolt 3.
5. Remove the oil shield plate 4 together with the O-ring 5.
6. Remove the rotor tappet assembly 6 to the bottom.



■ Inspection

1. Inspect the roller 7 and the outside of the roller 8 for bad contact and damage.
2. Make sure that the roller turns smoothly.
3. Blow air into the oil hole on the body. Look for clogging.



■ Assembly

1. Replace the O-rings and the gaskets with new ones.
2. Align the position of the plugs on the drive unit body of the fuel injection pump and the tappet.
3. Install the oil shield plate.
4. Install the injection-timing adjusting bolt and screw it in fully.
5. Install the fuel injection pump.
6. For details on the procedure, refer to this document:
P131 [Adjustment]

● Assembly

- Replace the O-rings and the gaskets with new ones.
- Replace the ball bearings approximately every 8000 hours to 10000 hours.
- When you install them to the engine, make sure that the backlash of the driving gear is between 0.13 mm to 0.31 mm. If necessary, adjust the number of shims.

■ Connecting the speed control device

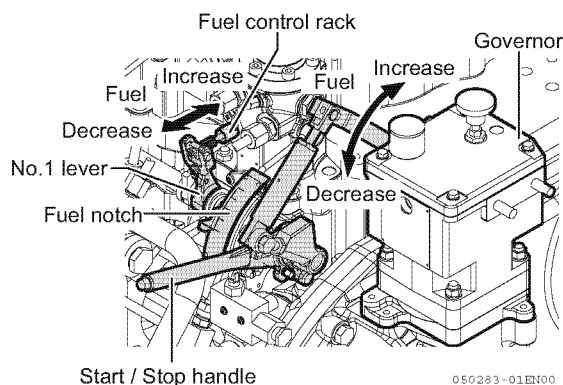
NOTICE

An incorrect coupling of the governor and fuel injection pump can cause these malfunctions:

- Incorrect speed regulation
- Engine cannot be stopped
- Unusual increase in engine speed.

Carefully examine and adjust the coupling after you:

- Replace or do maintenance in the governor.
- Replace or do maintenance on the fuel injection pump.



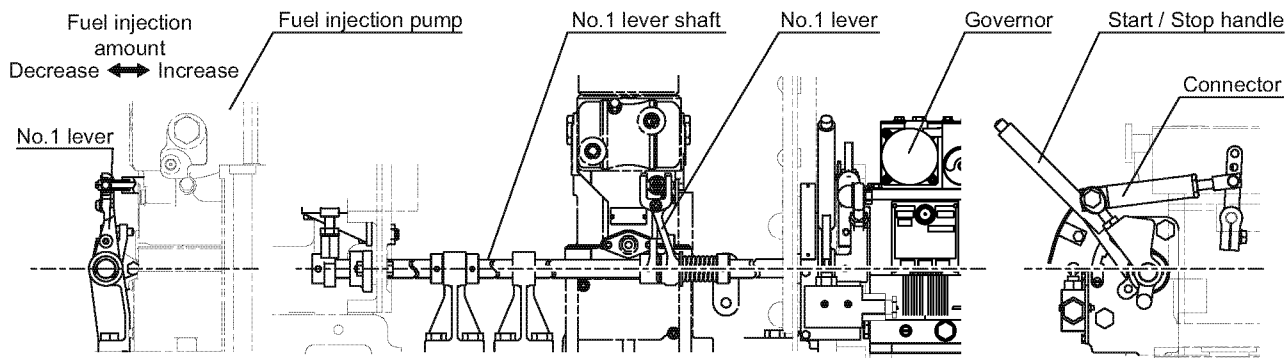
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● Adjustment

Obey the instructions that follow when you do maintenance of the speed control device.

1. Move the start/stop handle to STOP.
2. Set the rack scales 0(zero). Do it for the fuel injection pumps of all cylinders. Use the rack adjusting bolt. Make sure that the No. 1 lever moves easily.

Adjusting the fuel injection amount (rack scale)
(P131 [Adjusting the fuel injection amount (fuel injection pump rack scale)])

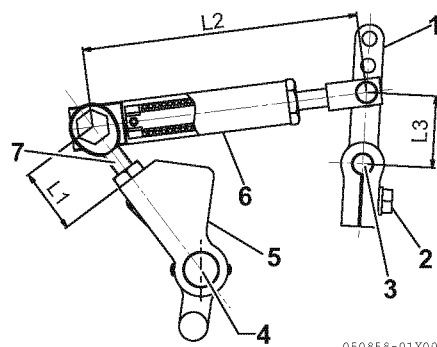


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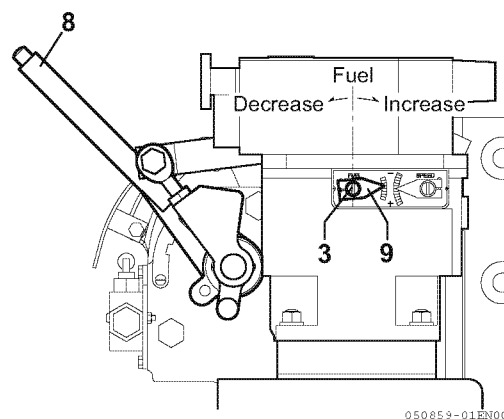
3. Make sure that the distance (L1) between the center of the No. 1 lever shaft 4 and the center of the connector 6 is approximately 36 mm. If necessary, screw the connecting bolt 7 in or out to adjust the length.
4. Connect the connecting bolt 5 of lever No. 2 to the connector.
5. Put a minus screwdriver into the end of the governor output shaft 3. Turn it fully toward the fuel DECREASE side. Set the pointer 9 to 0 (zero) on the scale.
6. Install the speed control lever 1 to the end of the governor output shaft. Loosen the set bolt 2 of the speed control lever.
7. Connect the connector to the speed control lever.
8. Set the pointer to 1 on the scale. Turn the governor output shaft to the fuel INCREASE side. Tighten and lock the speed control lever with the set bolt to the governor output shaft.
9. Check the governor links for defects.
10. Move the start/stop handle 8 to RUN. Check that the scales of all fuel injection pumps are 4.

Standard dimensions at the handle stop position

L1	36 mm
L2	158 mm
L3	45 mm



050858-01X00



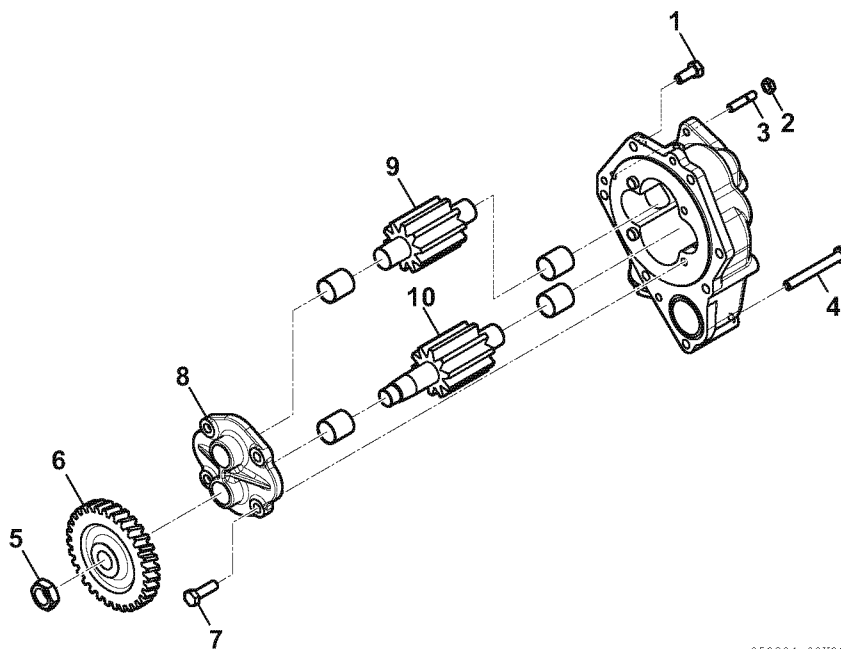
050859-01EN00

Disassembling the Lubricating Oil Pump, Lubricating Oil Cooler, and Lubricating Oil Pressure Control Valve

■ Lubricating oil pump

● Disassembling

Remove the parts in the sequence shown in the illustration.



050294-00X00

● Inspection

Check the following:

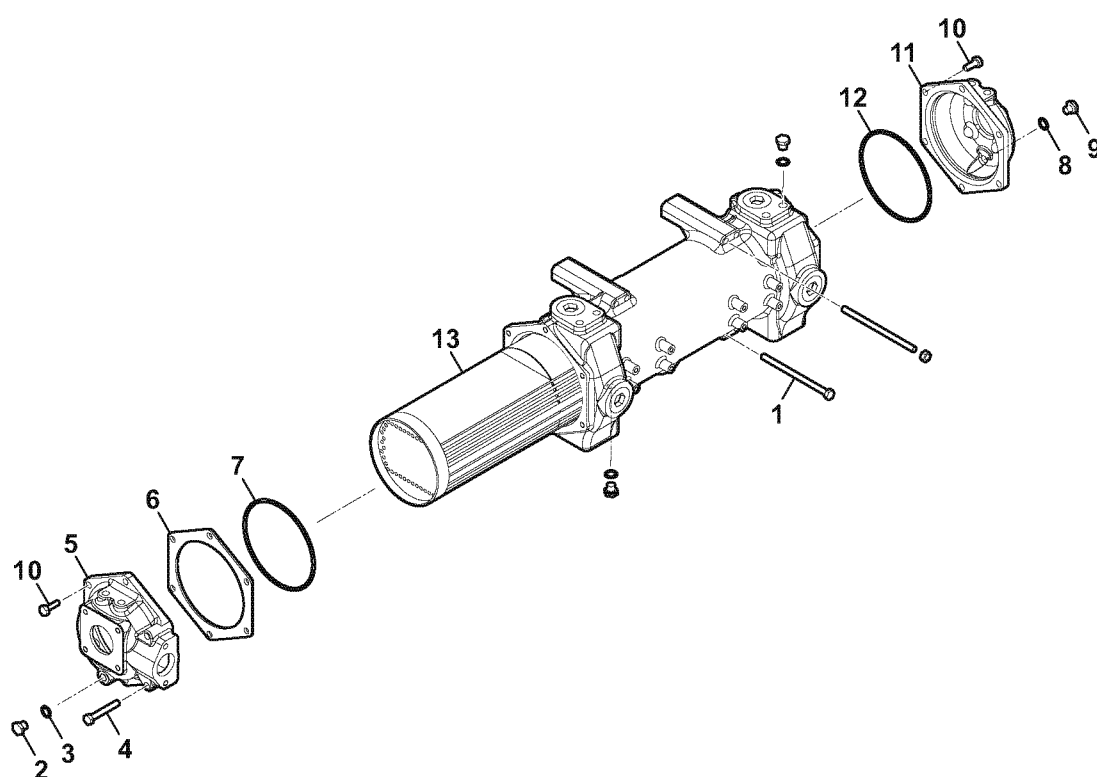
- Pump gear bushing for burns and unusual wear
- Clearance of the gear and the pump body (housing)
- Clearance of the gear and the cover
- No.1 gear and No.2 gear for teeth contact and unusual wear
- Driving gear for teeth contact and backlash during installation.

Repair or replace, if there is a defect.

■ Lubricating oil cooler

Disassemble and clean if the cooling effect decreases or during regular inspections.

- Remove the cooling tube assembly from the cooler barrel. Remove scale from the cooling tube surface. Scale is easy to remove with cleaning agent NEOS One-1.
- Clean the cooling tubes with a cleaning brush.
- Remove the cooling tube (assembly) from the cooler barrel. When you assemble again, align the match marks of the barrel and the tube sheet.
- Replace the O-rings and the gaskets with new ones during assembly.



050335-00X00

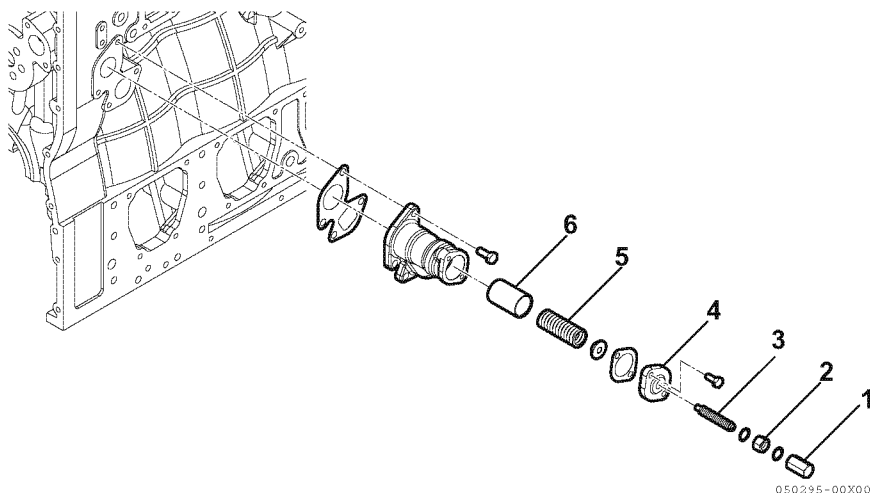
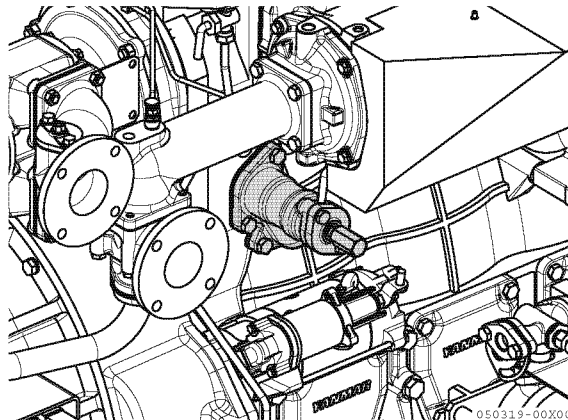
■ Lubricating oil pressure control valve

● Disassembly

Remove the parts in the sequence shown in the illustration.

▲ CAUTION

Be careful. The spring 5 of the pressure control valve can suddenly come out. Loosen the adjusting bolt 3 before you disassemble the pressure control valve.



● Inspection

- Inspect the valve seal of the pressure control valve body for contact and cracks.
- Inspect the valve 6 operation.
If you find a defect, correct it.
- Check the spring for breakage and fatigue.
Replace the spring with a new one if it does not have enough force to adjust the oil pressure.

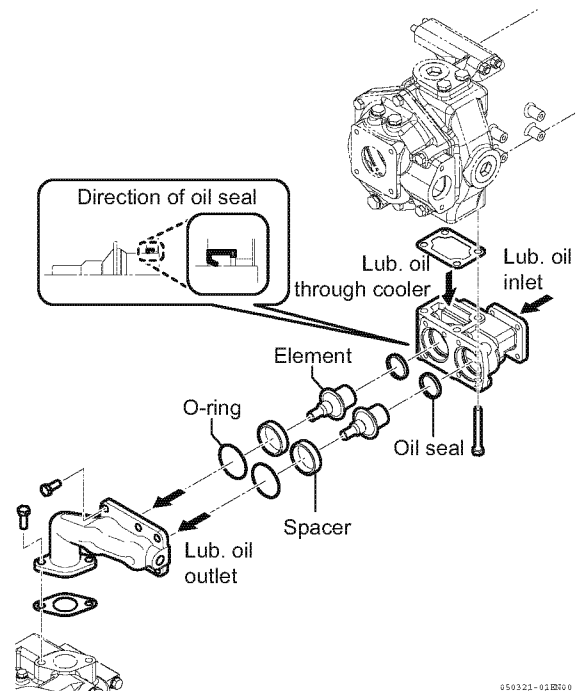
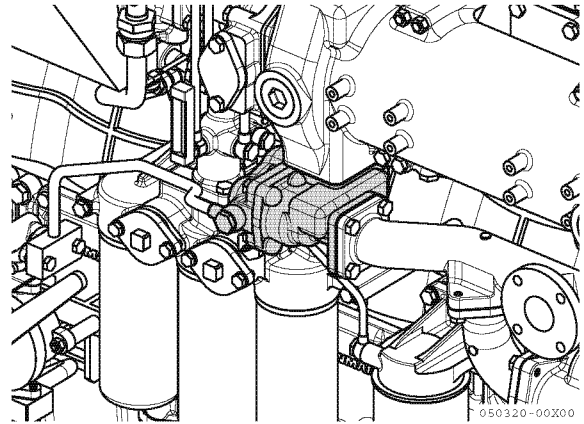
● Adjusting the pressure

P163 [Standard Adjustment Value]

■ Lubricating oil thermostat

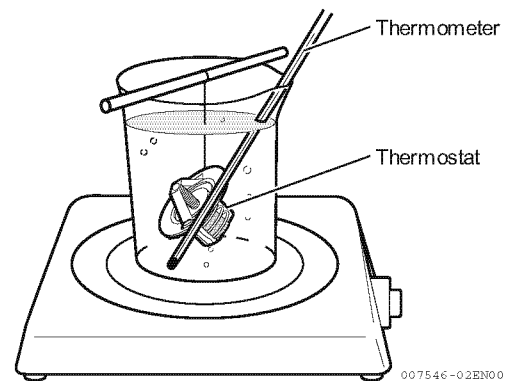
- After disassembly, soak the element in warm water. Make sure that it operates.
- Fix the piston if it is caught or stuck.
- Replace the oil seals and O-rings with new ones every time you do a disassembly.

Thermostat (element)		
Valve opening temperature	60°C	65°C
Full opening temperature	75°C	80°C
Valve lift	Approximately 11 mm or more at the full opening temperature	
Installation No.	1 pc	1 pc
Symbol	D	M



● Inspection

- Put the thermostat (element) in a container of water. Insert the thermometer and heat the water. If the valve opens at the opening temperature and fully opens at the full opening temperature, it is in the good condition. If the valve is damaged, replace it with a new one. Keep the thermostat away from the heat source. Put a plate in the bottom, support it with a wire, or hang it.



Disassembling and Assembling the Cooling Water Pump

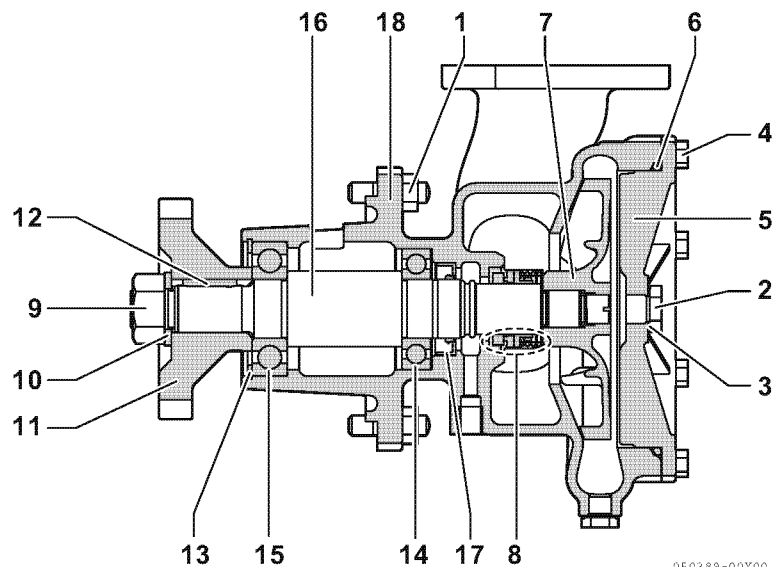
■ Freshwater pump

If there is an oil or water leak from the shaft, do overhaul as in regular inspections and replace parts with new ones, if necessary.

● Precautions for disassembling

Remove the parts in the sequence shown in the illustration.

- Replace the ball bearing every 8000 hours to 10000 hours.
- Replace the O-ring 6 with a new one every time you disassemble.



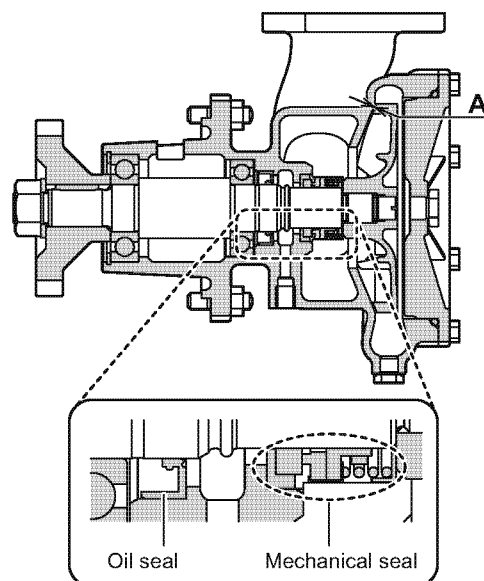
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● Precautions for assembling

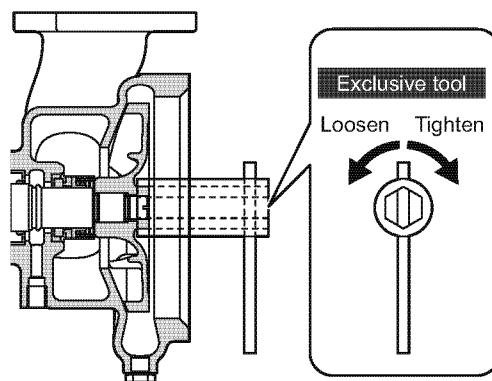
- Measure the clearance A (1 ± 0.5) between the impeller and the body. If the clearance is too large, replace the worn impeller with a new one.
- When you replace the mechanical seal 8, make sure that you do not cause damage to the seat and that no dirt collects.

Apply turbine oil VG32 to the bellows in contact with the shaft.

- When you replace the oil seal 17, make sure that it points in the direction of the seal lip. Apply lithium grease to the oil seal lip.



Impeller detaching / attaching



050380-01EN00

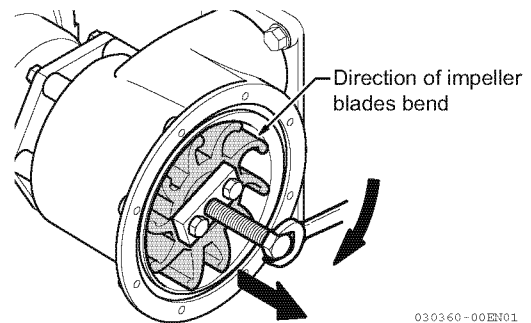
■ Seawater pump (rubber impeller)

If there is an oil leak or a water leak from the drain hole, and if pumping is not possible, do overhaul as in other regular inspections. Replace deteriorated parts with new ones if necessary.

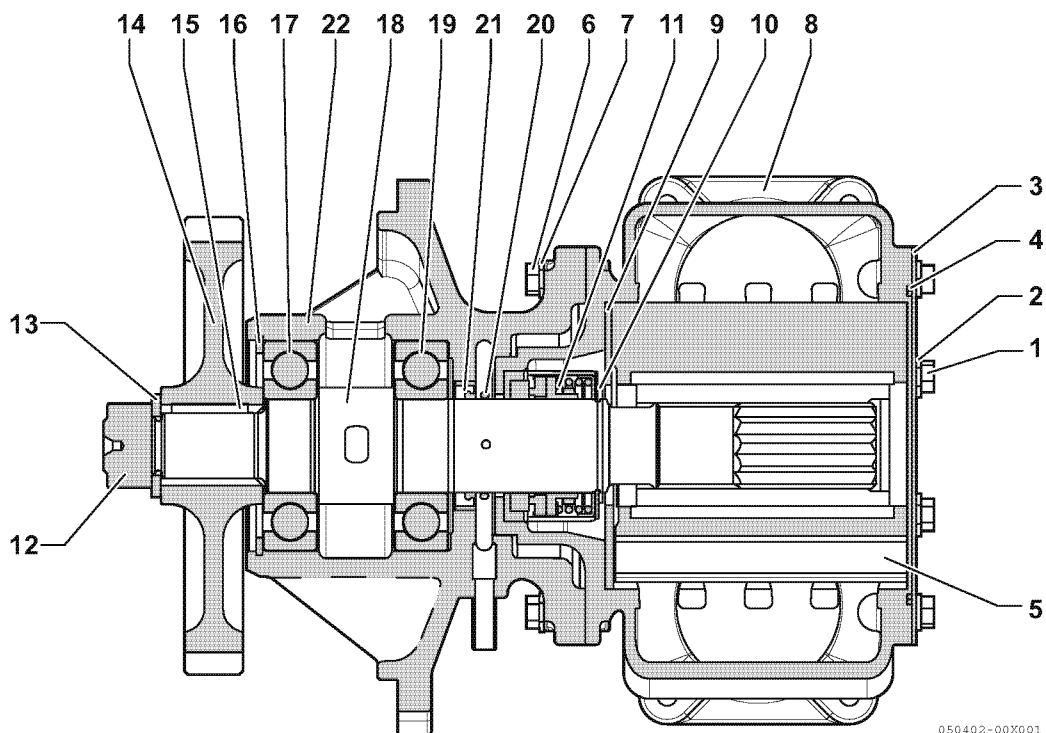
● Precautions for disassembling

Remove the parts in the sequence shown in the illustration.

- Remove the impeller with the special tool (option) shown in the figure on the right.
- If the vane end of the rubber impeller 5 is damaged or if the vane has cracks, replace the impeller with a new one.
- If the mating surface of the impeller and the wear plate 9 or the cover 3 has wear, replace it with a new one.
- Replace the ball bearings with new ones approximately every 8000 hours to 10000 hours.
- Replace the O-rings 4 and 20 with new ones every time you disassemble.



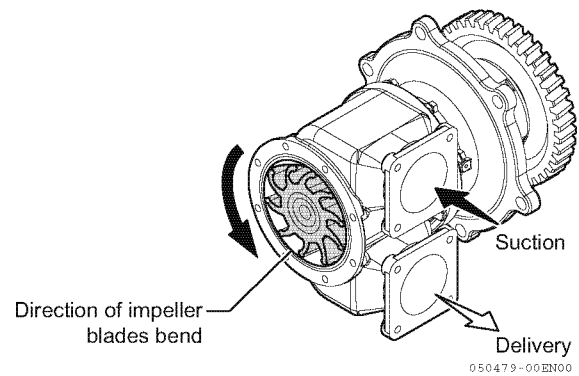
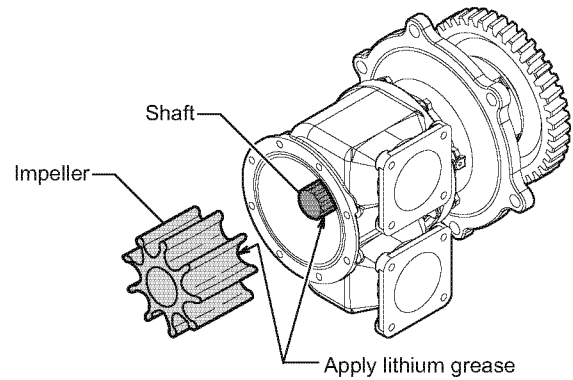
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050402-00X001

● Precautions for assembling

- Fill lithium grease to the bearing.
- Apply white Vaseline to both end faces and the outer diameter (sliding parts) of the impeller.
- Apply lithium grease to the serration portion of the pump shaft a little.
- Fill lithium grease to the oil seal lip.
- When you install the impeller to the body, make sure that the impeller blades point in the direction of rotation. The seawater pump turns counter-clockwise. When you install the impeller, make sure that the tip of the blades (the bend) points to the right. Install them with the pump shaft (impeller) turning to the left.
- Replace the O-ring in the mating surface with a new one.
- Use the new gasket. Apply sealing agent (Three-Bond No.4 or its equivalent) to the whole gasket surface.
- Replace the oil seal with a new one. Apply lithium grease to the seal lip and install it. Be careful not to mistake up and down of the seal lip.
- Clean carefully the bearing.
- When you replace the mechanical seal, make sure that you do not cause damage to the seat and that no dirt collects.

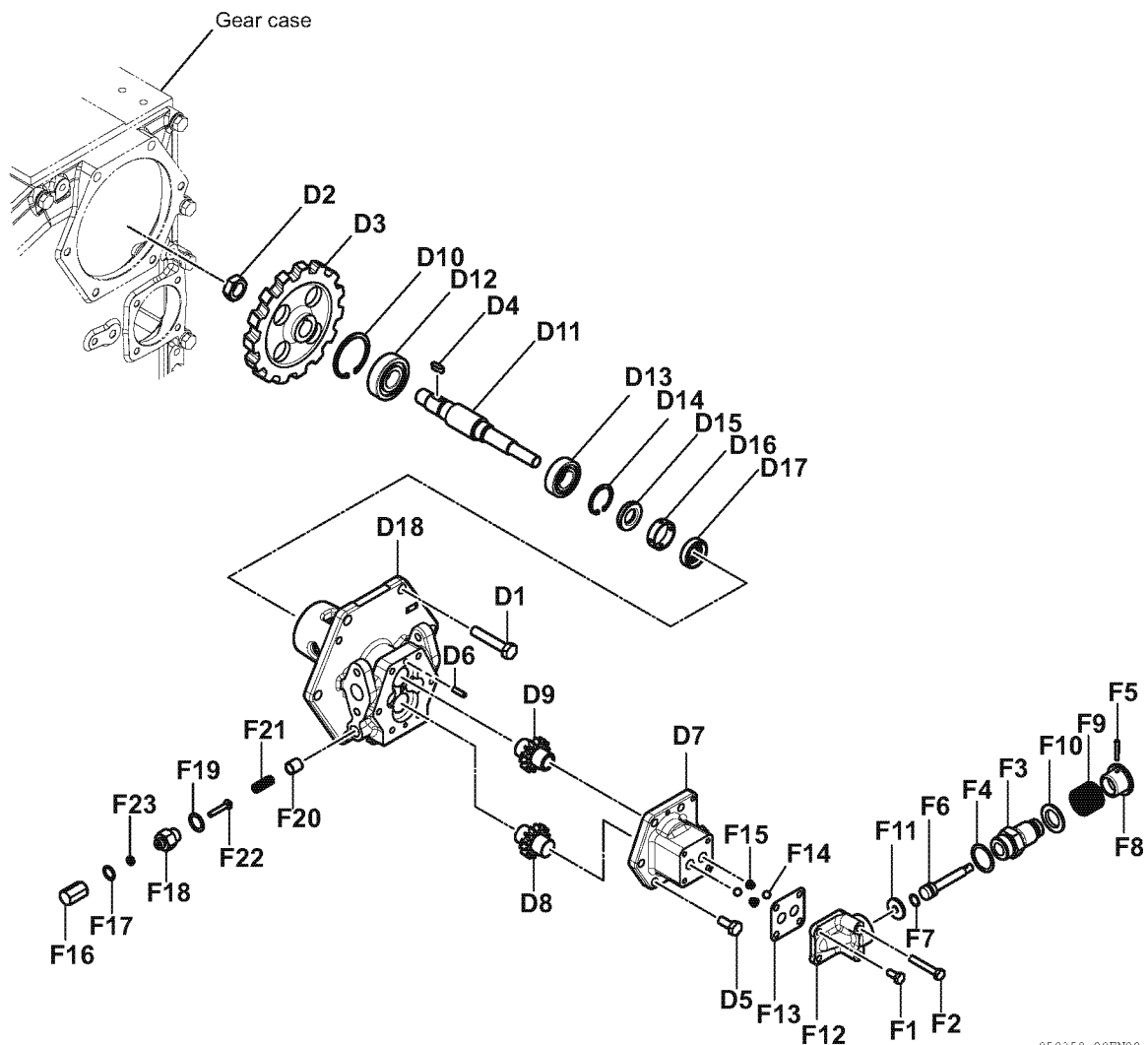


Disassembling and Assembling the Fuel Feed Pump

If the oil in the overflow oil pipe of the feed pump increases, or when you examine internal parts during scheduled inspections, replace the degraded part if necessary.

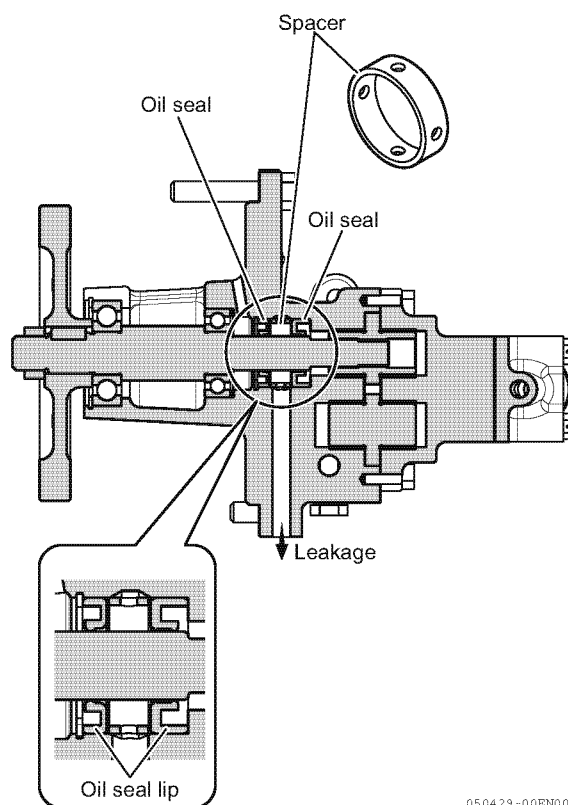
■ Precautions for disassembling

- When you remove the priming pump, put these parts in a container to prevent loss: the small steel ball and the spring.
- Apply liquid gasket (ThreeBond TB1201) on the mating surfaces of the feed pump body (D18) and the cover (D7).
- Replace the oil seal with a new one every 2 to 3 years.



■ Precautions for assembling

- When you find deformation or wear of the oil seal, replace it with a new one even if the usage time is short.
- Replace the shaft with a new one if the contact portion of the seal has wear.
- Install the oil seals (D15 and D17) as shown in the figure on the right. The different type (width) of the oil seal is used.
- Be careful not to mistake up and down of the seal lip.
- When you install the intake and delivery valves (steel ball) (F14), and the spring (F15), be careful that the installation sequence is reverse for the intake and delivery valves.
- Replace the ball bearings (D12 and D13) approximately every 8000 hours to 10000 hours.



050429-00EN00

Intake/Exhaust System

■ Exhaust manifold

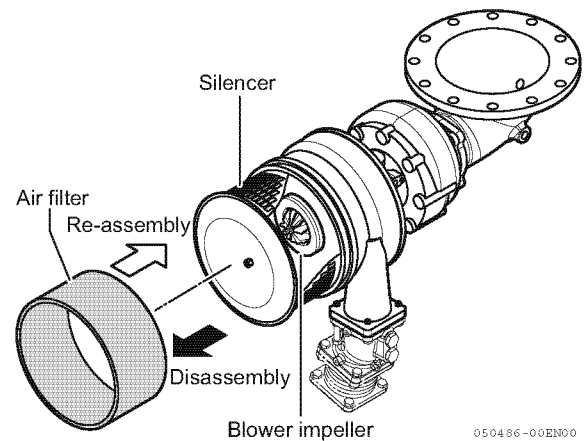
This engine has a water-cooled exhaust manifold. When you disassemble, examine the manifold for cracks. When you re-assemble, replace the gaskets to prevent water and gas leaks.

■ Turbocharger

- Clean the air filter (sponge material) approximately at intervals of 1 week (40 to 50 hours).
- Remove the silencer approximately every 1200 hours. Turn the blower impeller with your finger. Make sure that it moves easily and without rattling.
- If it does not move smoothly, overhaul the part.

● Disassembly and inspection

For disassembly and inspection procedures, refer to the separate operation manual by the manufacturer.

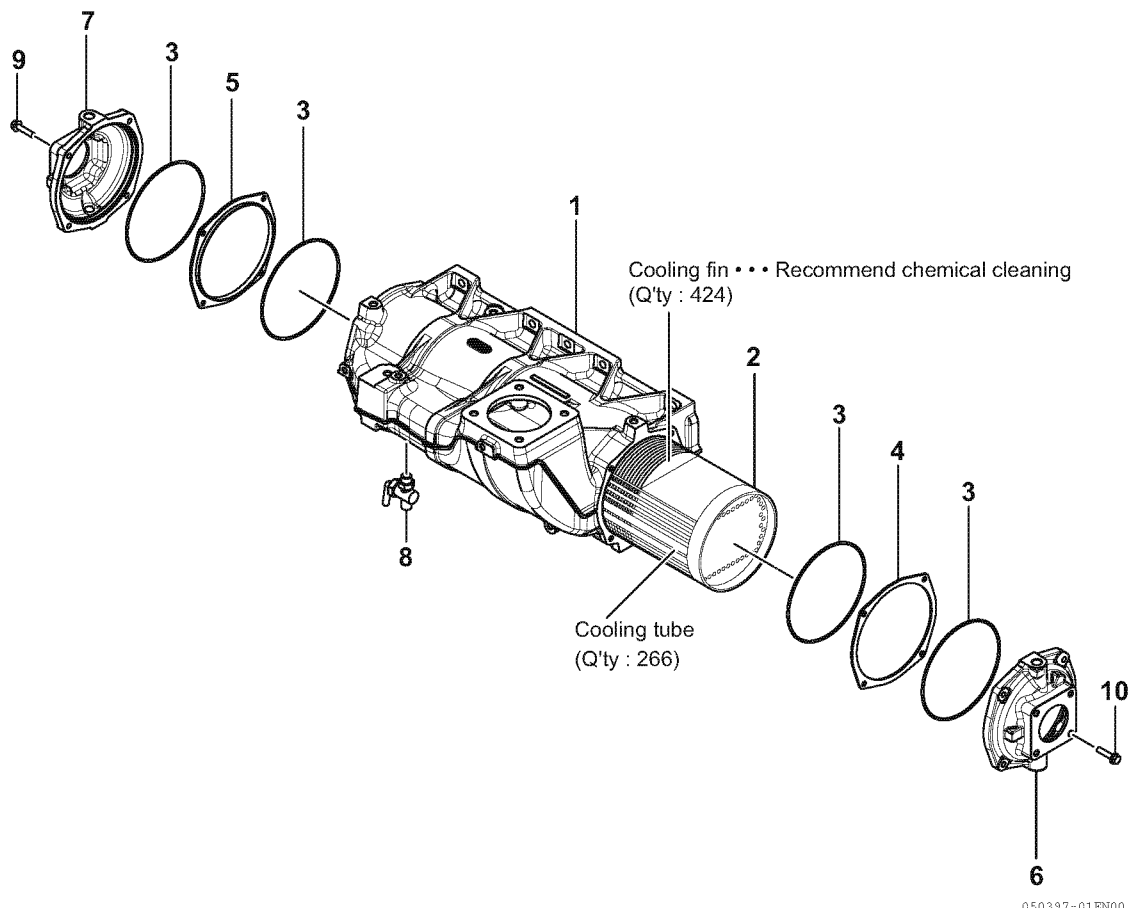


050486-00EN00

■ Air cooler

The air cooler quickly becomes dirty on the water side and the air side. Clean it at regular intervals depending on the engine's operating conditions and properties.

- On the air side, steam cleaning is sufficient on the air side. If it is very dirty, soak in a cleaning fluid solution. Blow with compressed air.
We recommend cleaning with One-1 (NEOS Co., Ltd.) or Emocon 1 E-55 (Kurita Water Industries Ltd.).
- On the water side, clean the inside of the tube with a brush.
- The cover of the water chamber in the air cooler has an anti-corrosive coating. If the coating is damaged, clean and degrease it sufficiently. Then apply epoxy paint (Hi-Pon H White).
- Replace the O-rings and the gaskets with new ones.



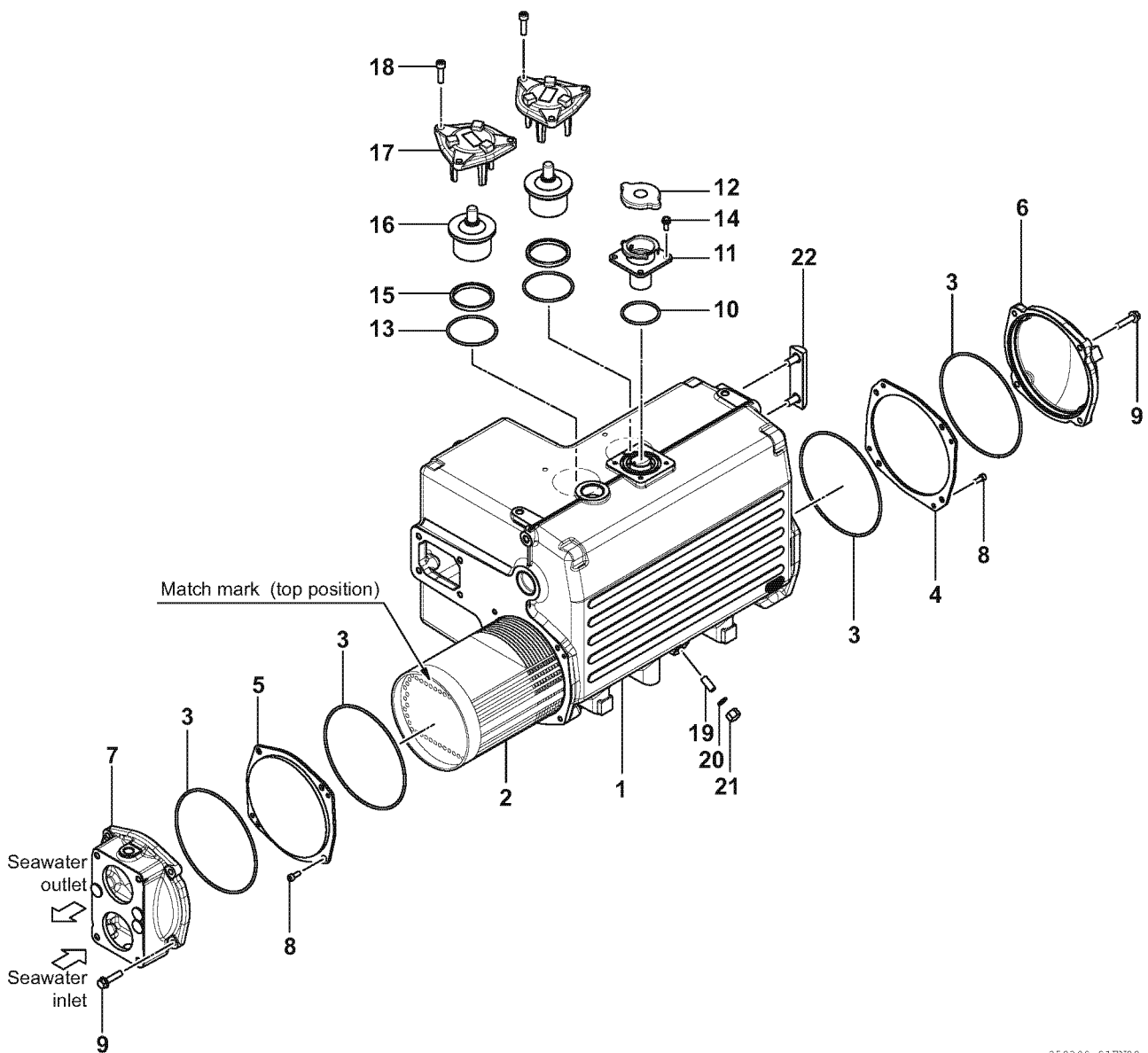
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Freshwater Cooler

Clean the cooling tube in the same way as the lubricating oil cooler. On the seawater side, clean the tube with a brush (optional).

● Precautions for inspection and servicing

- Scale and rust caused by seawater adhere inside the cooling tube 2 to decrease the cooling effect. Disassemble and inspect the cooling tube and use "Weston K-1" to eliminate scale and rust.
- Scale and rust caused by freshwater adhere outside the cooling tube to decrease the cooling effect. Be sure to use rust inhibitor.
- If dirt is adhered to the filler cap 12, you cannot close it completely and freshwater decreases. Inspect and remove dirt and scale.
- Use the new gaskets and the O-rings.
- For tightening the bolts, refer to P164 [Tightening Torque for Major Bolts and Nuts].
- After installing the freshwater cooler, do a water pressure test of the cooling tube.



NOTICE

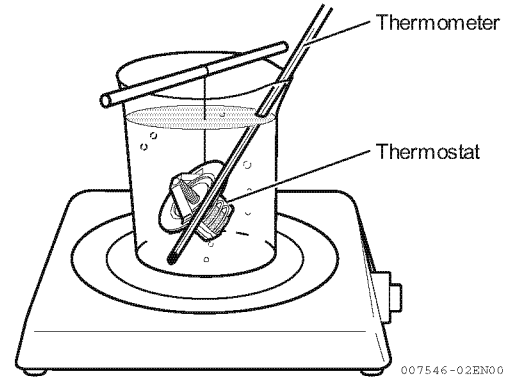
Use antifreeze in cold conditions.

● Freshwater thermostat inspection

Put the thermostat (element) 16 in a container of water. Insert the thermometer and heat the water. If the valve opens at the opening temperature and fully opens at the full opening temperature, it is in the good condition. If the valve is damaged, replace it with a new one. Keep the thermostat away from the heat source. Put a plate in the bottom, support it with a wire, or hang it.

NOTICE

- Inspect the thermostat seat surface for wear and corrosion.
- Use the new O-rings and the gaskets.
- For tightening the bolts, refer to P164 [Tightening Torque for Major Bolts and Nuts].



Thermostat (element)	
Valve opening temperature	74°C
Full opening temperature	86°C
Valve lift	Approximately 9.5 mm at the full opening temperature
Installation No.	2 pcs

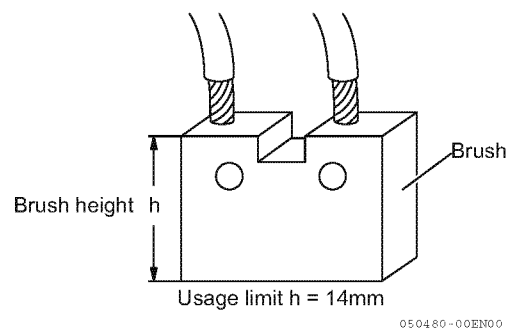
Electric Equipment

■ Starter

● Maintenance inspection

Perform these checks when you do a maintenance inspection.

- Wire harness looseness
- Motor brush height



■ Stop solenoid

● Maintenance inspection

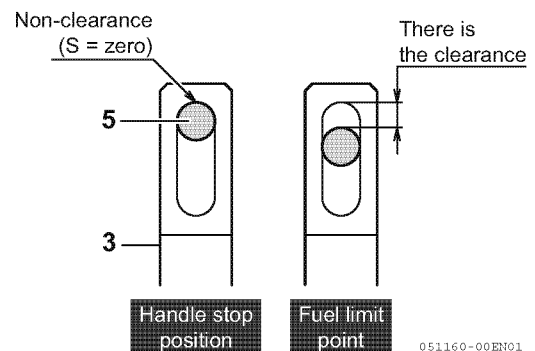
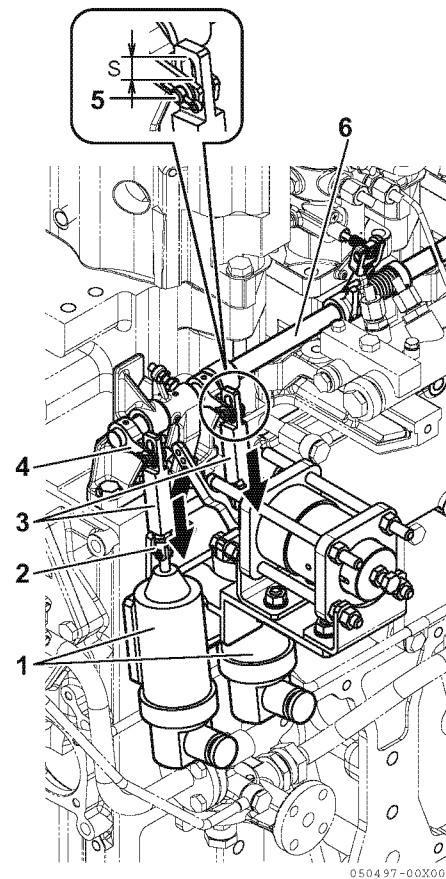
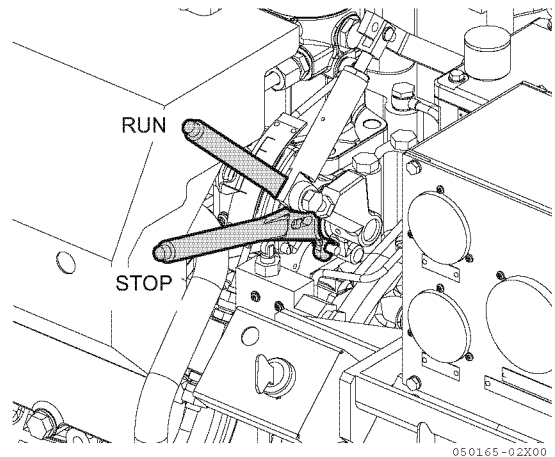
Perform these checks when you do a maintenance inspection.

- Wire harness looseness
- Inspecting and adjusting the linkage system

● Adjust

There are 2 sets of stop solenoid. Follow these instructions to adjust both sets.

1. Install the stop solenoid 1. Loosen the locknut of the joint-A 2.
2. Set the start/stop handle to STOP.
3. Insert the shaft of the stop solenoid at full stroke (to the position where the solenoid is fully pulled).
4. At that time, screw the joint-B 3 into the joint-A 2 (or slide the solenoid) to adjust so that the clearance S between the slot of the joint -B 3 and the straight pin 5 of the solenoid lever 4 becomes zero. This is the stop position of the solenoid.
5. Release the shaft of the solenoid and set the start/stop handle to RUN.
6. Insert the rack to the fuel limit point (refer to Records of Shop Trial).
7. At that time, make sure that there is the clearance S between the slot of the joint-B 3 and the straight pin 5 of the solenoid lever 4. Without this clearance, you cannot operate the engine at maximum output.
8. Tighten and lock the locknut of the joint-A 2.
9. Operate the engine at maximum actual output.
10. Excite the 2 sets of stop solenoid and make sure that the engine stops correctly.



■ Pressure temperature switch

Make sure at regular intervals that the lubricating oil pressure switch operates with standard temperature.

Standard actuation pressure	0.2 MPa ± 0.03 MPa
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Make sure at regular intervals that the cooling water temperature switch operates with standard temperature.

Standard actuation temperature	95 °C ± 2 °C: ON 90 °C ± 2 °C: OFF
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■ Freshwater temperature meter

With the water temperature sender unit and the freshwater temperature meter connected, measure at regular intervals the difference between the actual temperature (measure with a mercury thermometer) and the indicated temperature.

- If the difference is more than ± 8 °C, replace the freshwater temperature meter or the water temperature sender unit.
- Test voltage: DC 24 V

■ Engine lubricating oil pressure meter

Connect the hydraulic pressure sender unit and the engine lubricating oil pressure meter. Compare the indicated value with the actual pressure (integrated Bourdon tube pressure gauge) at regular intervals.

- If the difference is more than ± 0.05 MPa, replace the engine lubricating oil pressure meter or the hydraulic pressure sender unit.
- Test voltage: DC 24 V

■ Tachometer

Connect the tachometer sensor and the tachometer. Measure the rotation speed. Compare it with the rotation speed that is shown on the standard speed gauge (not a standard installation).

If the difference at rated speed is more than the standard value, replace the tachometer.

Standard value (min⁻¹)	Rated engine rotation speed			
	at 20 °C	+100 -0	at -20 °C to +60 °C	+150 -50

Do these checks when the tachometer indicates 0 (zero) during operation.

- Check the clearance between the tachometer sensor and the flywheel ring gear.

Standard value (mm)	0.5 to 0.8
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If the clearance is too large, adjust it in the instructions that follow.

1. Turn the flywheel until you can see the teeth of the ring gear in the center of the sensor installation hole.
2. Be careful not to damage the tip of the sensor. Screw the sensor slowly until it is in contact with the ring gear.
3. Return the flywheel by a 1/3 turn and lock it with a locknut. (Screw pitch = 1.5 mm)

- Check the wiring for looseness.

If you find looseness, re-tighten it.

- Remove the tachometer and check the tip of the sensor for breakage.

If you find breakage, replace the sensor assembly.

- If you cannot find the above defects, replace the sensor assembly or the tachometer.

■ Battery

● How to operate the battery

After you filled and charged the battery, the battery has a lot of electricity. Obey the instructions that follow to use it correctly and safely.

● Installing the battery

1. If the terminals on the battery or the cable have oxidation, polish them with sandpaper or a wire brush.
2. Check the top of the battery bracket for sand or small stones. Put it on the specified location.
3. Fix the battery equally and gradually with fixing metals to prevent a one-sided tightening.
4. When you connect a cable, connect it to the positive side first.
5. Do not hit the terminal with a tool.
6. To avoid oxidation of the terminal, apply a thin layer of grease or Vaseline to the surface of the terminal. You can also spray a corrosion inhibitor (oxidation inhibitor) on the terminal.

● Removing the battery

When you remove the battery, first remove the cable, then remove the fixing metal.

- When you remove a cable, first remove it on the grounding side.
- Carefully put down the removed battery on even ground. Make sure that there are no small stones etc.

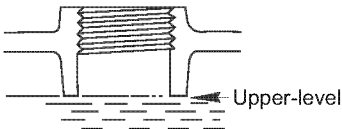
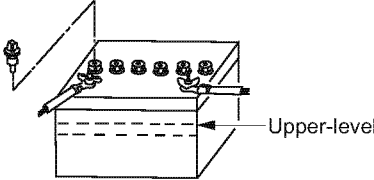
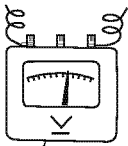
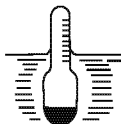
● Storing the battery

- The battery discharges over time. Keep it in a cold and dark area.
- Keep the battery charged.

Summer (monthly average temperature above 15 °C): at intervals of 1 month

Winter (monthly average temperature below 15 °C): at intervals of 2 months

● Storing the battery in use

Handling Part	Instruction	Precaution
Fluid level	Fill with purified water to the top level. Fluid level (top level)   053194-00EN00	Do not fill too much.
Battery charge	If the specific gravity is less than 1.220 or the battery tester indicates yellow or red, charge the battery.  Battery tester (voltmeter)  Hydrometer 053195-00EN00	Be careful of sulfuric acid and sparks.
Terminals	If a terminal has oxidation, polish it with sandpaper or a wire brush. Polish the inner surface of the terminal on the cable side with the same procedure.	When you remove a cable, first remove it on the grounding side. When you connect a cable, connect it to the positive side first.
Fixing frame	If the battery is loose, tighten it.	Do not cause sparks.
External view of the battery	If the part is dirty, wash it with freshwater. If the part has cracks, replace it. If the part has deformation, find the cause and repair it.	If you disconnect the battery, do not cause a spark.
Filler plug	If the part is loose, tighten it. Make sure that the exhaust gas hole is not clogged. In case of loss of the filler plug, replace it with an equivalent part.	Do not use a plug made of cork, wood or metal.

■ Digital thermometer

The exhaust gas inlet and the exhaust outlet of the turbocharger have digital thermometers. A battery is necessary to operate a digital thermometer.

The digital thermometer uses one special-purpose lithium battery. Replace the battery, if

- the battery charge mark is repeatedly displayed
- the temperature is not displayed
- the temperature is dimly displayed.

Obey these instructions when you replace the battery:

● Replacing the battery

1. Removing the upper cover

Loosen the screws 6 that are locking the upper cover 1 with a M3 Phillips head screwdriver. Then remove the upper cover while caring not to drop it. (You cannot fully remove the screw.)

2. Removing the connector

Pinch the tip of the connector 4 of the lead wire 7 coming out from the battery holder 3 and pull it up from the PCB to remove it. Never pull the lead wire when you remove the connector. It will cause disconnection.

3. Removing the battery holder

Pinch the battery holder and lift it up above the cover to remove it.

4. Opening the battery holder

The battery holder 3 has a shell structure with a hinge on one side. Pull the pawl of the battery holder outside like opening the shell to open the battery holder. The battery 2 comes out at this time. Care must be taken not to drop it.

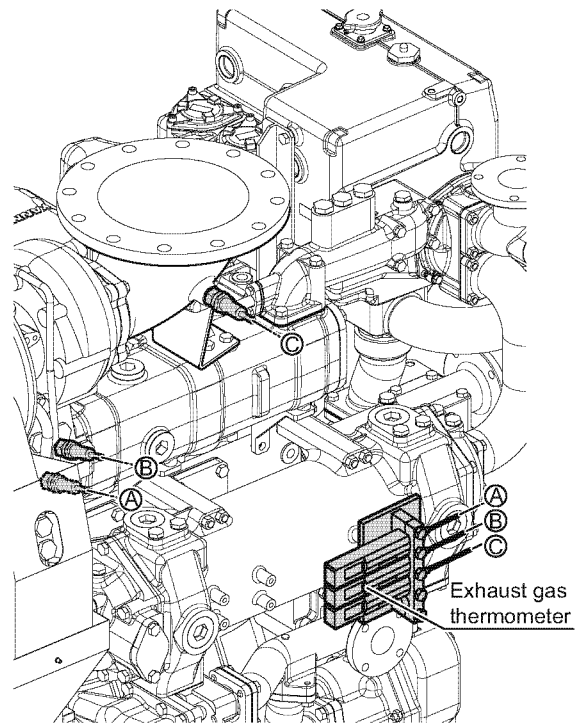
5. Replacing the battery

Insert the new battery 2 to the battery holder 3. There are "+" and "-" marks inside the battery holder to show the polarity. Care must be taken not to insert the battery in the incorrect polarity. (The red lead wire side is "+" and the black lead wire side is "-".)

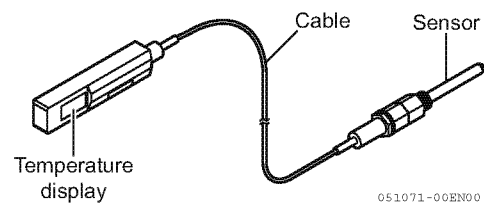
If you insert the battery in the incorrect polarity, a defect can occur.

6. Closing the battery holder

Close the battery holder while making sure that the pawl of the holder is securely stuck. (Check that



050164-01EN00



051071-00EN00

the pawl is stuck with a click sound). If you insert the battery in the incorrect polarity, the holder does not close completely. Check that the battery is inserted in the correct polarity.

7. Inserting the battery holder

Store the battery holder in the body case 5.

8. Setting the system voltage to 0V

Touch the connector polarity on the board with a screwdriver for approximately 3 seconds before inserting the connector 4. This is to secure the system reset at the time of inserting the connector (the system voltage must be cleared to 0V).

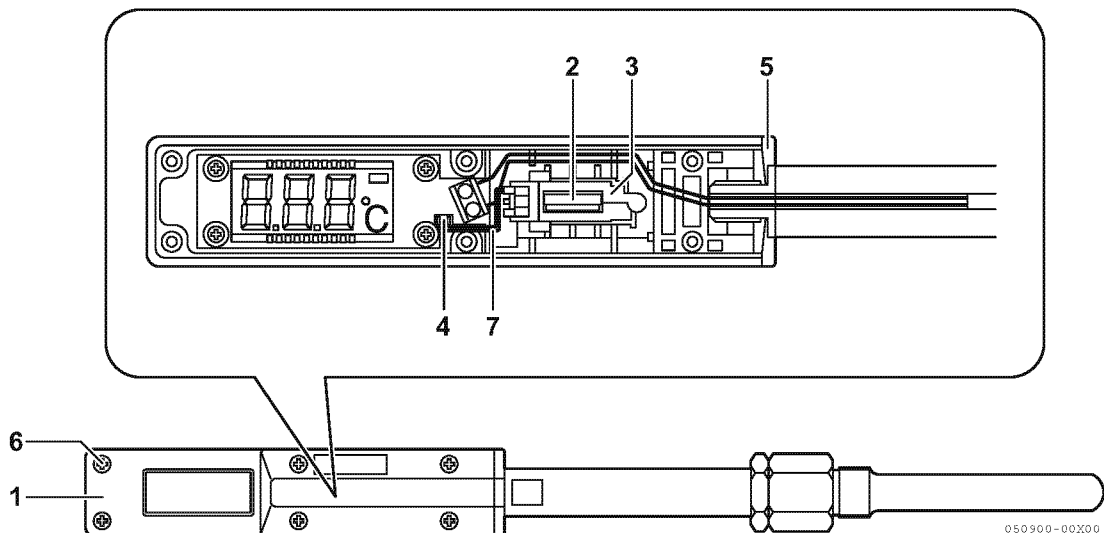
9. Inserting the connector

Insert the connector on the tip of the lead wire 7 attached in the battery holder 3 to the connector of the printed circuit board. The connector has a polarity. You cannot insert the connector in a reverse direction. If you find it difficult to insert the connector, do not forcibly insert the connector and check the polarity. (Care must be taken not to pinch the lead wire when you close the upper cover).

10. Closing the upper cover

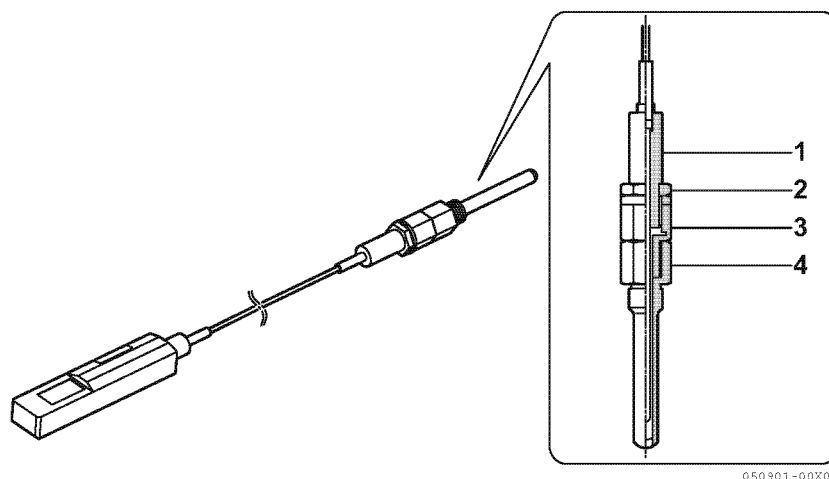
Install the upper cover 1 to the body case 5.

Tighten the screws 6 equally. (Standard tightening torque: 0.4 N·m) If the tightening of the screws is inappropriate, the front cover may be removed while using. It can cause an accident.



● Installing the temperature sensor

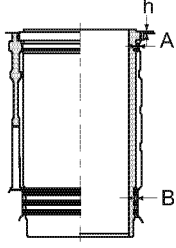
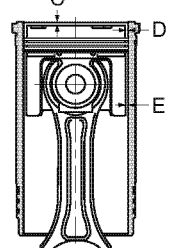
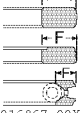
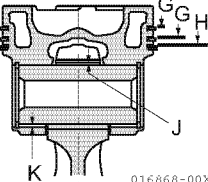
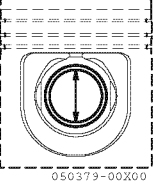
1. Remove the protective tube 4 and the joint 3 from the thermometer. The protective tube and the joint are attached with left-handed threads.
2. Install the protective tube to the thermostat seat.
3. Screw the joint into the protective tube for 2 to 3 turns (approximately 5 mm). The thread is left-handed.
4. Put the temperature sensor 1 with the locknut 2 attached into the joint.
5. Do not turn the temperature sensor. Turn the joint counterclockwise. When the joint is screwed into the protective tube, the temperature sensor is also screwed into the joint. Screw the joint into the protective tube until it is seated.
6. Tighten the locknut. Be careful not to twist the temperature meter cable.



STANDARD MAINTENANCE TABLE

Standard Maintenance Table

Unit: mm

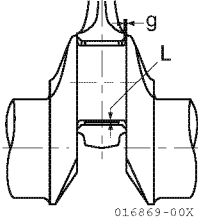
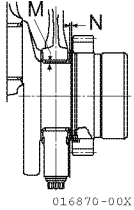
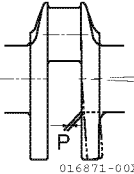
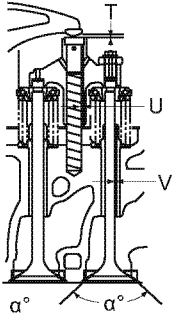
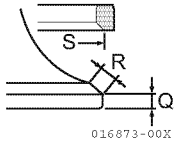
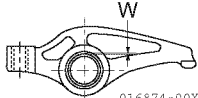
Part name		Standard dimensions		At installation Standard clearance	Max. allowable clearance	Usage limit of parts	Drawing
		Nominal dimension	Toler- ance				
Cylinder and cylinder liner	Inner diameter of the top part of the cylinder block (top)	198	+0.046 0	A=0.025 to 0.101			 016865-00X
	Outer diameter of the cylinder liner (top)		-0.025 -0.055				
	Inner diameter of the top part of the cylinder block (bottom)	194	+0.046 0	B=0.015 to 0.101			
	Outer diameter of the cylinder liner (bottom)		-0.015 -0.055				 016866-00X
	Ejection of the cylinder liner			h=0.05 to 0.11	h=0.11		
	Top clearance	1.9	±0.1	C=1.80 to 2.11	2.11		
	Inner diameter of the cylinder liner	Ø 170	+0.025 -0.005			+0.5 ^{*1} Wear value 0.25	
	Outer diameter of the piston head	Ø 166.308	±0.015	D=3.672 to 3.732			
	Outer diameter of the piston skirt	Ø 169.938	±0.015	E=0.042 to 0.102	E=0.21	0.27	
Piston, piston pin and rings	Thickness of the piston rings	No.1=5.35 No.2=5.35	± 0.15			No.1F=5.2 No.2F=5.2 ^{*2}	 016867-00X
	Thickness of the oil rings	3.2	±0.15			F=3.05	
	Width of the piston ring	No.1=3.0 No.2=3.0	-0.02 -0.035		G=0.3	No.1=-0.21 No.2=-0.21	 016868-00X
	Width of the piston ring groove	No.1=3.0	+0.12 +0.10	G=0.120 to 0.155		+0.27	
		No.2=3.0	+0.09 +0.07	G=0.090 to 0.125		+0.27	
	Width of the oil ring groove	4	-0.01 -0.03	H=0.03 to 0.07	H=0.24	-0.13	
	Width of the oil ring groove		+0.040 +0.020			+0.22	
	Inner diameter of piston pin bearing	Ø 70	+0.092 +0.065	J=0.065 to 0.105	J=0.25	+0.18	 050379-00X
	Outer diameter of the piston pin		0 -0.013				
	Inner diameter of the piston pin hole *3		+0.040 +0.025	K=0.025 to 0.053	K=0.1	+0.09	
	Outer diameter of the piston pin		0 -0.013			-0.09	

*1: This is the limit for the position of ring no. 1 when the piston is at top dead center.

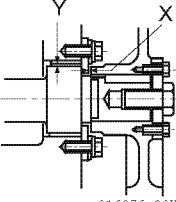
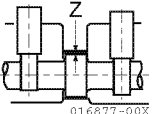
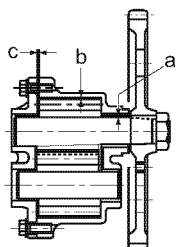
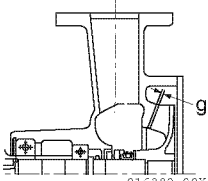
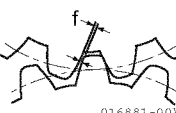
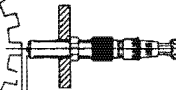
*2: Replace the ring no. 2 when the taper face is gone.

*3: Measure the inner diameter of the piston pin hole vertically. The piston pin boss has a horizontal recess.

Unit: mm

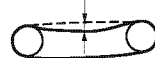
Part name		Standard dimensions		At installation Standard clearance	Max. allowable clearance	Usage limit of parts	Drawing
		Nominal dimension	Toler- ance				
Crankshaft	Inner diameter of the crank pin bearing	Ø 130	+0.165 +0.1	L=0.10 to 0.19	L=0.22	+0.18	 016869-00X
	Outer diameter of the crankpin		0 -0.025			Uneven wear 0.1	
	Length of the crank pin	68	+0.15 +0.05	g=0.35 to 0.55	g=0.7		
	Large end width of the connecting rod		-0.30 -0.40				
	Inner diameter of the main bearing	Ø 150	+0.139 +0.074	M=0.074 to 0.164	M=0.2	+0.18	 016870-00X
	Outer diameter of the main shaft		0 -0.025			Uneven wear 0.1	
	Width of the base part main bearing	60	-0.02 -0.04	N=0.19 to 0.34	N=0.42		 016871-00X
	Width of the thrust bearing	4	-0.085 -0.135				
	Width of the base part main bearing	68	+0.030 0	Adjustment value P=0 to 0.023 (engine is cold)	Maximum allowed P=0.033 (engine is cold)		
	Deflection						
Valve mechanism	Valve head clearance (intake/exhaust)			T=0.3 (intake) T=0.6 (exhaust)	T=0.3 (intake) T=0.6 (exhaust)		 Intake = 120 deg. Exh. = 90 deg. 016872-00E
	Outer diameter of the intake valve	Ø 12	-0.050 -0.070	V=0.060 to 0.096	V=0.23	-0.20	
	Inner diameter of the intake valve guide		+0.026 +0.010			+0.16	
	Outer diameter of the exhaust valve	Ø 12	-0.060 -0.080	V=0.070 to 0.106	V=0.23	-0.20	
	Inner diameter of the exhaust valve guide		+0.026 +0.010			+0.16	
	Outer diameter of the valve bridge rod	Ø 14	+0.046 +0.028	U=0.014 to 0.052	U=0.2	-0.07	
	Inner diameter of the valve bridge guide		+0.080 +0.060			+0.18	
	Thickness of the intake/exhaust valve	Q=2.9 (intake) 2.0 (exhaust)				Q=2.5 (intake) 1.6 (exhaust)	 016873-00X
	Width of the intake/exhaust valve seat	R=5.4 (intake) 5.7 (exhaust)				R=6.0 (intake) 6.1 (exhaust)	
	Diameter of the contact part of the valve sheet	R=5.5 (intake) 5.6 (exhaust)	±0.1			S=55.5 (intake) 56.5 (exhaust)	 016874-00X
	Outer diameter of the rocker arm shaft	Ø 36	-0.009 -0.034	W=0.029 to 0.119	W=0.2	-0.12	
	Inner diameter of the rocker arm bush		+0.085 +0.020			+0.18	

Unit: mm

Part name		Standard dimensions		At installation Standard clearance	Max. allowable clearance	Usage limit of parts	Drawing
		Nominal dimension	Toler- ance				
Camshaft	Outer diameter of the camshaft (datum part)	Ø 104	-0.072 -0.107	Y=0.072 to 0.202	Y=0.27	-0.20	
	Inner diameter of the camshaft base part bearing		+0.095 0			+0.28	
	Clearance of the camshaft base part thrust			X=0.15 to 0.23	X=0.38		
	Outer diameter of the camshaft middle portion	Ø 104	-0.072 -0.107	Z=0.072 to 0.202	Z=0.27	-0.20	
	Inner diameter of the camshaft middle portion bearing		+0.095 0			+0.28	
Lubricating oil pump	Outer diameter of the lubricating oil pump shaft	Ø 30	-0.040 -0.053	a=0.040 to 0.074	a=0.15		
	Inner diameter of the lubricating pump shaft bush		+0.021 0				
	Clearance on the outer circumference of the case and gear			b=0.20 to 0.296	b=0.50		
	Width of the pump case	Ø 84	+0.054 0	c=0.072 to 0.161	c=0.20		
	Width of the pump gear		-0.072 -0.107				
Clearance between the cooling water pump and impeller				g=0.5 to 1.5	g=1.8		
Transmission gear	Gear backlash	Timing gear M=4.5		f=0.15 to 0.25	f=0.4		
	Outer diameter of the camshaft idle gear shaft	Ø 100	-0.036 -0.071	0.036 to 0.106	0.2	-0.17	
	Inner diameter of the bush		+0.035 0			+0.14	
	Opposite side of the flywheel	Ø 80	-0.030 -0.060	0.030 to 0.090			
	Outer diameter of the idle gear shaft		+0.030 0				
Other	Clearance between the tachometer sensor (magnetic pickup) and ring gear	-	-	0.5 to 0.8	0.8	-	

Standard Adjustment Value

■ Standard Adjustment Value

Adjustment item				Adjustment value			Remarks
Valve clearance (engine is cold)	Intake valve			0.3 mm			
	Exhaust valve			0.6 mm			
Intake valve	Open	Crankshaft angle before TDC		60°± 2°			
	Closed	Crankshaft angle after BDC		6°± 2°			
Exhaust valve	Open	Crankshaft angle before BDC		70°± 2°			
	Closed	Crankshaft angle after TDC		40°± 2°			
Injection timing	Crankshaft angle before TDC FIC			8° to 10° / 6.5° to 8.5°			1450 / 1405 min ⁻¹
Pressure	Fuel injection starting pressure			35 MPa ± 0.5 MPa			
	Engine lubricating oil pressure			0.5 MPa to 0.6 MPa			
	Marine gear lubricating oil pressure			0.25 MPa ± 0.05 MPa			
	Marine gear hydraulic oil pressure		When engaged	3.4 MPa ± 0.05 MPa / 3.5 MPa ± 0.05 MPa			YXH(2)-500 / YXH-500L
			At neutral	0.3 MPa ± 0.01 MPa / 0.5 MPa ± 0.1 MPa			Standard/ electronic trolling
Temperature	Freshwater			75 °C to 85 °C			
	Engine lubricating oil			70 °C or less			
Top clearance				1.80 mm to 2.11 mm			
Engine freshwater full				Engine body: total 85 ℓ			
Engine lubricating oil capacity		Total		200 ℓ			
		Effective		80 ℓ			
Marine gear lubricating oil capacity		Total		YXH-500: 22 ℓ	YXH2-500: 22 ℓ	YXH-500L: 45 ℓ	
		Effective		YXH-500: 1 ℓ	YXH2-500: 1 ℓ	YXH-500L: 1 ℓ	
Alternator drive V-belt tension				Deflection: approx. 4 mm			When pushed with the 6.5N V-belt force 

TIGHTENING TORQUE FOR MAJOR BOLTS AND NUTS

■ Tightening Torque for Major Bolts and Nuts

NOTICE

- Tighten the major bolts with the specified method.
- Unless otherwise specified, apply lubricating oil on the thread and bearing surface. Then tighten the bolt or nut.
- Parts with a star in the following tables have a match mark. But when you tighten such a part, do not refer to the match mark. Tighten it to the specified torque, specified tightening angle or specified hydraulic pressure.

No.	Name	Thread diameter x pitch	Face-to-face width of bolt or nut mm	Tightening torque N·m	Remarks
1	Head bolt	M22 × 1.5	30	590 ± 30	Refer to P166 for the tightening method.
2	Head auxiliary bolt	M14 × 1.5	19	91 to 99	
3	Main bearing bolt (studded side)	M27×2.0	-	530 ± 30	
4	★ Main bearing nut	M27×2.0	41	-	Refer to P166 for the tightening method.
5	Side bolt	M18×1.5	27	295 ± 10	Refer to P167 for the tightening method.
6	★ Rod bolt	M24×1.5	32	-	Refer to P110 for the tightening method.
7	★ Balance weight bolt	M22×1.5	24	-	Refer to P124 for the tightening method.
8	Flywheel tightening bolt	M22 × 1.5	27	640 ± 30	
9	Cam gear mounting bolt	M14×1.5	19	137 ⁺²⁰ / ₀	
10	Flywheel side Idle gear support mounting bolt	M18 × 1.5	24	235 ⁺²⁰ / ₀	
11	Opposite side of the flywheel Idle gear support mounting bolt	M14 × 1.5	19	137 ⁺²⁰ / ₀	
12	Rocker arm shaft support tightening nut	M12 × 1.75	17	54 ⁺¹⁰ / ₀	
13	Swing arm tightening bolt	M16 × 1.5	24	118 ⁺²⁰ / ₀	
14	Piston cooling nozzle mounting bolt	M16 × 1.5	22	49 ⁺⁵ / ₀	
15	Fuel injection valve retaining nut	M14 × 1.5	22	100 ⁺⁵ / ₀	
16	Fuel injection valve retaining stud bolt	M14 × 1.5	-	100 ⁺¹⁰ / ₀	
17	Nozzle mounting nut	M28 × 1.5	27	166 ± 10	

No.	Name	Thread diameter x pitch	Face-to-face width of bolt or nut mm	Tightening torque N·m	Remarks
18	Nozzle sleeve	M28 × 1.5	-	235 $^{+10}_0$	
19	LOP drive gear tightening nut	M24 × 2.0	36	170 ± 10	
20	Fuel injection pressure adjusting nut	M35 × 1.5	41	100 ± 3	
21	High-pressure fuel pipe joint (pump side)	M10 × 1.5	Hex-socket 8	30 to 34	
22	Fuel injection pipe (cap nut - high-pressure pipe joint)	M18 × 1.5	24	70 to 80	
23	Fuel injection pipe (cap nut - sleeve)	M28 × 1.5	36	90 to 100	
24	Fuel injection pipe sleeve (fuel oil valve side)	M18×1.5	24	50 to 55	
25	Fuel injection pump mounting bolt	M12 × 1.75	17	52 to 56	
26	Damper tightening bolt	M20 × 1.5	22	392 ± 20	
27	Intake bend tightening bolt	M12 × 1.75	19	52 to 56	
28	Air cooler tightening nut	M12 × 1.75	19	52 to 56	
29	Cooling water passage pipe tightening bolt	M10 × 1.5	17	29 to 32	
30	Oil pan tightening bolt	M10 × 1.5	17	29 to 32	
31	Engine mounting foot tightening bolt	M16 × 1.5	24	139 to 150	

Tightening method for the connecting rod bolt (angular tightening)

Obey the P110 [Tightening the connecting rod bolt (angle tightening)] order to tighten the bolt.

● When you reuse the bolt

1. Apply Protec grease or Protec oil to the thread and bearing surface of the rod bolt.
2. Tighten the bolt to a seating torque of 50 N·m ± 5 N·m.
3. Tighten to the match mark in 3 steps (intermediate angles: 40° and 80°) and alternatively.

● When replacing the bolt with a new one

1. Apply Protec grease or Protec oil to the thread and bearing surface of the rod bolt.
2. Without the crank pin bearing, tighten to approximately 110° for a break-in.
3. Tighten the bolt to a seating torque of 50 N·m ± 5 N·m.
4. Tighten the top and bottom connecting rod bolts to the specified tightening angle of 110°. Do it alternatively in 3 turns (intermediate angles: 40° and 80°).

Use the attached angle gauge

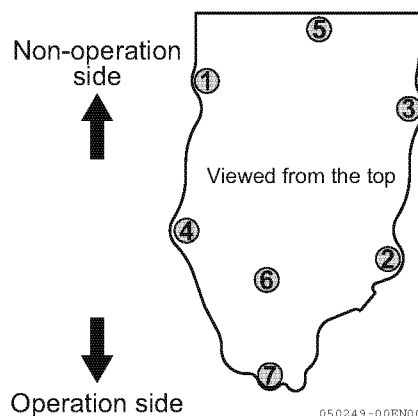
5. Align and make a match mark on the large end of the connecting rod marking line.

Cylinder head bolt tightening method

(Tightening in 3 steps)

- Apply Protec grease or Protec oil to the thread of the cylinder head bolt.
- Follow the tightening order shown on the right figure and tighten the bolts in the order shown on the following table.

Procedure	Tightening torque	
	N·m	
Bolt type	Head bolts 1 to 6 (M22 × 1.5)	Auxiliary bolt 7 (M14 × 1.5)
1st time	150 ± 20	Do not tighten
2nd time	350 ± 20	50 ± 3
3rd time	590 ± 30	95 ± 4



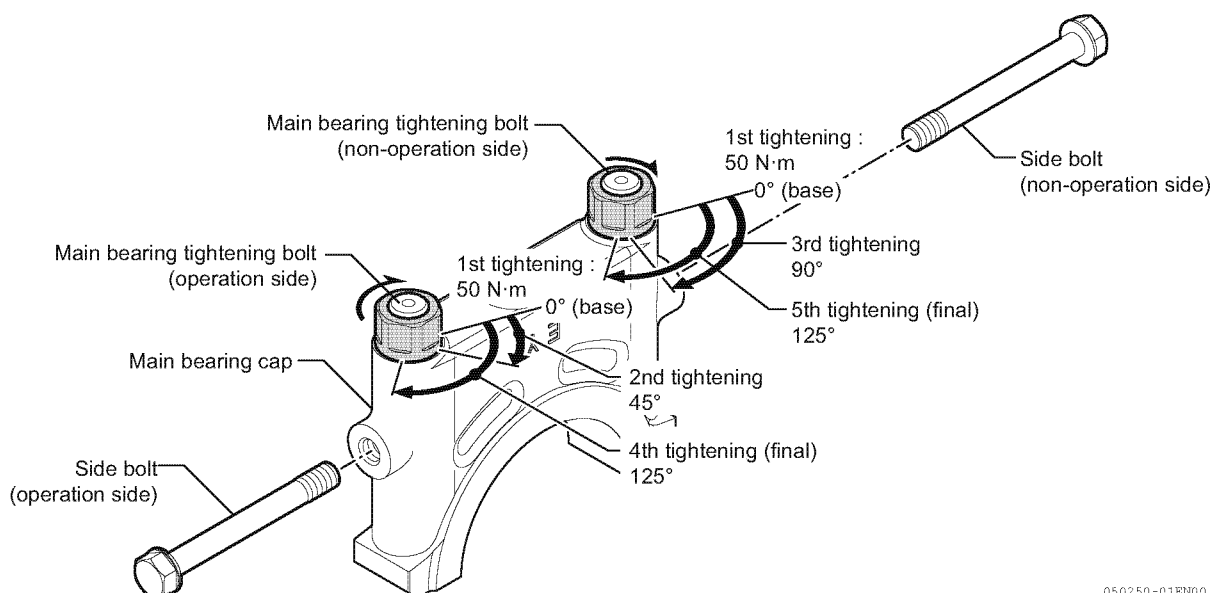
(Cylinder head bolt tightening order)

Tightening method for the main bearing nut (angular tightening)

- Apply Protec grease or Protec oil to the thread and bearing surface of the main bearing nut.
- Follow the tightening order shown on the right figure and tighten the bolts in the order shown on the following table.

Procedure	Tightening nut	Tightening torque and angle
1st tightening	Operation side and non-operation side	Seating torque 50 N·m ± 5 N·m
2nd tightening	Operation side	Approx. 45°
3rd tightening	Non-operation side	Approx. 90°
4th tightening	Operation side	125° (final)
5th tightening	Non-operation side	125° (final)

- Refer to P121 [How to make a nut match mark].
Use an "angle gauge" for tightening angle.



Tightening method for the main bearing side bolt (tighten the side bolt after tightening the main bearing nut)

- Apply Protec grease or Protec oil to the thread and bearing surface of the main bearing side bolt.

Procedure	Tightening bolt	Tightening torque
		N·m
1st tightening	Operation side	100
2nd tightening	Non-operation side	215
3rd tightening	Operation side	295 ± 10
4th tightening	Non-operation side	295 ± 10

NOTICE

- Install the main bearing so that the mark (EY) is displayed on the opposite side of flywheel.
- The bolts must be installed in the same positions. When you use an equivalent bolt shipped from the factory, use the same procedure as described above. However, align the main bearing nuts to the match mark when you tighten them. Tighten them gradually and alternately. After you tighten them, make sure that the match mark on the nut is 0 mm to 0.5 mm ahead of the match mark on the main bearing cap in the direction of tightening.

■ General bolt tightening torque

Thread diameter	mm	M6	M8	M10	M12	M14	M16	M18
Pitch	mm	1.0	1.25	1.5	1.75	1.5	1.5	1.5
Face-to-face width	mm	10	13	17	19	22	24	27
Tightening torque	N·m	6 to 7	15 to 16	29 to 32	52 to 56	91 to 99	139 to 150	202 to 218

- For general bolts (nuts), do not apply lubricating oil to the thread and the bearing surface.
- When a female side is of aluminum, use 80 % of the value shown in the above table.
- Each standard tightening torque shown in the above list applies only to bolts with a "7" mark on the head (strength class: 7T/S45C).

■ Pipe joint bolt tightening torque

Thread diameter	mm	M8	M12	M14	M16	M18	M20	M22
pitch	mm	1.25	1.25	1.5	1.5	1.5	1.5	1.5
Face-to-face width	mm	14	17	19	22	24	27	30
Tightening torque	Carbon steel	N·m	12 to 17	25 to 34	39 to 49	49 to 59	69 to 78	88 to 98
	Brass		8 to 12	18 to 25	27 to 34	34 to 41	48 to 55	62 to 69
			147 to 196					98 to 137

TEST OPERATION AFTER SERVICING

Make sure to operate the engine for a test after servicing in the instructions that follow.

■ Checks after assembly

- Check that all bolts and nuts are securely tightened and locked.
Pay special attention to inside of the engine where it can be difficult to check visually during operation.
- Check all parts of the engine for defects when you turn the flywheel or do a priming.
- Check that the turning device and the turning bar are back to GEAR OUT.
- Record your servicing and inspection details and the replaced parts on the service chart.

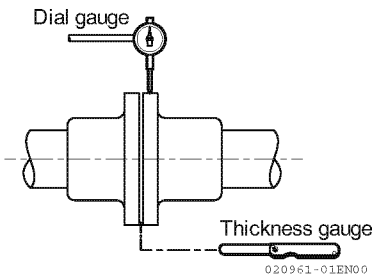
■ Checks before operation

- For fuel oil, lubricating oil, and cooling water, refer to P26 [Fuel Oil, Lubricating Oil & Cooling Water] and use those recommended by YANMAR.
- Drain the fuel filter, water separator, and fuel tank.
- Ventilate the engine room well.

■ Checks after installation

When you install the engine, measure the shaft center with the propeller shaft (or intermediate shaft).

Evaluation standards		Measurement tools
Deviation from center	0.05 mm or less	Dial gauge
Face runout	0.05 mm or less	Thickness gauge



■ Checks before operation

Check P31 [Operation] and obey the instructions that follow.

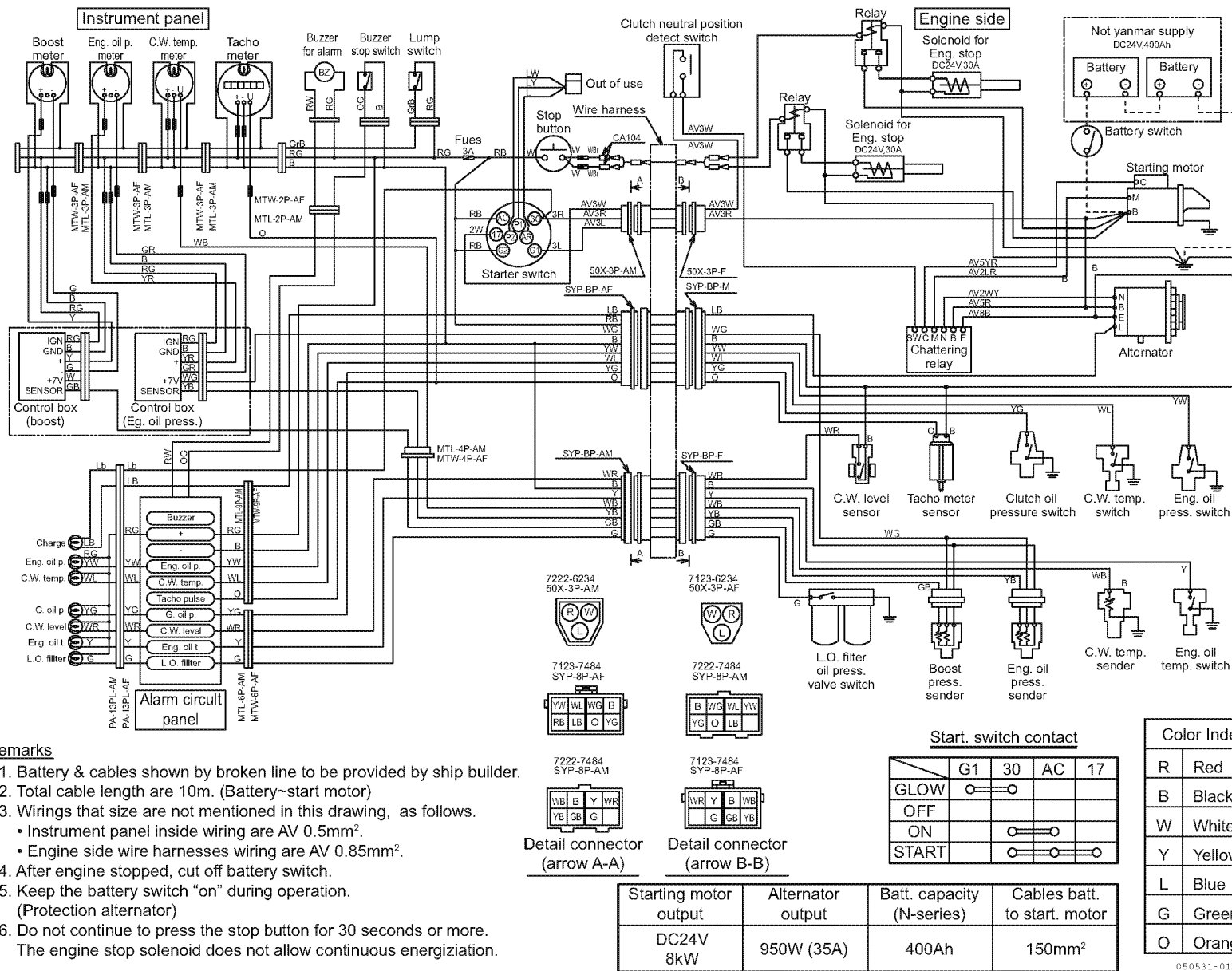
■ Test operation procedures

Item	Procedure	Precautions
1 Checks before operation	1. Check and refill the fuel system	
	1- Clean the fuel tank, fuel oil pipes and other interior parts with kerosene, diesel oil or fuel oil.	
	2- Fill the fuel tank with clean fuel oil that is free of water and dirt.	Dirt, dust and water content can damage the parts in the fuel system.
	3- Bleed the air from the fuel oil system. Bleed the fuel filter, water separator, and primary filter in the piping.	Make sure that you fill with correct fuel oil.
	2. Check refill the lubricating oil	
	1- Check the oil pan that collects oil for contamination with drainage, water or fuel. Clean if necessary.	Do not let dust and water content enter the fuel system.
	2- Remove the filler port (yellow), and fill with engine lubricating oil. Fill with lubricating oil to the top line of the dipstick.	Engine lubricating oil capacity (in the oil pan) Total capacity: 200 ℓ
	3- Make sure that you turn the flywheel. This sends lubricating oil to all lubrication points. In this case, check the dipstick again and fill with lubricating oil to the top line of the dipstick.	The moving part can be seized up by lack of oil. It can cause an accident.
	4- Fill with lubricating oil to the marine gear side.	Total capacity for YXH-500: 22 ℓ Total capacity for YXH2-500: 22 ℓ Total capacity for YXH-500L: 45 ℓ
	3. Check and refill the cooling water	
	1- Close the water drain cock before you fill the freshwater.	
	2- Remove the filler cap of the freshwater cooler. Fill water until it overflows from the filler.	Water consumption: 85 ℓ
	3- Close the seawater drain cock.	
	4- Tighten the side cover bolt of the seawater pump.	
	5- Open the Kingston cock.	
	4. Check that the alarm device operates correctly.	
	5. Operate the remote controller handle and check that the engine side passive part operates correctly.	
	6. Lubricating engine components •Ball joints of the remote control cables (governor and clutch)	

Item	Procedure	Precautions
2 Warm-up operation	1. The air heater pre-heats the intake air warmer when in cold operating conditions. This makes the engine start easier. Energize the air heater for 20 to 30 seconds and start the engine. (Option)	
	2. Check for water and oil leaks when you start the engine. Check for gas leaks, lubricating oil pressure and hydraulic oil pressure when you start the engine. •Check the discharge of cooling water (seawater) •Check the engine vibration and unusual sounds	• Engine lubricating oil pressure 0.5 MPa to 0.6 MPa • Marine gear lubricating oil pressure 0.25 MPa $\pm$ 0.05 MPa • Marine gear hydraulic oil pressure (when engaged) YXH-500, YXH2-500: 3.4 MPa $\pm$ 0.05 MPa YXH-500L: 3.5 MPa $\pm$ 0.05 MPa • If there is a failure, check the piping system. • If there is a defect, stop the engine and check it.
	3. Do a low speed operation (warm-up operation) at no load. Check that the gauge for the cooling water temperature shows 40°C (left end) or more.	Do not increase to the high speed suddenly. • Avoid the operation in the speed range of the resonance.
3 Cruise operation (load operation)	1. Do not operate the engine at full load suddenly. Gradually increase the engine to the rated speed in 10 minutes or so.	Check the engine for unusual heat and unusual sounds.
	2. Do a running-in.	Do not operate the engine under unfavorable conditions including sudden acceleration and overload operation.
	3. Check the difference of exhaust temperature.	A difference of exhaust temperature between the cylinder outlets is normal if it is less than 40 °C.
	4. Check the marine gear.	
	5. Do an idling operation at least once every 4 hours if you operate your boat at low speeds for a long time.	Turn off the marine gear to operate the remote controller.
4 Engine stop	1. Set the clutch to neutral. Operate the engine at no load for approximately 5 minutes.	If you stop the engine suddenly at high speed, the temperature of engine components increases.
	2. Turn off the battery switch.	
5 Checks after stopping	1. Re-check water and oil leaks.	The oil seal in particular.
	2. Check the bolts and nuts for looseness.	The engine installation parts in particular.
	3. Close the Kingston cock and the fuel cock.	
	4. Drain the cooling water if the cooling water can freeze because of cold weather.	Drain the water from the seawater pump.

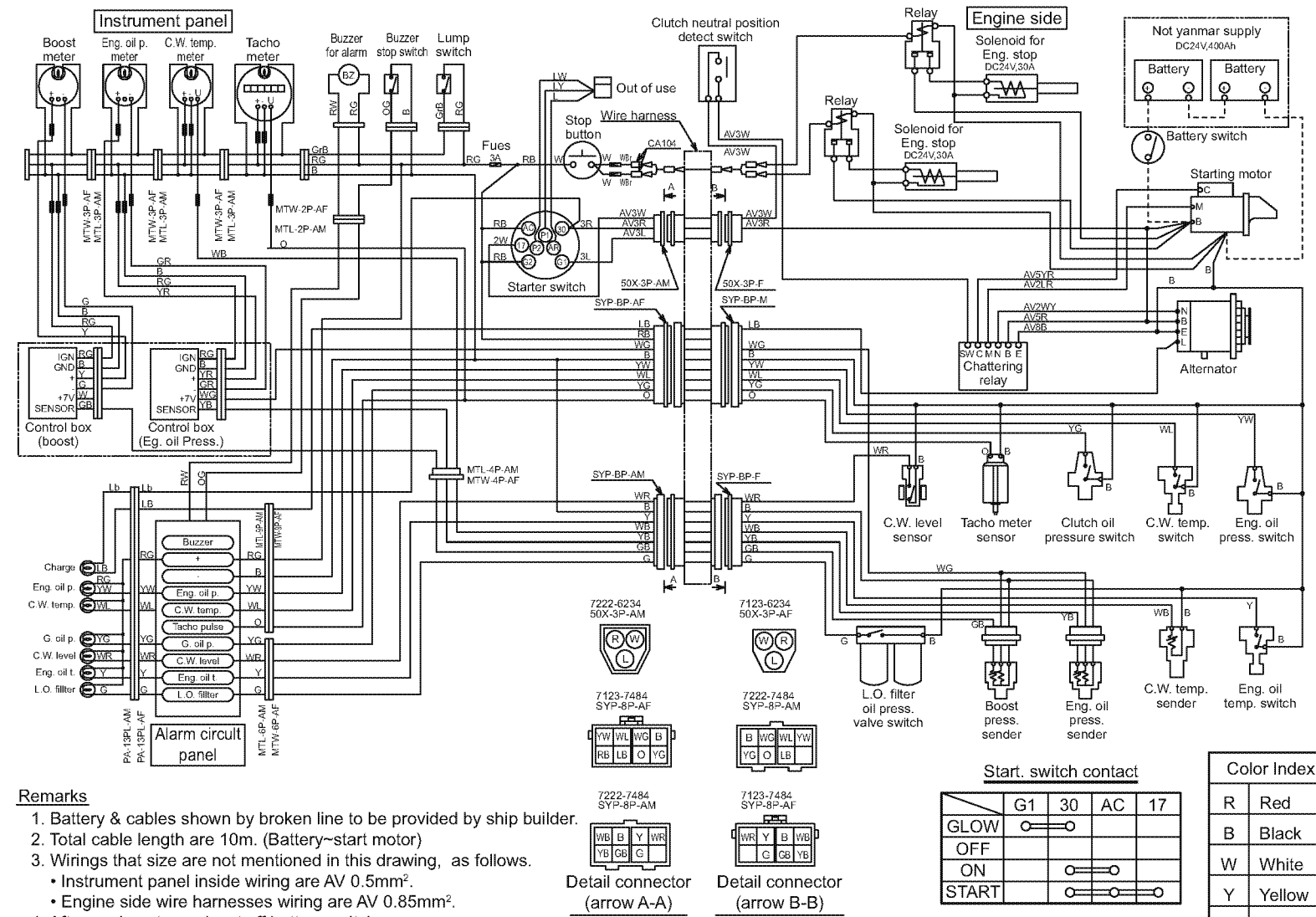
Wire Connection Diagram

■ Stop solenoid w/o air heater, 1 line (body earth)



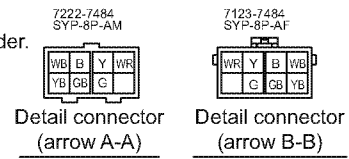
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■ Stop solenoid w/o air heater, 2 lines (earth float)



Remarks

1. Battery & cables shown by broken line to be provided by ship builder.
2. Total cable length are 10m. (Battery~start motor)
3. Wirings that size are not mentioned in this drawing, as follows.
 - Instrument panel inside wiring are AV 0.5mm².
 - Engine side wire harnesses wiring are AV 0.85mm².
4. After engine stopped, cut off battery switch.
5. Keep the battery switch "on" during operation. (Protection alternator)
6. Do not continue to press the stop button for 30 seconds or more. The engine stop solenoid does not allow continuous energization.



Starting motor output	Alternator output	Batt. capacity (N-series)	Cables batt. to start. motor
DC24V 8kW	950W (35A)	400Ah	150mm ²

Parts Number List for Daily Wear Maintenance

■ Parts Number List for Daily Wear Maintenance

	Part name	Part No.	Number of parts necessary (Per 1 unit)	Remarks
1. Filter				
	1-1 Engine-installed fuel filter element			
	Seal washer (small round 8)	22190-080002	2	
	Seal washer (W14 S1)	22190-140002	2	
	O-ring (centerbolt)	41650-501160	2	
	O-ring (case mounting)	41650-501170	2	
	Element kit (8 micron)	41650-501140	2	
	1-2 Lubricating oil filter			
	cartridge	148633-35400	3	with rubber gasket
	1-3 Lubricating oil bypass filter			
	cartridge	148633-35450	1	with rubber gasket
2. Anti-corrosive zinc				
	2-1 Engine			
	anti-corrosive zinc	27200-400400	2	
	Oval gasket	126685-09330	2	
	Rubber gasket	132310-09330	2	
	2-2 Marine gear			
	anti-corrosive zinc	27210-200370	2	Installed to the lubricating oil cooler
	Rubber gasket	123210-09310	2	
	Copper gasket	23414-250000	2	
	3. Fuel injection valve			
3-1	Fuel injection valve nozzle	140695-53000	6	
3-2	Gasket of the fuel injection valve	133670-11930	6	
3-3	O-ring of the fuel injection valve	152623-53360 24311-000400	6 6	
3-4	Joint end gasket of the fuel injection pipe	140695-59640	6	
4. Exhaust thermometer				
4-1	Battery (CR2450YU)	147883-91350	2	Digital exhaust thermometer

O*peration* **M***annual*

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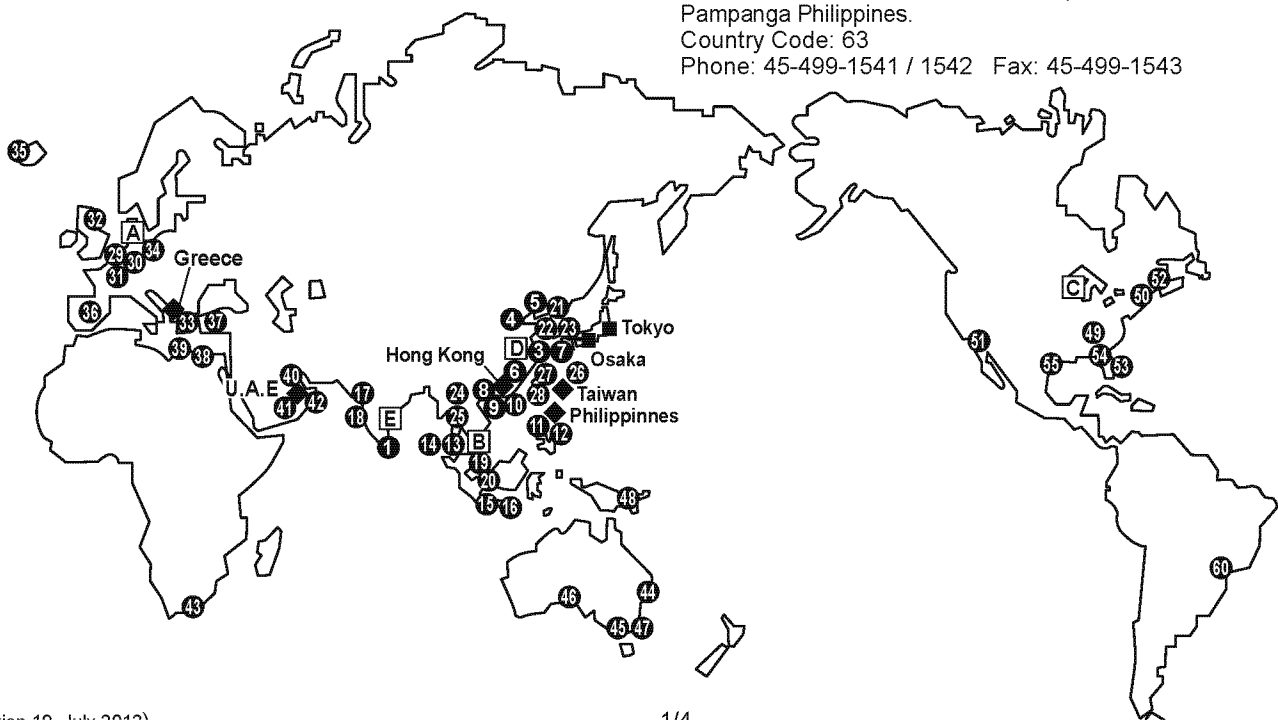
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Phone: 51-418-8998 Fax: 51-418-5880
E-mail: chibako@korea.com

THAILAND (Country Code: 66)

24 Siam Consotium Service Co., Ltd.

103-107. Damronglatpipat Road, Klongtoey, Prakanong,
Bangkok, Thailand 10110
Phone: 2-249-8023 Fax: 2-249-7985

25 Star Marine Engineering Co., Ltd

2/5 M11 Tumbol Bangphueng Phrapradaeng ,
Samutprakarn , Thailand 10130
Phone: 2-816-8001 Fax: 2-463-2616
E-mail: info@starmarineeng.com

TAIWAN (Country Code: 886)

26 Yanmar Engineering Co., Ltd Taiwan Branch

No.56, Yugangjung 2 Rd., Chienchen Dist, Kaohsiung, Taiwan
Phone: 7-815-4198 Fax: 7-815-3280
E-mail: yanmar-service@umail.hinet.net

27 Yee Foo Marine Industrial Co., Ltd.

6F-3, No.369 Fusing North Road, Taipei,
Taiwan ROC. 105
Phone: 2-8712-0848 Fax: 2-8712-0797

28 Seikoh Co., Ltd.

No.56 Yugang Jung 2 Rd., Chien Chen Dist. Kaohsiung, Taiwan
Phone: 7-831-2303 Fax: 7-882-3911

EUROPE

NETHERLANDS (Country Code: 31)

29 Yanmar Europe B.V. (YEU)

Brugplein 11, 1332 BS Almere-de Vaart, Netherlands
Phone: 36-5493200 Fax: 36-5493209

30 Nicoverken Holland B.V.

Algerastraat 20, 3125 BS Schiedam, The Netherlands
Phone: 10-2380999 Fax: 10-2380988
E-mail: shiprepair@nicoverken.nl
Web: http://www.nicoverken.nl

31 Fuji Trading (Marine) B.V.

Kortenoord 2-8 3087 AR Rotterdam, The Netherlands
Phone: 10-429-8833 Fax: 10-429-5227

U.K. (Country Code: 44)

32 Shipaid Diesel Services Ltd.

Units, 1&2, Plot 10, Westminster Trading Estate,
Westminster Road, North Hykeham Lincoln, LN6 3QY
Phone: 1522-696642 Fax: 1522-695153
E-mail: service@shipaid.co.uk

GREECE (Country Code: 30)

33 YANMAR ENGINEERING CO., LTD.

Greece Liaison Office

5th Floor, 130, Sygrou Avenue, Athens, Greece
Phone: 210-922-2481 Fax: 210-922-2484
E-mail: yanmargr@tee.gr / yanmar@weboffice.gr

GERMANY (Country Code: 49)

34 Nippon Diesel Service

Hermann-Blohm-Str. 1 D-20457, Hamburg, Germany
Phone: 40-317710 Fax: 40-311598

ICELAND (Country Code: 354)

35 MARAS E.H.F

Akralind 2 201 K-pavogur Iceland
Phone: 555-6444 Fax: 565-7230
E-mail: maras@maras.is

SPAIN (Country Code: 34)

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TURKEY (Country Code: 90)

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38 Mapso

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39 Mapso-Alexandria Office

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Phone: 3-483-3453 Fax: 3-483-3486

U.A.E. (Country Code: 971)

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Box 214831 Dubai, U.A.E.
Phone: 4-341-8787 Fax: 4-341-8778
E-mail: ymrdubai@eim.ae

41 Albwardy Marine Engineering (LLC)

Dubai Shipdocking Yard P.O. Box 6515 Dubai, U.A.E.
Phone: 4-324-1001, 4-324-1561 Fax: 4-324-1005

42 Goltens Co. Ltd. Dubai Branch

Al Jadaf Ship Docking Yard P.O. Box 2811, Dubai, U.A.E.
Phone: 4-324-1642 Fax: 4-324-1963
Web: <http://www.goltens.com>

AFRICA

SOUTH AFRICA (Country Code: 27)

43 IMS CAPE, A Division of ZEST ELECTRIC MOTORS (PTY) LTD.

124 Marine Drive Service Road, Parden Eiland, 7420,
South Africa, P.O. Box 63 Parden Eiland 7420
Phone: 511-8201 Fax: 511-8238

OCEANIA

AUSTRALIA (Country Code: 61)

44 Forgacs Cairncross Dockyard Pty. Ltd.

Thynne Road Morningside, Brisbane, Queensland 4170,
Australia
Phone: 7-322-70856 Fax: 7-3399-6164

45 Waterside Engineering Pty. Ltd.

48-50 Export Drive Brooklyn 3025, Victoria, Australia
Phone: 3-9314-3722 Fax: 3-9314-3799
E-mail: waterside-eng.com

46 Jaitco

10199 Kurra Road, Neutral Bay, N.S.W. 2089, Australia
Phone: 2-99098545 Fax: 2-99531728

47 Japan Marine Engineering Co., Ltd.

475 Warrigal Road Moorabbin Victoria Australia 3189
Phone: +61-3-9555-5277 Fax: +61-3-9555-5344
E-mail: sales@jmeaust.com.au

PAPUA NEW GUINEA (Country Code: 675)

48 Lutheran Shipping

P.O. Box 1459, Lae, Papua New Guinea
Phone: 42-6190 Fax: 42-5806 Telex: NE 44172

NORTH AMERICA

U.S.A. (Country Code: 1)

49 Yanmar America Corp. (YA) Georgia Office

101 International Parkway, Adairsville, GA 30103, U.S.A.
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50 YANMAR AMERICA CORPORATION. NEW YORK BRANCH

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07024 U.S.A.
Phone: 201-592-8500 Fax: 201-592-8503
E-mail: HWatanabe@yanmar.com

51 Marine Turbo & Diesel Inc.

1090 7th Street, Richmond, Ca, 94801, U.S.A.
Phone: 510-236-3525 Fax: 519-236-3576

52 GOLTENS New York Corp.

160 Van Brunt Street, Brooklyn, NY 11231 U.S.A.
Phone: 718-855-7200 Fax: 718-802-1147

53 GOLTENS Miami Co. Inc.

2323 N.E. Miami Court • Miami, Florida 33137 U.S.A.
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54 TRANSMARINE PROPULSION SYSTEM, Inc

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55 UNITED WORLD ENTERPRISE, INC

6310 Winfree Houston, Texas 77087 U.S.A.
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SOUTH AMERICA

BRASIL (Country Code: 55)

60 Metalock do Brasil Ltda

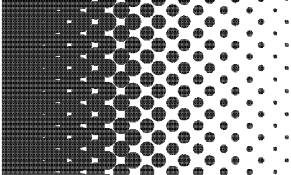
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