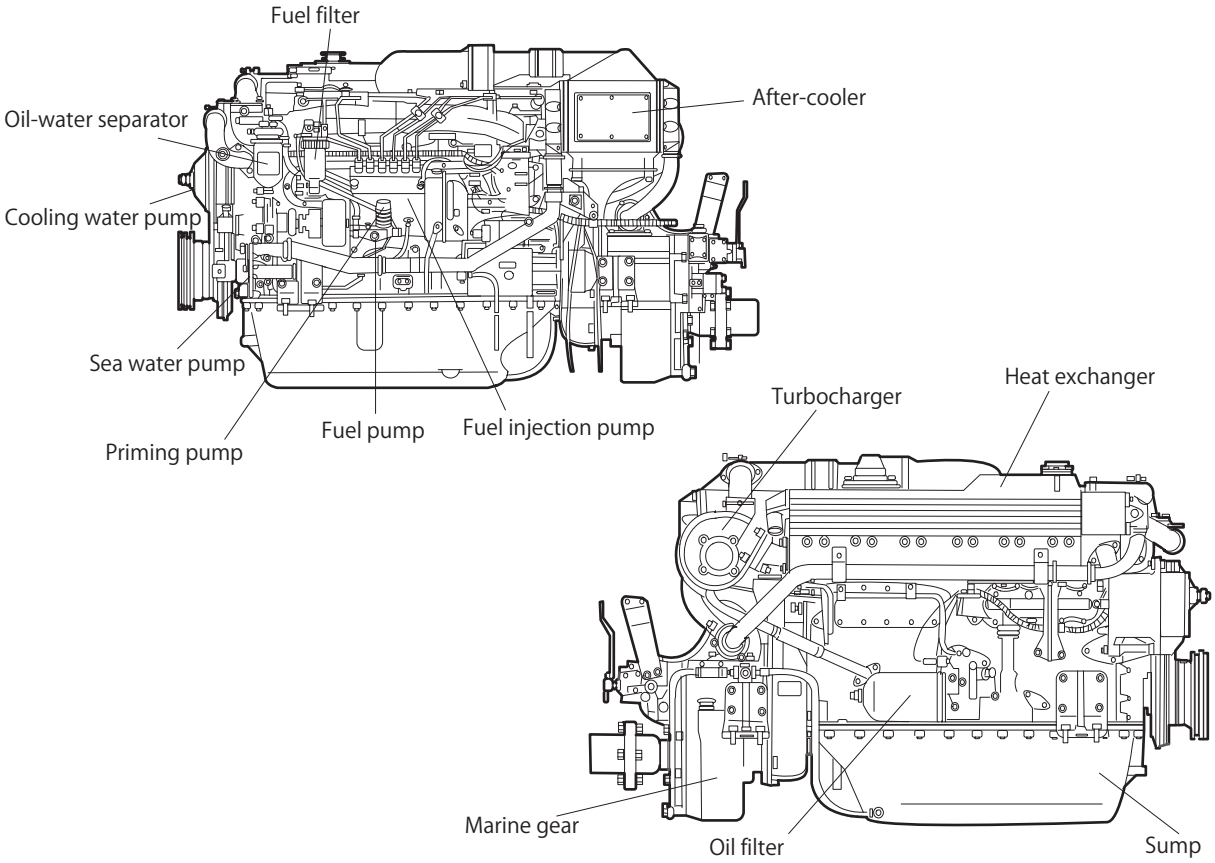
Advanced Operaton II



1 . The Basis of Diesel and Gasoline Engine
2 . Maintenance of Fuel and Lubricating System
3 . Maintenance of Cooling and Electrical System
4 . Maintenance of Drivetrain and Steering System
5 . Engine failure,Overheat
6 . Abnormal Vibration,Odor and Noise

1 .The Basis of Diesel and Gasoline Engine

1 .Differences in the diesel engine and the gasoline engine

	Diesel engine	Gasoline engine
Fuel oil	Diesel oil or crude oil A	Gasoline
Combustion system	Ignition by compressed air and fuel	Electrical spark ignition with air-fuel mixture
Fuel delivery system	Fuel injection	Carbureter or electric fuel injection
Starting aids	**Glow plug**	**Choke**
Speed governing device	**Governor**	Throttle butterfly(carbureter)
Compression ratio / explosive compression	High	Low
Mechanism / weight	**Complicated and heavy**	**Simple, light weight**
Noise / vibration	**Big**	Small
Combustion efficiency / fuel cost	Good	Bad

Crude oil A・・90% of diesel oil and spodogenous oil.

2 .Alarm device / Safety device

1 Oil pressure, circulating water temperature, electric charge, exhaust temperature, and so on are monitored and reported to the driver via gauges on the dashboard.
2 The Fuel injection pump sends fuel to the fuel injection valve by high pressure lines.This output limitation device is sealed.
3 The Governor controls the quantity of fuel to the fuel injection pump. it is a revolution speed limitation device.
4 A Blow-by gas pipe takes un-combusted gas inside the crankcase and discharges it.When there is more smoke than usual in the exhaust, it is possible that fuel is in the engine oil.

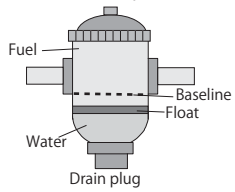
2 .Maintenance of Fuel and Lubricating System

1 .Diesel oil

1 Good diesel has low viscosity and density.

Oil-water separator

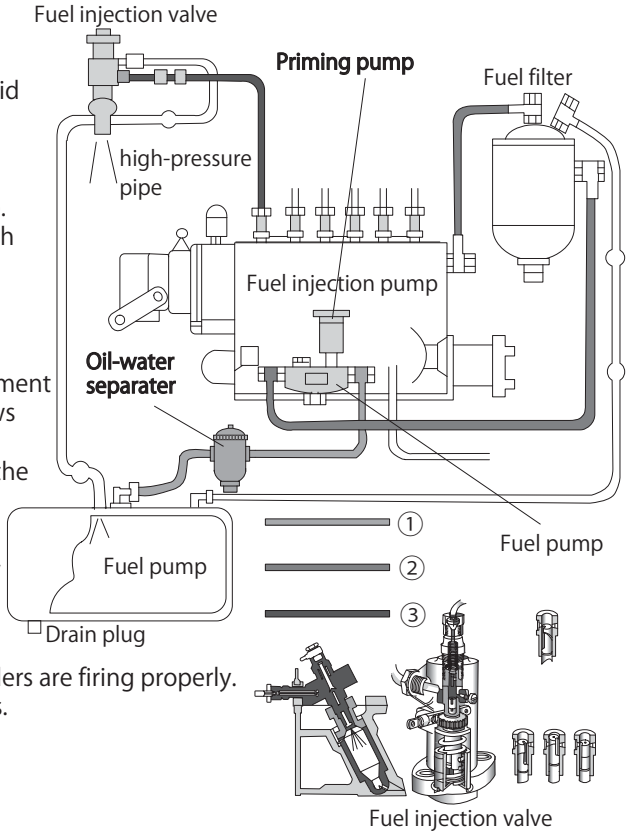
2 An oil water separator is installed in the fuel line. Drain fluid of the bottom routinely.
3 Water and sludge collect at the bottom of the oil water separator and is kept in that drum.



2 .The priming of the fuel line of the diesel engine(Air vent work)

When you change a diesel fuel filter, run out of fuel or disturb the fuel system, air is trapped.
When you try to start the engine this air acts as a lock, preventing the normal supply of fuel into the cylinder. Here are the steps to take in bleeding air from a diesel fuel system:

1.Turn off fuel valve.
2. Clean outside of filter housing.
3. Install new filter element and new gaskets. A little oil on the gasket will aid a tight seal.
4. I'd suggest that you fill a spin-on filter with clean fuel before installation.
5. Open the bleed plug on the filter closest to the fuel tank.
6. Open fuel supply valve so that the fuel is available to the filter and pump.
7. Most all equipment has a hand priming pump lever to pump fuel through the system and replace trapped air. (Check operator's manual.) Pump several times until full flow, without air bubbles, escapes from the bleed plug holes.
8. You may need to bleed filters, fuel pump and lines to the injectors.
9. Close bleed plugs after all air is removed from the fuel tank, filters, settlement bulb, and fuel pump (only one at a time working through all bleed screws beginning closest to tank and ending at nozzles if necessary).
10. Try the engine; if it doesn't start or runs poorly, you may have to bleed the injection line.
11. Loosen injection lines at the injectors about one turn. The use of two wrenches will prevent the binding or twisting of the steel lines. Usually, it is enough to bleed just half of the lines at a time.
12. Crank the engine until all air is forced out and fuel is present.
13. Engine will start to pop on one or two cylinders.
14. Tighten the injector lock nut one at a time to tell by sound which cylinders are firing properly.
15. Run the engine until it runs smoothly. This will bleed the other injectors.

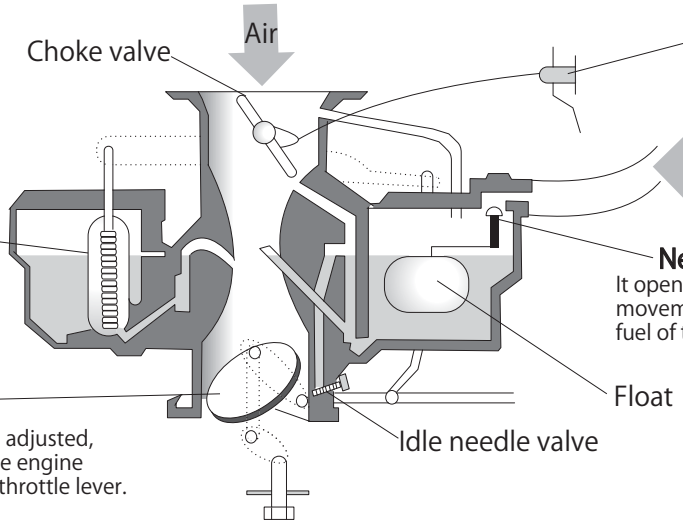


No attempt should be made to service the injection pump or nozzles. This requires special tools and know how. All new gaskets, O-rings, and seals will have to be replaced to prevent leaking. By Dr. Von H. Jarrett, Extension Agricultural Engineer (http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1552&context=extension_curall)

3 .Gasoline

1 High-octane gasoline・・The grade of gasoline to prevent knocking of the engine when the compression ratio is high.
2 **Knocking**・・Abnormal combustion. Timing may be off.
3 Air-fuel mixture・・The mixture of fuel of air in the carburetor. This mixer is **heavier than air** alone.
4 Ventilation・・Ventilate the engine compartment before the engine start to prevent of an explosion accident.
(There is a vent/blower in the bottom of the engine comprtment)

4 .Carbureter



5 .Other fuel systems

1 Electronic controlled fuel injection system
2 Gasoline direct injection systems

6 .The deterioration of the engine oil

Engine oil gets rid of the frictional heat of the operating parts, seals gap of the piston and the cylinder, and washes and collects frictional metal powder, carbon.You must change the oil regularly.
1 Interfusion of the metal powder・・Glitter in the engine oil can be seen.
2 Interfusion of carbon・・It becomes black dark brown, and viscosity rises.
3 Interfusion of water・・IIt becomes milk white, and (emulsification),viscosity rise. (The leakage of the oil cooler, the cylinder liner and Interfusion from the blow-by gas pipe)
4 Interfusion of fuel・・Smell becomes strong, and viscosity falls down.
5 Aged deterioration of chemical admixture of engine oil(oxidization).

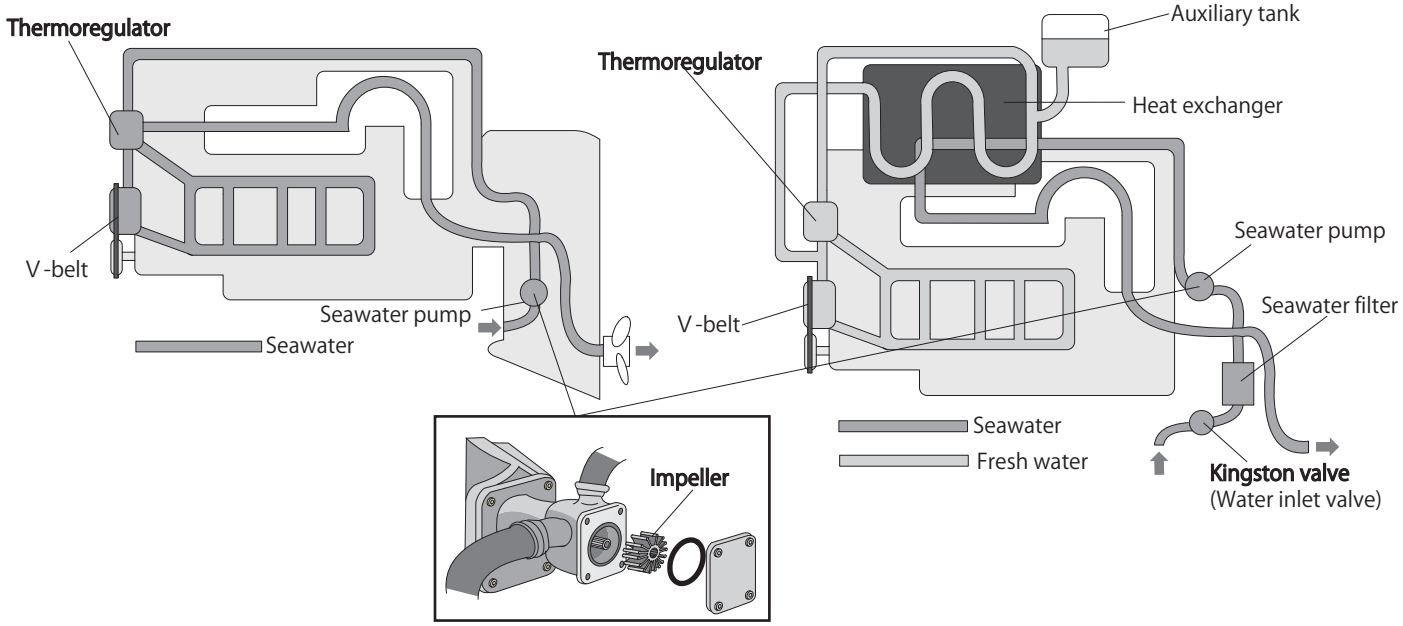
7 .Changing the engine oil

1 Engine oil is warmed up with engine running.(liquidity is improved.)
2 The drain plug of the sump of the engine bottom part is removed, or from the insertion hole of the oil dipstick with using a pump, and oil is removed.(An oil filter is exchanged, too.)
3 Run the engine after oil is supplied to the upper limit of the mark of the level gauge.
4 After engine oil circulates, an engine is stopped and the amount of engine oil is measured again.

3 .Maintenance of Cooling and Electrical System

1 .Direct cooling system and indirect cooling system

Direct cooling system(an example of inboard-outdrive engine) **Indirect cooling system**(an example of inboard engine)



1 Thermo-regulator・・This controls the flow of cooling water. It is installed directly in the seawater system in the direct cooling engine and installed in the fresh water system in the indirect cooling engine.
2 Anode・・The zinc prevents electric corrosion of the metal. it is checked regularly, and exchanged if it is reduced by half.
3 Coolant・・It mixes with the cooling fresh water. It has effect of anti-rust and effect on prevention of freezing. It is exchanged regularly.
4 Kingston valve・・The valve of the cooling seawater inlet. Close this valve when an impeller is replaced.
5 Impeller・・A propeller made of rubber inside a seawater pump. It becomes stiffened by age deterioration. It is checked regularly and exchanged because it causes overheat when damaged. And, it is damaged with the heat when there is not water inflow.
6 V-belt・・A V belt transfers power from the crank shaft to the cooling water circulating pump and a generator. When the tension allowance of the belt is too big(10mm is suitable.) or is broken, the engine will not run properly.
7 Heat exchanger・・Fresh water for engine cooling is cooled with the seawater.

2 .Battery

1 .Battery charging

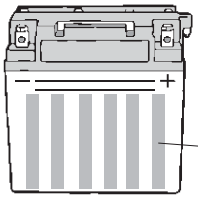
1 Specific gravity・・Normal operation state: 1.28 in 20° C. Specific gravity falls as it discharges electricity.
2 Constant voltage charge・・Charging a 12V battery requires d.c.13.5V ~ 14.5V and small current.
3 Constant current charge・・Electric current of about 1/10 of the battery capacity for a long time.The battery will become overcharged in the end.
4 Quick charge・・Problem: Polar plates are often damaged.

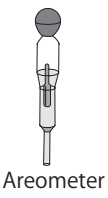
2 .Attention in the charge

1 A mixed gas of oxygen and hydrogen occurs during charging. Remove caps of fill port, and ventilate.
2 Stop the charge process for a while when temperature of the electrolyte exceeds 45° C.
3 The terminal voltage and the electrolytic liquid specific gravity will rise and become stable.
4 Supply distilled water from the top end of the polar plates even 10mm-15 mm above when electrolytes decrease.
5 The “plus” (+) terminal is removed to prevent the countercurrent to the alternator when a battery on the boat is charged.

3 .Other attention

1 When the battery cables are removed, remove a negative (-) terminal first. (this prevents a short circuit)
2. When the battery cables are installed, the plus (+) terminal is fixed first.
3 After a battery terminal is fastened, grease is applied to prevent rust and oxidation.
4 The battery needs to be replaced when specific gravity doesn't rise even if it is charged.



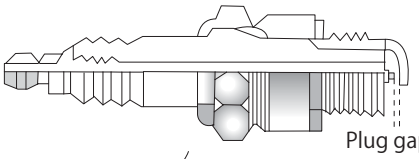


The condition of the battery	Gravity
Full	1.28
1/4 discharge	1.25
1/2 discharge	1.22
3/4 discharge	1.19
Fully discharge	1.16

3 .Ignition system of gasoline engine

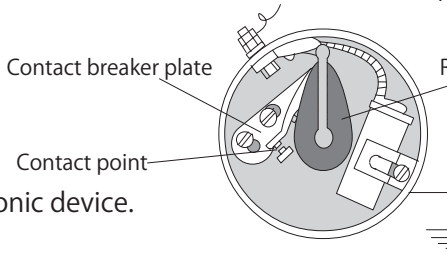
1.Spark plug

1 If an insulator and a ignition part are burned in the light brown or the dark gray, a spark plug is normal.
2 When a ignition part is wet and carbon accumulates, polish it with a wire brush and plug gap is adjusted.
3 A spark plug is replaced when a ignition part part is white



2 .High tension lead(spark plug lead)

1 When that deteriorates, the spark of the spark plug becomes weak.
2 When high tension current discharges electricity,there is danger which the vaporization gas of the gasoline catches fire.
3 High frequency noise is made, and it has a bad influence on the electronic device.

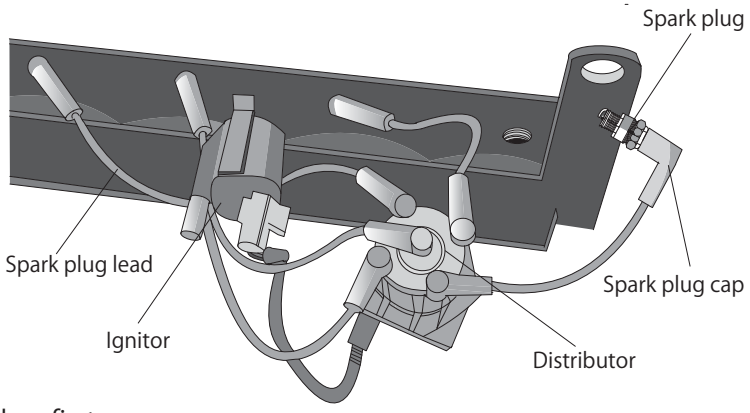


3 .Distributor

1 Electricity leaks with the damp, the crack, and so on.
2 The gap of the contact breaker is checked

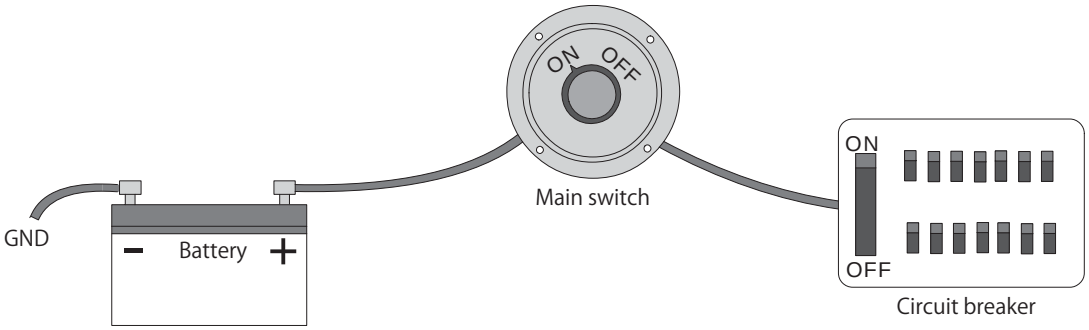
4 .The test of the ignition system

1 A spark plug is removed, and contact it with the place for a ground.(Leave it from a carburetor.)
2 When a starter runs, if a strong bluish white sparks fly from the spark plug, it is normal.



4 .Fail-safe device of electrical system

1 When the switch is turned on, the main switch is turned on first.
2 When the switch is turned off, the switch of a circuit breaker is turned off first.



4 .Maintenance of Drivetrain and Steering System

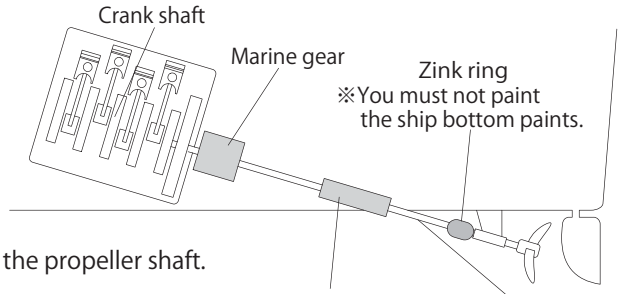
1 .Drivetrain system of inboard engine

1 .Marine gear

1. The clutch, main gear, and reverse gear are contained in the gear box.

2 .Stern tube

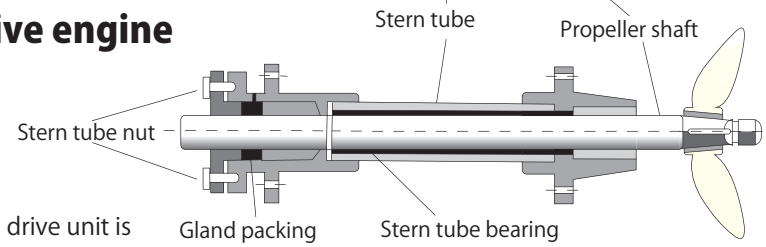
1. The part where a propeller shaft goes through the hull is called the "stern tube" .
2. There is either a "gland packing-type" or a mechanical seal-type.
   The nut of a gland packingtype should be fastened so as about one water drop leaks out in three seconds during operation.
   And, when a propeller shaft doesn't run, there is no leaking.
3. A bearing made of the hard rubber is used between the stern tube and the propeller shaft.



2 .Drivetrain system of inboard-outdrive engine

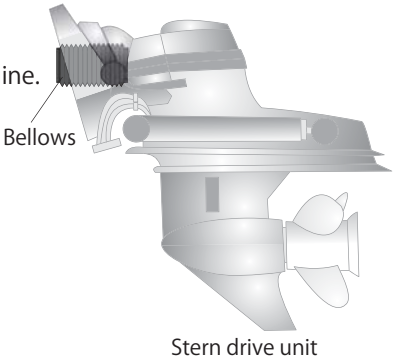
1 .Stern drive

1. A reduction gear and a clutch and gear oil are contained in the case.
2. When gear oil is to be measured, the drive unit is made vertical.(tilted down)
3. When the hydraulic fluid of the power steering is checked, a drive unit is moved to a position of going straight (tilted down) .



2 .Bellows

1. Bellows is made of **rubber** to protect a universal joint which connects a drive unit with the engine.
2. When the bellows is damaged, the universal joint rusts, and is damaged.
3. When bellows is damaged, some boats may flooded.



3 .Propeller

1 .Tapered propeller(inboard engine)

1. The rotating direction in ahead run is usually **counterclockwise**.
2. A cap is filled with the grease.

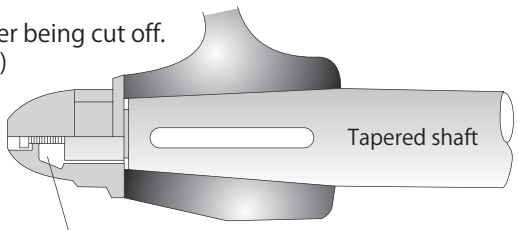
2 .Spline propeller(inboard-outdrive engine,outboard engine)

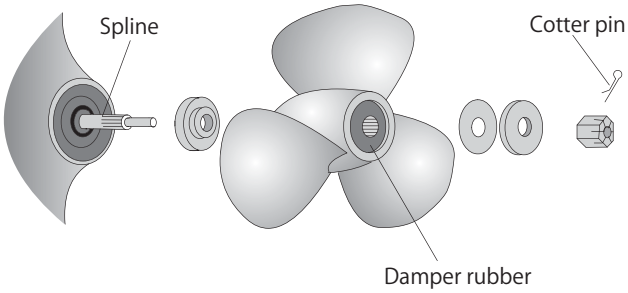
1. Anti-corrosion grease is applied to the spline.
2. A cotter pin is put in the nut so that a nut may not become loose.

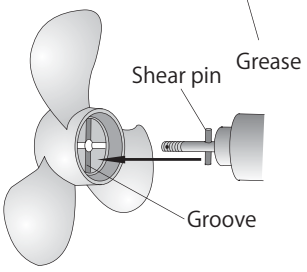
3 .Impact absorption(inboard-outdrive engine,outboard engine)

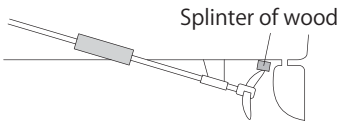
Impact absorption is the mechanism which doesn't transmit shock to the gear and/or the engine when an obstacle hits a propeller.

1. Damper rubber: The shock is absorbed by rubber in the central part of the propeller being cut off.
2. Shear pin: The shock is absorbed by a shear pin's breaking.(small outboard engine)







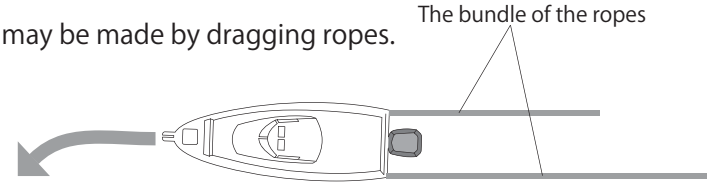


4 .Replacement of propeller

A block and so on is put so that a propeller may not rotate.

5 .Emergency rudder

When rudder equipment breaks down, a temporary rudder may be made by dragging ropes.



5 .Engine failer,Overheat

1 .The engine doesn't start.

1 .The starter motor doesn't run.

1 The remote controller lever is not in the neutral position.
2 Dead Battery.
3 A battery terminal connection is loose.
4 The main switch is "off" position.
5 The loose connection of others electric system, blown fuses.

2 .The starter motor runs, but an engine doesn't start.

1 The fuel cock isn't open. Clogged fuel line.
2 Insufficient **Preheating.(Diesel engine)**
3 **Choke** isn't being used at a cold time.(**Gasoline engine**)
4 **The primary pump** isn't being used.(**Outboard engine**)
5 Trouble in the fuel system (Carburetor, gasoline engine, governor, diesel engine)
6 Trouble in the ignition system(Gasoline engine)

2 .The engine stops soon even if it starts. / The engine stops suddenly.

1 .The engine stops soon even if it starts

1 The fuel cock isn't open.Clogged of the fuel line.
2 **Choke** isn't returned.(Gasoline engine)
3 Impurities of the fuel line.
4 Trouble of the ignition system(Gasoline engine)
5 There is **too much oil** in the mixed fuel.(**Two-stroke engine**)
6 Trouble of the fuel system (Carburetor, gasoline engine, governor, diesel engine)

2 .the engine stops suddenly

1 Impurities in the fuel line.
2 Trouble in the ignition system (Carburetor, gasoline engine engine)
3 Overheating
4 Trouble in the fuel system (Governor, diesel engine)
5 The **air vent screw** on the fuel tank is closed.(Outboard engine)

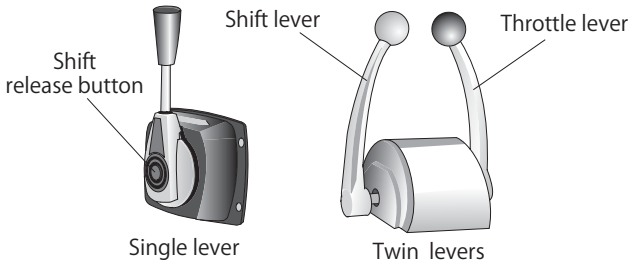
3 .Low output of the engine / Boat's speed doesn't come out fully.

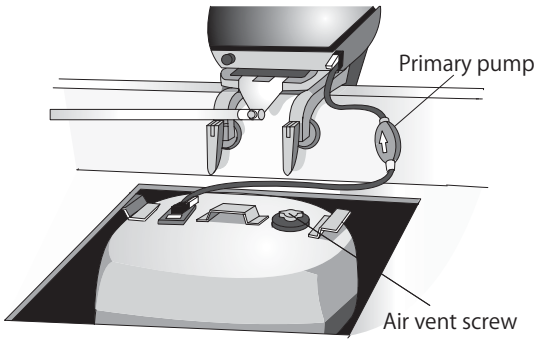
1 .Low output

1. **Low Output**
1 Impurities in the fuel line.
2 The **choke** isn't returned.(Gasoline engine)
3 Broken or loosened **throttle cable**.
4 **High Air temperature** in the engine compartment.
5 The **air filter** of the turbo-charger is dirty.
6 The exhaust pipe is choked with carbon.
7 Overheat
8 The trouble of the fuel system
(Carburetor, gasoline engine, or governor, diesel engine)

2. Low speed.(engine output appears.)

1 The pitch or diameter of the propeller don't match.
2 **Damage to the propeller**
3 Damage to the shear pin or a damper rubber.
4 The **clutch slips**.
5 Seaweed and shellfish stuck to the hull, the rudder and the propeller.
6 An inappropriate trim angle (**Inboard outdrive engine**)



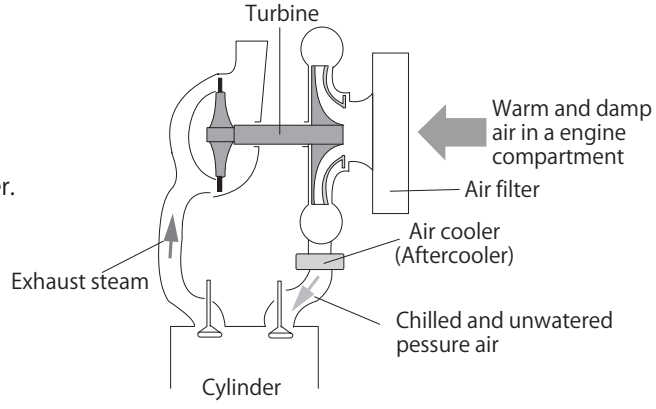


4 .Overheat

1 The seawater inlet may be clogged.
2 The **kingston valve** may be closed.
3 The **V-belt** is broken or loose.
4 The thermo-regulator may not be functioning.
5 The trouble of seawater pump or circulating pump
(**Damaged impeller**)
6 Shortage of coolant
7 The heat exchanger is clogged.
8 Engine oil is low. A clogged oil filter.
9 Engine overload
10 The pitch or a diameter of the propeller don't match.
11 Seaweed and shellfish stuck to the hull, the rudder and the propeller.

Turbocharger

The air intake system has two of normal aspiration(unblown) and pressure-charging aspiration. Check the air filter of the turbocharger regularly because it becomes dirty easily.



5 .The battery doesn't charge.

1 The **V-belt** is broken or loose.
2 The alternator is not functional
3 The shortage of the electrolyte in the battery.
4 The battery terminals may not be tight.
5 The life of the battery may have expired.

6.Abnormal Vibration,Odore and Noise

1 .Abnormal vibration

1 .The trouble of a propeller

1 The **deformation of a propeller**
2 The bend of a propeller shaft
3 Play of the propeller shaft
4 A **foreign object** is caught in the propeller shaft.

2 .The trouble of a engine

1 Looseness of the engine installation.
2 The impurities of the fuel line.
3 The trouble of the ignition system(**Gasoline engine**)
Knocking
Low-octane gasoline・Early ignition timing adjustment
・overload

2 .Abnormal odore

1 Overheat
2 The short circuit of the electric system
3 Heating of a axle bearing.(shortage of engine oil)

3 .The color of exhaust gas

1 .Black

1 **Overload operation**
2 Lack of air(clogged air filter)
3 The defect of the fuel injection valve, the decline of the injection pressure.

2 .White

1 There is **too much engine oil**, and it burns.
2 Piston rings were worn away, and oil burns.
3 Long low rotation operation
4 Steam occurs from a exhaust pipe when it is cold.

4 .Abnormal noise

1 Looseness of the moving part
2 Trouble with a **bearing.**
3 The **V-belt** is slipping.