Basic Knowledge of Honda Outboard Motor

Ver.1.0.0

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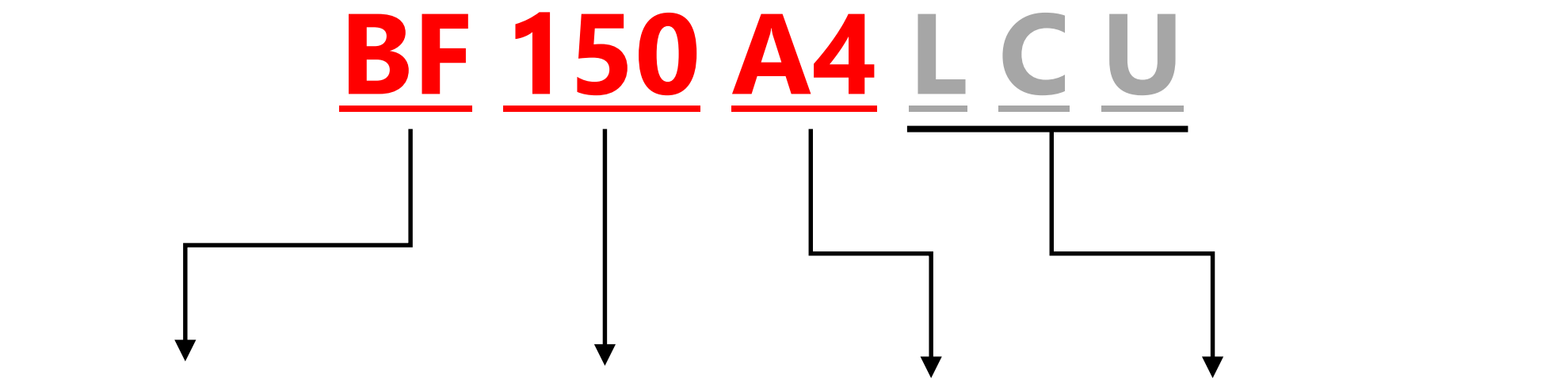
Model Identification

The model designations are divided by the horsepower band of the outboard motor.
In addition to that, the general specifications can be identified.



BF2 - BF20 Specifications

HONDA

Basic Specification						
Type	BF2.3	BF5	BF8	BF10	BF15	BF20
						
Engine type	Air cooled, 4-Stroke OHV 1 cylinder/2 Valves		Water cooled, 4-Stroke SOHC 2 cylinder/2 Valves			
Total displacement	57.2 cm^3	127 cm^3	222 cm^3		350 cm^3	
Bore x stroke	45.0 mm X 36.0 mm	60.0 mm X 45.0 mm	58.0 mm X 42.0 mm		59.0 mm X 64.0 mm	
Compression ratio	8.0	9.8				
Valve train	OHV 2 valve (Intake 1 / Exhaust 1)		SOHC 2 valve (Intake 1 / Exhaust 1)			
Rated output	1.47 kW (2PS)/ 6000 r/min	3.7 kW (5PS) / 5000 r/min	5.9 kW (8PS)/ 5000 r/min	7.3 kW (9.9PS) / 5500 r/min	11 kW (15PS)/ 5000 r/min	14.7 kW (20PS)/ 5500 r/min
Fuel supply system	Carburetor					
Ignition system	Transistor	Digital CDI	PGM-IG			
Starting system	Recoil starter		Electric motor/Recoil starter			

BF25 - BF60 Specifications

HONDA

Basic Specification				
Type	BF25A	BF40D	BF50D	BF60A
				
Engine type	Water cooled, 4-Stroke, Inline 3-Cylinder			
Total displacement	499 cm^3	808 cm^3		998 cm^3
Bore x stroke	58.0 mm X 63.0 mm	70.0 mm X 70.0 mm		73.0 mm X 79.5 mm
Compression ratio	9.2	9.4		9.2
Valve train	SOHC 2 valve			
Rated output	18.4 kW (25PS)/5500 r/min	29.4 kW (40PS)/5500 r/min	36.8kW (50PS)/5750 r/min	44.1 kW (60 PS)/5500 r/min
Fuel supply system	Vertical triple carburetors	Programmed Fuel Injection (PGM-FI)		
Ignition system	CDI	Transistor type battery ignition		
Starting system	Electric motor/Recoil starter	Electric motor		

BF75 - BF100 Specifications

HONDA

Basic Specification				
Type	BF75DK3	BF80A	BF90DK4	BF100A
				
Engine type	Water cooled, 4-Stroke, Inline 4-Cylinder			
Total displacement	1496 cm^3			
Bore x stroke	73.0 mm X 89.4 mm			
Compression ratio	9.7			
Valve train	OHC 4 valve (Intake 2 / Exhaust 2)			
Rated output	55.2 kW (75PS)/5500 r/min	58.8 kW (80PS)/5500 r/min	66.2kW (90PS)/5800 r/min	73.6 kW (100 PS)/5900 r/min
Fuel supply system	Programmed Fuel Injection (PGM-FI)			
Ignition system	Transistor type battery ignition			
Starting system	Electric motor			

BF115 - BF150 Specifications

HONDA

Basic Specification			
Type	BF115D	BF135A	BF150A
			
Engine type	Water cooled, 4-Stroke DOHC 4 cylinder/16 Valves		
Total displacement	2354 cm^3		
Bore x stroke	87.0 mm X 99.0 mm		
Compression ratio	9.6		
Valve train	DOHC 4 valve (Intake 2 / Exhaust 2)		
Rated output	84.6 kW (115PS)/5250 r/min	99.3 kW (135PS)/5500 r/min	110.3kW (150PS)/5500 r/min
Fuel supply system	Programmed Fuel Injection (PGM-FI)		
Ignition system	MicroComputer Programmed		
Starting system	Electric motor		

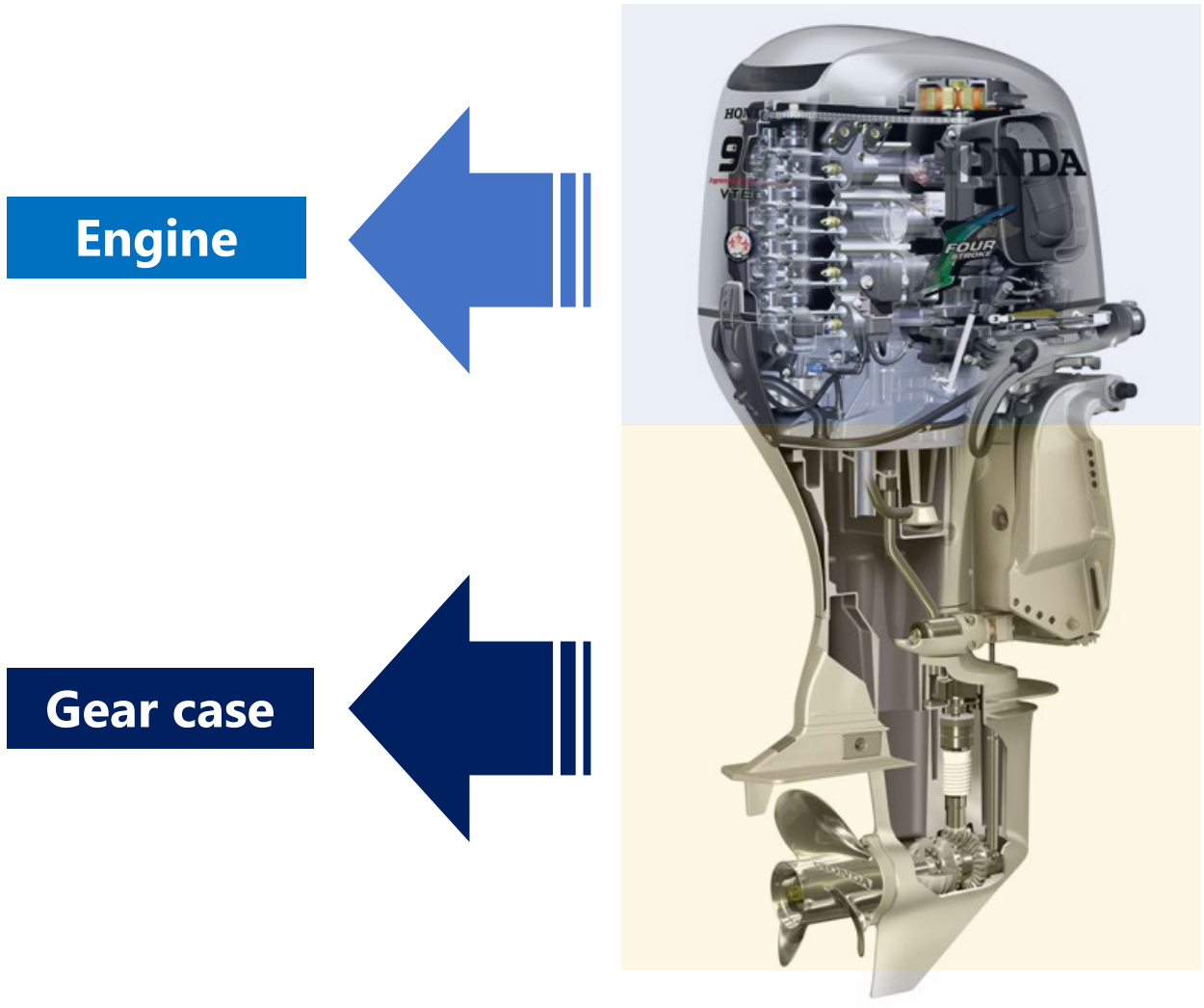
BF175 - BF250 Specifications

HONDA

Basic Specification				
Type	BF175D	BF200D	BF225D	BF250D
				
Engine type	Water cooled, 4-Stroke, SOHC, 60˚ V6, 24 Valve			
Total displacement	3583 cm^3			
Bore x stroke	89.0 mm X 96.0 mm			
Compression ratio	9.4			
Valve train	SOHC 4 valve (Intake 2 / Exhaust 2)			
Rated output	128.7 kW (175PS)/5500 r/min	147.1 kW (200PS)/5500 r/min	165.5kW (225PS)/5500 r/min	183.9kW (250PS)/5500 r/min
Fuel supply system	Programmed Fuel Injection (PGM-FI)			
Ignition system	MicroComputer Programmed			
Starting system	Electric motor			

Basic Structure of an Outboard Motor

Outboard motors can be roughly divided into two parts: the **engine** part that generates the power and the **gear case** part that transmits the power to the propeller. Each of these is explained in detail in the following sections.



Engine

- What is an Engine?
- The Engine's Four Processes
- The Engine's Three Elements of Combustion
- Engine Component Overview
- Cylinder Head
- Camshaft
- Timing Belt/Chain
- Valve
- Valve Configurations
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- Cylinder Block
- Piston
- Connecting Rod
- Crankshaft
- Flywheel
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- Ignition Coil
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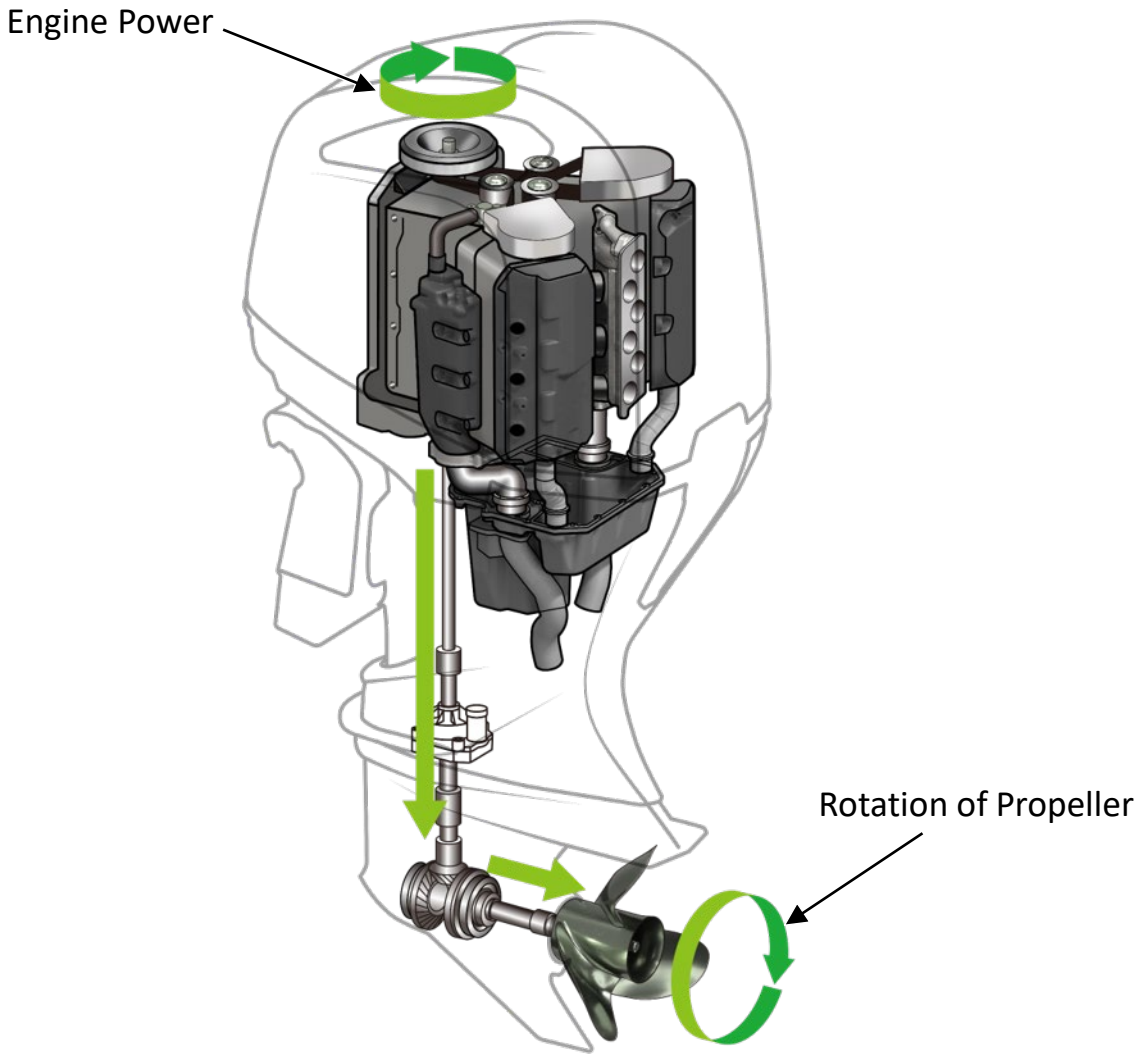
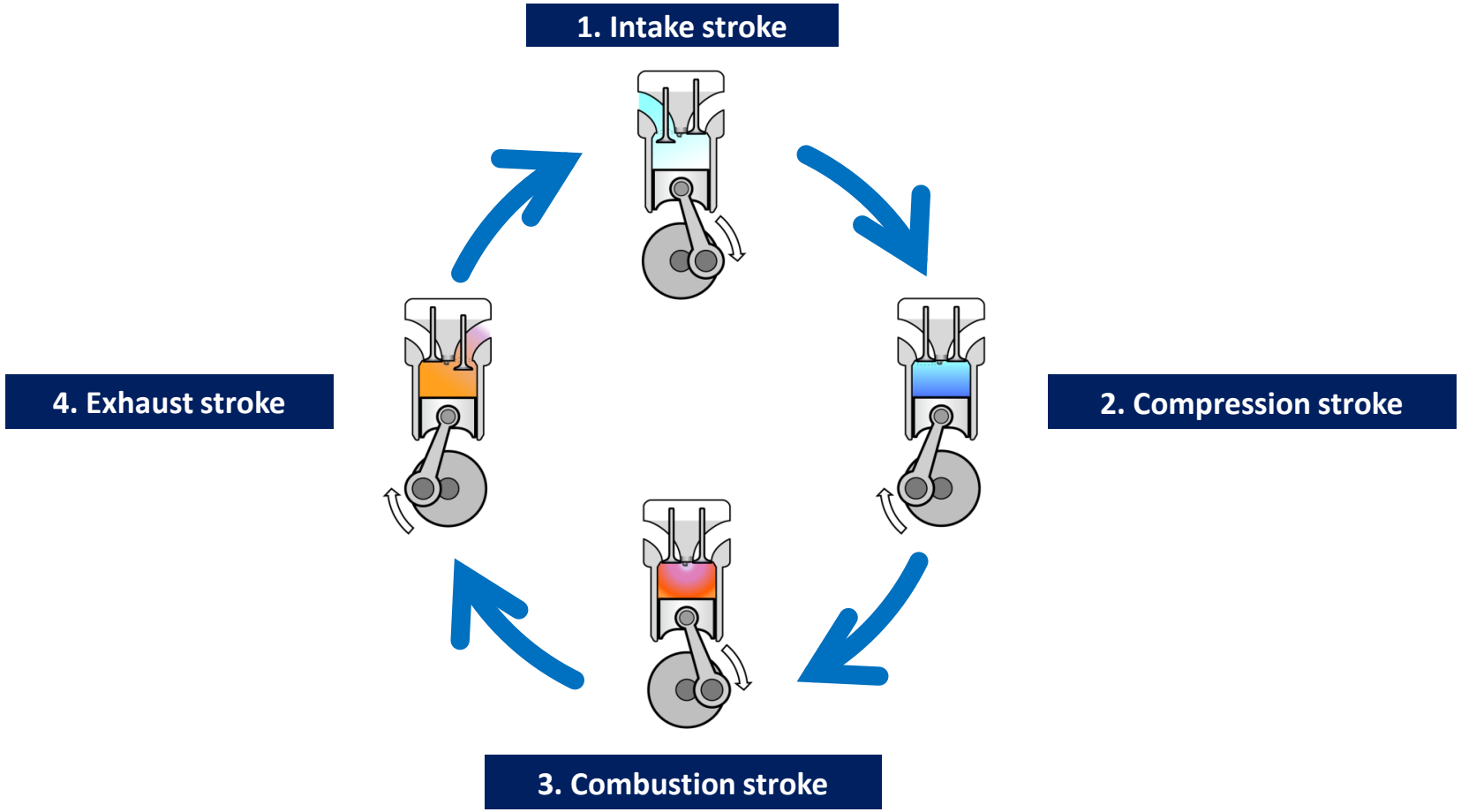
What Is an Engine?

An engine is a device that generates power. In an outboard motor, the engine's power is used to rotate the propeller.
The power produced by the engine is generated by repeating four processes. In the following pages, you will learn about the four processes.



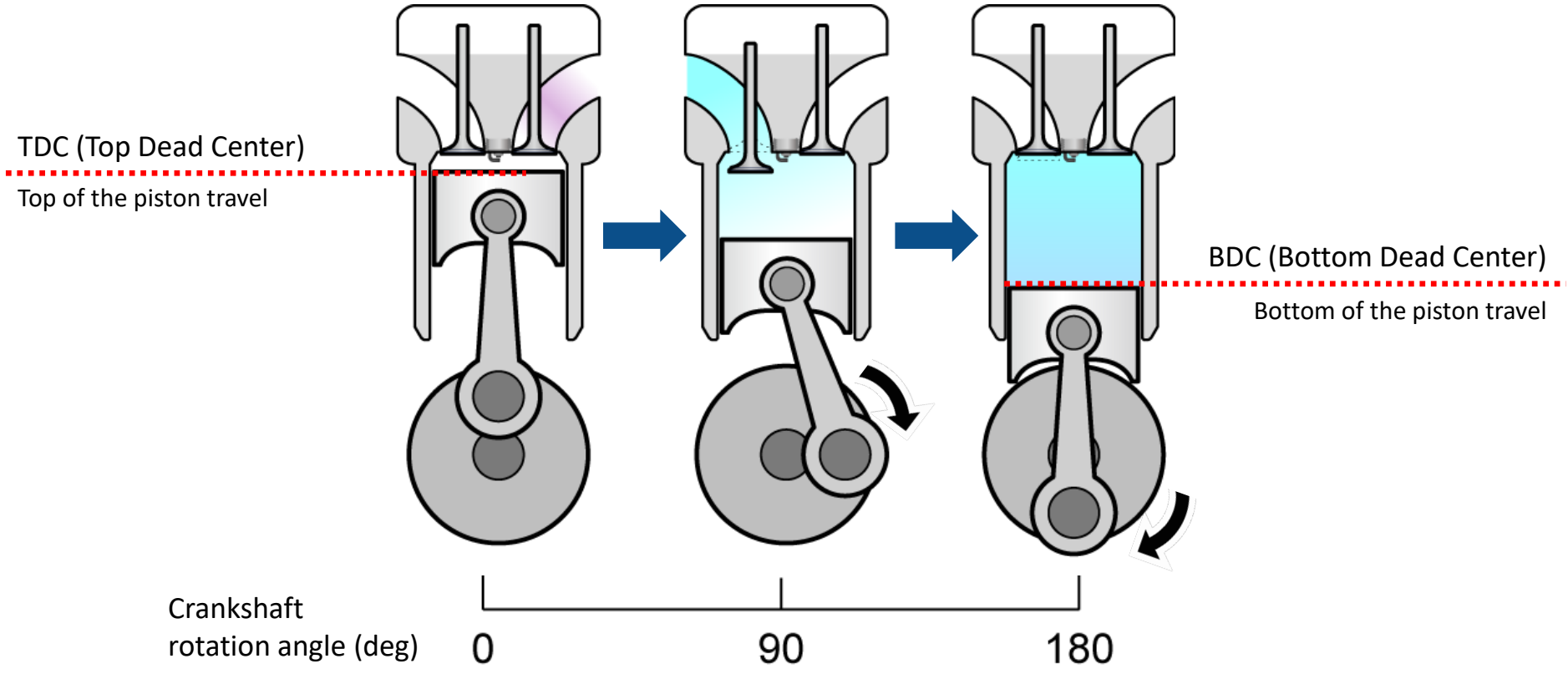
The Engine's Four Processes

An engine operates by repeating the **four processes** of **intake, compression, combustion, and exhaust**.
The stroke that provides power to the engine is the combustion stroke, where the combustion energy pushes the piston down, which in turn rotates the crankshaft.
In other words, the engine uses the combustion energy of the air-fuel mixture to convert the reciprocating motion of the pistons into the rotational motion of the crankshaft and extracts the power.
From the next page, each of these processes will be explained in turn.



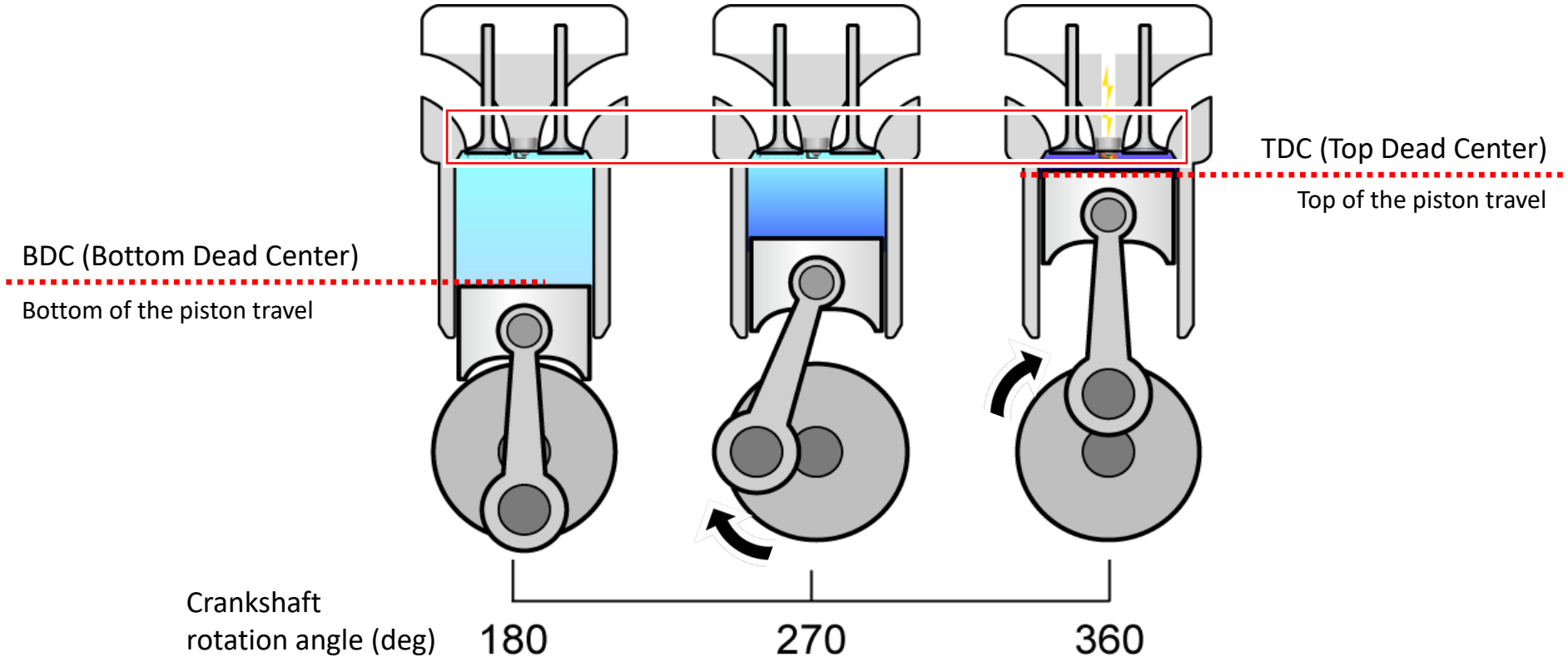
1. Intake Stroke

The process by which the air-fuel mixture is drawn into the cylinder is called the intake stroke.
As the crank shaft rotates, the intake valve opens and the piston lowers to take in the air-fuel mixture.
By the time the crankshaft has rotated 180 degrees, the piston has reached bottom dead center and the intake valve has fully closed.
The intake stroke includes all the motions up to this point.



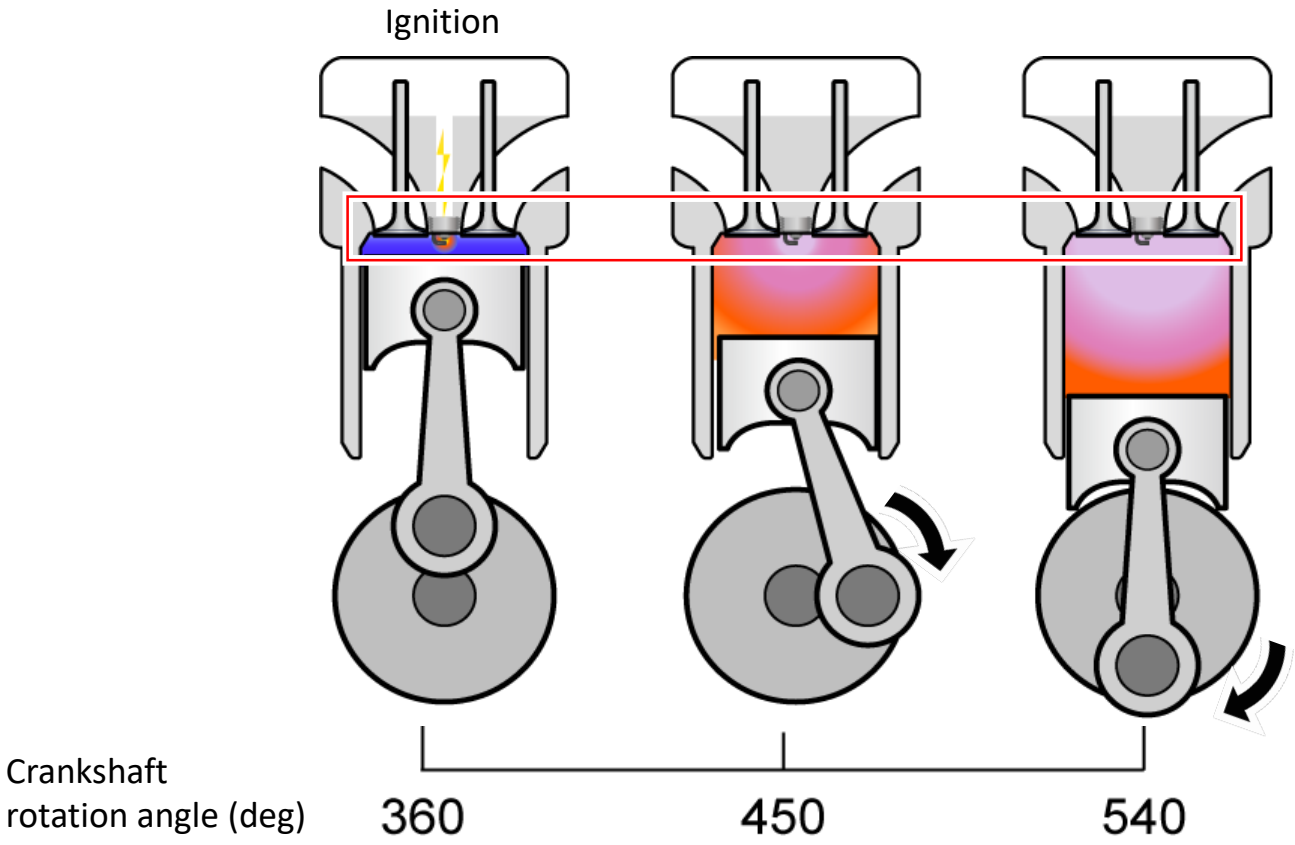
2. Compression Stroke

The process of compressing the air-fuel mixture taken into the cylinder is called the compression stroke.
In the intake stroke, the piston moved to bottom dead center. During compression stroke, it moves to top dead center while the crankshaft rotates. The intake and exhaust valves remain closed during this time, keeping the cylinder sealed so that the air-fuel mixture can be compressed. By the time the crankshaft has completed one rotation (360 degrees), the piston has reached top dead center and the compression stroke has been completed. The position of the piston at this time is called compression top dead center.



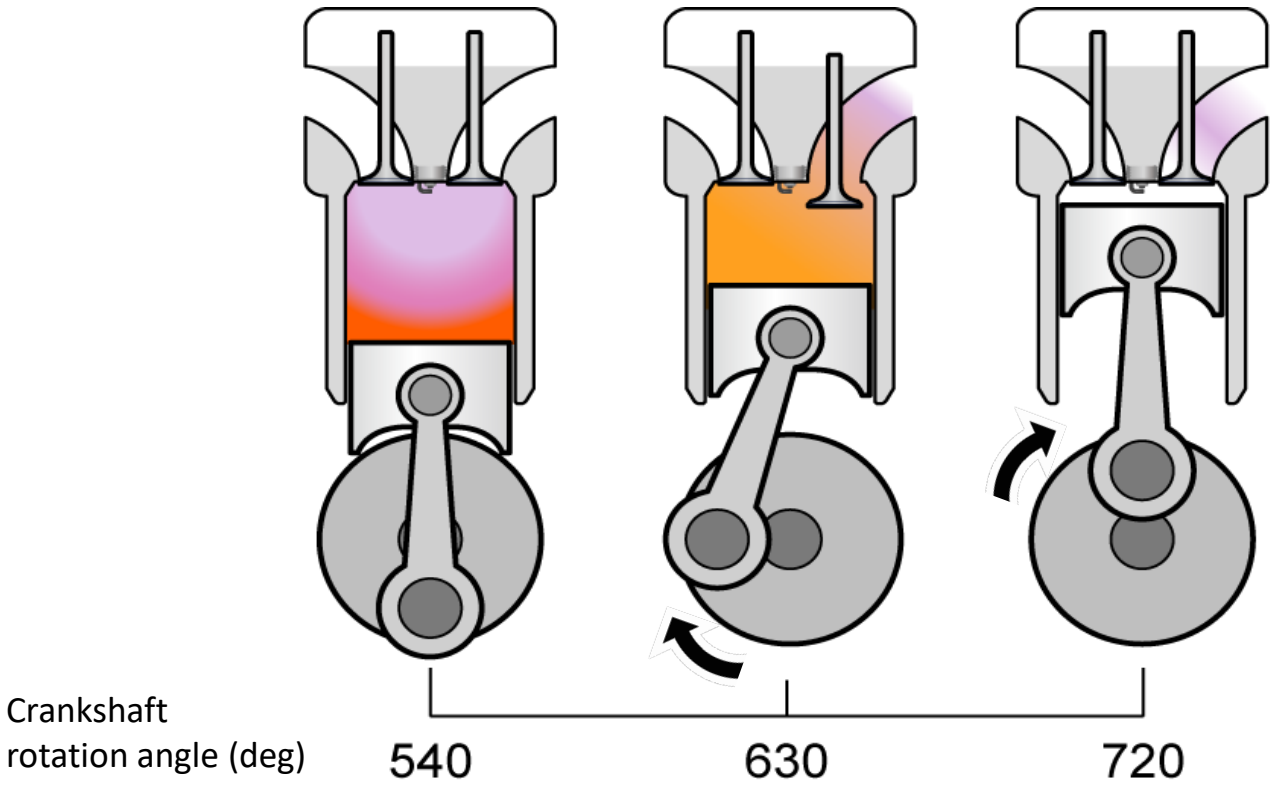
3. Combustion Stroke

The process of burning the compressed air-fuel mixture and pushing the piston down is called the combustion stroke.
During combustion stroke, the air-fuel mixture burns after being ignited by the spark plugs, and the combustion pressure lowers the piston from compression top dead center to bottom dead center.
By the time the crankshaft has rotated 540 degrees, the piston has reached bottom dead center.
The intake and exhaust valves remain closed during this process.



4. Exhaust Stroke

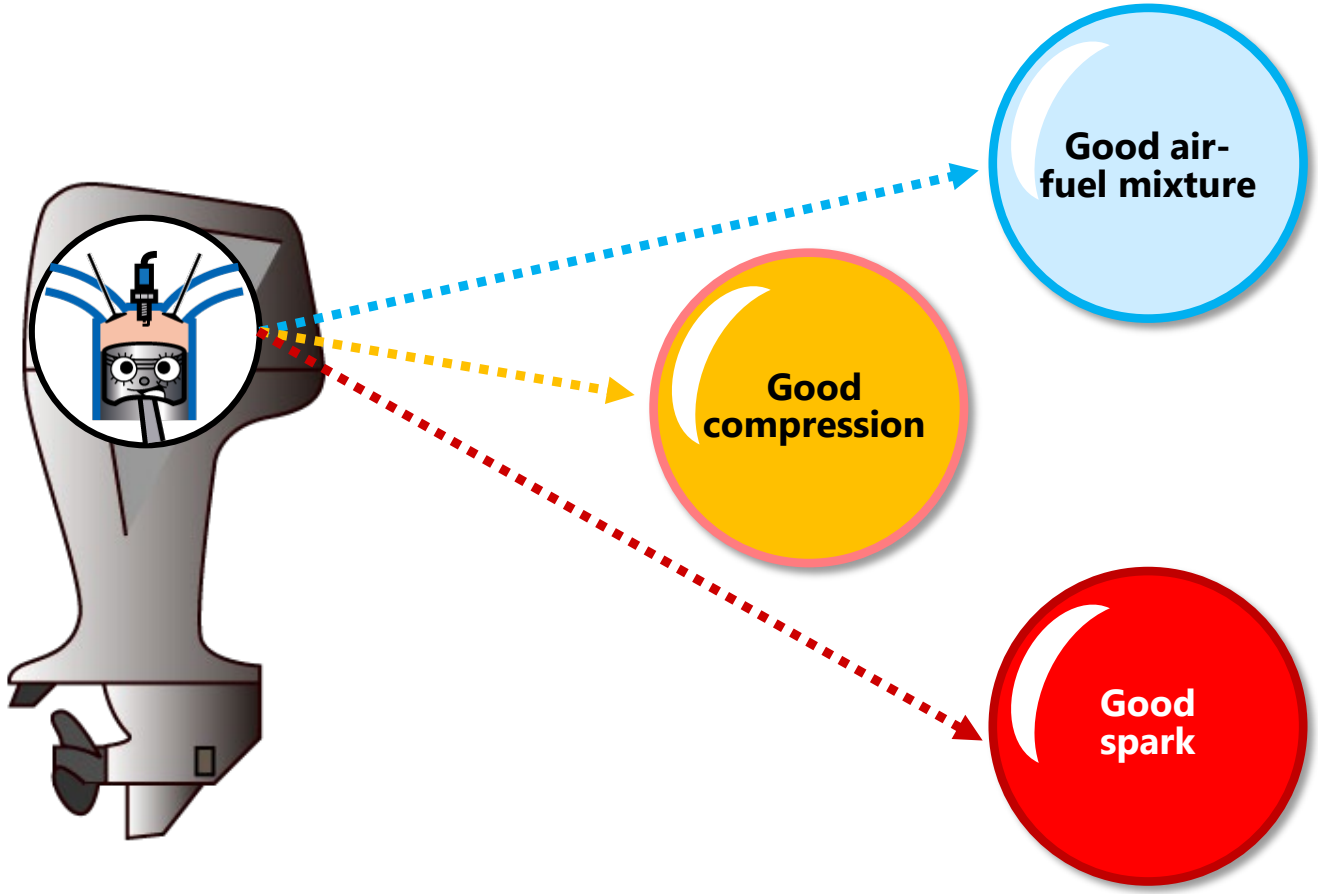
The process by which exhaust gas is discharged from the cylinder is called the exhaust stroke.
In the combustion stroke, the piston moved to bottom dead center. During exhaust stroke, it moves to top dead center while the crankshaft rotates. The exhaust valve opens during this process so that the exhaust gas can escape. By the time the crankshaft has rotated 720 degrees, the piston has reached top dead center and the exhaust stroke has been completed. After the exhaust stroke finishes, the intake, compression, combustion and exhaust strokes are repeated to keep the engine running.



The Engine's Three Elements of Combustion

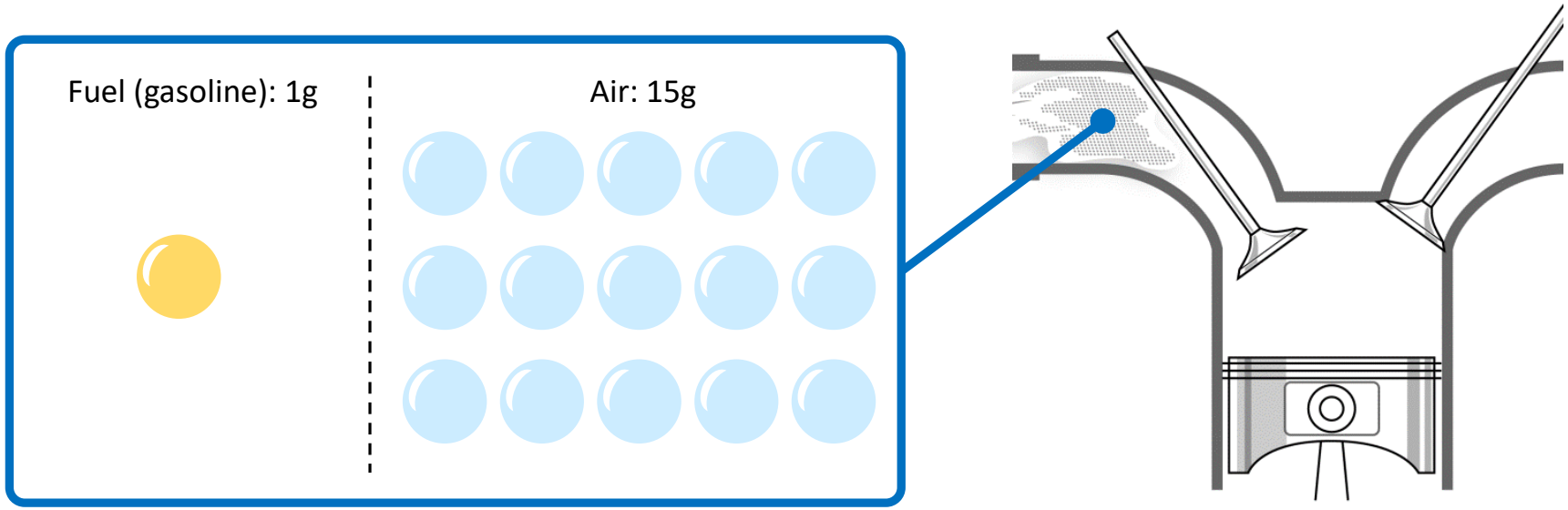
In order to start the gasoline engine and keep it running by burning the air-fuel mixture, the **three elements of combustion** are important.
The three elements of combustion are a **good air-fuel mixture, good compression, and good spark**. In order to achieve these, the equipment and parts responsible for each element must be in good condition.
If the engine does not start or run properly, the first step in narrowing down the cause of the problem is to check the three elements of the gasoline engine.
Let's think about what the components of the three elements are while learning about the components of the engine.

- **Good air-fuel mixture**
- **Good compression**
- **Good spark**



Good Air-fuel Mixture

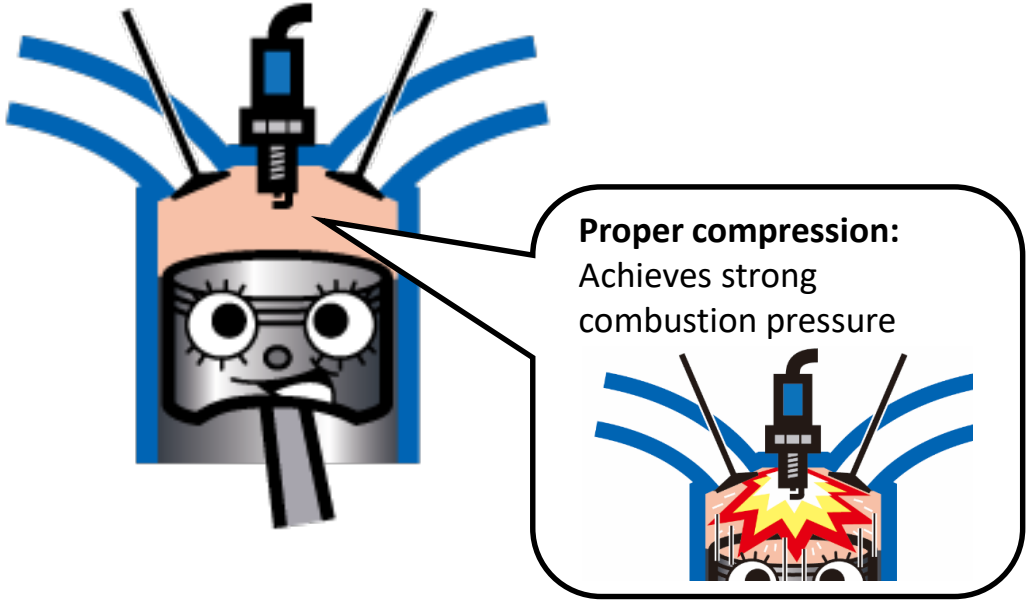
When the fuel and air is sucked into the cylinder, there has to be the right ratio of air to fuel.
If there is too much or too little fuel, the air-fuel mixture cannot combust.
A good air-fuel mixture is one in which **gasoline and air are mixed in the proper ratio**, which is 1g of gasoline to 15g of air.

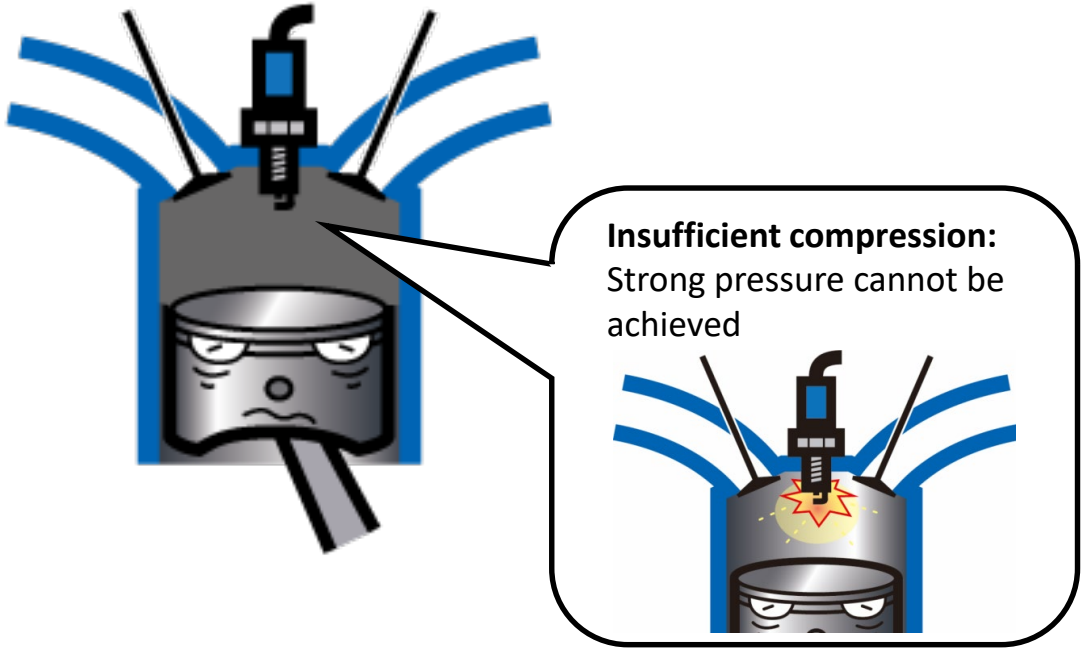


The Engine's Three Elements of Combustion

Good Compression

By compressing the air-fuel mixture, more power can be generated when the fuel is burned. **When compressing the air-fuel mixture, the right amount of compression is required.** The degree of compression is described by the "compression ratio".
The higher the compression ratio, the greater the combustion pressure. However, if the compression pressure is too high, a phenomenon called knocking will occur.



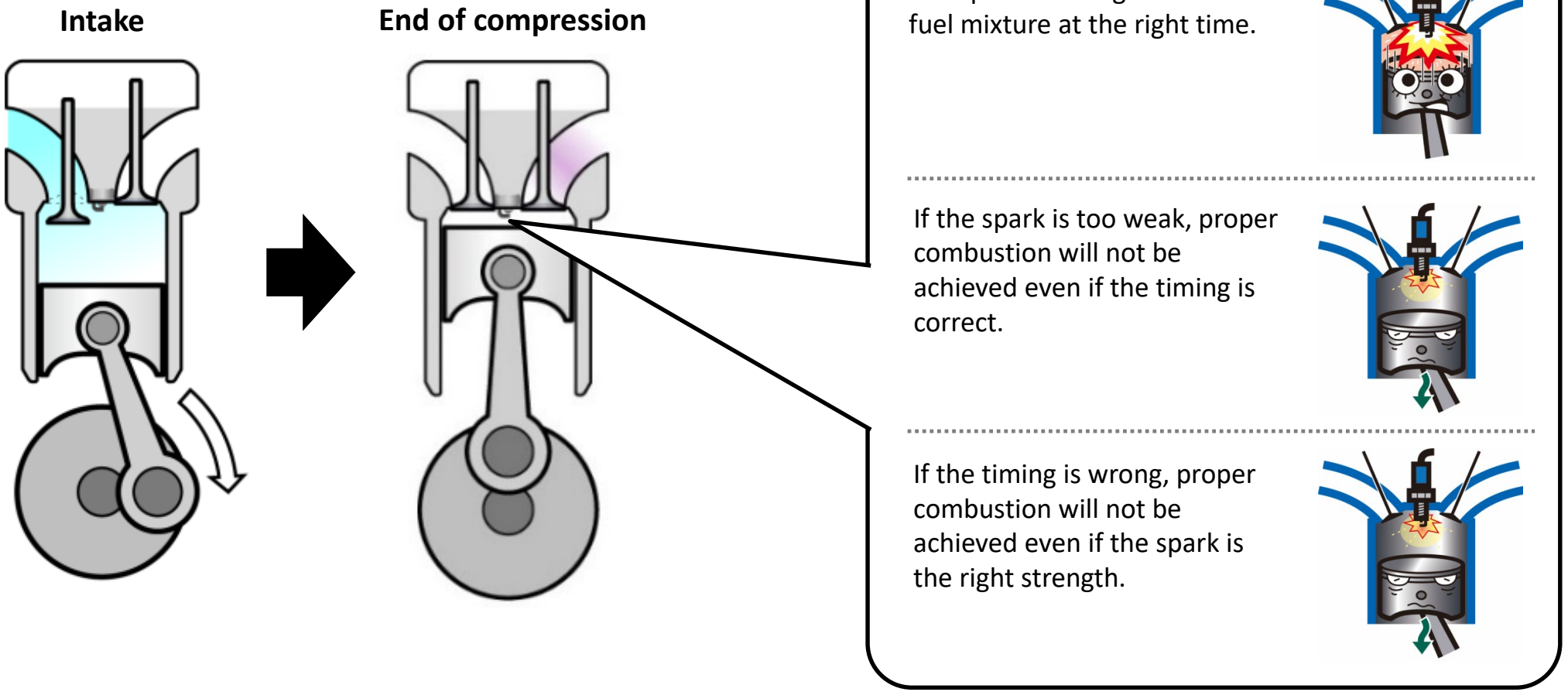


Knocking is an abnormal combustion of the engine, which causes abnormal noise and vibration.
It can also cause the inside of the engine to become too hot and cause damage in some cases.

The Engine's Three Elements of Combustion

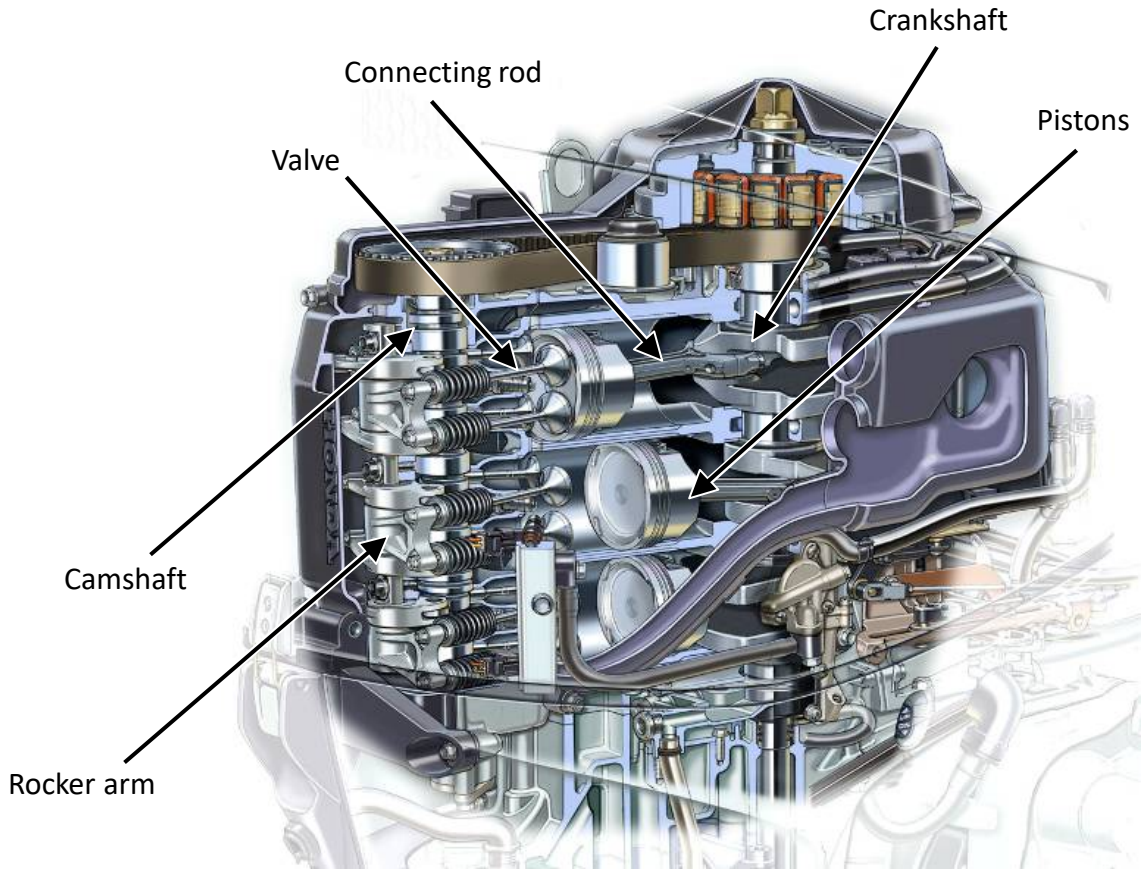
Good Spark

Gasoline engines are **powered by the combustion of an air-fuel mixture**. If a strong spark is not generated at the right time, the air-fuel mixture cannot be burned sufficiently, resulting in the engine not running or a lack of power.



Engine Component Overview

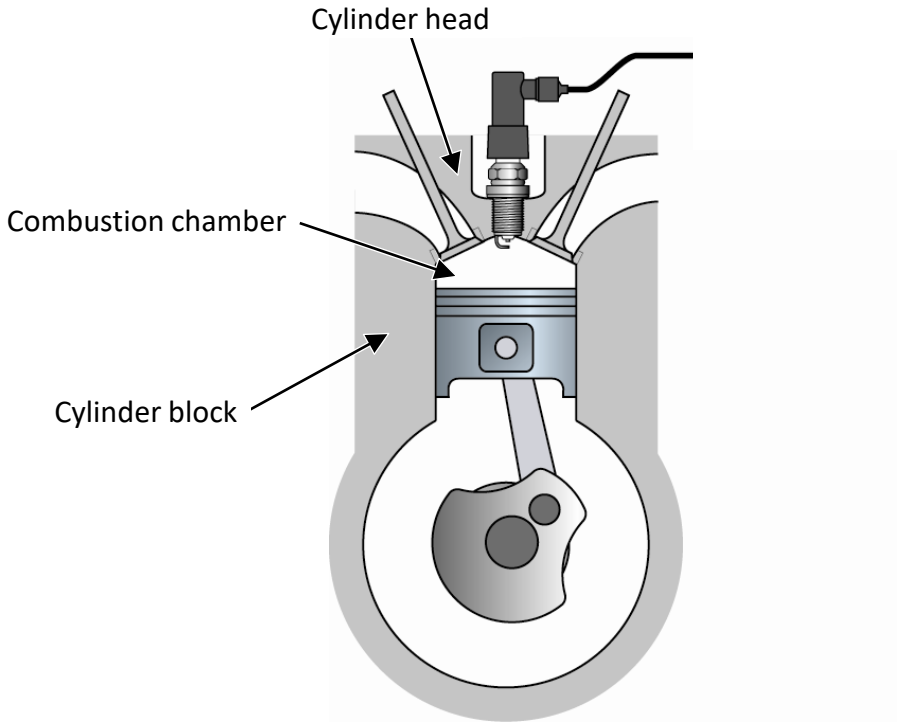
An engine is made up of various components.
In the following pages, you will learn about each of the components that make up an engine.



Cylinder Head

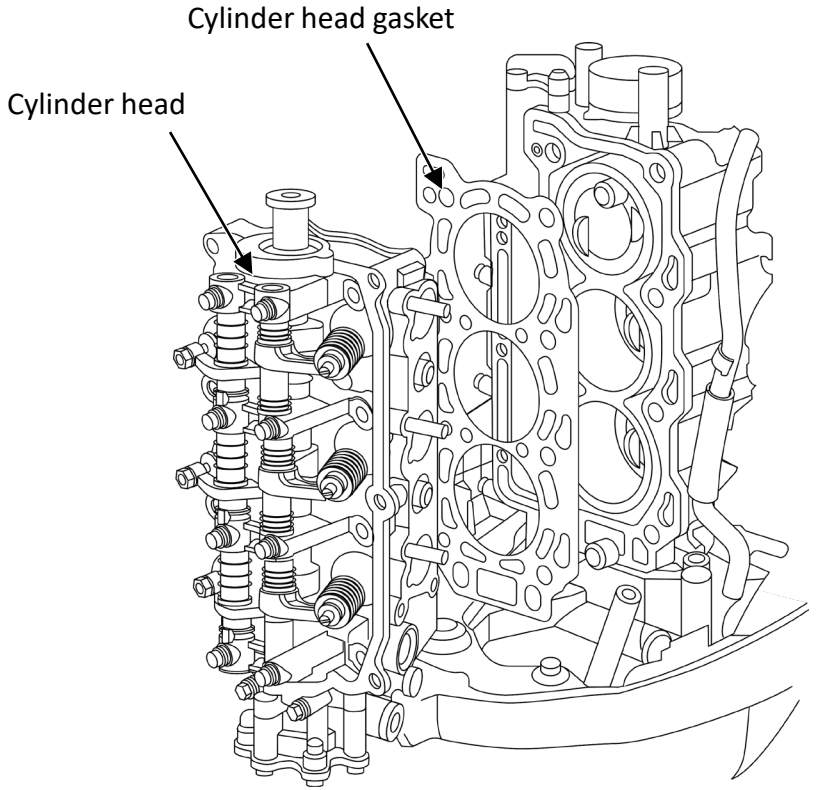
Overview

It is attached to the top of the cylinder block, covering the cylinder from above to make up the combustion chamber.
The combustion chamber must be durable enough to efficiently burn the air-fuel mixture and withstand the combustion pressure.



Structure

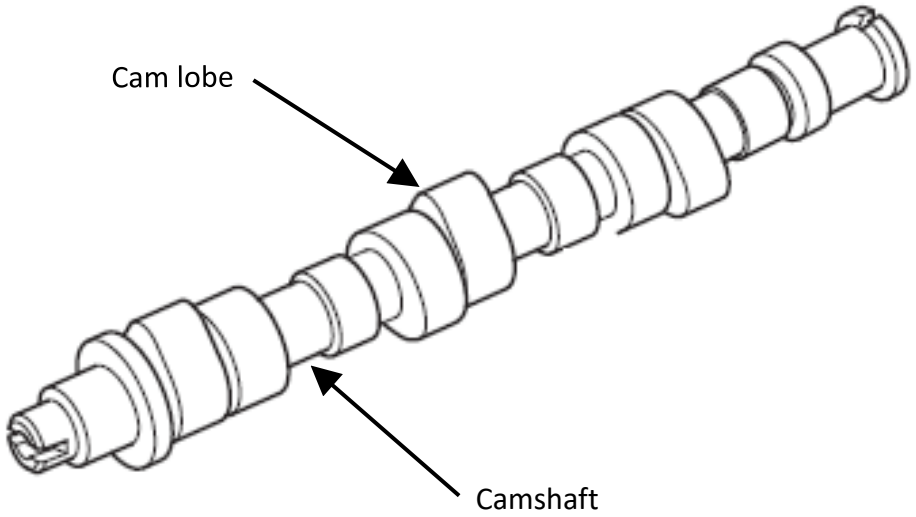
The cylinder head, together with the piston, forms the combustion chamber and is exposed to high heat and high combustion pressure.
Inside, there are oil passages and a water jacket for cooling.



Camshaft

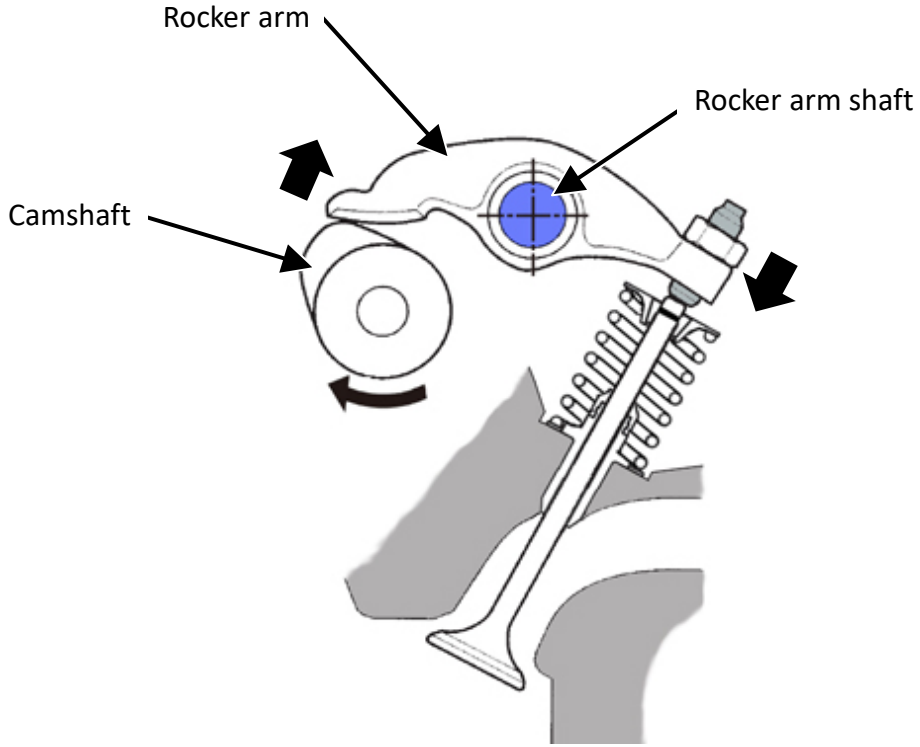
Role

The camshaft opens and closes the valves by means of convex protrusions on the camshaft called cam lobes.



Operation

As the camshaft rotates, the rocker arm is pushed up by the cam lobe. With the rocker arm shaft as the fulcrum, the rocker arm pushes the valve down and opens the port. As the camshaft rotates further and exceeds the convexity of the cam lobe, the spring force pushes the valve up and closes the port.



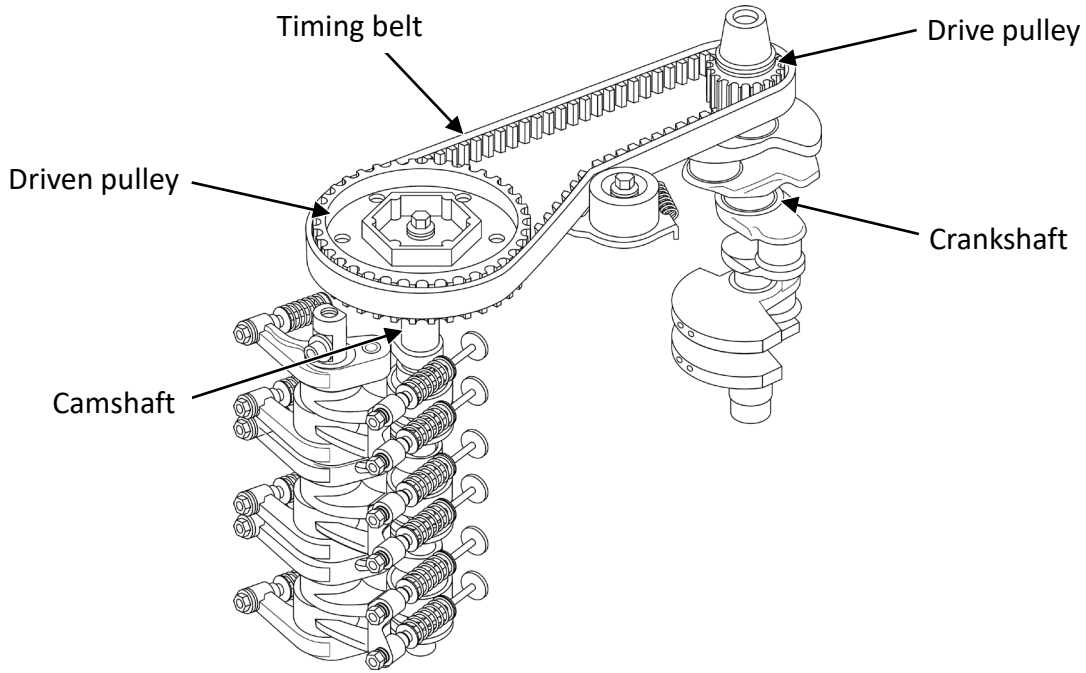
Timing Belt/Chain

Role

Role of the timing belt and the timing chain is to correctly transmit the opening and closing timing of the valve that moves in conjunction with the reciprocating motion of piston.

Structure

The rotation of the drive pulley, which is connected directly to the crankshaft, is transmitted to the camshaft, which moves with the drive pulley, via a belt or chain. The driven pulley rotates at one-half the speed of the drive pulley.



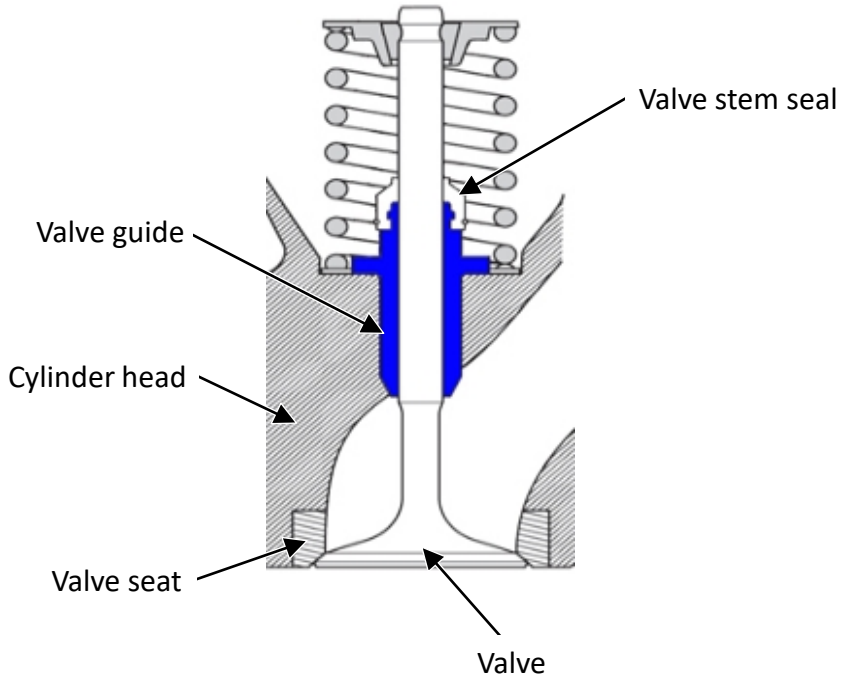
Necessity of Maintenance

When the timing belt breaks, the valve opening and closing timing shifts, causing the valve face to contact the piston, resulting in serious damage to the engine.

Valve

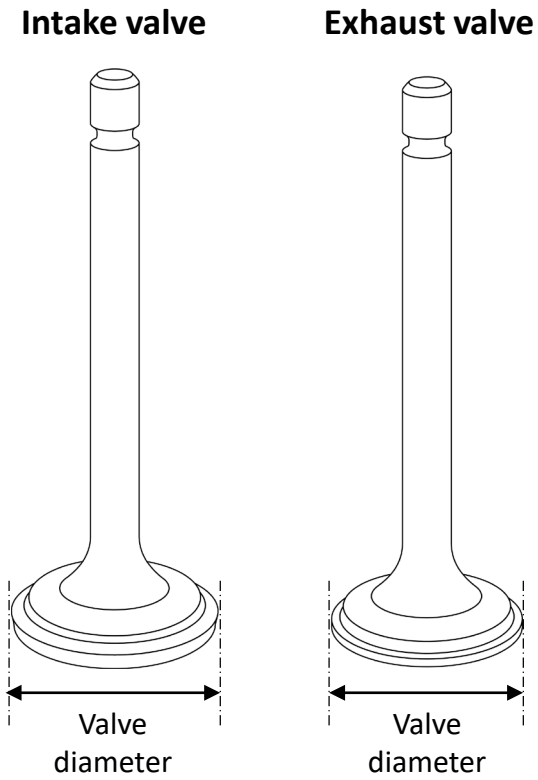
Role

The intake valve creates a path (port) for the air-fuel mixture to enter the cylinder. The exhaust valve creates a path for the combustion gases produced by the combustion of the air-fuel mixture to exit the cylinder. Both valves also close their respective passages, sealing the area during compression and combustion of the air-fuel mixture.
The valve stem seal prevents engine oil from entering the combustion chamber.



Structure

The diameter of the intake valve is larger than that of the exhaust valve in order to increase the amount of air intake.



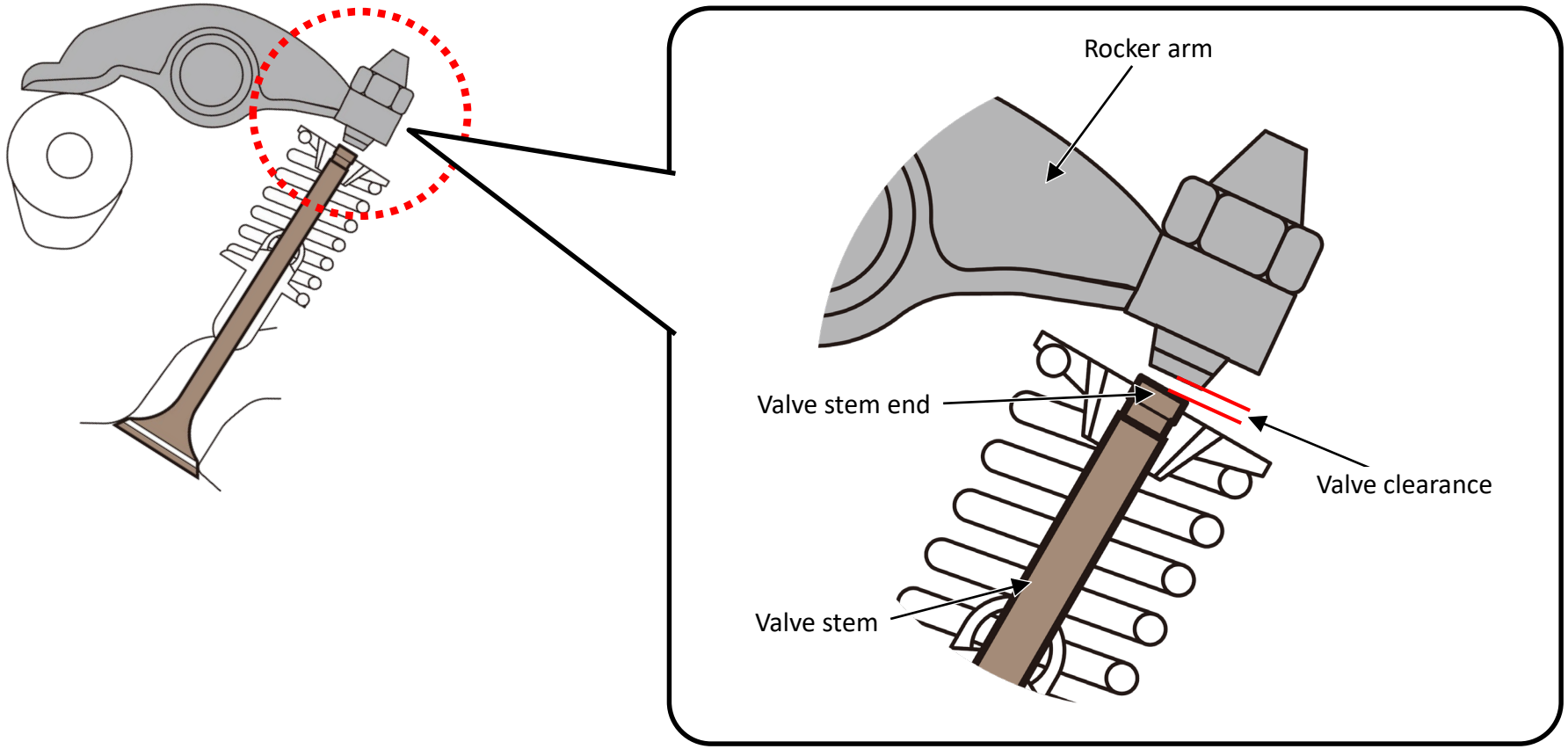
When the valve stem seal wears out, oil on the cylinder head will enter the combustion chamber through the gap with the valve stem, causing white smoke and reduced oil amount.

Valve Clearance

Overview

When the engine temperature rises, the cylinder head and valves expand thermally, causing the valve stem end and rocker arm to interfere with each other. For this reason, a small gap is provided between the valve stem end and the rocker arm in advance in anticipation of thermal expansion. This gap is called the valve clearance.

By maintaining this clearance, the valve opening and closing are properly maintained even when the engine temperature rises.



Valve Clearance

Necessity of Maintenance

Valve clearance changes as the engine continues to operate.
If the valve clearance is not correct, the timing of valve opening and closing will be misaligned, resulting in noise, and reduced intake and exhaust efficiency.

The intake side holds less heat because of the air-fuel mixture, while the exhaust side holds more heat because of the intensely heated exhaust gases.
Since the thermal expansion of the valve itself on the exhaust side is greater than on the intake side, the clearance may also be greater.
Valve clearances should be adjusted to specifications when the engine is cold.

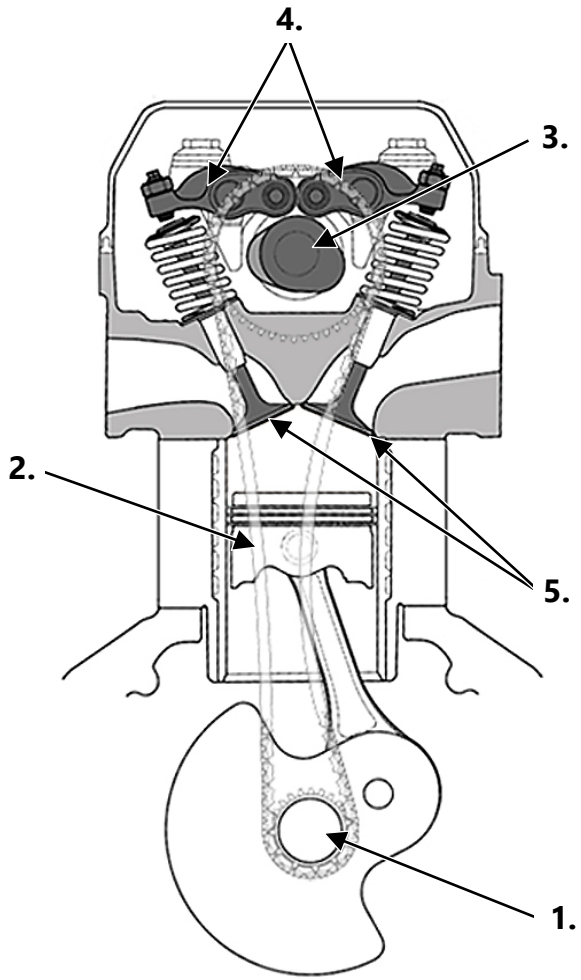
OHC Design

In the OHC design, the valves and camshafts are installed in the cylinder head. Some have one camshaft, and some have two camshafts, one for intake and one for exhaust. The engine with one overhead camshaft is called the SOHC type, and the one with two is called the DOHC type.

SOHC:	Single Over Head Camshaft
DOHC:	Double Over Head Camshaft

Order of power transmission

1. Crankshaft
2. Chain (or belt)
3. Camshaft
4. Rocker arms
5. Valves



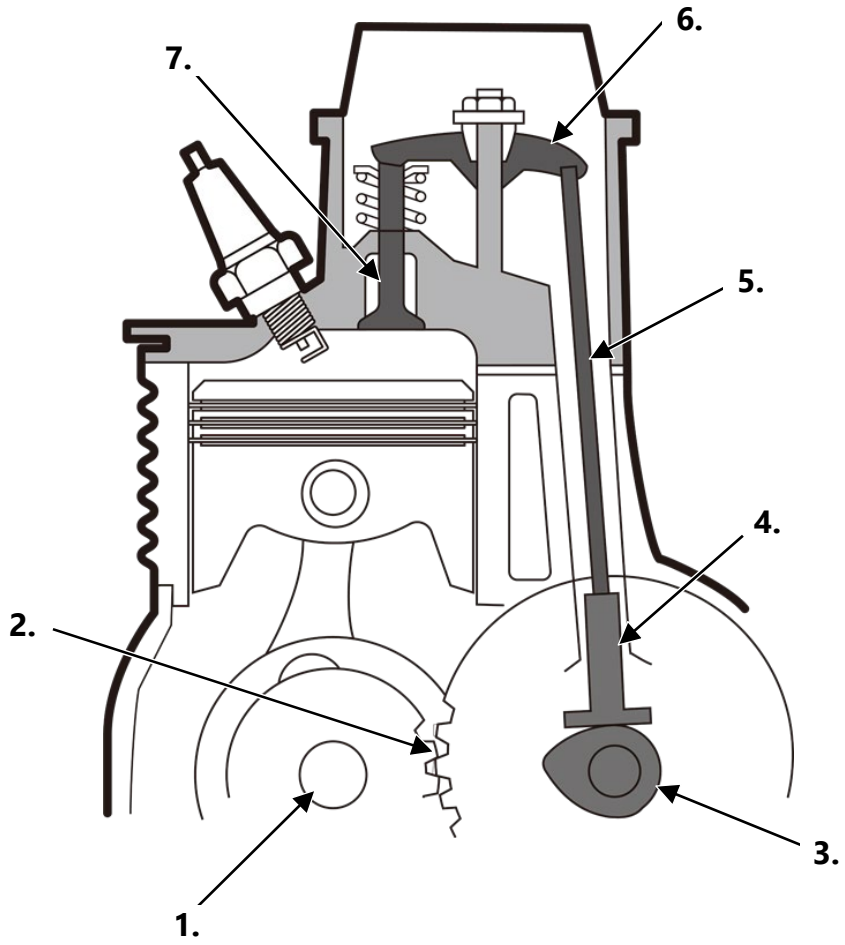
OHV Design

In the OHV design, the valves are installed in the cylinder head. Since the camshaft is located in the cylinder block, the valve is driven via the valve lifter and push rod.

OHV:	Over Head Valve

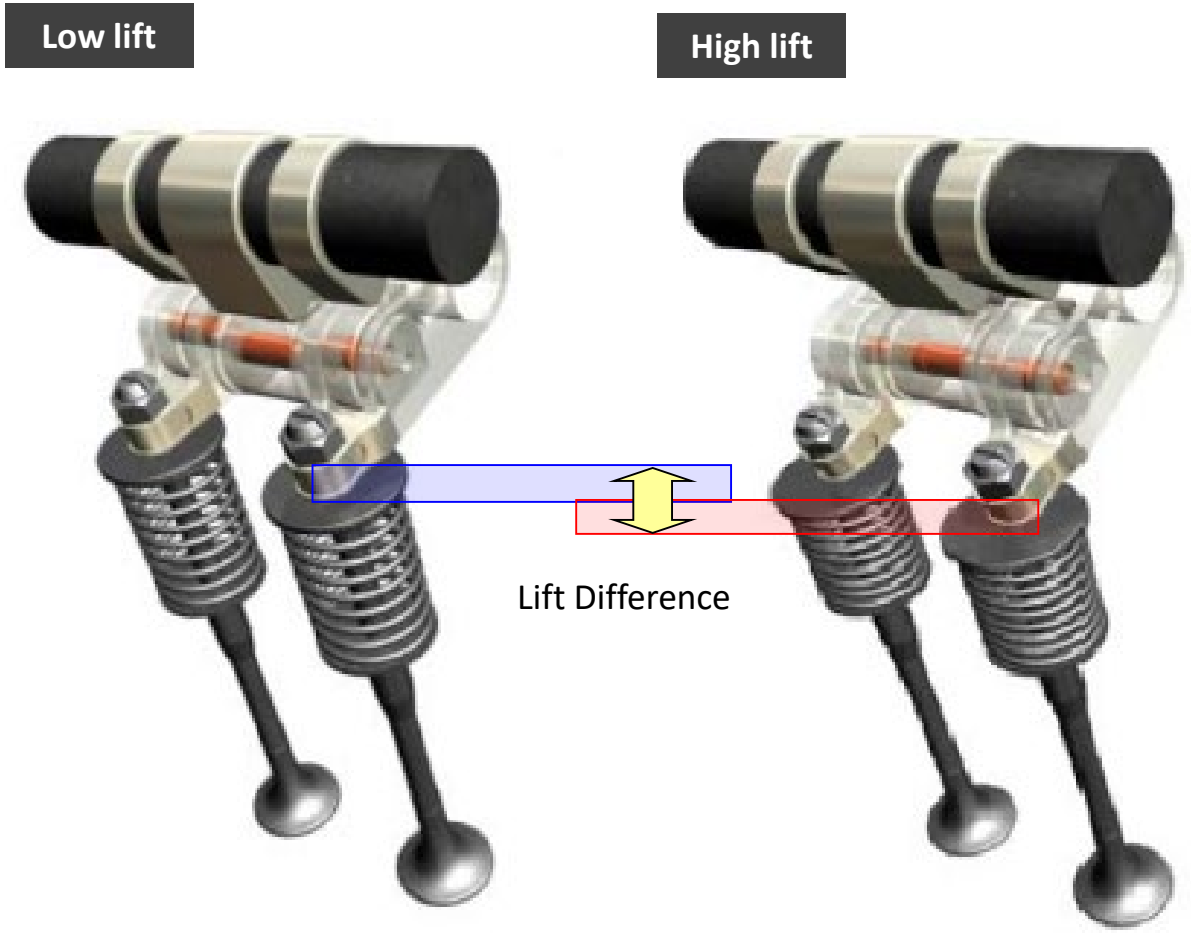
Order of power transmission

1. Crankshaft
2. Gear
3. Camshaft
4. Valve lifter
5. Push rod
6. Rocker arms
7. Valves



VTEC (Variable Valve Timing)

Honda VTEC (Variable Valve Timing and Lift Electronic Control System) changes the valve lift height and inlet opening duration to provide optimum performance from low to high RPM and obtains optimum output characteristics in the entire RPM range.



Cylinder Block

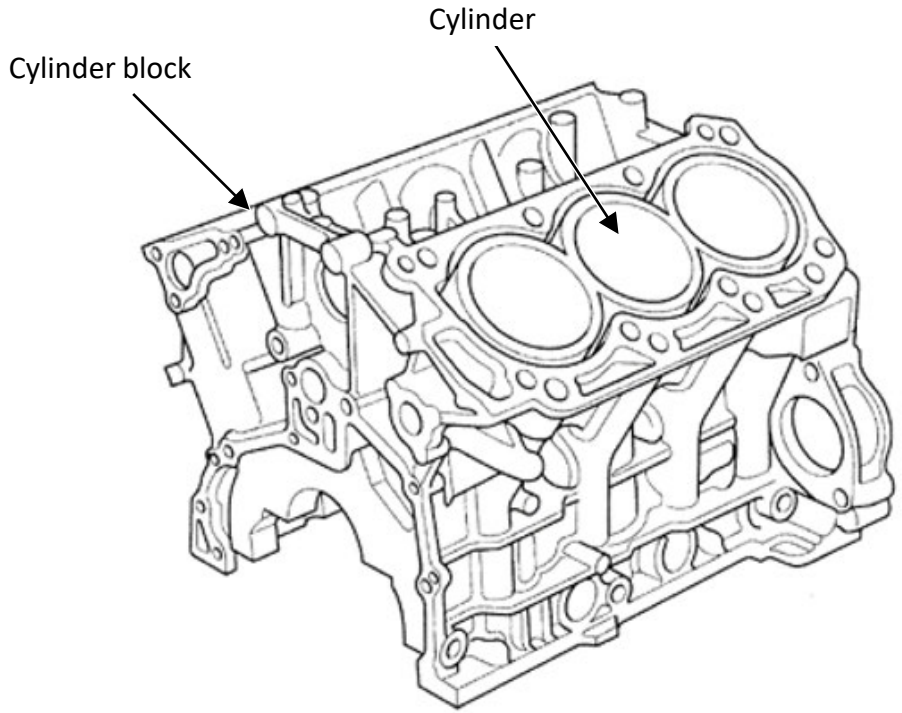
Role

The cylinder block is the backbone of the engine and plays an important role in maintaining compression and receiving combustion pressure along with the piston.

When the cylinder is worn, the gap between the cylinder and the piston becomes large, causing compression to leak and oil on the cylinder wall to enter the combustion chamber, resulting in white smoke and reduced oil amount.
When the cylinder is worn, boring the cylinder and replacing it with an oversized piston will ensure proper clearance.

Structure

The main part of the cylinder block is the cylinder section that houses the piston.
The cylinder bore is finished to a precise circular shape, and the block is equipped with passages for cooling water and engine oil.



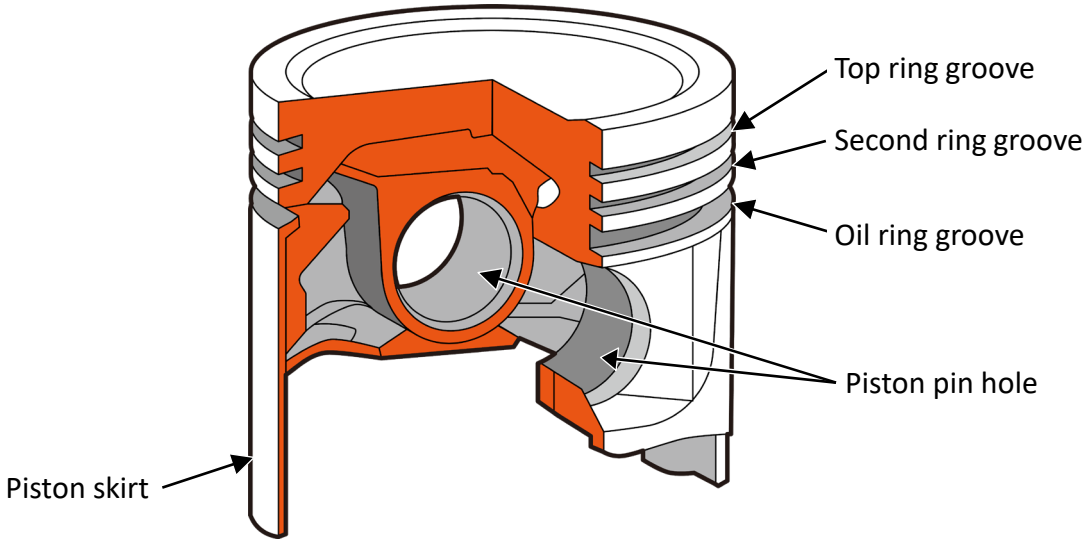
Piston

Role

The piston compresses the air-fuel mixture taken in and transmits the pressure of the combustion gases combusted by the spark plug ignition to the crankshaft, as well as pushing the exhaust gases out of the engine.

Structure

The piston needs to be light weight, to have adequate strength, excellent heat and pressure resistance.
Generally, the piston is made of aluminum alloy which satisfies these requirements.



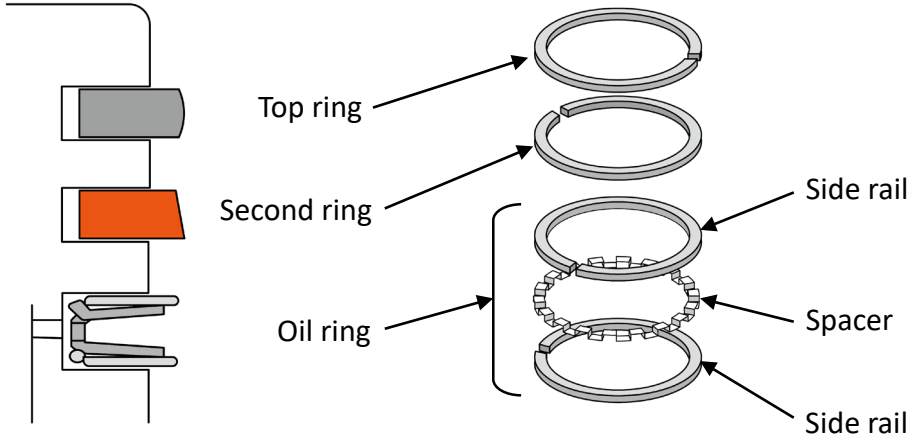
Piston Ring

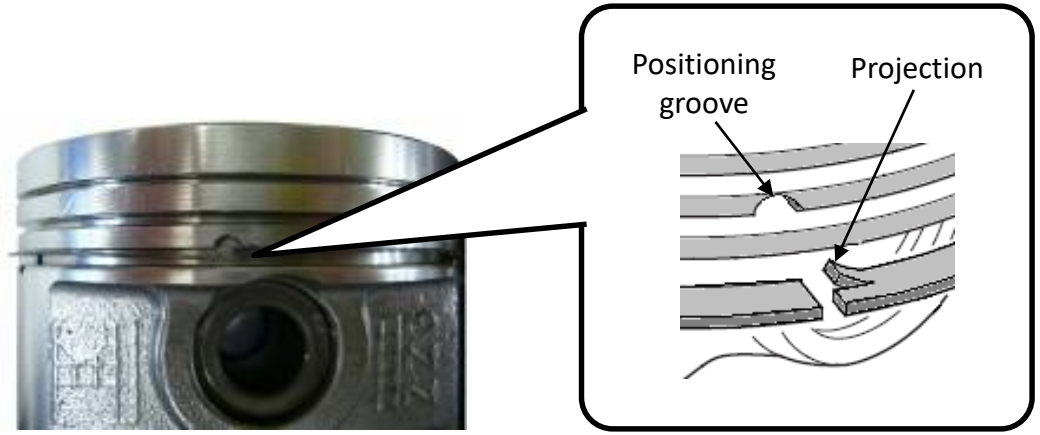
Role

Each of the piston rings has its own role. The top ring seals the combustion gases. The second ring seals the combustion gases and lubricating oil. The oil ring scrapes off excess oil.

Structure

The piston ring consists of a top ring, a second ring, and an oil ring. The top ring and second ring are hard and have high heat and wear resistance. The oil ring consists of two side rails and one spacer. Each piston ring has a different shape, and some oil rings are designed to fix the position of the piston and oil ring.





When piston rings are worn, the gap between them and the cylinder increases, causing compression to leak and oil from the cylinder wall to enter the combustion chamber, resulting in white smoke and reduced oil amount. When the cylinder is worn, boring the cylinder and replacing the piston with an oversized piston will ensure proper clearance.

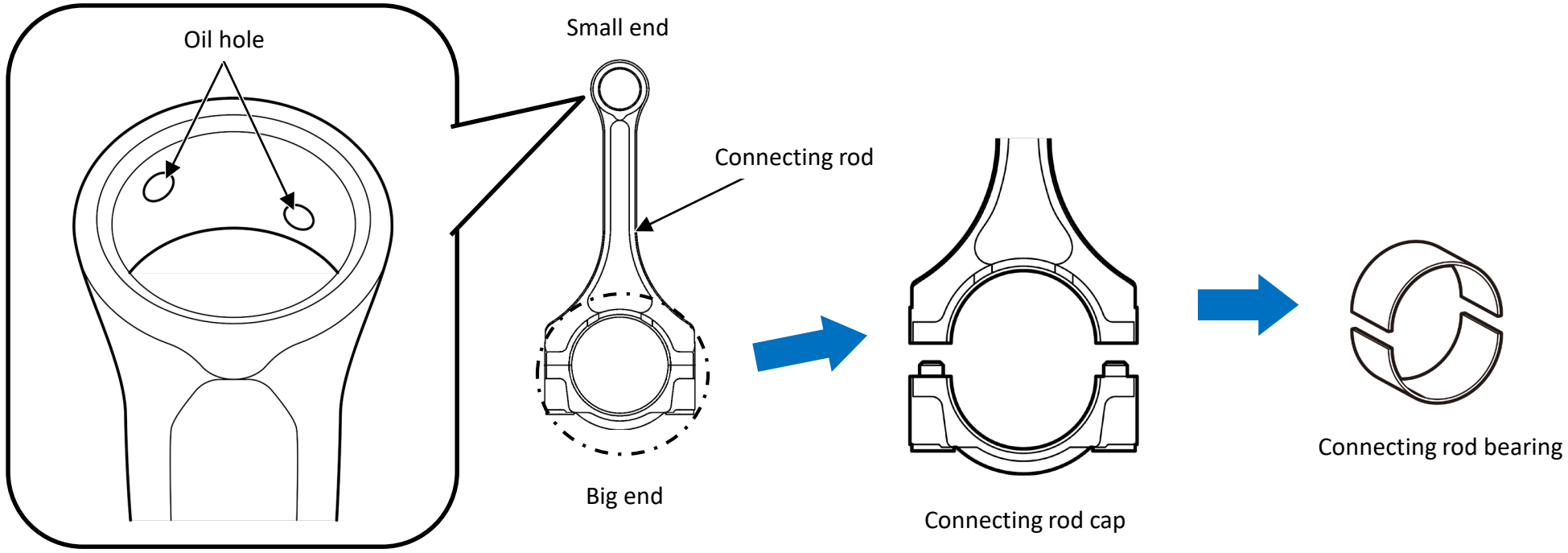
Connecting Rod

Role

The connecting rod converts the reciprocating motion of the piston into the rotary motion of the crankshaft.

Structure

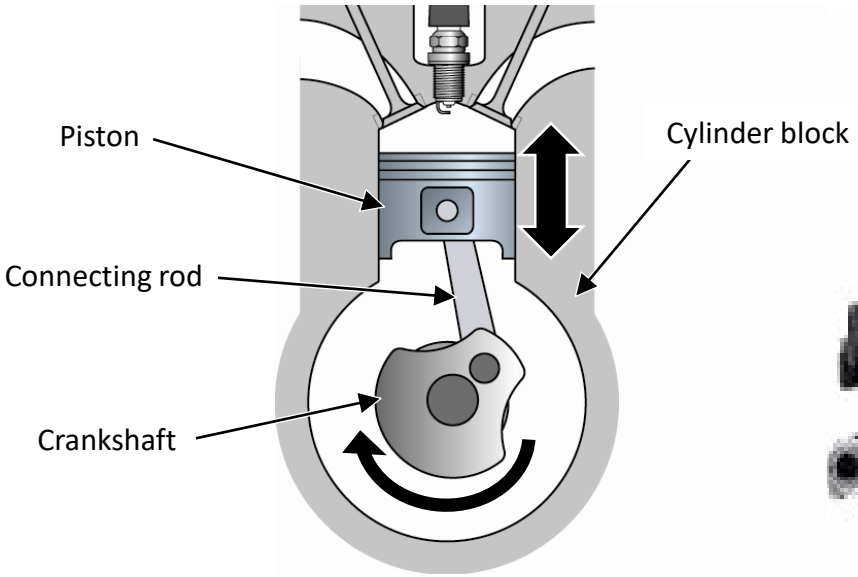
The connecting rod consists of two pieces, the rod and the cap. The big end of the connecting rod is connected to the crankshaft. A bearing is installed on the inside of the big end and is continually lubricated by oil which passes through the inside of the crankshaft from the crankshaft main journal. The rod and the rod cap are paired and the big end bore is machined together. Handle them as a pair. The small end of the connecting rod is connected to the piston via the piston pin. The splashing engine oil to the piston enters the oil hole in the small end, and continually lubricates the bore.



Crankshaft

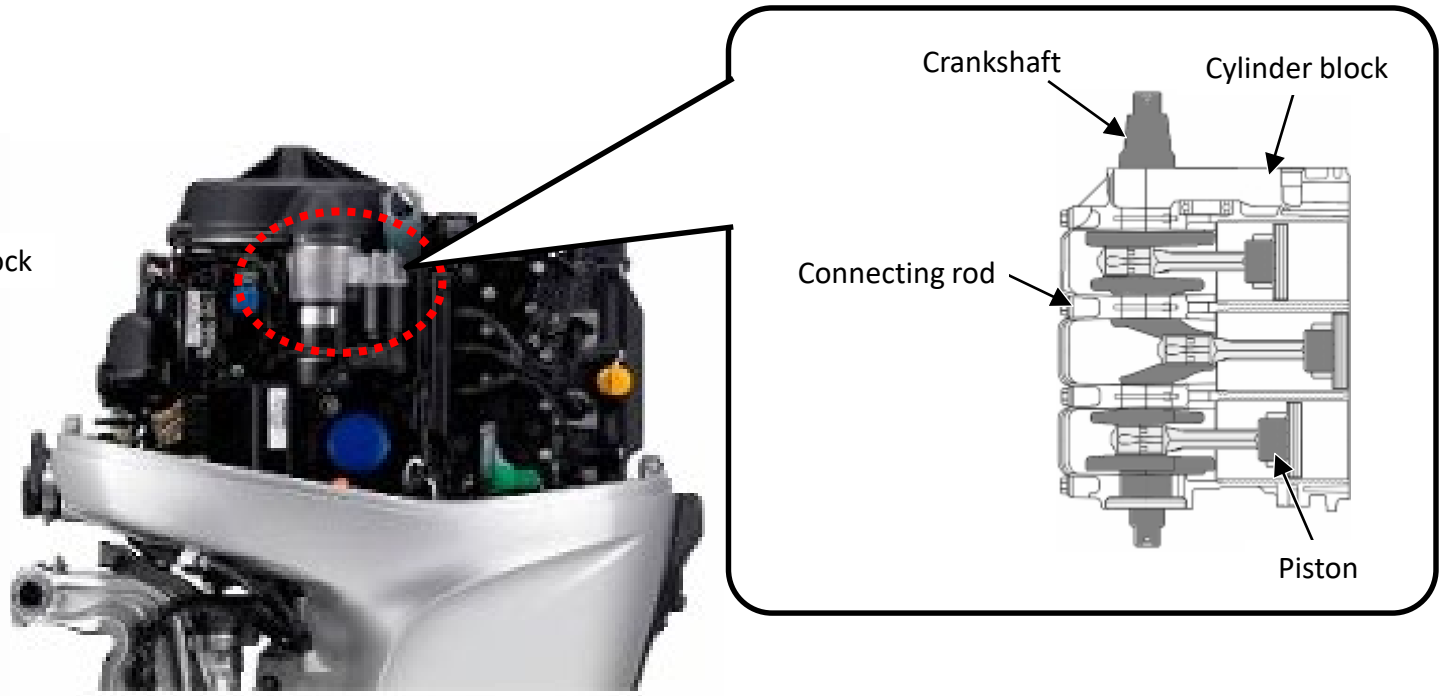
Role

The crankshaft converts the linear motion of the piston into rotational motion via the connecting rod.



Structure

Since the crankshaft rotates at high speed while receiving a large amount of force, it must have sufficient strength and rigidity to ensure a well-balanced structure both statically and dynamically.



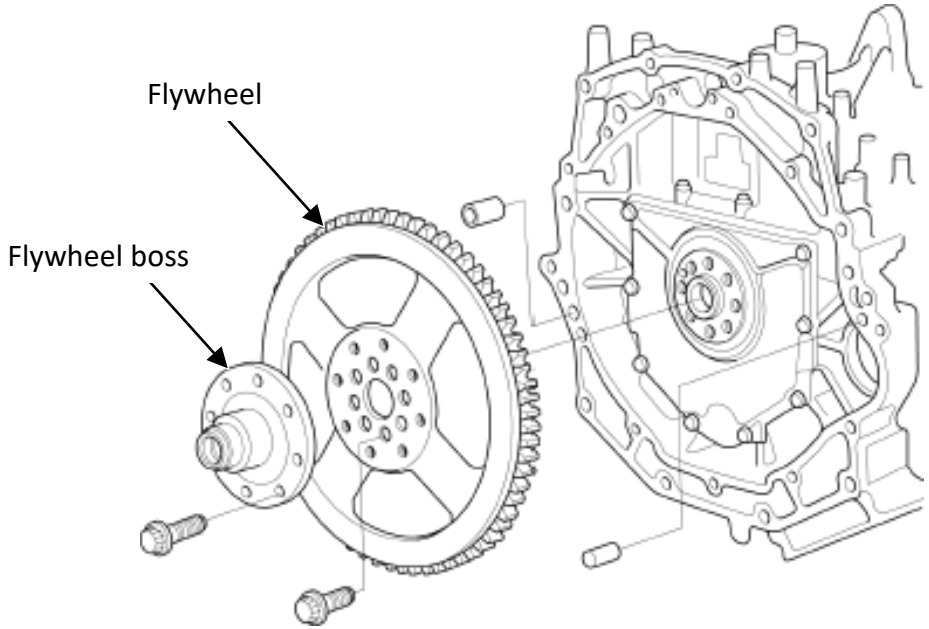
Flywheel

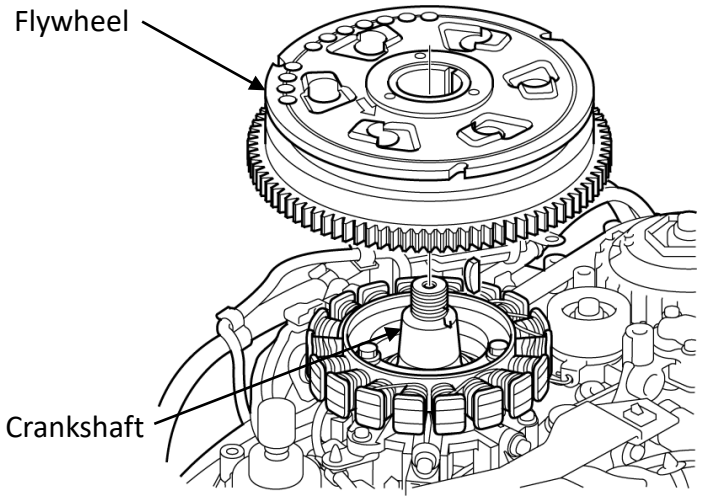
Role

The flywheel works to turn the crankshaft smoothly by inertia. When starting the engine, the pinion gear of the starter motor engages with the ring gear to rotate the crankshaft.

Structure

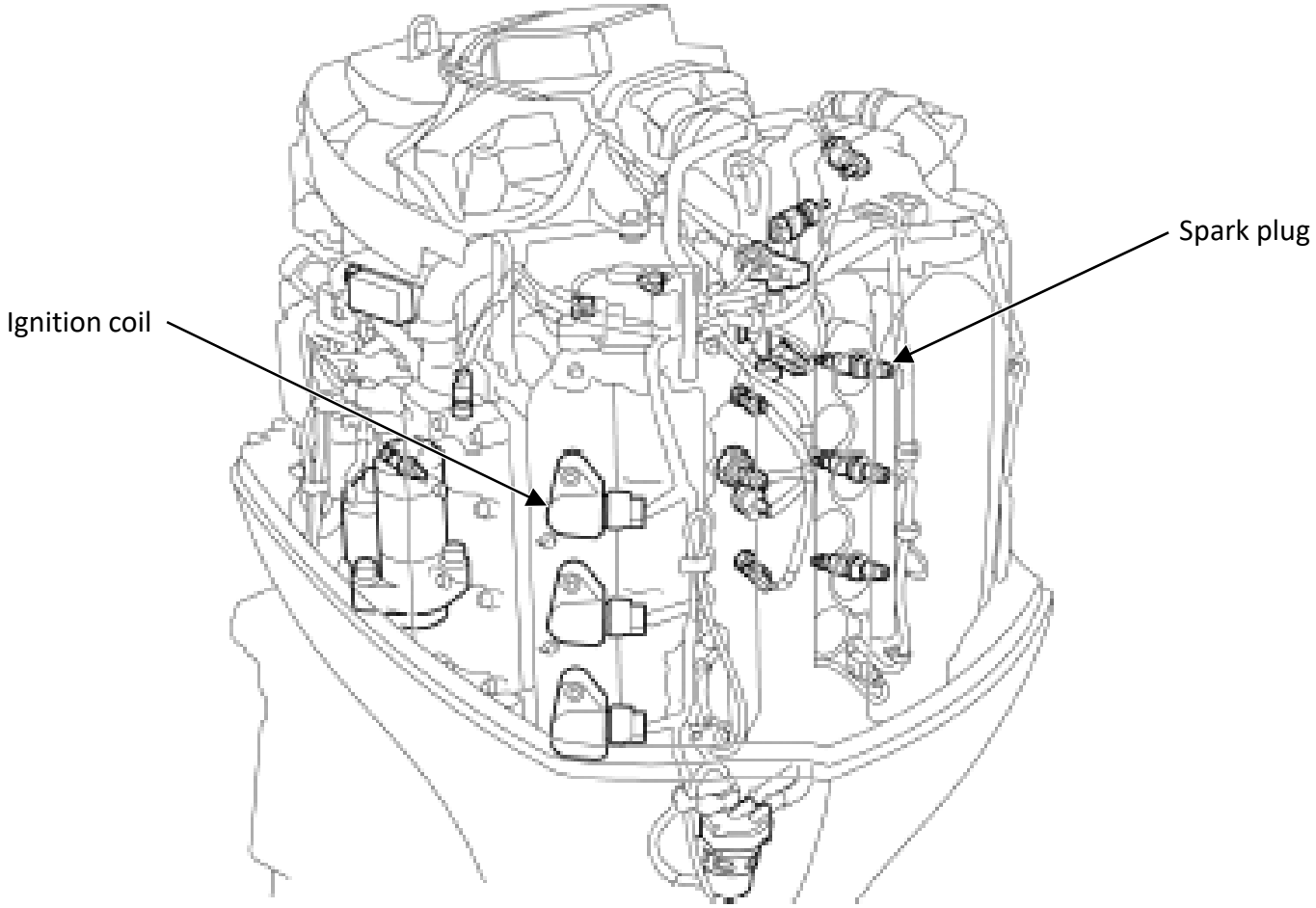
The outer periphery of the flywheel is the ring gear for starting the engine, which engages with the pinion gear of the starter motor.





Ignition System Overview

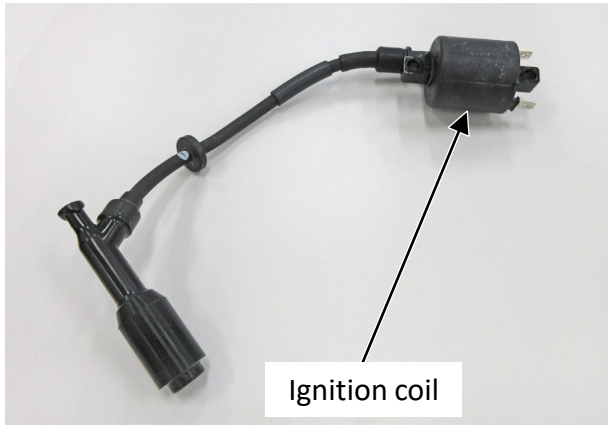
The ignition system provides a strong spark to ensure that the compressed air-fuel mixture burns well, and ignites at the optimum time depending on the engine condition.



Ignition Coil

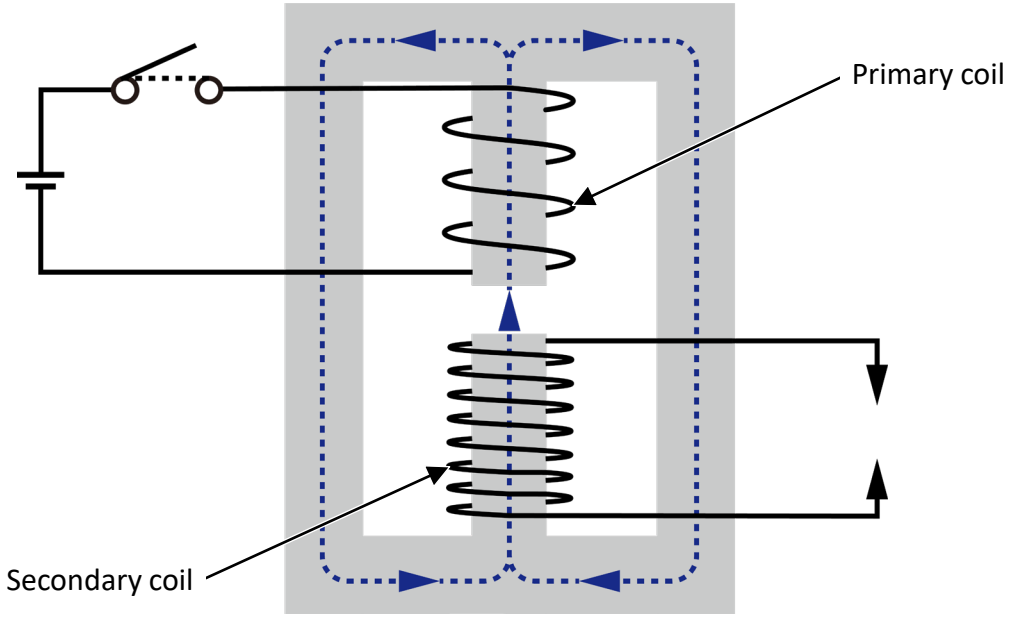
Role

The ignition coil uses the electricity from the battery to generate a high voltage that produces a strong spark at the spark plug.
High-tension cords and ignition coils with separate plug caps are used for the models whose horsepower is less than 75 horsepower, and integrated direct ignition coils are used for the models whose horsepower is 75 horsepower or higher .



Structure

The primary and secondary coils are wound around the center core (iron core). The secondary coil has more turns than the primary coil. When the current flowing in the primary coil is turned off, a high voltage (secondary voltage) is generated on the secondary coil side, which ignites the spark plug.



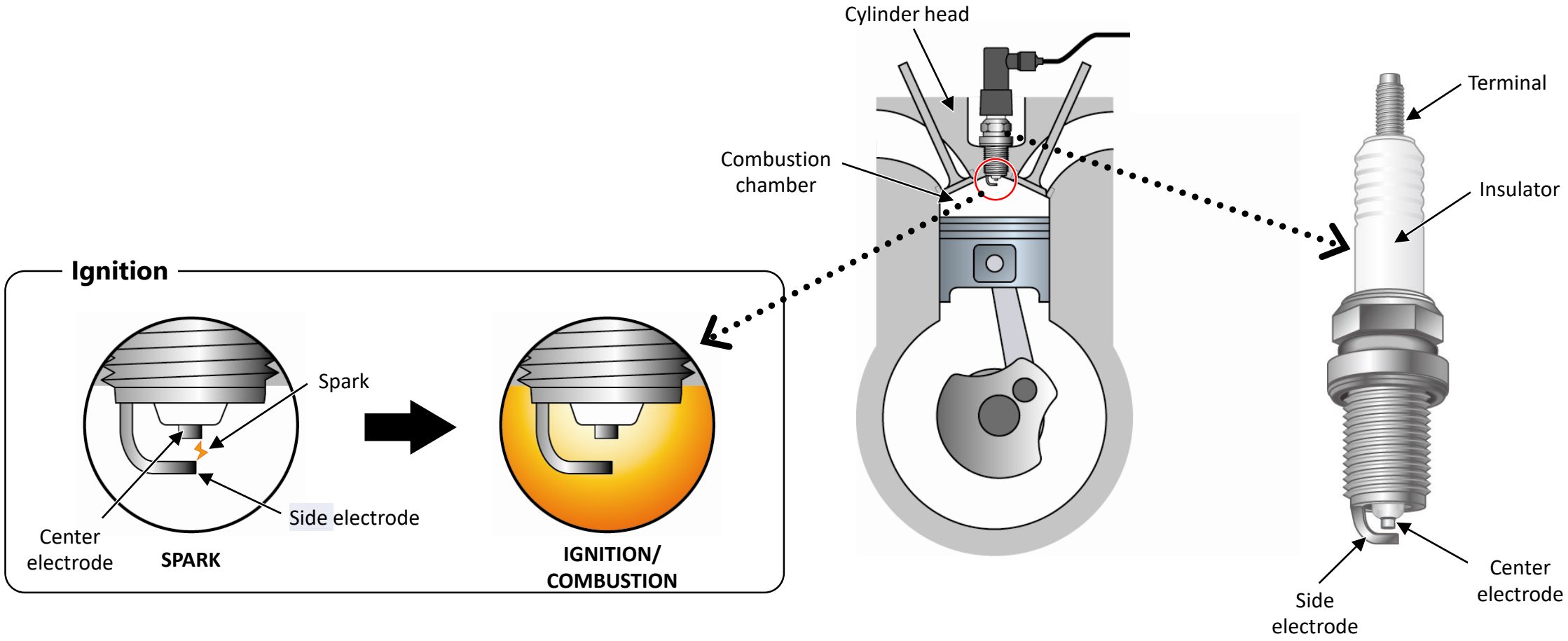
Spark Plug

Role

Sparks are generated by discharging the high voltage generated by the ignition coil between the center and side electrodes. This ignites the air-fuel mixture in the combustion chamber.

Structure

The spark plug consists of a terminal that receives the voltage produced by the coil, an insulator that prevents leakage, a center electrode that fires sparks, and a side electrode, and an appropriate gap is provided between the center electrode and the side electrode.

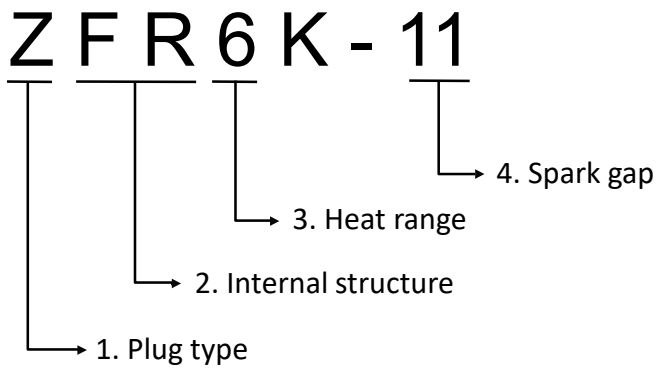


Spark Plug Codes

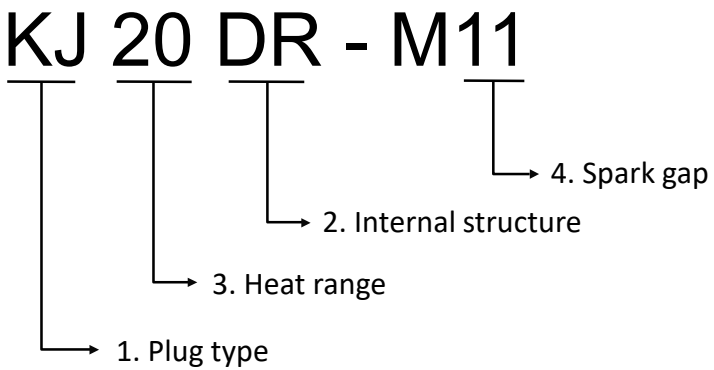
The spark plug code marked on the insulator indicates information such as the thread reach, thread diameter, and heat range of the spark plug.

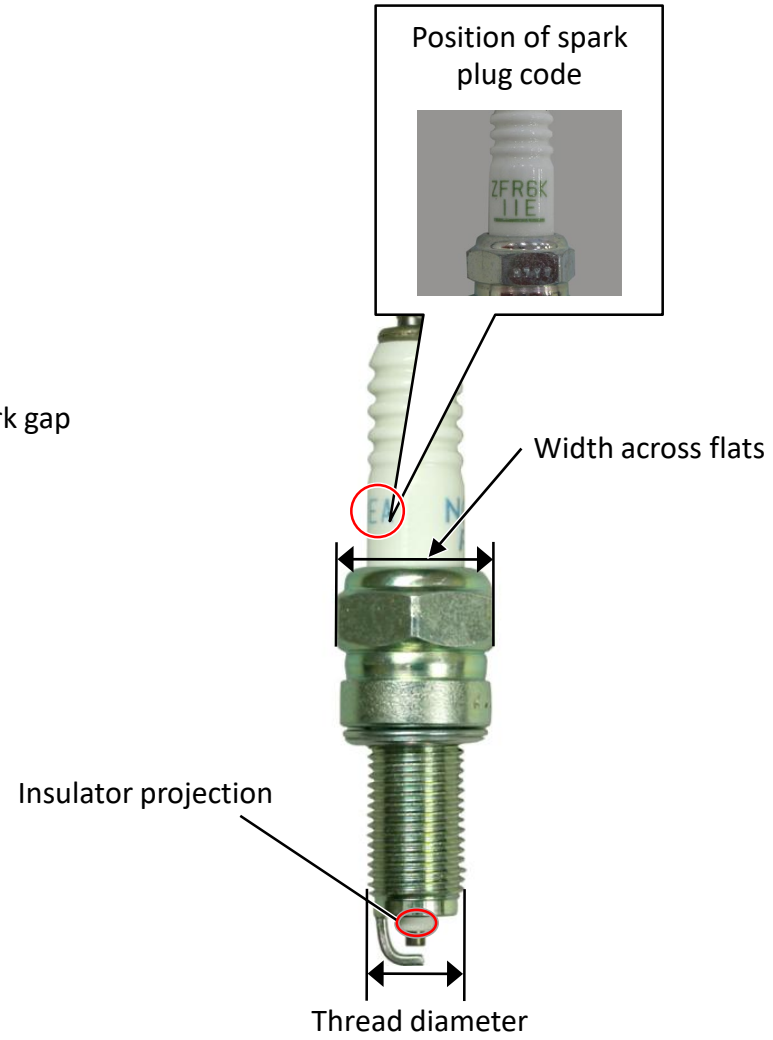
Examples of spark plug codes

- **NGK**



- **DENSO**





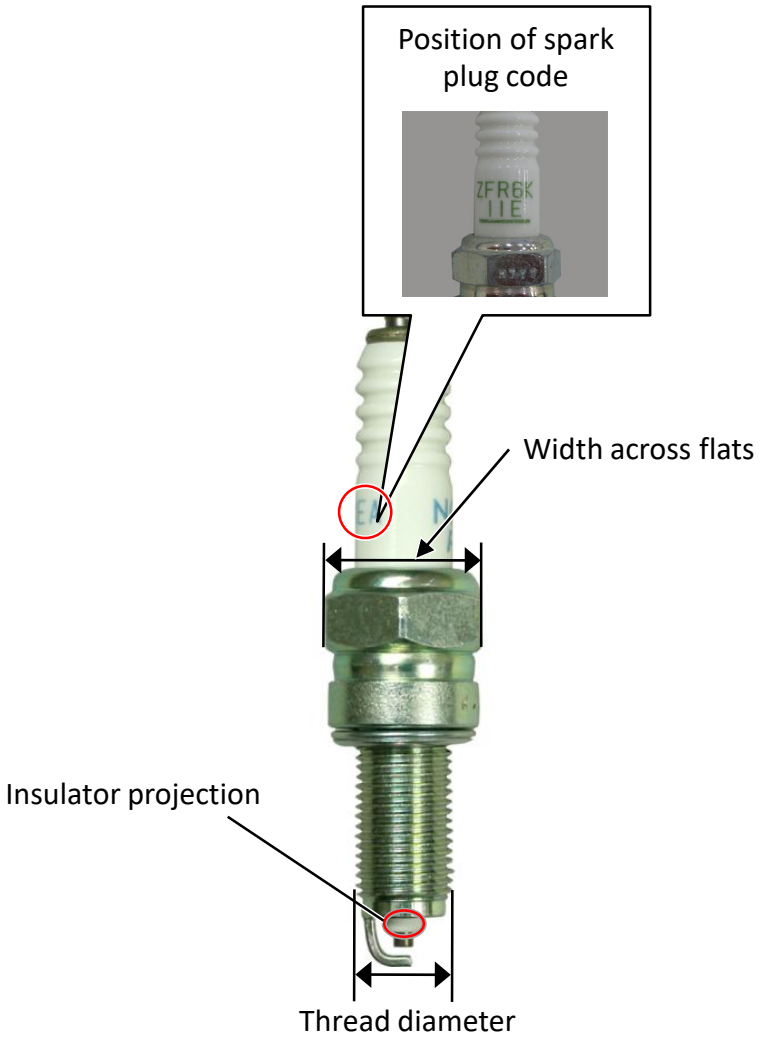
1. Plug type

NGK	DENSO	Type
Z	KJ	Projecting plug
IZ	SKJ	Iridium plug

Spark Plug Codes

2. Internal structure

NGK	DENSO	Type
F	D	Thread diameter: 14mm, Thread reach: 19mm
R	R	With resistor (The internal resistor reduces radio noise.)



3. Heat range

Heat range is a spark plug's ability to carry heat from the combustion chamber. The larger the number is, the more easily heat is released.

NGK	DENSO	
4	14	Heat is not easily released
5	16	
6	20	
7	22	
8	24	
9	27	
10	31	Heat is easily released

4. Spark gap

The number specified in this position indicates the spark gap. In the above examples, "9" indicates that the spark gap is 0.9 mm. When no number is specified, the spark gap is 0.7 mm, the standard gap width.

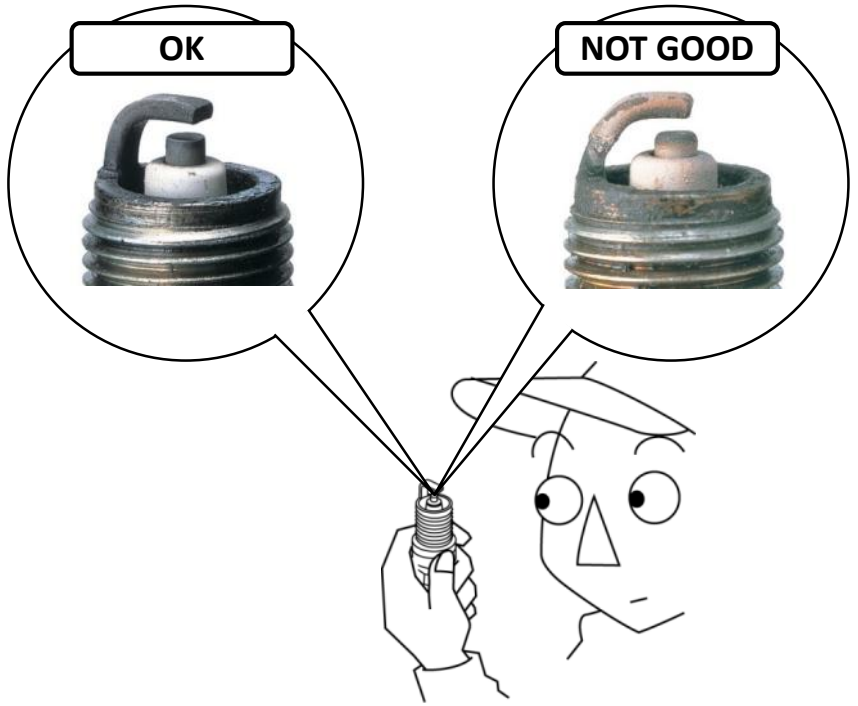
Necessity of maintenance

When a spark plug is being used, the tips of the electrodes wear out first since discharge mainly occurs at the tips. This causes the spark gap (between the center and side electrodes) to widen. In addition to the electrode wear, carbon fouling on the electrodes and insulator projection progresses depending on its usage condition. If electrode wear or carbon fouling progresses further, the spark produced by the spark plug becomes weaker. This is why periodic maintenance has to be performed.

What happens if maintenance is not done?

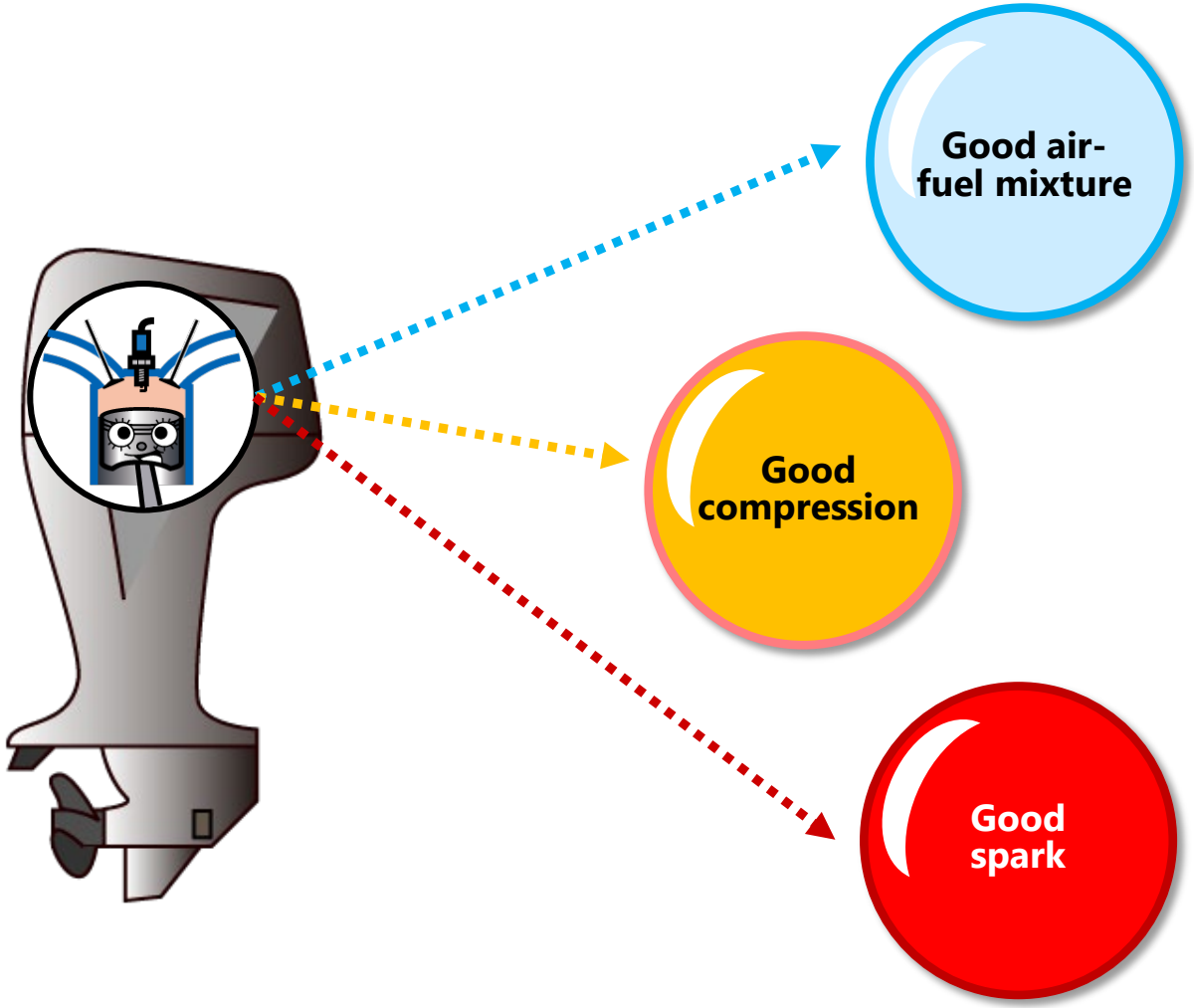
Failure to perform maintenance of the spark plug leads to the following troubles

- Starting problem
- Engine stall
- Insufficient power
- Insufficient vehicle speed
- Fuel economy degradation



Engine Components Summary

The related parts of the engine body are classified according to the engine's three elements of combustion.
The three elements of combustion are maintained when the following components of the engine are working properly.



1. Engine Components for "Good Air-fuel Mixture

- Cylinder head
- Camshaft
- Timing belt/chain
- Valve (Valve clearance)

2. Engine Components for "Good Compression"

- Piston (Piston ring)
- Cylinder
- Valve (Valve clearance)

3. Engine Components for "Good Spark"

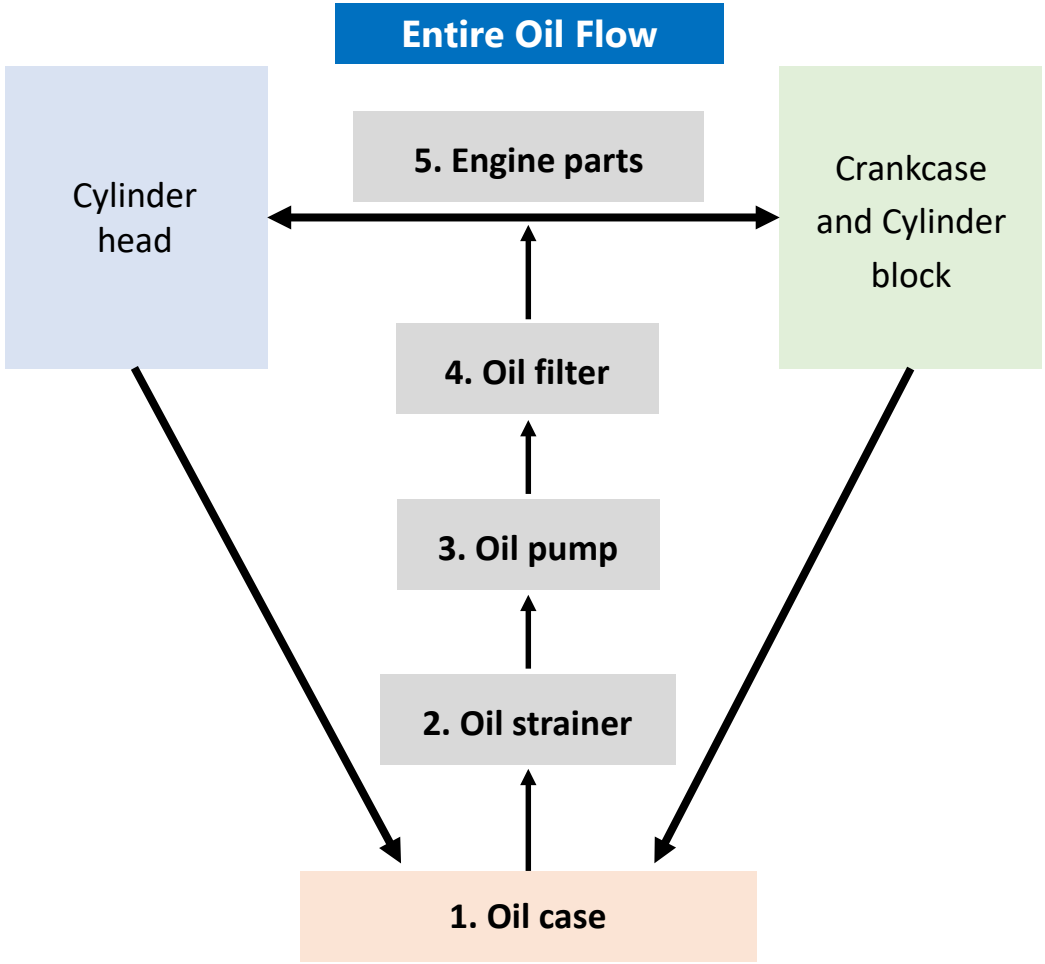
- Ignition coil
- Spark plug

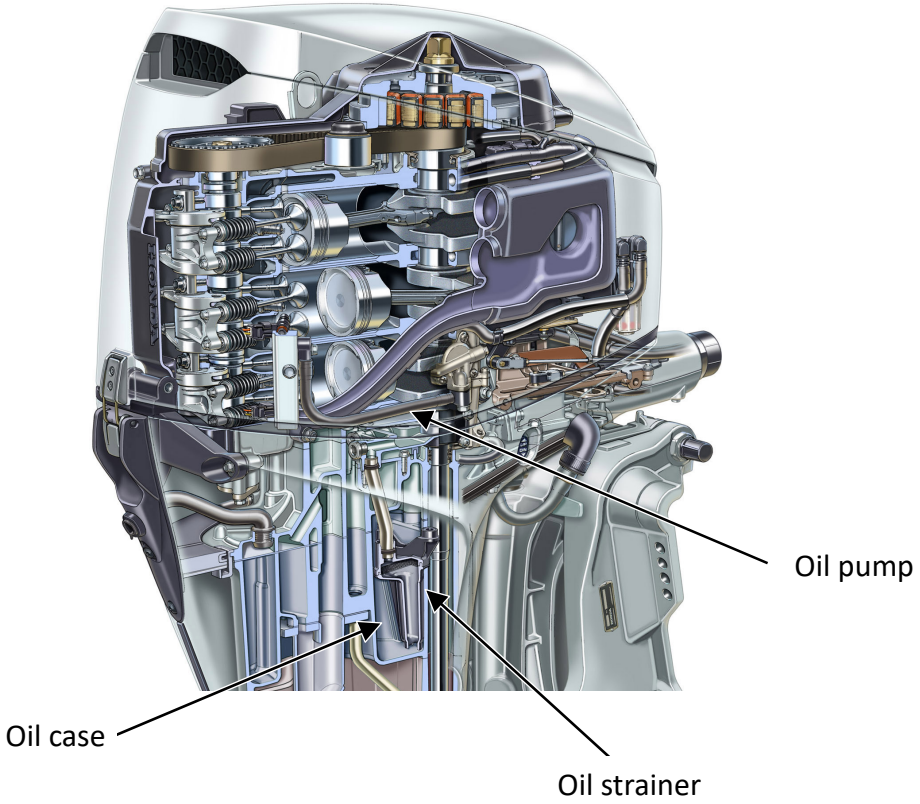
Engine Lubrication System

- Engine Lubrication System Overview
- Oil Filter
- Oil Pump

Engine Lubrication System Overview

The engine lubrication system consists of an oil pump, oil strainer, and oil case.
Oil in the **[1] oil case** passes through the **[2] oil strainer**, is pumped by the **[3] oil pump**, passes through the **[4] oil filter**, and is supplied to **[5] each part of the engine**.
Oil is supplied to the sliding and rotating parts of the engine to reduce the frictional resistance of the parts by the oil, so that the performance of the engine can be fully demonstrated.

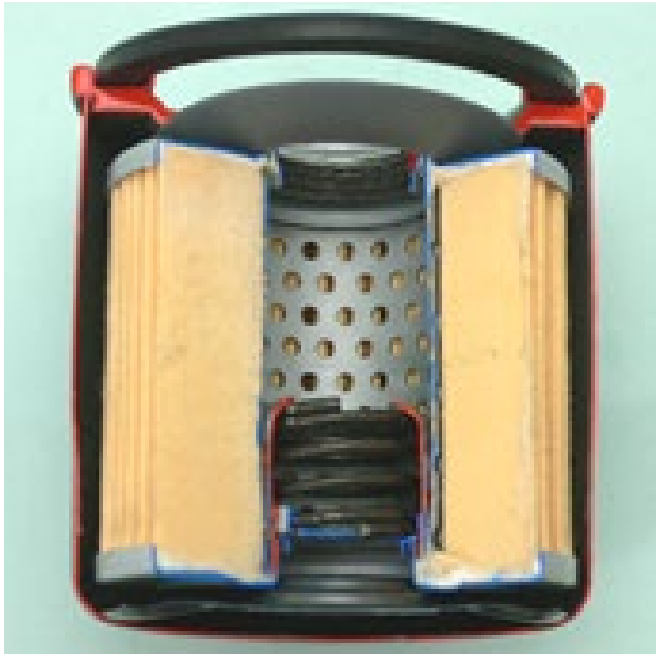




Oil Filter

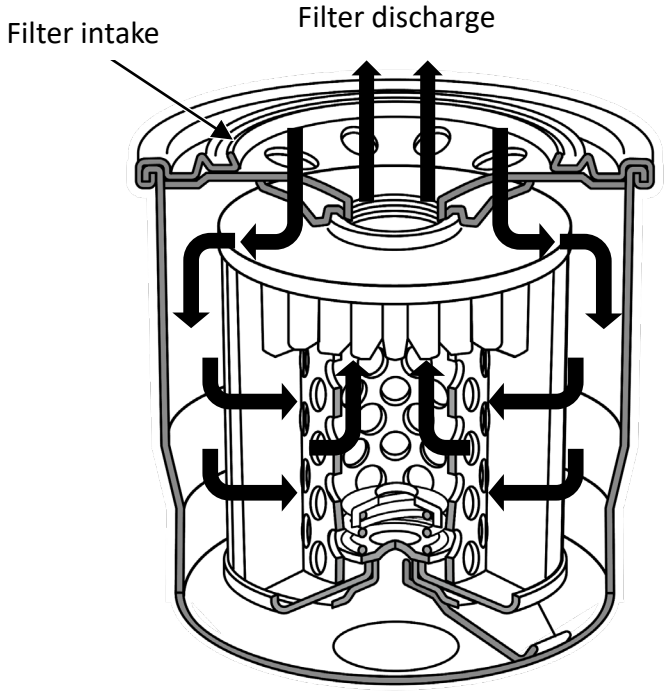
Role

The oil filter removes impurities such as wear particles and sludge from the engine oil in order to maintain the engine performance.



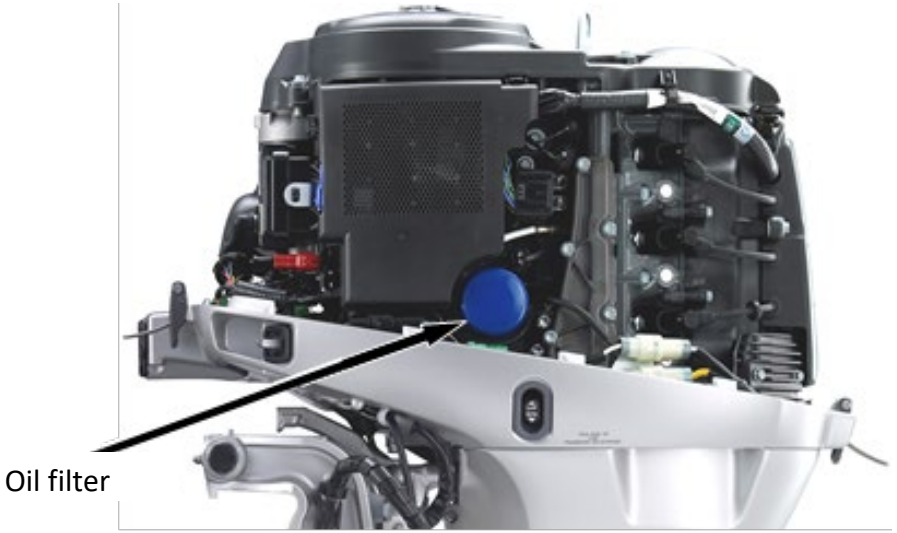
Structure

Oil entering from the filter intake is filtered as it passes from the outer region towards the inside. The cleaned oil is sent along a central passage from the filter discharge to the rest of the engine.



Oil Filter

The cartridge type oil filter is broadly used on the outboard motors. It is an paper filter housed in a metal casing, facilitating replacement job.

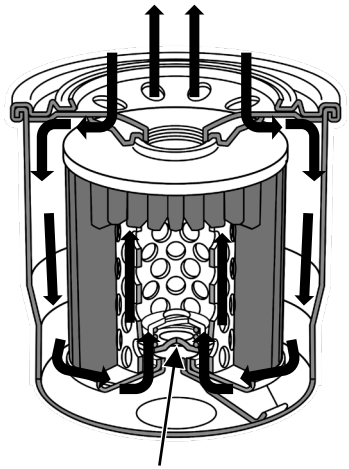


Necessity of maintenance

Oil filter clog

As the oil filter removes impurities from the oil, the gaps in the element become clogged with dirt. The clogged element also becomes a resistance to the oil circulation. As the oil filter becomes more clogged, the bypass valve in the filter opens to prioritizes circulation over removing impurities. This causes unfiltered dirty oil to be sent to the various parts of the engine, which leads to engine damage.

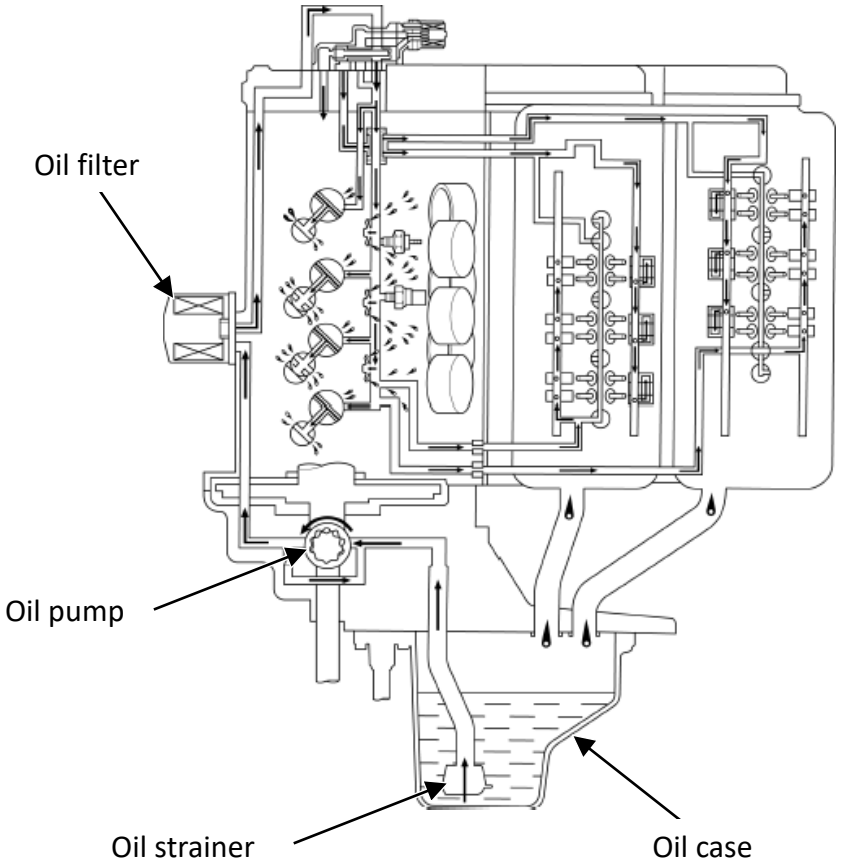
When clogged



Oil Pump

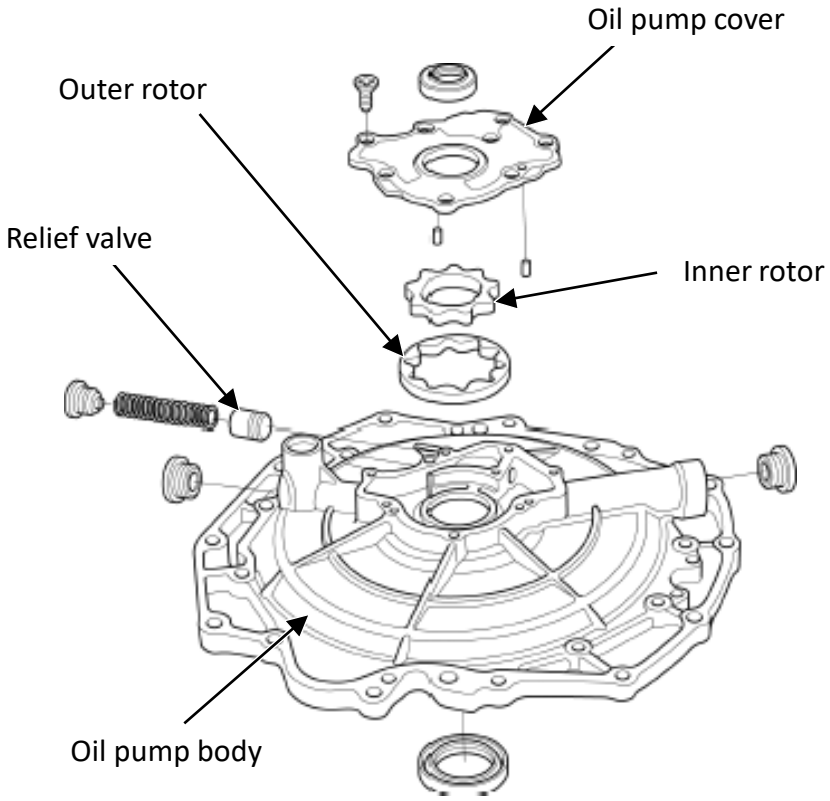
Role

The oil pump draws up engine oil. After the oil strainer removes debris, the engine oil is pumped to the engine's various lubricating parts.



Structure

The oil pressure generated by the oil pump is created by the inner and outer rotors which are turned by the engine. At high RPM, the maximum oil pressure is controlled by a relief valve.

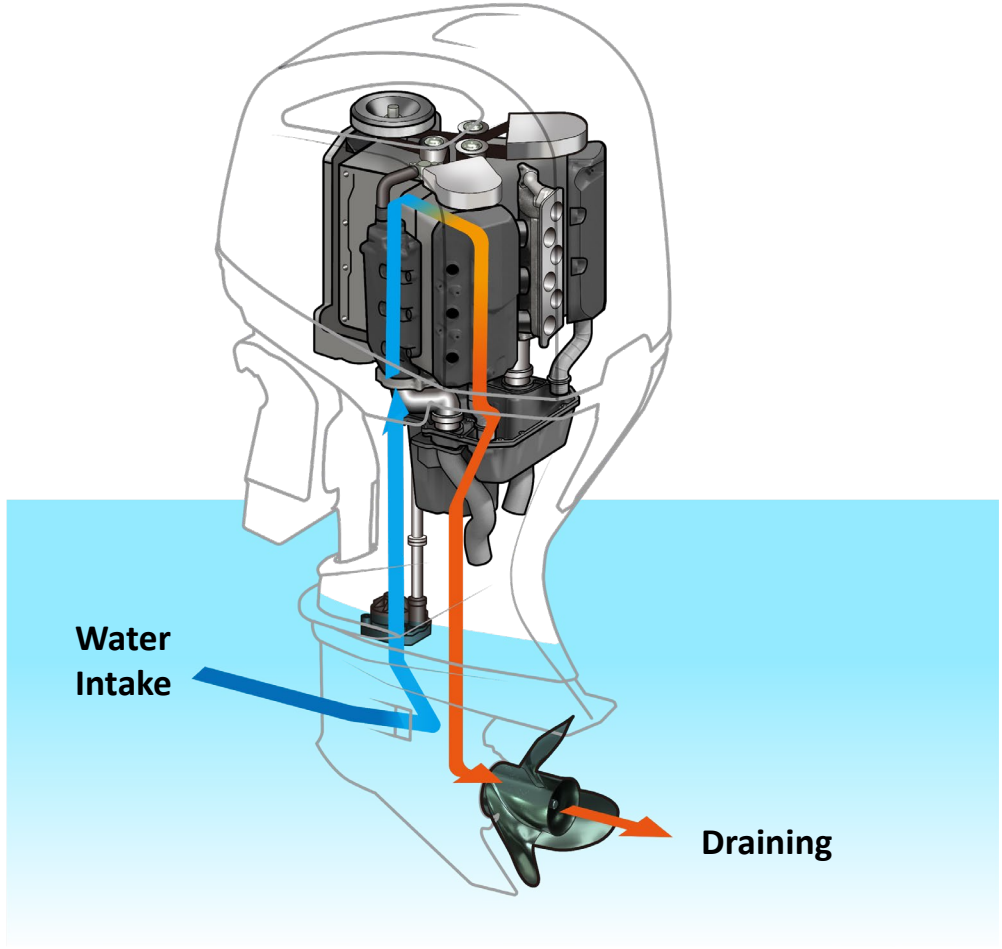


Cooling System

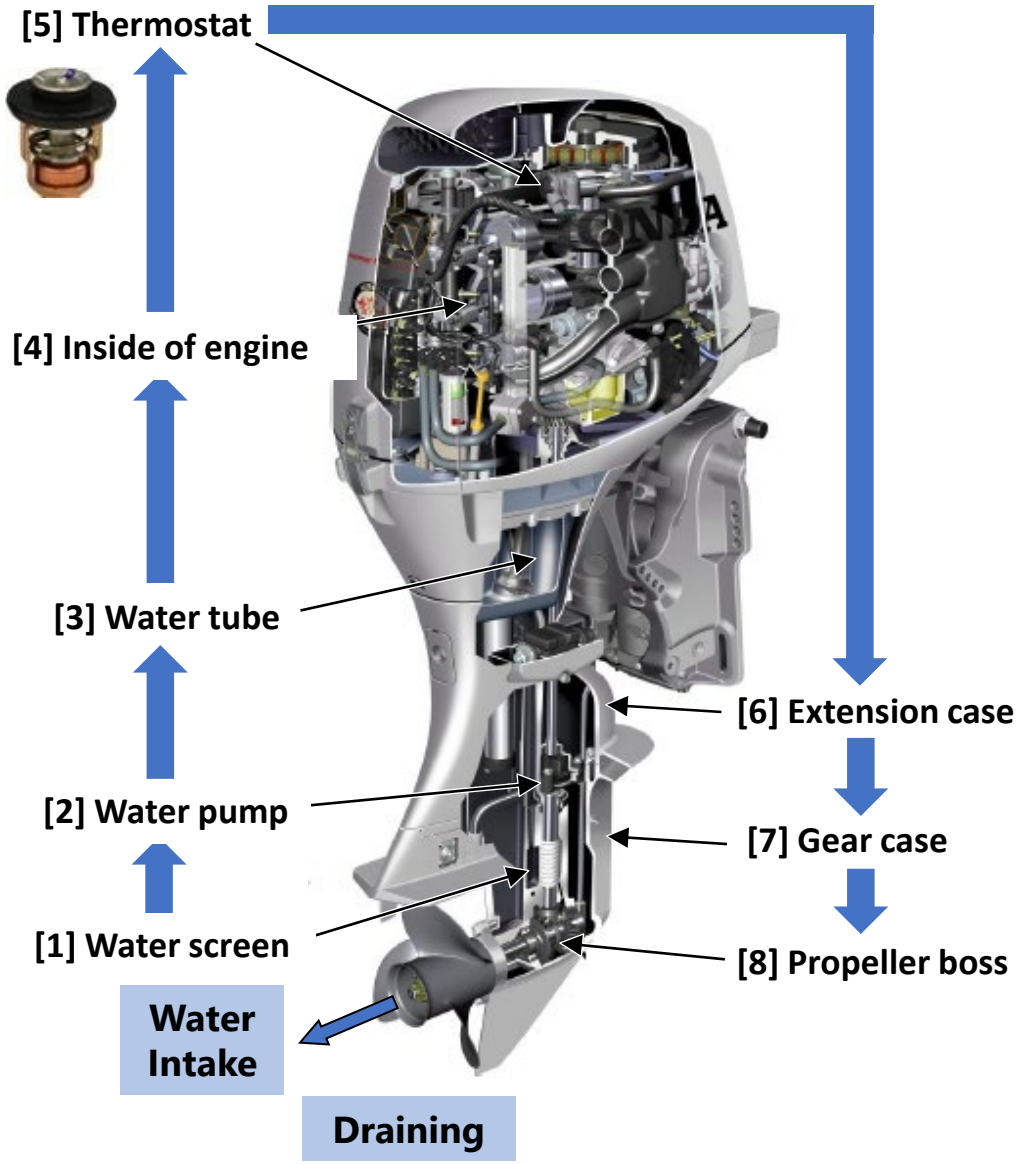
- Cooling System Overview
- Basic Structure of a Cooling System
- Water Pump/Impeller Housing
- Thermostat

Cooling System Overview

The cooling system absorbs the heat generated in the engine and lowers the engine temperature.
To cool the engine, seawater or fresh water is sucked up and channeled through the engine's internal passages to drain into the ocean or lake.

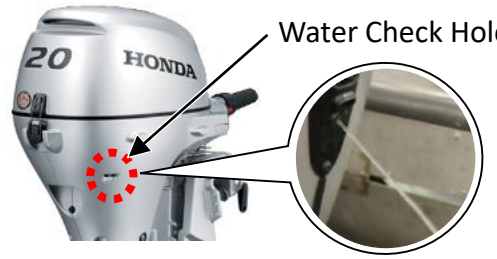


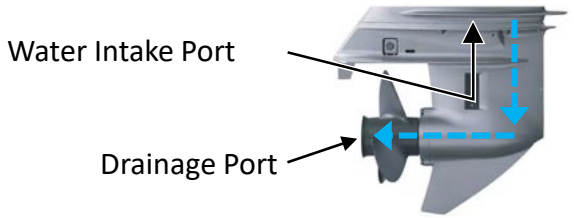
Basic Structure of a Cooling System



The cooling water is sucked in through the **[1] water screen** in the gear case and passes through the cooling water passage to cool the various parts of the engine.

- **Water before Cooling:**
  Cooling water sucked in through the water screen by the **[2] water pump** driven by the vertical shaft passes through the **[3] water tube** and **[4] internal passage of the engine** for cooling.
- **Water after Cooling:**
  The temperature in the engine is controlled by the **[5] thermostat** at the cooling outlet of the engine and is discharged into the water through the **[6] extension case**, **[7] gear case**, and **[8] propeller boss**.
- Some of the cooling water that has passed through the water pump is discharged from the water check hole to indicate that cooling water has been sucked up.

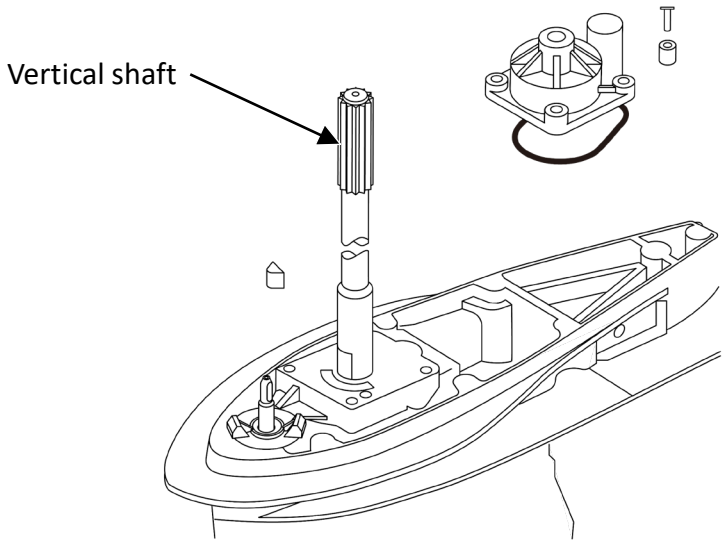


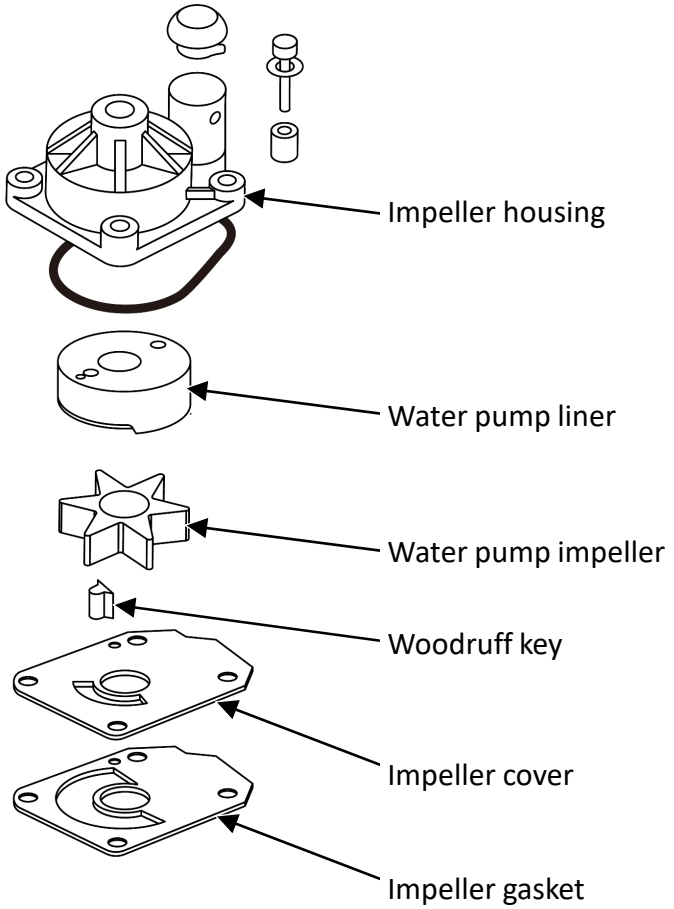


Water Pump/Impeller Housing

The water pump impeller in the impeller housing rotates, drawing in cooling water from outside and pumping it into the cooling water passage in the engine.

Impeller housing → **Internal structure of impeller housing**





Necessity of Maintenance

If the pump is worn out or damaged, the circulation function of the cooling water will be reduced, causing overheating, which can develop into a major failure.

Thermostat

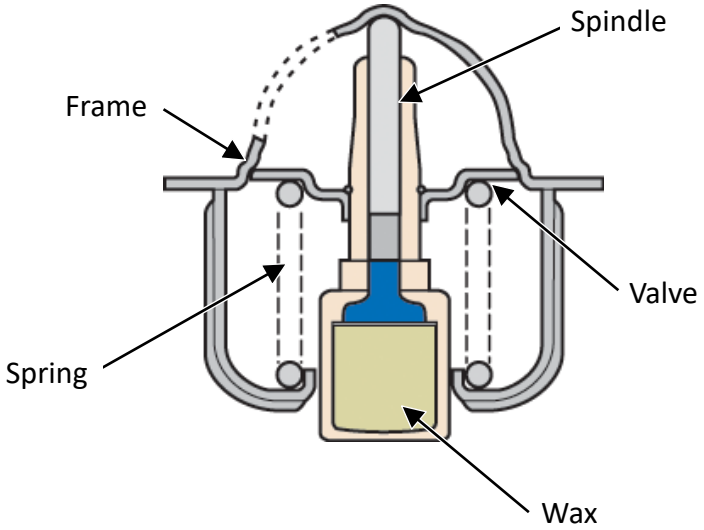
Role

The thermostat is installed in the middle of the cooling water passage and controls the cooling water to circulate at a constant temperature.
As a result, the fluctuating engine temperature is maintained at a constant level.

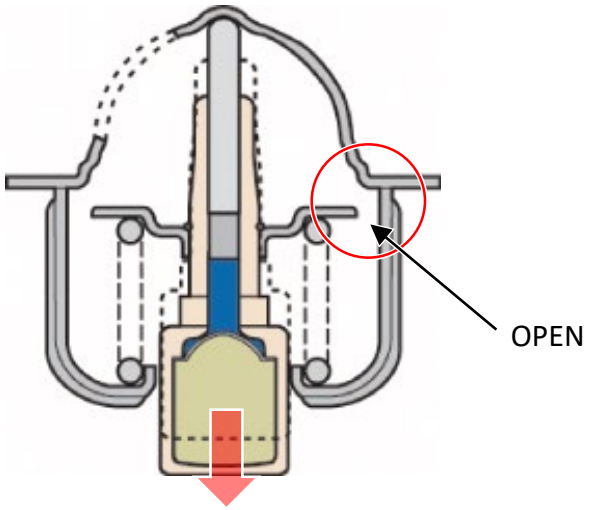
Structure/Operation

As the engine warms up, the wax built into the thermostat begins to expand thermally, and the thermostat opens. When the engine is overcooled, the wax in the thermostat begins to contract, closing the waterway again, and then opening it again when it warms up.

When the water is cold



When the water is hot



Thermostat

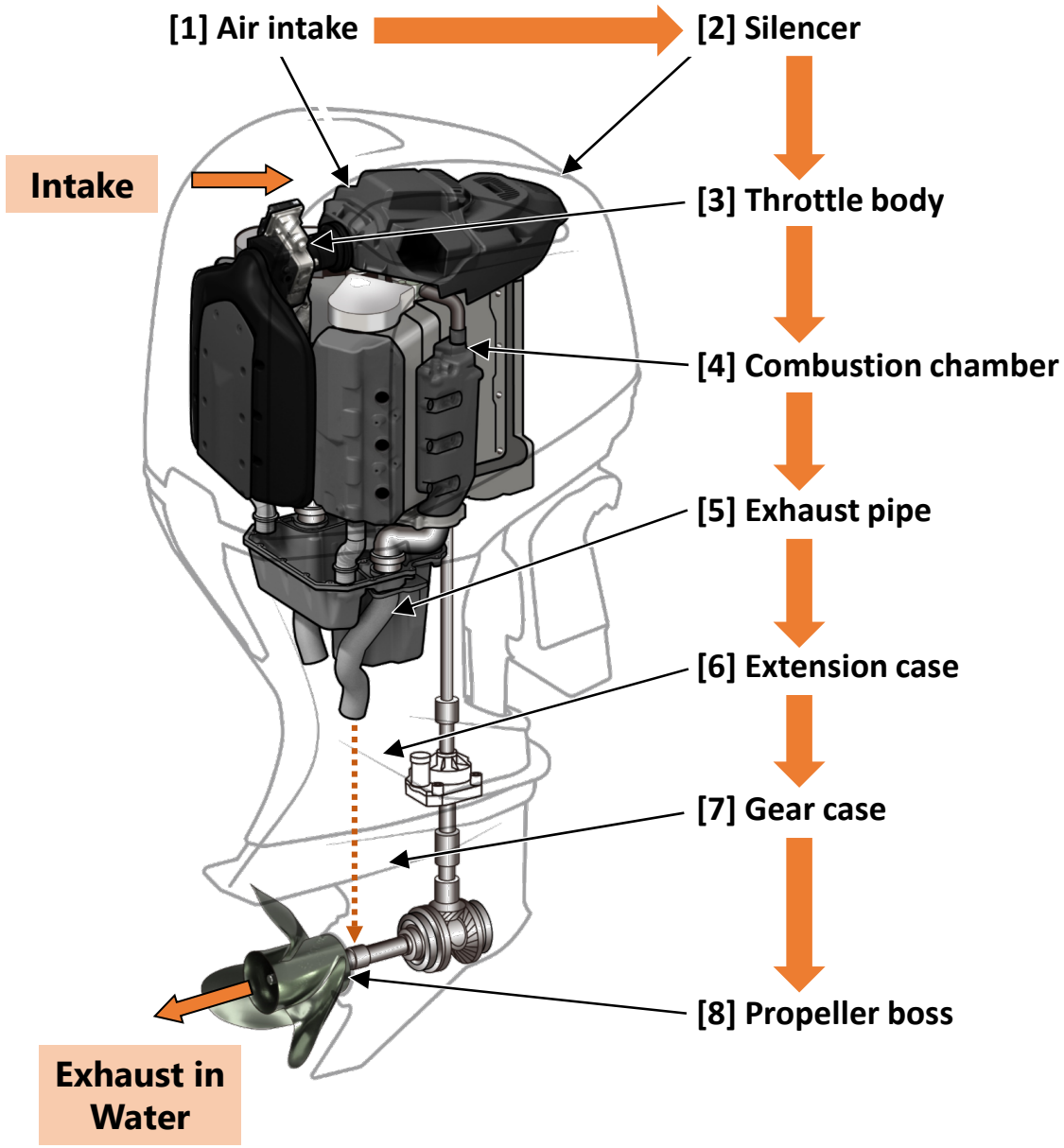
Necessity of Maintenance

If the thermostat is stuck open, it will cause overcooling. If the thermostat is stuck closed, it will cause overheating, which will result in major engine damage.

Intake/Exhaust System

- Intake/Exhaust System Overview
- Throttle Body
- EACV (Electronic Air Control Valve)
- Blow-by Gas Reduction System

Intake/Exhaust System Overview

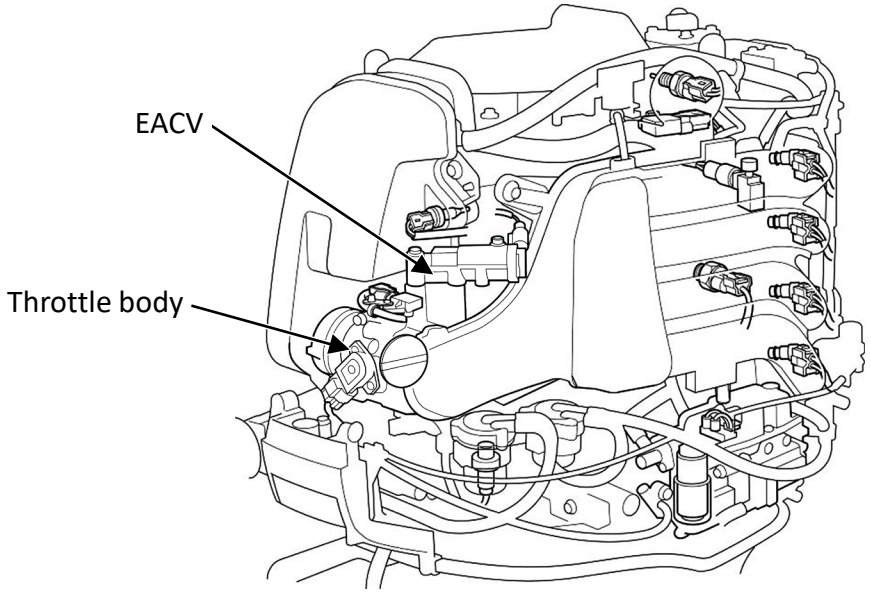


- **Intake:** Air sucked in through the **[1] air intake** passes the **[2] silencer** and drawn into the **[3] throttle body**, intake manifold and inlet pipe, and into the **[4] combustion chamber**.
- **Exhaust:** After combustion, exhaust gas passes through the exhaust valve, **[5] exhaust pipe**, **[6] extension case**, **[7] gear case**, **[8] propeller boss**, and is discharged into the water.
- **Propeller boss exhaust:** Exhausting through the propeller boss has the effect of muffling noise, but at idle, the exhaust creates bubbles in the water, which in turn creates noise. Therefore, it is also exhausted through the idle port.

Throttle Body

Role

The throttle valve opens and closes according to the degree of throttle opening, changing the intake air volume to control the engine output and engine speed.

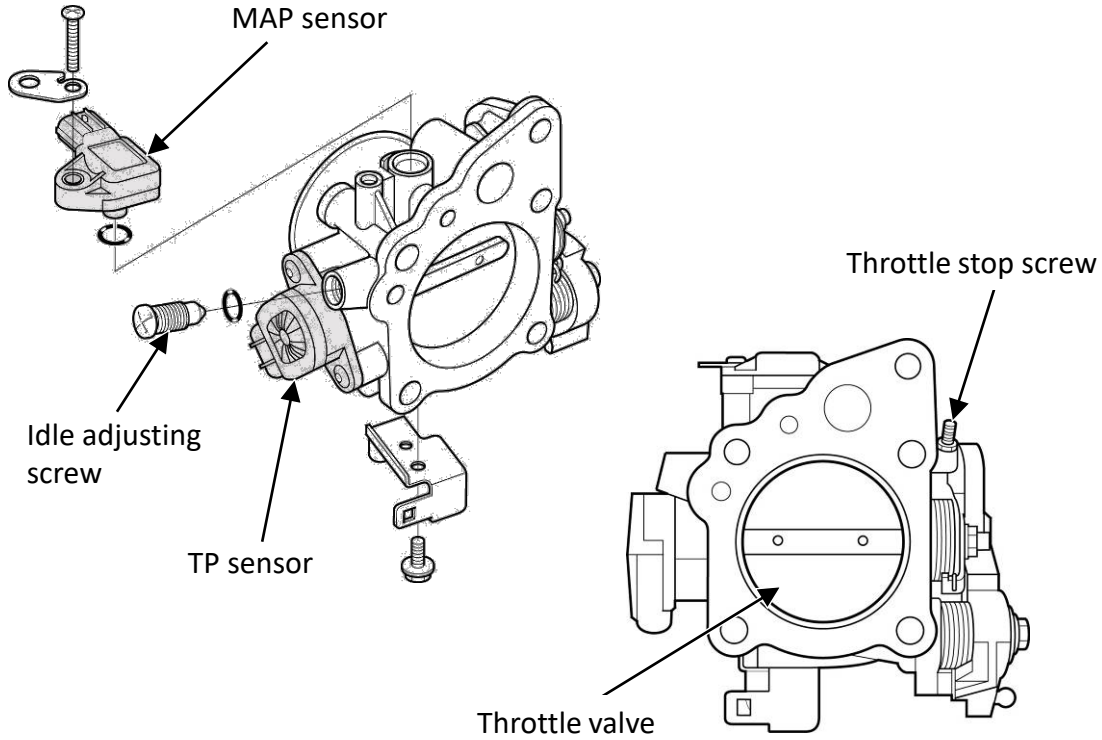


Necessity of Maintenance

As the throttle body is used, it becomes dirty and clogged with carbon, which can cause unstable idling.

Structure

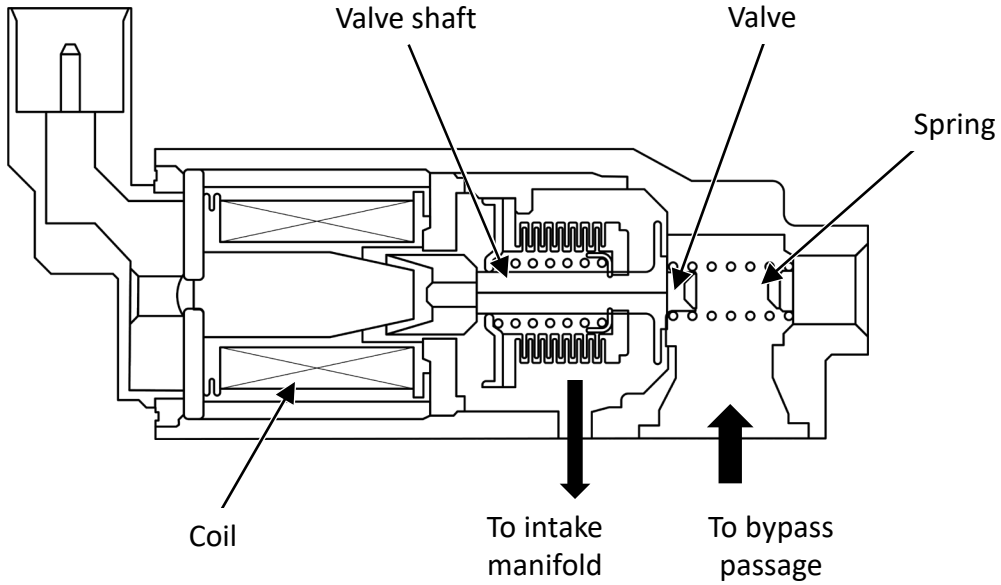
The throttle body consists of the throttle valve, TP sensor, MAP sensor, EACV, idle adjustment screw, and throttle stop screw.
See "Engine Control System" section for details on the TP sensor and MAP sensor.



EACV (Electronic Air Control Valve)

Overview

The EACV is an actuator that mainly controls the idling speed of the engine. It is a solenoid valve that supplies intake air to the intake manifold when the throttle valve is fully closed, and automatically adjusts the idling speed appropriately according to the engine's load, temperature and wear condition.



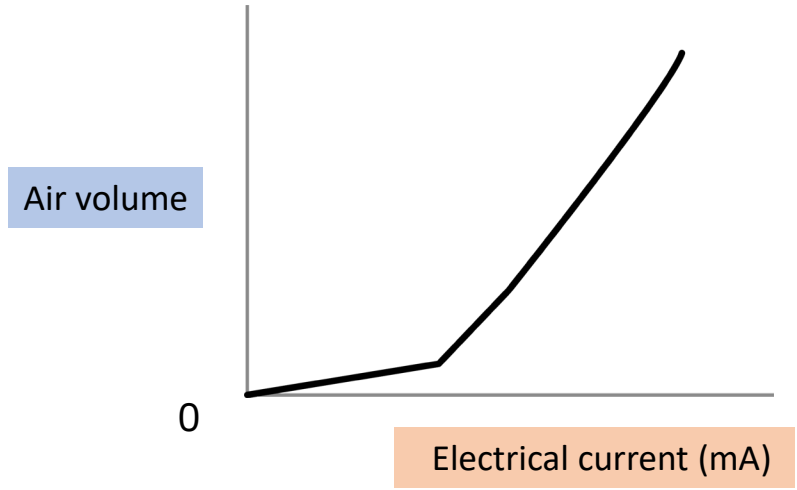
Necessity of Maintenance

As the EACV is used, it becomes dirty and clogged with carbon, which can cause unstable idling.

Structure/Operation

- The EACV is mounted on a throttle body spacer, and consists of a valve shaft, valve, coil, spring and body.
- When the ECU energizes the coil, the coil is excited. As the valve shaft moves back and forth, the gap between the valve and the body changes, and the amount of air flowing is adjusted. The valve opening is determined by the strength of the excitation according to the current value and the spring force.

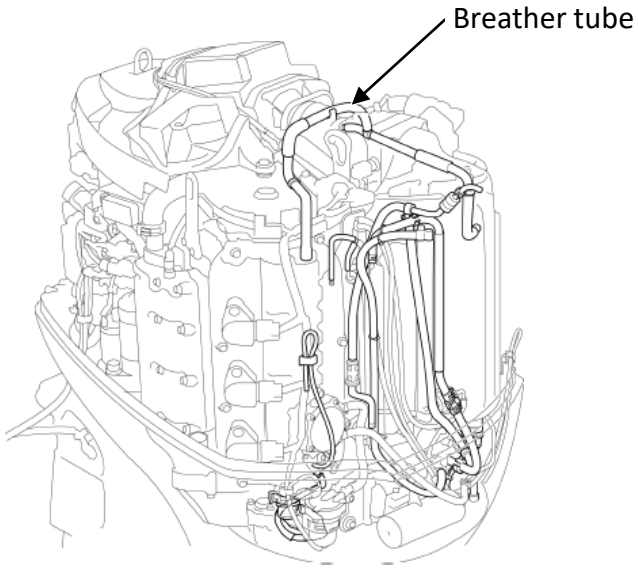
Control current characteristics



Blow-by Gas Reduction System

Overview

During the compression and combustion processes, when the pressure in the cylinder is high, unburned gas and combustion gas leak into the crankcase through the gap between the piston and cylinder. This gas is called "blow-by gas," and the blow-by gas reduction system returns it to the intake system to prevent it from being released into the atmosphere.
The blow-by gas that leaks into the crankcase is returned to the intake system through the breather tube.



Necessity of Maintenance

If the breather tube is damaged or cracked, blow-by gas will be released into the atmosphere, causing air pollution.
If the breather tube is clogged, the internal pressure in the crankcase will increase, causing oil to flow into the combustion chamber.

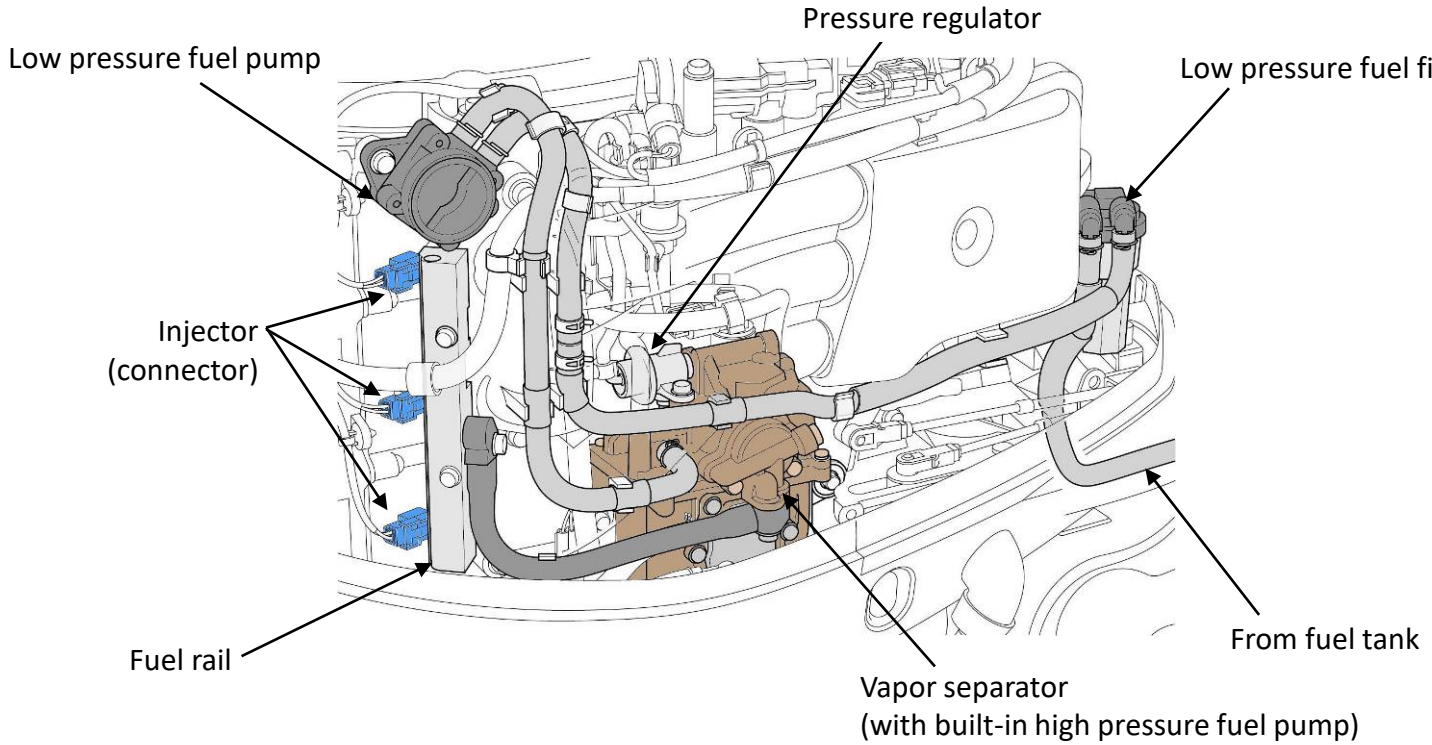
Fuel Supply System

- Fuel Supply System Overview
- Low Pressure Fuel Filter/Water Separator
- Low Pressure Fuel Pump
- Vapor Separator
- High Pressure Fuel Pump
- High Pressure Fuel Filter
- Pressure Regulator

Fuel Supply System Overview

The fuel supply system is a mechanism that supplies fuel from the fuel tank to the engine.
In Honda outboard motors that use PGM-FI, the low pressure fuel pump pumps fuel from the fuel tank into the vapor separator, where it is pressurized by the high pressure fuel pump and pumped to the injectors at the end of the fuel rail.
This section explains the role, structure, and operation of the main components of the fuel supply system.
Details of injectors and PGM-FI fuel injection control will be explained in “Engine Control System” section.

SYSTEM LOCATION



Fuel Supply System Overview

The fuel supply system is divided into a low pressure supply, where the fuel is sent from the fuel tank to the engine, and a high pressure supply, where it is pressurized for fuel injection.

Low pressure fuel supply

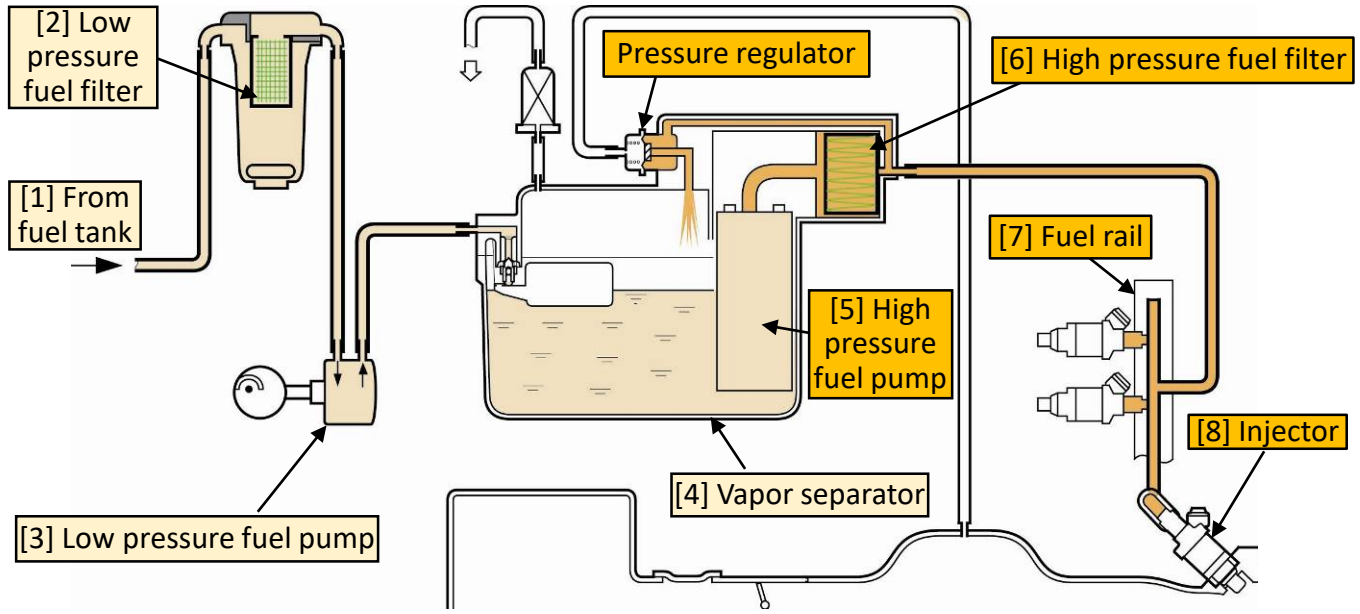
Fuel from **[1] fuel tank** is sent to the outboard motor by **[3] low pressure fuel pump** via **[2] low pressure fuel filter**. Next, the fuel is temporarily stored in **[4] vapor separator**. In the vapor separator, a float valve maintains the fuel level at a constant level.

High pressure fuel supply

Fuel in the vapor separator is sent to **[7] the fuel rail** via the **[6] high pressure fuel filter** by the **[5] high pressure fuel pump**. **[8] Injector** is installed at the end of the fuel rail, and the fuel pressure is maintained at a specific level by the pressure regulator.

Order of Low Pressure Supply

[1] Fuel tank
▼
[2] Low pressure fuel filter
▼
[3] Low pressure fuel pump
▼
[4] Vapor separator
▼
To high pressure fuel supply



Order of High Pressure Supply

From low pressure fuel supply
▼
[5] High pressure fuel pump
▼
[6] High pressure fuel filter
▼
[7] Fuel rail
▼
[8] Injector

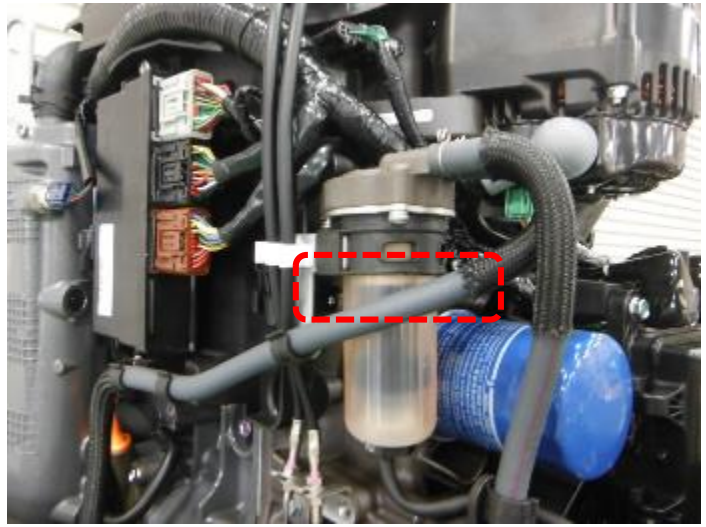
Necessity of Maintenance

The fuel line is a periodic replacement part. If it deteriorates, it may cause fuel leakage. If it shows signs of deterioration, it should be replaced regardless of the inspection period.

Low Pressure Fuel Filter/Water Separator

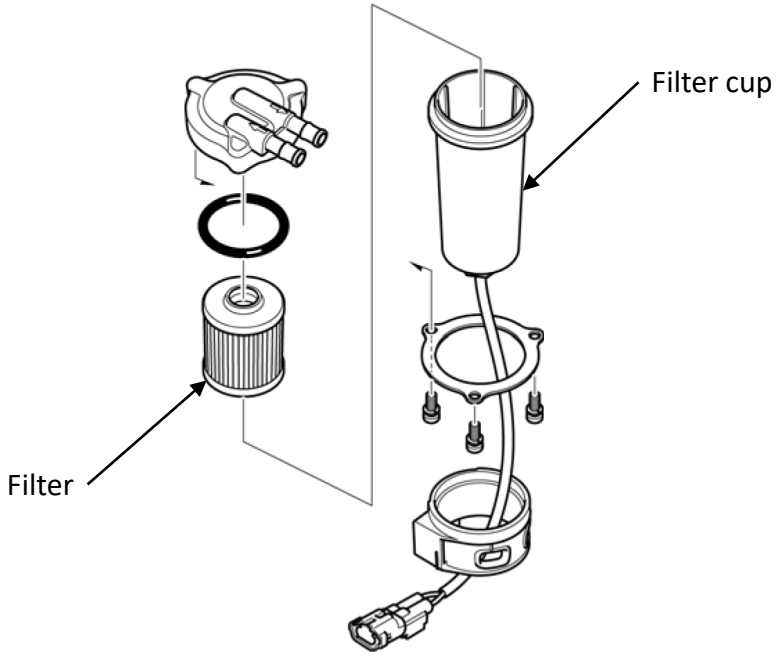
Role

The low pressure fuel filter/water separator removes water and foreign matter from the fuel and prevents them from entering the fuel supply system.
The fuel entering the outboard motor first passes through the low pressure fuel filter/water separator.



Structure

A filter and a water level sensor (float type) are provided in the filter cup.
Debris and foreign matter in the fuel are filtered out by the filter.
Moisture is separated and accumulates in the filter cup.
When a certain amount of water accumulates in the filter cup, the water level sensor detects the full water level and the signal is sent to the ECU, which sounds a buzzer.
For details, refer to the "Water Separator Level Sensor Full-water Level Warning" section.

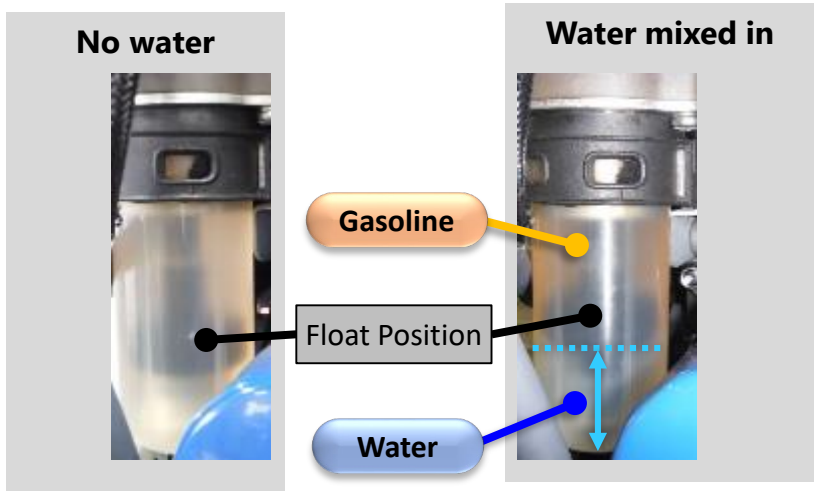


Low Pressure Fuel Filter/Water Separator

Necessity of Maintenance

Filter:
Be sure to replace the filter when it is heavily soiled or when it is due for periodic replacement.
If the filter becomes clogged, the fuel supply will be insufficient, and the engine revolution malfunction will occur.

Filter Cups:
Seawater or moisture in the fuel line can significantly shorten the life of the engine.



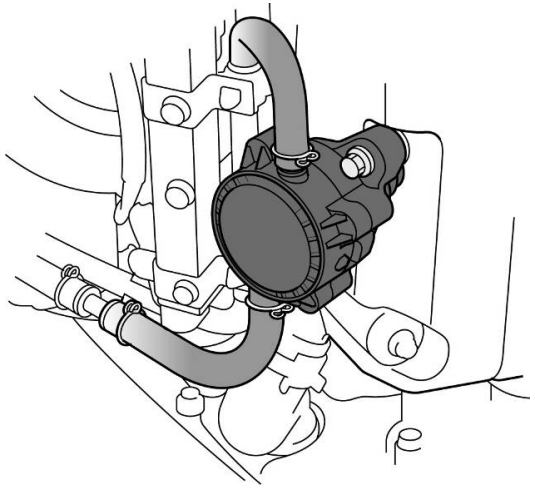
Due to specific gravity, water stays at the bottom of the cup.

If there is a lot of water mixture, check the fuel tanks, etc. on the hull side and investigate the ingress route. (Air vents, fueling port packing, etc.)

Low Pressure Fuel Pump

Role

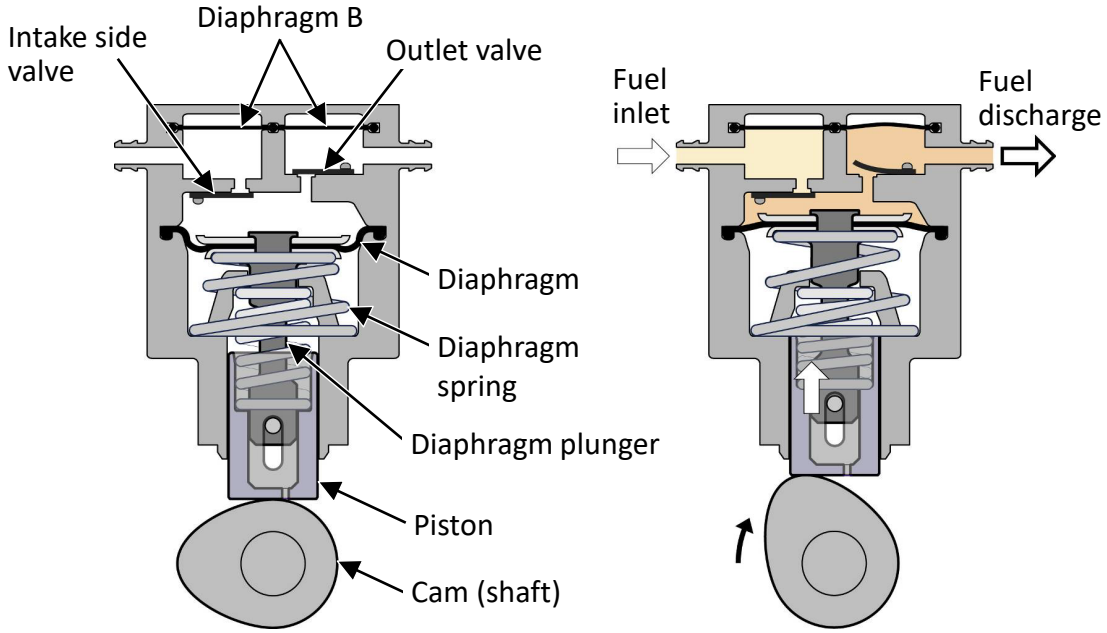
The low pressure fuel pump feeds fuel from the fuel tank to the vapor separator.



Structure/Operation

The low pressure fuel pump is actuated by the camshaft.

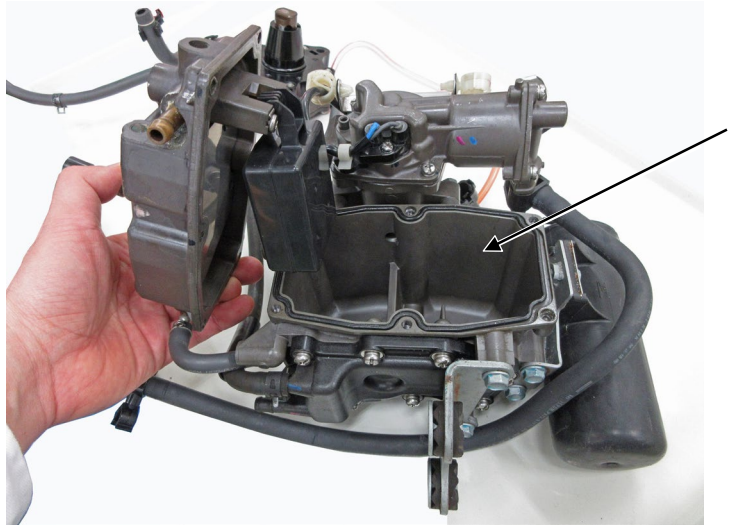
- When the piston moves to the bottom of its stroke, the plunger connected to the diaphragm is pulled down. At the same time, the one-way valve on the intake side opens and fuel is drawn in.
- When the piston is pushed in, so that it moves up, the plunger is free to move up by the force of the diaphragm spring.
- If the spring force is higher than the float valve seating pressure of the vapor separator, the spring raises the diaphragm.
  ＊ See the next section for more detail on float valves.
- The diaphragm forces fuel into the diaphragm chamber. This opens a one-way valve to deliver the fuel to the outlet.
- Diaphragm B cushions the abrupt rise in the fuel pressure.



Vapor Separator

Role

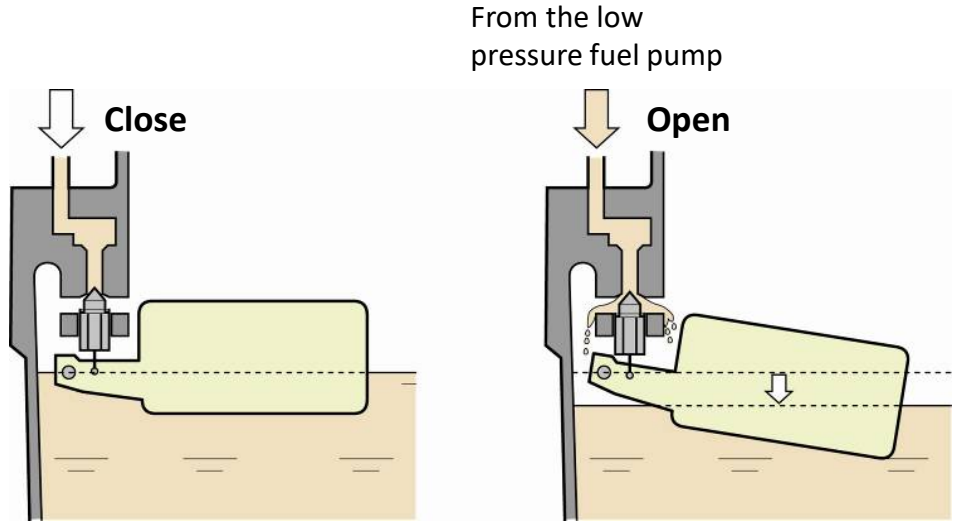
The vapor separator separates the fuel vaporized by the heat of the engine from the liquid fuel.
The defoamed solid fuel in the chamber is delivered to the high pressure fuel pump.



Structure/Operation

The chamber body is water-cooled.
The fuel level in the vapor separator chamber is maintained at a constant level by a float valve.
When the fluid level is high, the valve is closed and no fuel flows in because the seating pressure of the valve due to the buoyancy of the float is higher than the discharge pressure of the low pressure fuel pump.
When the fluid level drops, the float descends and the valve opens, allowing fuel to flow in.

Float valve operation



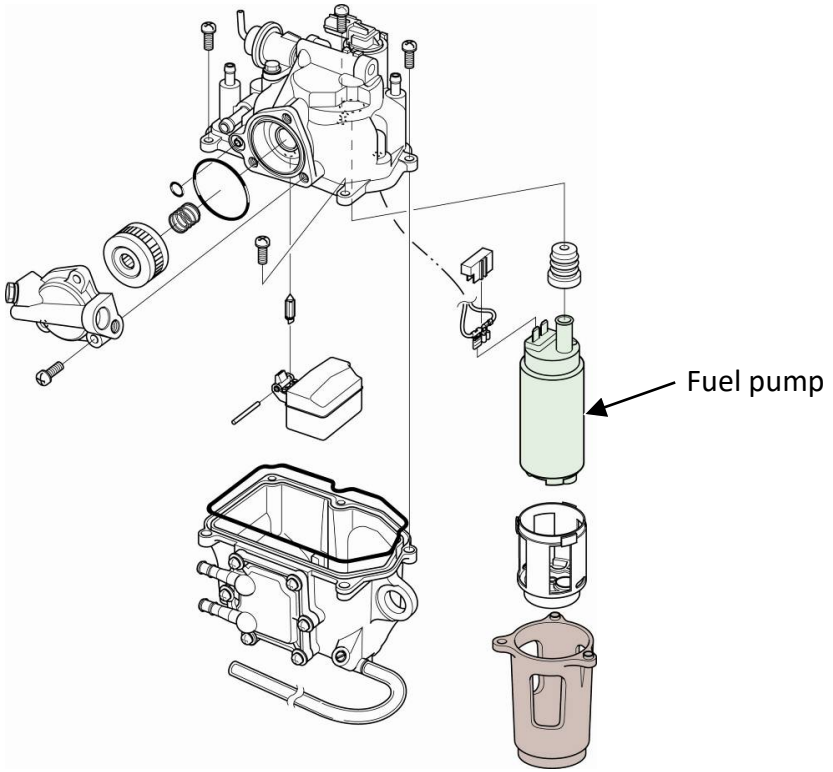
High Pressure Fuel Pump

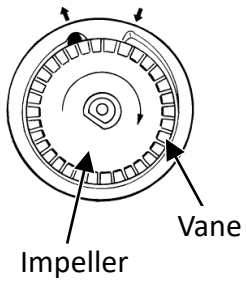
Role

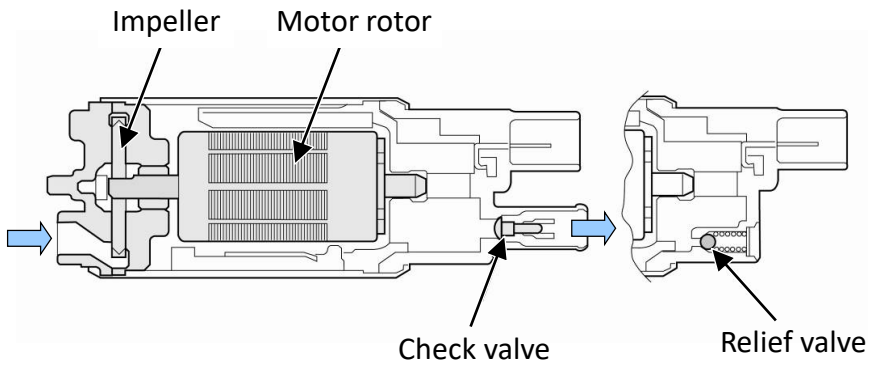
The high pressure fuel pump pressurizes the fuel in the vapor separator and supplies it to the injectors.

Structure/Operation

The high pressure fuel pump consists of a DC motor, an impeller, a check valve, and a relief valve.
The check valve passes fuel in one direction. It retains fuel pressure when the pump is stopped.
The relief valve opens if the fuel pressure rises too high, due to a pinched fuel hose for example.







High Pressure Fuel Pump

System Operation

When the ignition switch is turned ON:

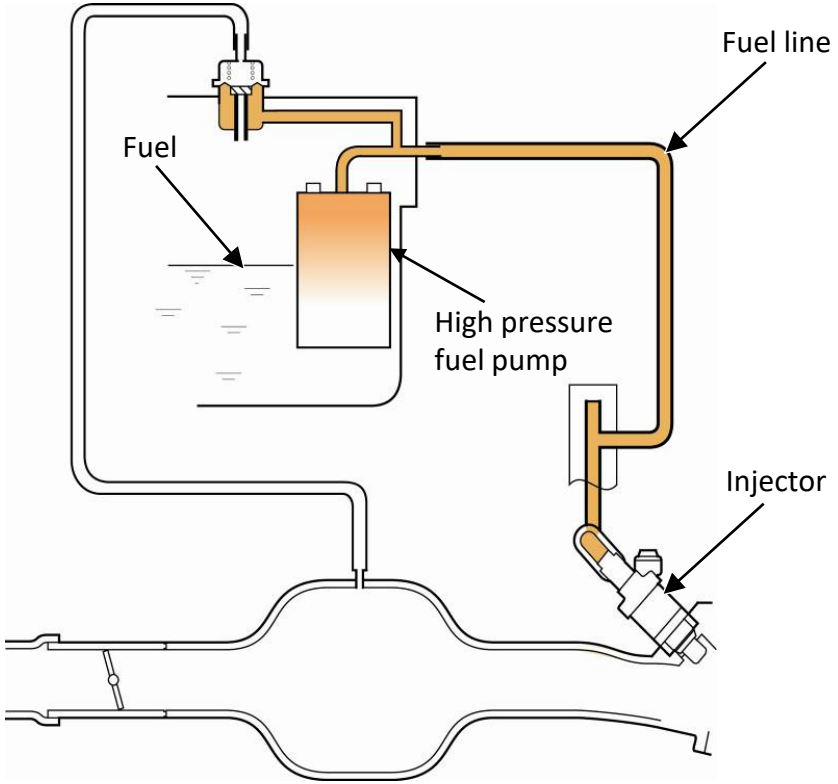
1. The high pressure fuel pump is actuated for two seconds by an electrical power which the ECU controls when the ignition switch is turned on.
2. Fuel is pumped into the fuel line by the high pressure fuel pump. The fuel is held back by the injector, which creates a fuel pressure in the fuel line.
3. The ECU stops the high pressure fuel pump two seconds after the ignition switch is turned on. The fuel pressure in the fuel line is maintained even after the high pressure fuel pump stops operating.

From engine start to running:

After the crankshaft starts to rotate, the high pressure fuel pump and the injector are actuated by electrical power which the ECU controls to supply fuel to the engine. The high pressure fuel pump continues operating as long as the engine is running, so that the fuel pressure in the fuel line is maintained.

When the engine is turned off:

The ECU stops the operation of the high pressure fuel pump and the injector when the engine is turned off.
The fuel pressure in the fuel line is maintained even when the components constituting the fuel line are not operating.



High Pressure Fuel Filter

Role

In order to remove fine impurities from the fuel, the fuel that has passed through the low pressure filter is passed through a finer high pressure fuel filter in two stages to prevent impurities from entering the fuel path to the injector.

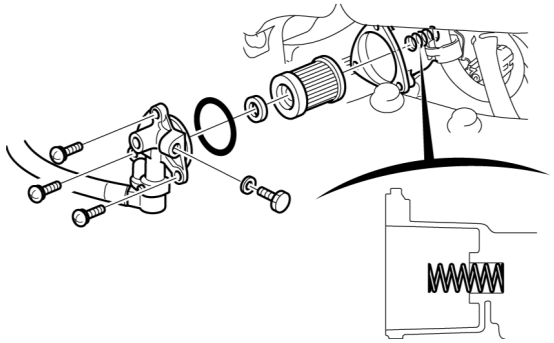
High pressure fuel filter
(Passing Particle Diameter: 25µ)

Low pressure fuel filter
(Passing Particle Diameter:40µ)

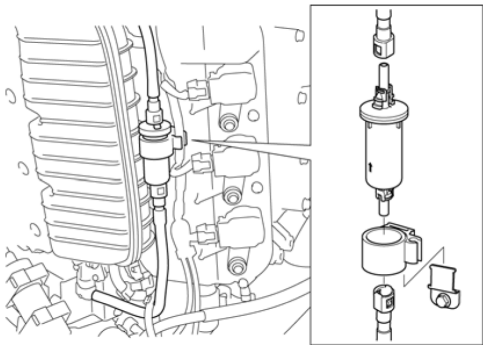
Structure

The fuel filter on the high pressure side is installed between the high pressure fuel pump and the fuel rail. Some are built into the vapor separator, while others are separate for ease of maintenance.

Built-in Type



Separate Type



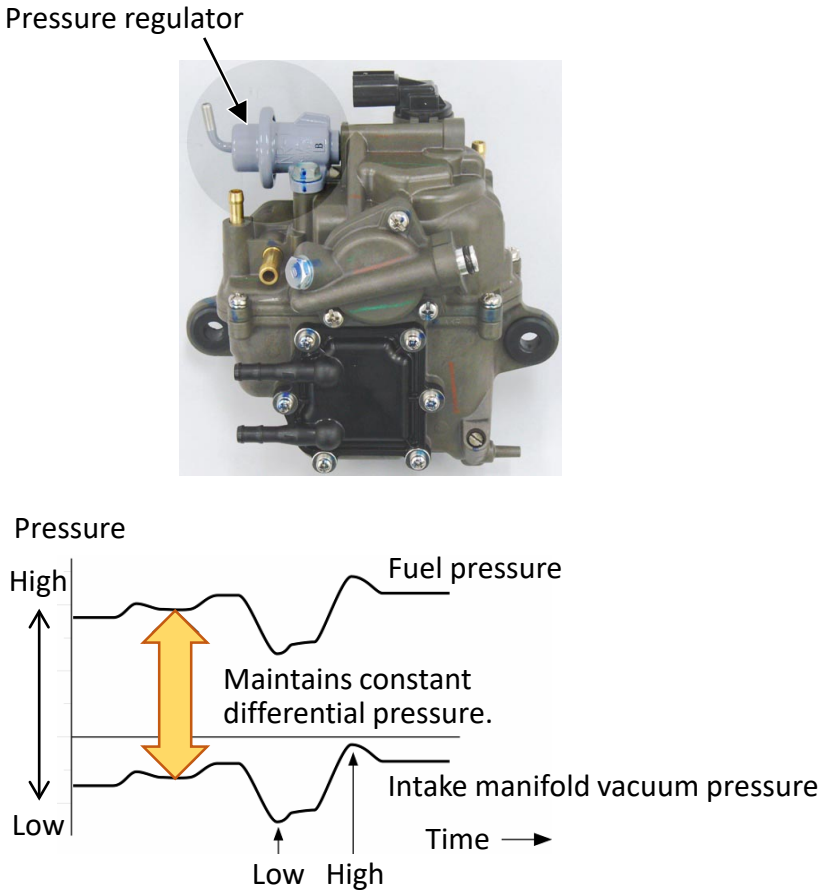
Necessity of Maintenance

Be sure to replace the filter when it is due for regular replacement. If the filter becomes clogged, the fuel supply will be insufficient, causing the engine revolution malfunction.

Pressure Regulator

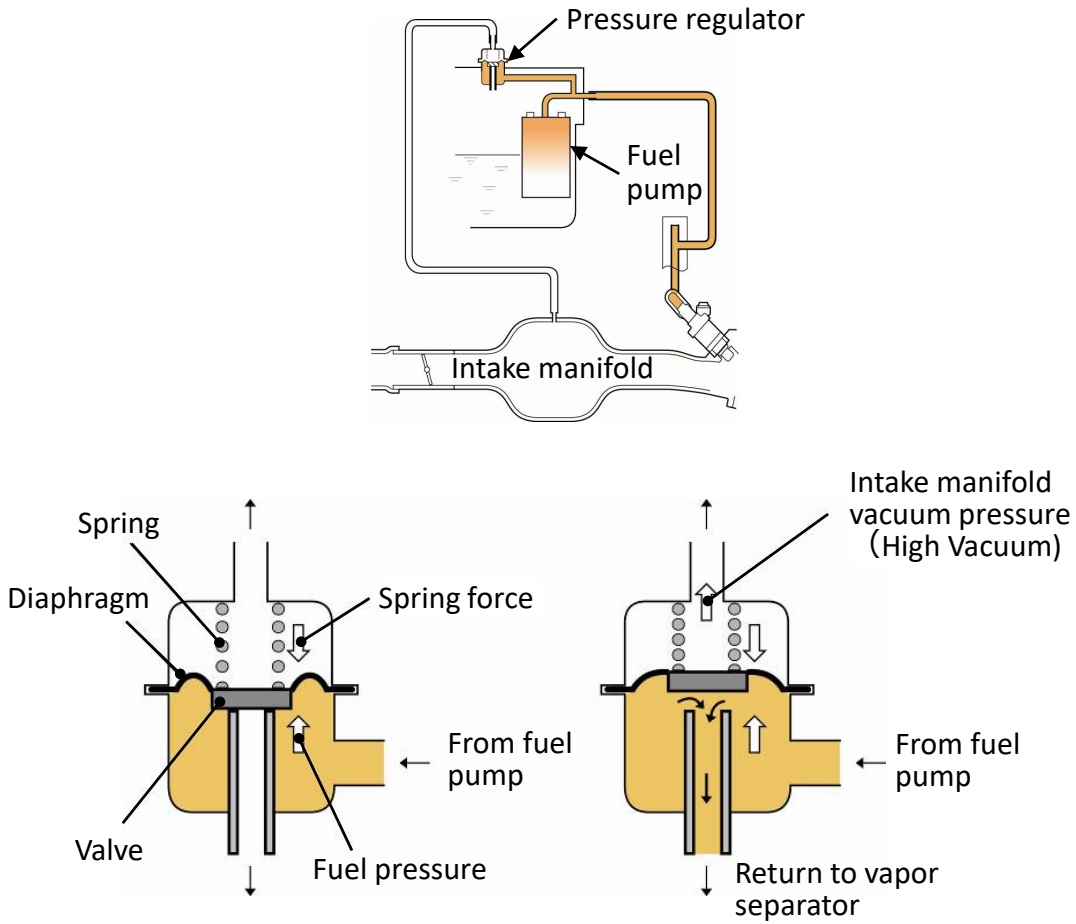
Role

The pressure regulator controls the pressure applied to the injectors by adjusting the fuel pressure so that the combustion pressure is always constantly higher than the intake manifold negative pressure.



Structure/Operation

When the differential pressure exceeds the specified level, the valve opens, and the excess fuel is returned to the vapor separator.
The opening of the return port is determined by the intake manifold negative pressure.

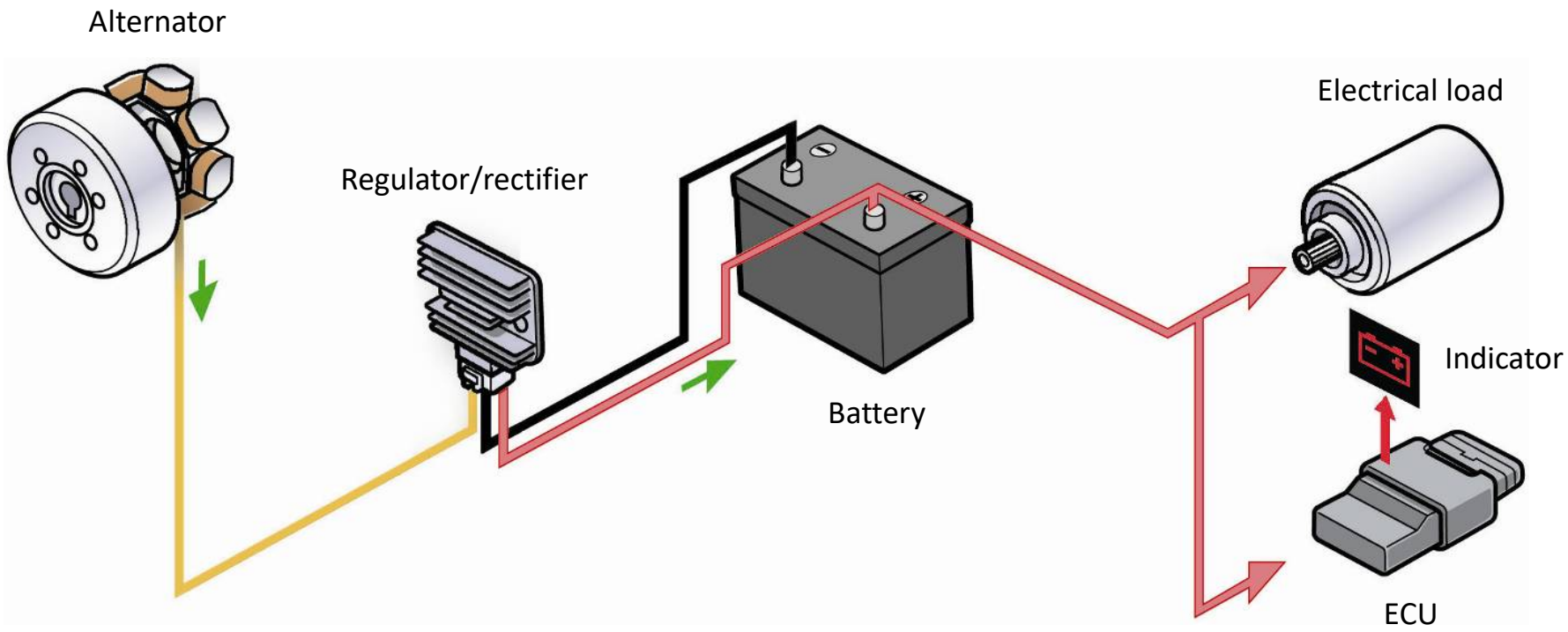


Battery/Charging System

- Battery/Charging System Overview
- Battery
- Alternator

Battery/Charging System Overview

The charging system charges the battery and provides DC power to the outboard motor and the boat's electrical system.
The figure below shows the configuration of the power generation and charging system for a small outboard motor.
In the following pages, the systems and components related to power generation and charging will be explained.



Battery

A battery is a rechargeable power source that turns the starter to start the engine and supplies electricity to the electrical equipment.

Role

During engine stop and start-up:
The battery provides electricity to all the electrical components.

At low engine speed:
When the alternator output is lower than that required by the electrical components, both the battery and the alternator provide electricity to them.

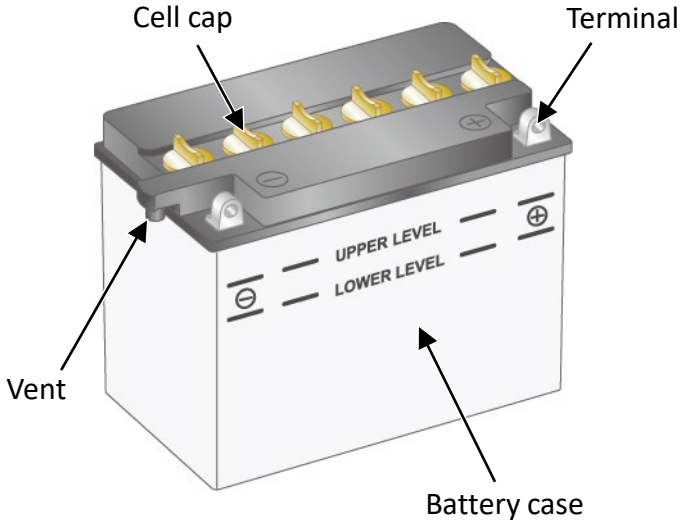
At high engine speed:
When the alternator output is higher than that required by the electrical components, the battery stores electricity received from the alternator.

Charging and discharging:
Charging is the process of storing electricity in a battery. Discharging, on the other hand, is the process of releasing the electricity stored in the battery. Since electricity in a battery is lost when it is discharged, it cannot be used unless it is recharged.

Structure

There are two types of batteries used in outboard motors: vented batteries and VRLA batteries (dry/wet type).
The main differences between them are related to "addition of distilled water" and "gas generated during charging".
The structural differences between vented and VRLA batteries are described below.

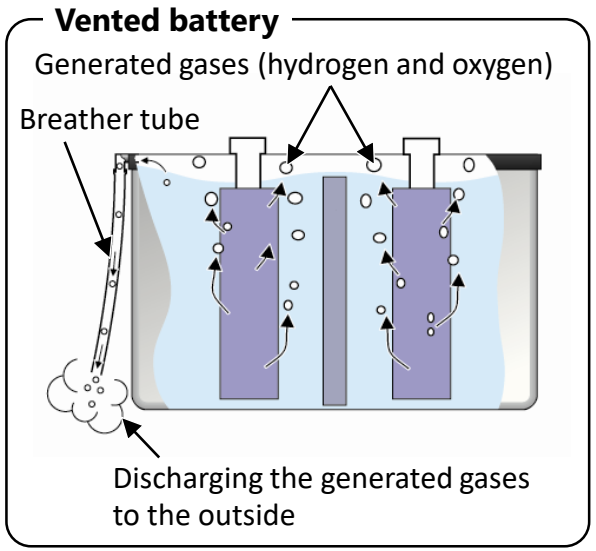
Vented batteries:
Vented batteries have removable cell caps for the addition of distilled water. They also have a vent to discharge the gas generated during charging.

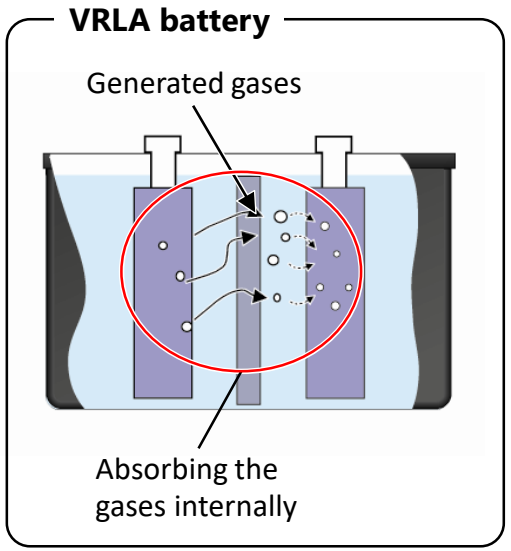


VRLA batteries (dry/wet type):
Since VRLA batteries do not require the addition of distilled water and do not discharge gas when charged, it has no cell caps or vent.

Gases generated during charging:

While a battery is being charged, gases (hydrogen and oxygen) are generated inside it. This is why vented batteries are equipped with a breather tube to discharge the generated gases. On the other hand, the VRLA battery absorbs the generated gases internally.





To prevent deformation or rupture caused by the gas generated, be sure to open the cell cap while charging a vented battery. In addition, quick charging may shorten the life of the battery by increasing the temperature and damaging the electrode plates, so do not use it except for emergency treatment such as when the battery is discharged.

Necessity of Maintenance

If the battery is left unused, it will gradually self-discharge, requiring periodic recharging. If the discharge progresses too far, sulfation and other problems may occur, and the battery may not be able to be recharged.

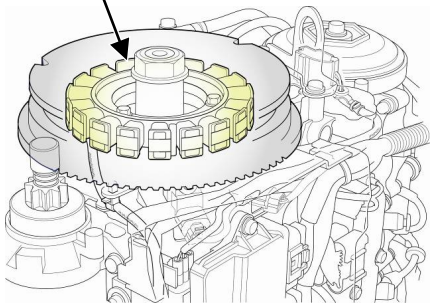
Alternator

Role

The alternator is a generator that generates AC electricity while the engine is running, supplying electricity to the battery and electrical components.

Alternator type:
For a small or medium outboard motor, a permanent magnet type alternator is used. On the other hand, for a large outboard motor (115 PS or more), an excited field coil type alternator is used.

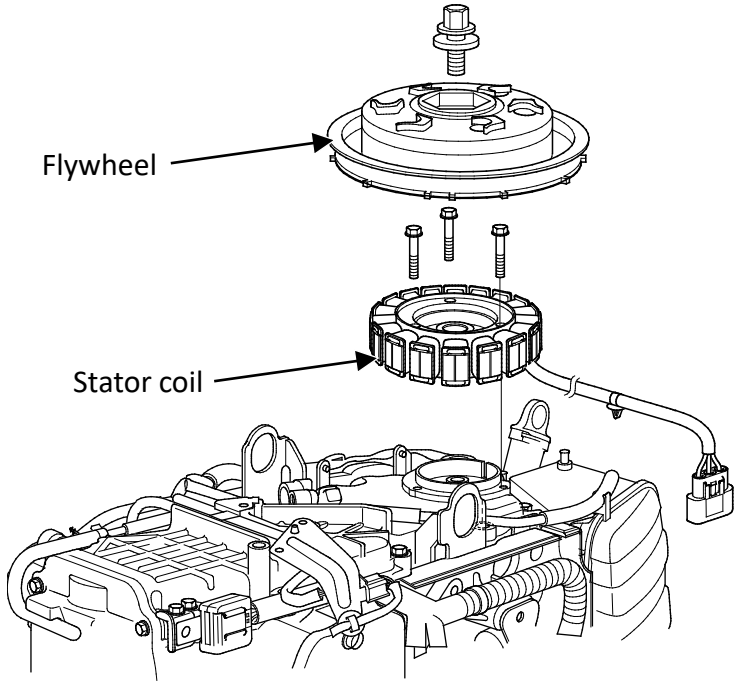
Permanent magnet type alternator



Excited field coil type alternator

Structure/Operation

Permanent magnet type alternator:
Permanent magnets are installed on the inside of a flywheel installed on the end of the crankshaft, and when the crankshaft rotates, electricity is generated in the stator coil.
With a small outboard motor, a single phase coil is used. With a medium size outboard motor, a 3-phase coil is used.



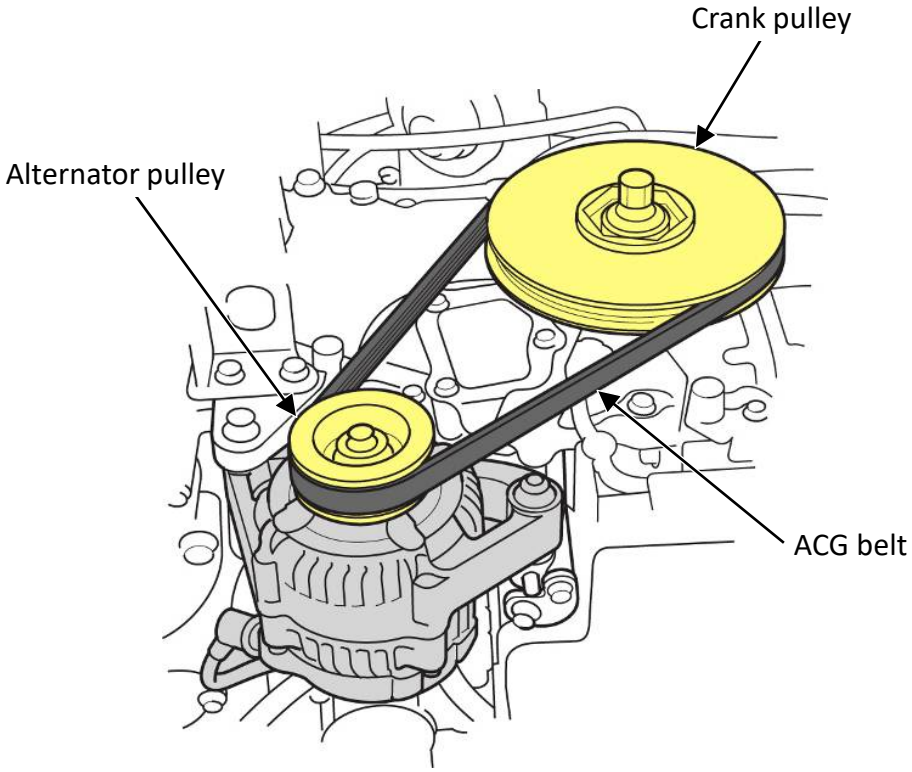
Structure/Operation

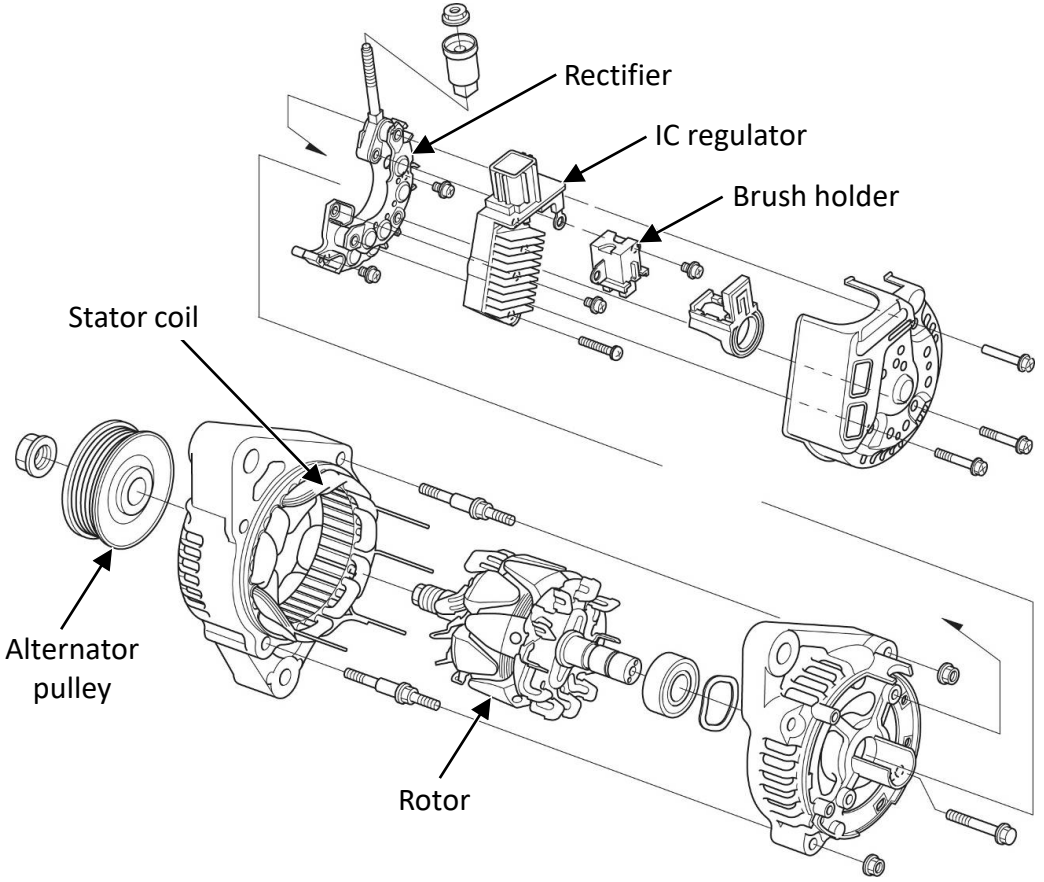
Excited field coil type alternator:

The rotation of the crankshaft is transmitted to the alternator via pulleys and an ACG belt, and the speed of the alternator rotor is increased according to the pulley ratio.

When the alternator pulley rotates, the rotor that is directly connected to the pulley also rotates.

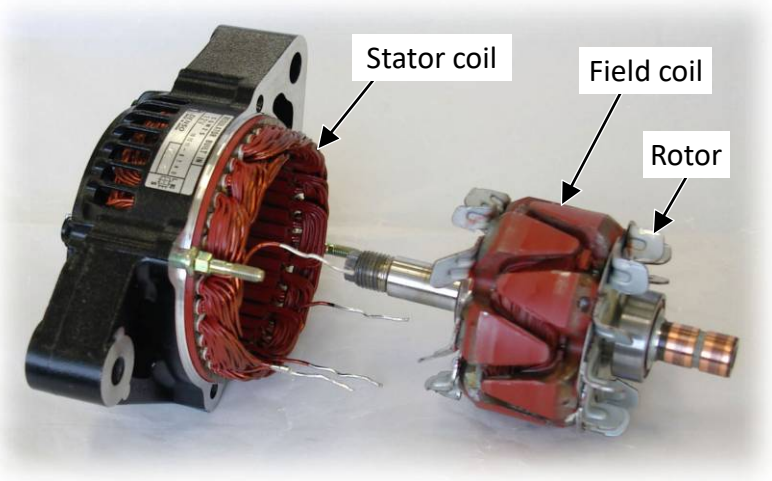
It has a built-in rectifier and regulator to perform rectification and voltage regulation.

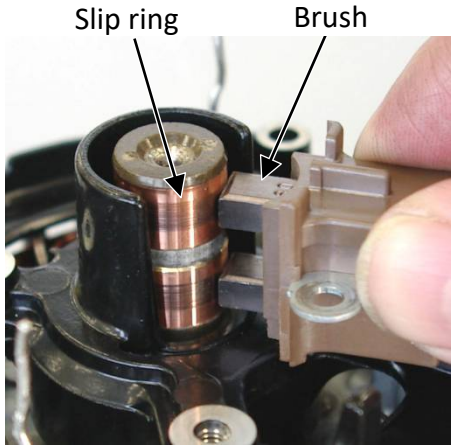




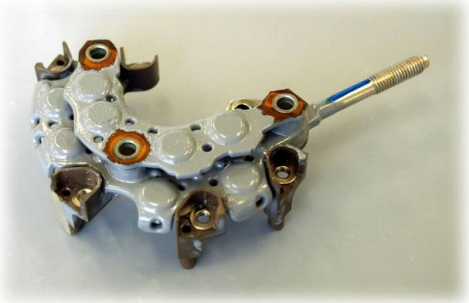
Alternator

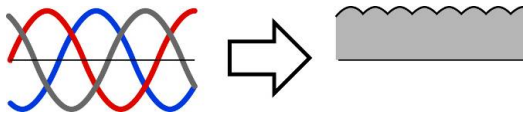
A field coil is wound around the rotor. The brushes and slip rings pass the battery current to the rotor.
The field coil is then excited by the current, and functions as an electromagnet.
The stator coil generates 3-phase alternating current.





Rectifier:
The alternating current generated by the stator coil cannot be charged to the battery or operate the electrical equipment as it is. Therefore, the rectifier converts the 3-phase alternating current into direct current.

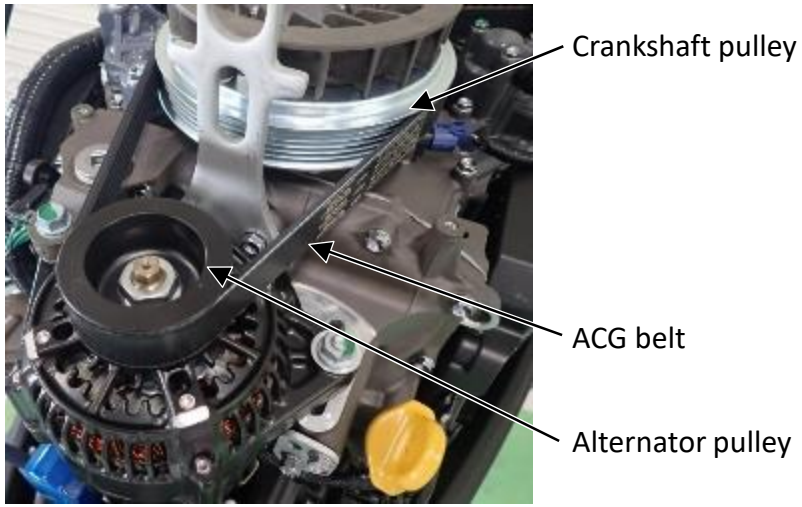




IC regulator:
The IC regulator regulates the alternator output. It controls current to the field coil to adjust its electromagnetic force, which in turn adjusts output by the stator coil.

Role

The crankshaft pulley and the alternator pulley are connected by a belt, and the rotation of the engine moves the ACG.
The alternator is a power generator and generates electricity while the engine is running.



Necessity of Maintenance

If the ACG belt is damaged or deteriorated, replace it with a new one.
If the ACG belt is broken, no power will be generated, and the battery will run out.

Engine Starting System

- Engine Starting System Overview
- Starter Motor

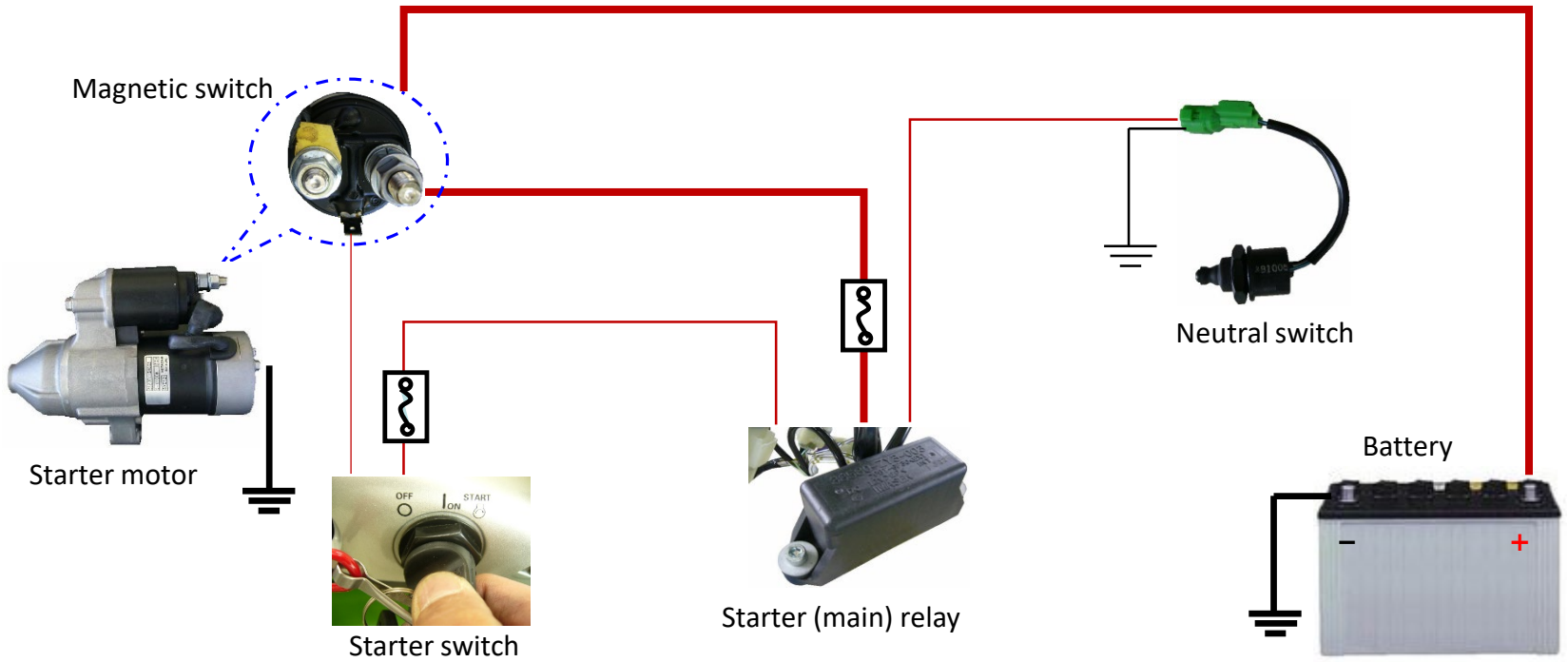
Engine Starting System Overview

Role

The starting system rotates the crankshaft from engine start-up until the engine can rotate continuously by itself.

Structure/Operation

The system consists of a starter motor, magnetic switch, starter switch, neutral switch, starter (main) relay and battery.
When the starter switch is turned to START position, current flows from the battery to the main relay.
As a result, voltage is applied to the magnetic switch, and the starter motor rotates.

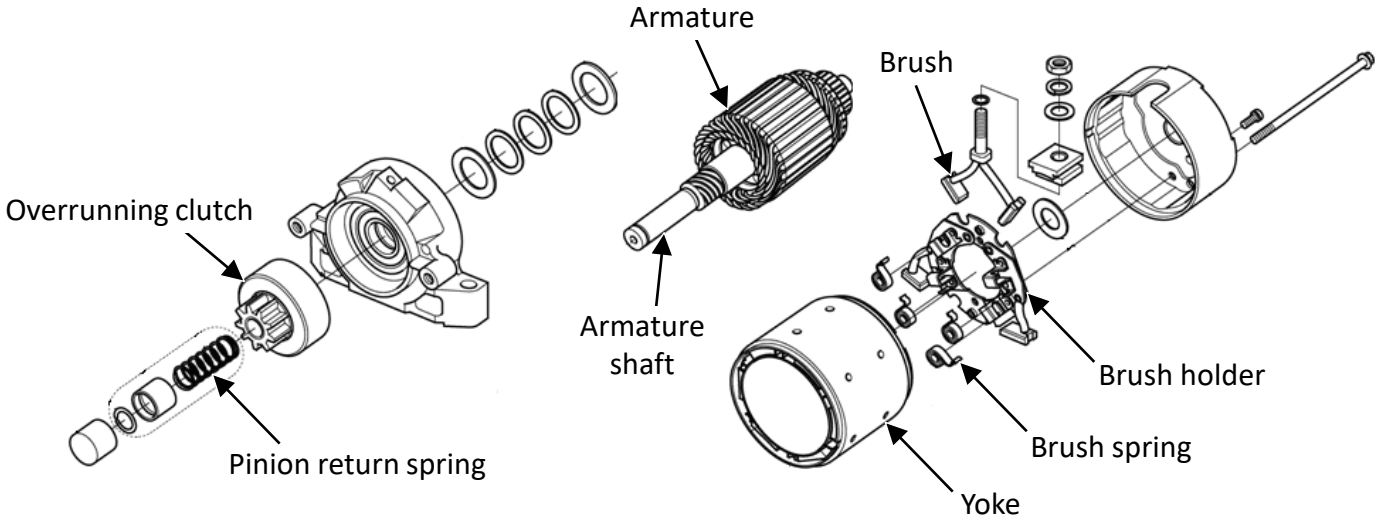


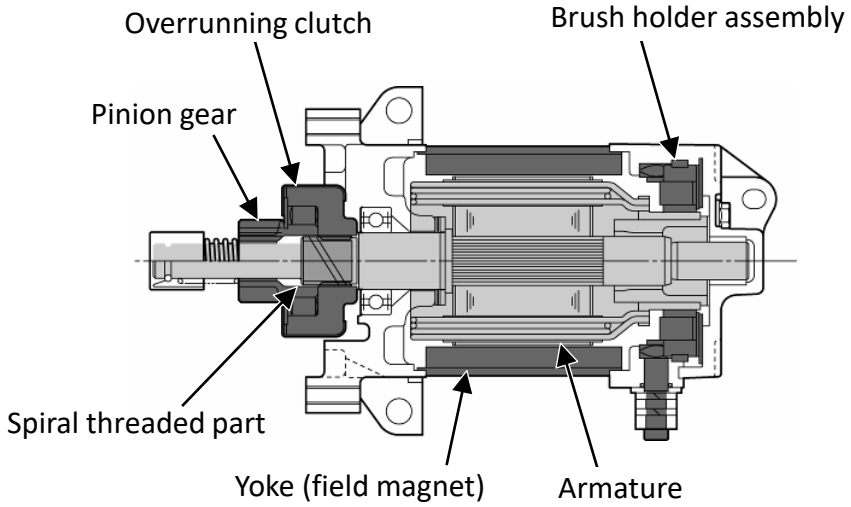
Role

The starter motor is energized and rotates the crankshaft to start the engine.
There are two types of starter motors available for Honda outboard motors: the inertia pinion engagement type and the shift lever pinion engagement type. The structure and operation of each type will be explained in the following pages.

Structure of Inertia Pinion Engagement type Starter Motor:

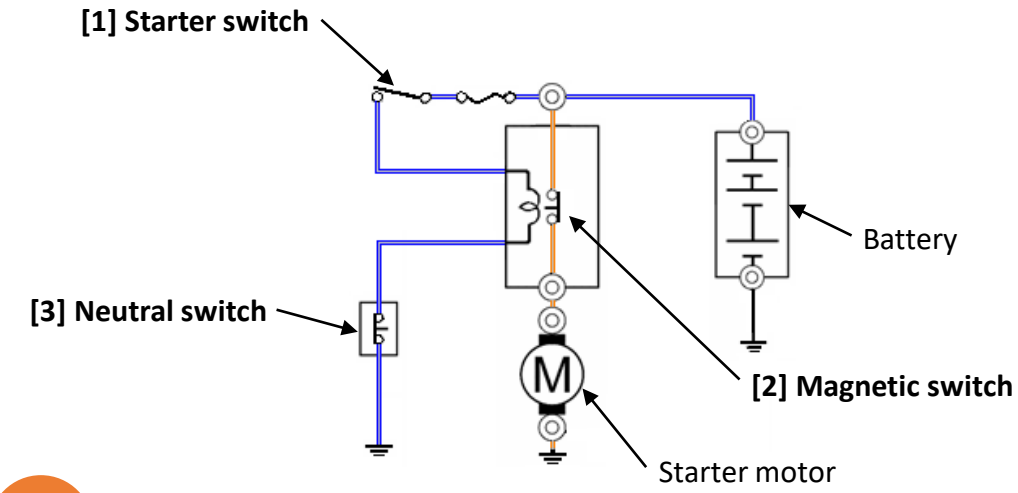
Inertia pinion engagement type starter motors are used in small outboard motors of 50 PS or less.





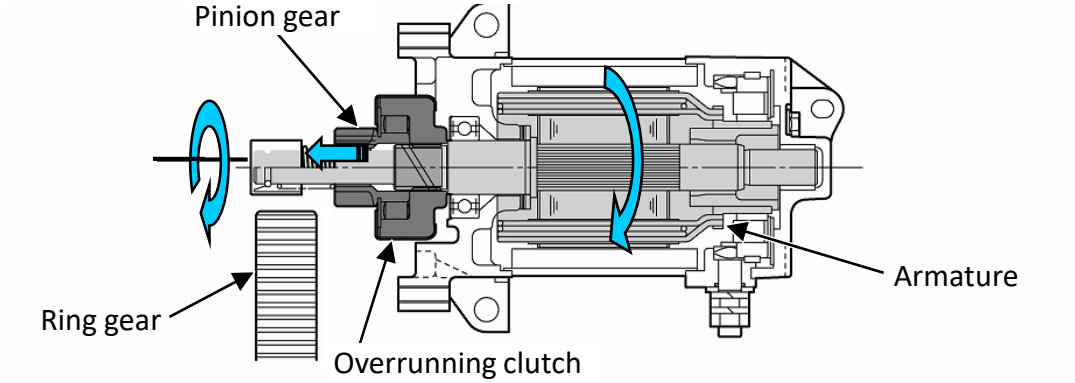
Electrical Circuit and Operation of Inertia Pinion Engagement Type Starter

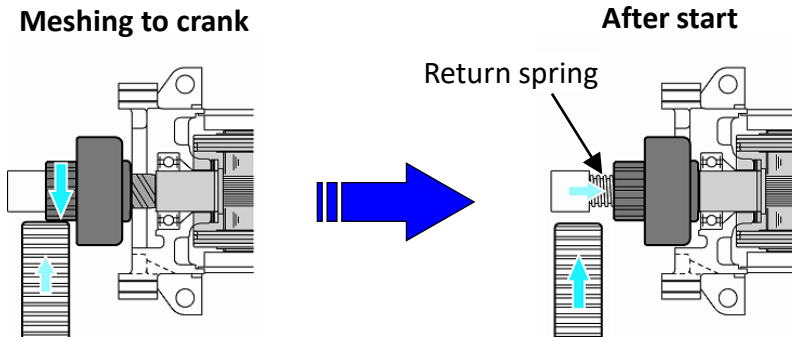
1. When the **[1] starter switch** is turned to the START position, battery current flows to the coil of the **[2] magnetic switch** and the **[3] neutral switch**.
2. Electromagnetic force generated in the coil of the magnetic switch pulls the contact to close. As a result, battery current flows through the starter motor, and the armature in the motor starts rotating.
   *Refer to the page on "Magnetic Switch“ for more information on magnetic switch.



* If the gear is shifted to forward or reverse, the neutral switch contact opens. The current will be interrupted by the neutral switch, preventing the starter motor from operating.

3. When the armature rotates, the pinion gear slides on the spiral threaded shaft and meshes with the ring gear, causing the crankshaft to rotate.
4. After the engine starts, the pinion gear rotates faster than the threaded shaft. This will return the pinion gear back to its original position.



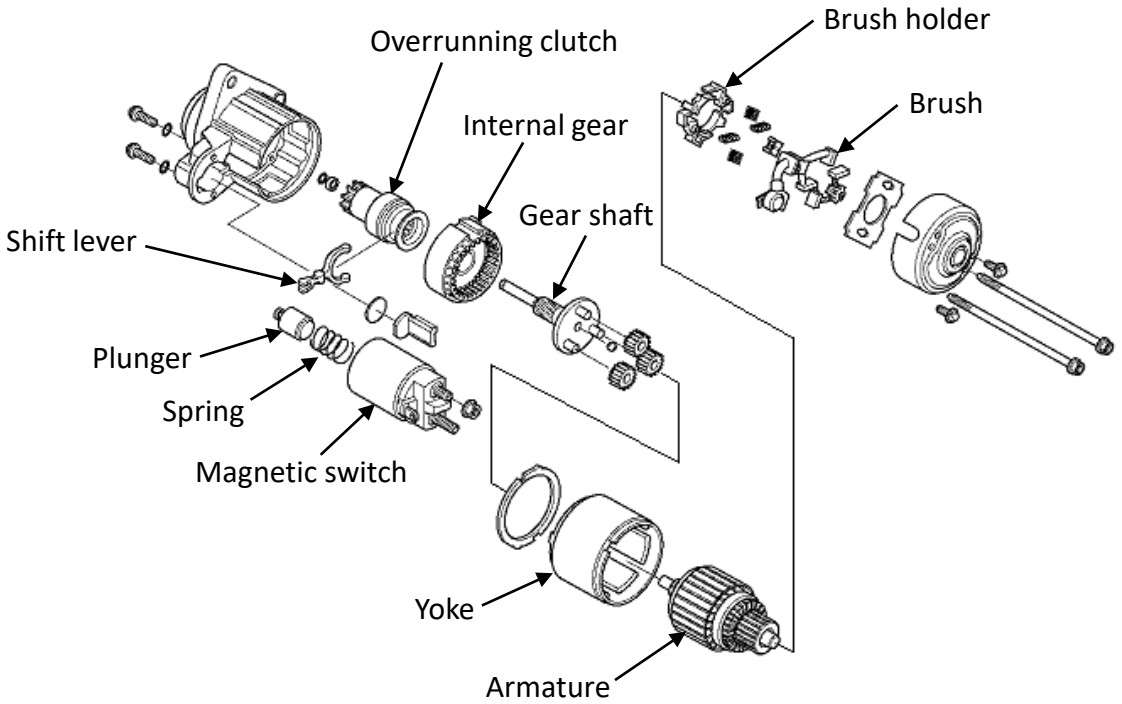


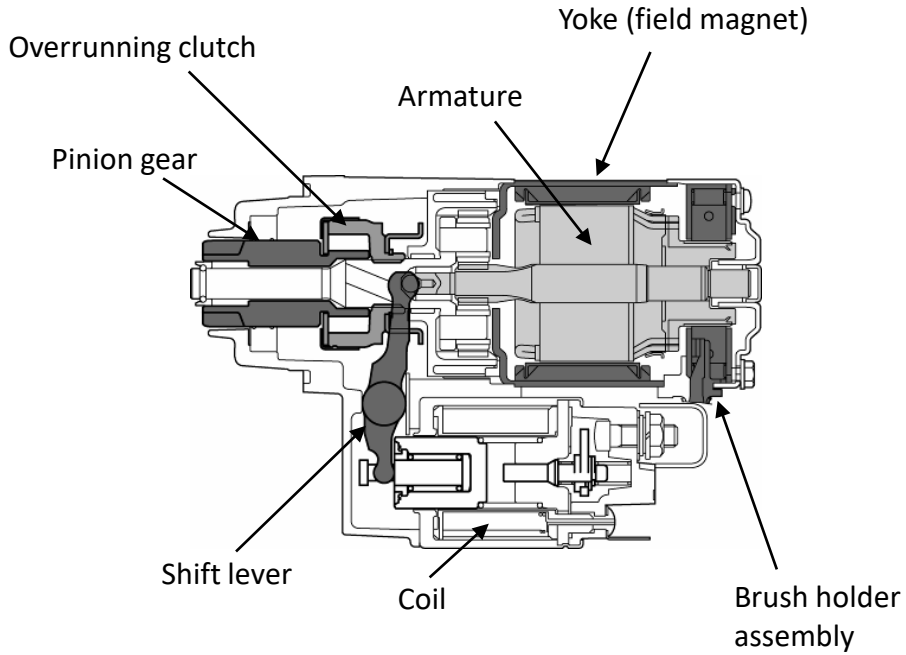
Armature rotates, pinion gear slides and ring gear turns.

Pinion gear returns to the original position

Structure of Shift Lever Pinion Engagement Type Starter Motor:

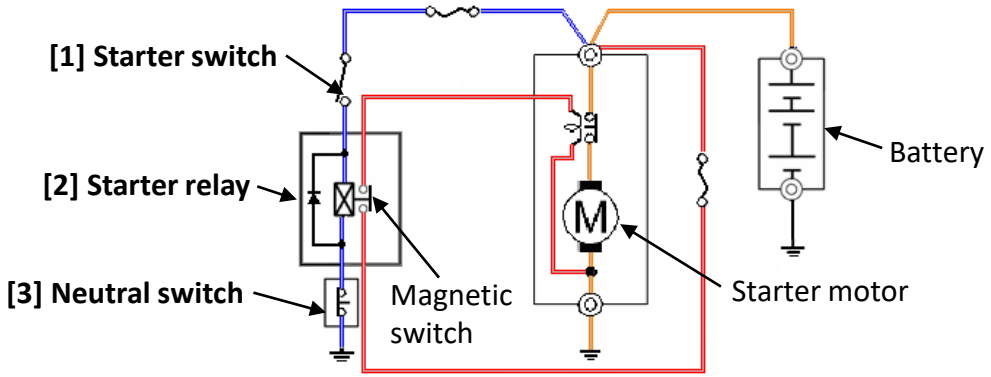
Shift lever pinion engagement type starter motors are used in models of 60 PS or more.





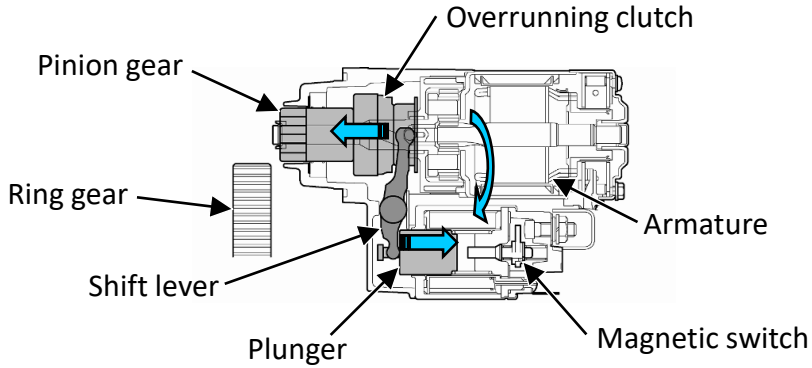
Electrical Circuit and Operation of Shift Lever Pinion Engagement Type Starter

1. When the **[1] starter switch** is turned to the START position, battery current flows to the **[2] starter relay** and the **[3] neutral switch**.
2. When the contact of the starter relay closes, an electromagnetic force generated in the coil of the built-in magnetic switch pulls its contact to close. As a result, current flows to the starter motor, and the armature in the motor starts rotating.
   *Refer to the page on "Magnetic Switch“ for more information on magnetic switch.

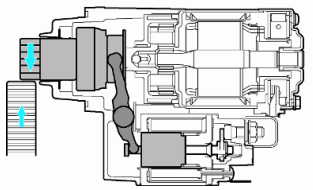


*If the gear is shifted to forward or reverse, the neutral switch contact opens. The current will be interrupted by the neutral switch, preventing the starter motor from operating.

3. Simultaneously, the plunger inside the magnetic switch moves the shift lever, pushing out the pinion gear.
4. The pushed-out pinion gear engages with the ring gear, causing the ring gear to rotate.
5. When the starter switch is returned to the ON position from the START position after the engine has started, the magnetic switch is turned off. The plunger returns to its original position, and the pinion gear is returned to its original position by the shift lever.

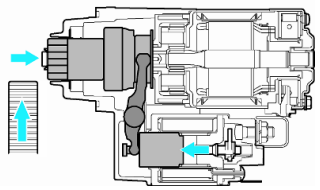


Meshing to crank



Armature rotates, pinion gear projects and ring gear turns.

After start



Pinion gear returns to the original position

Magnetic Switch

Role

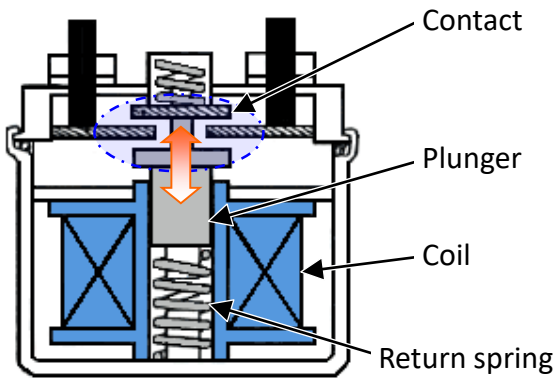
A magnetic switch is an electromagnetic switch that allows a large current to flow directly from the battery to the starter motor when starting the engine.

There are two types of magnetic switches for Honda outboard motors: a separate type and a starter motor integrated type.

Structure/Operation

Separate type (on 50PS or smaller models):

The magnet switch consists of a coil, return spring, plunger and contact. The contact is attracted by the electromagnetic force by the coil. A small current to the coil switches between ON and OFF of a large current to the motor.



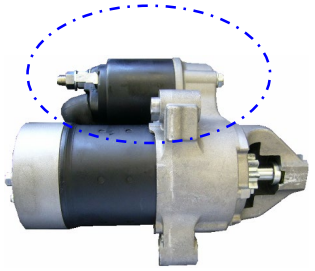
Integrated type (on 60PS and larger models):

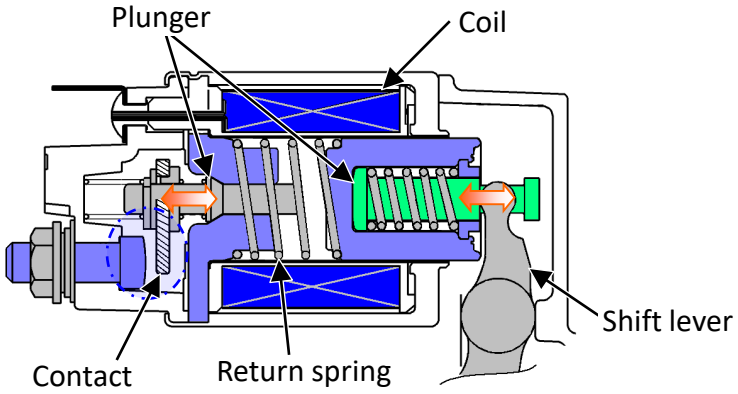
The magnetic switch is integral with the starter motor.

When the starter switch is turned ON, a small current from the battery turns on the starter relay, causing a large current to flow through the coil in the magnetic switch.

Then the contact is closed to pass a current to the motor.

Simultaneously, the shift lever is moved by the attraction force of the plunger, causing the overrunning clutch (pinion gear) to move.





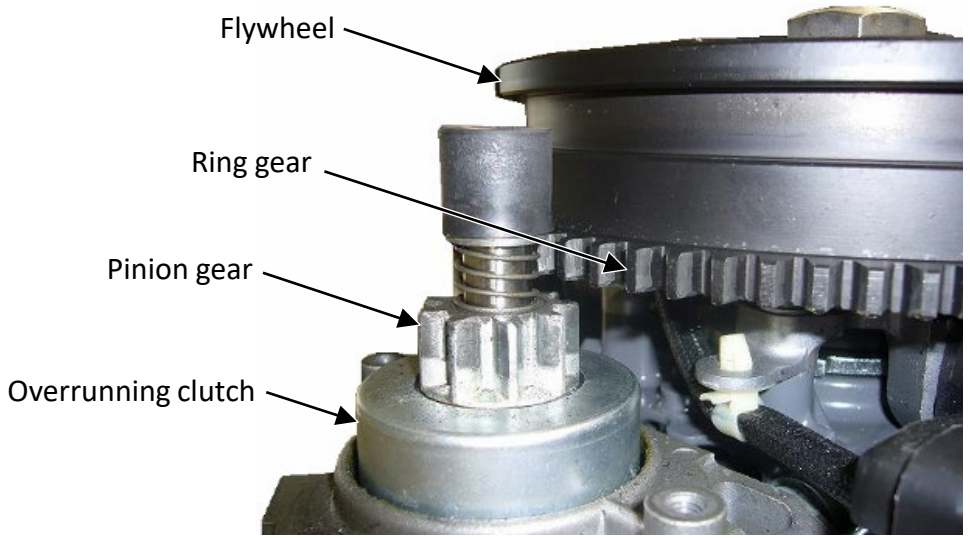
Overrunning Clutch

Role

The overrunning clutch is a clutch mechanism that prevents the motor from being turned by the flywheel ring gear after the engine has started.

Structure

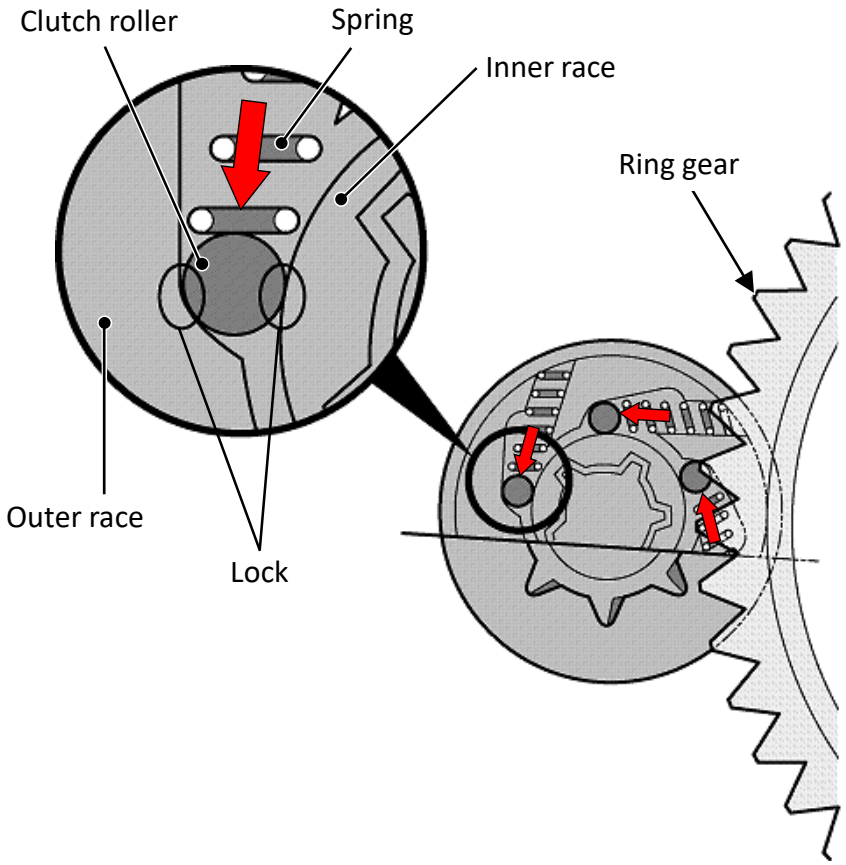
The outer race of the overrunning clutch is connected to the motor armature shaft, and the inner race is integrated with the pinion gear.



Overrunning Clutch

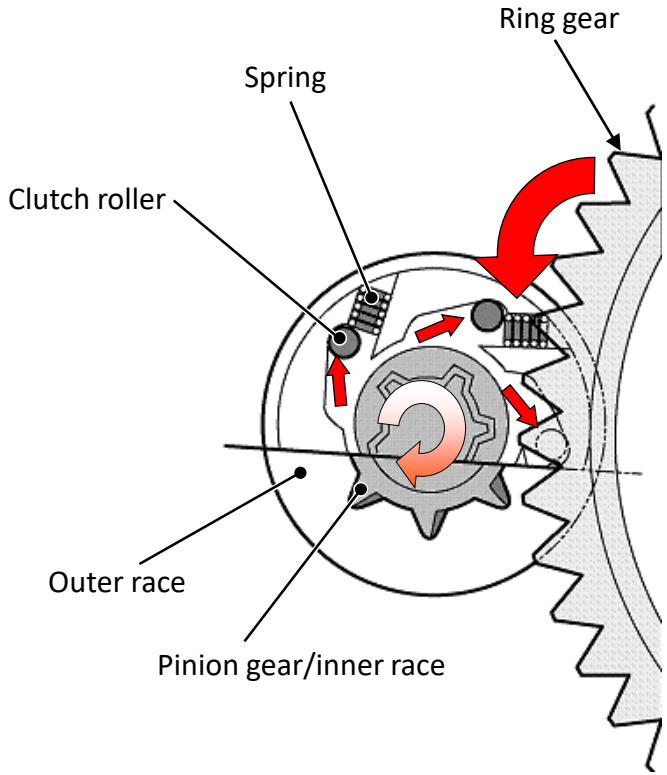
Operation during engine start-up:

As the outer race is driven by the armature (in clockwise direction in the figure below), the clutch roller is pinched in the small gap between the outer race and the inner race by the spring. As a result, the outer and inner races are locked and rotate together.



Operation after engine start-up:

As the engine starts and rotational speed of the ring gear increases, the pinion gear/inner race rotates faster than the outer race. This brings the clutch roller to the wide gap, overcoming the spring force. As a result, the inner race and outer race are freed.



Other Electrical System

- Power Supply System
- Oil Pressure Alert Control
- Overheat Alert Control
- Water Separator Level Sensor Full-water Level Warning
- Emergency Stop Switch

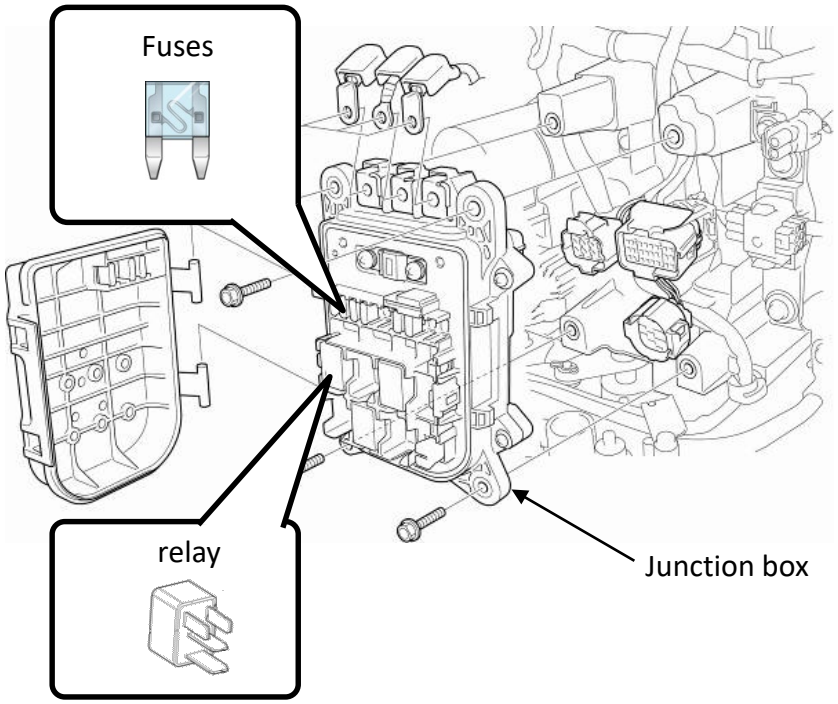
Power Supply System

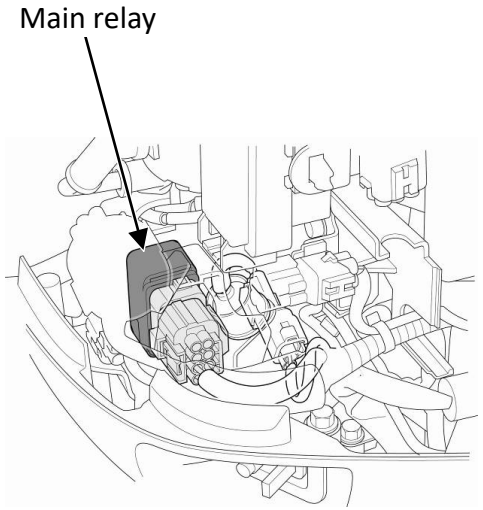
Role

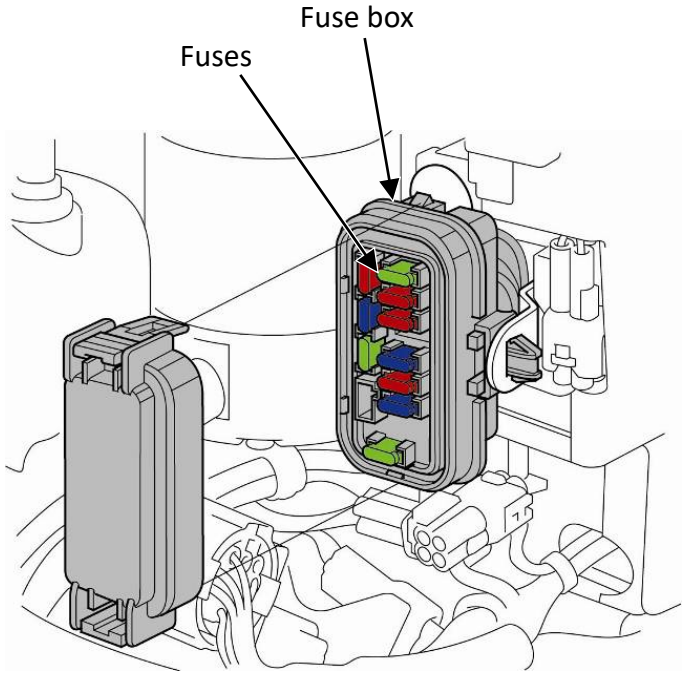
The power supply system supplies and shuts off power from the battery to the electrical components and each system by operating the starter switch.

Structure

The power supply system used in outboard motors consists of a battery, fuses and relays.
The larger models use a junction box, which consists of a relay for the fuel pump circuit, a main relay, and fuses.
Smaller models use a fuse box, which consists of multiple fuses, and the main relay is located outside.



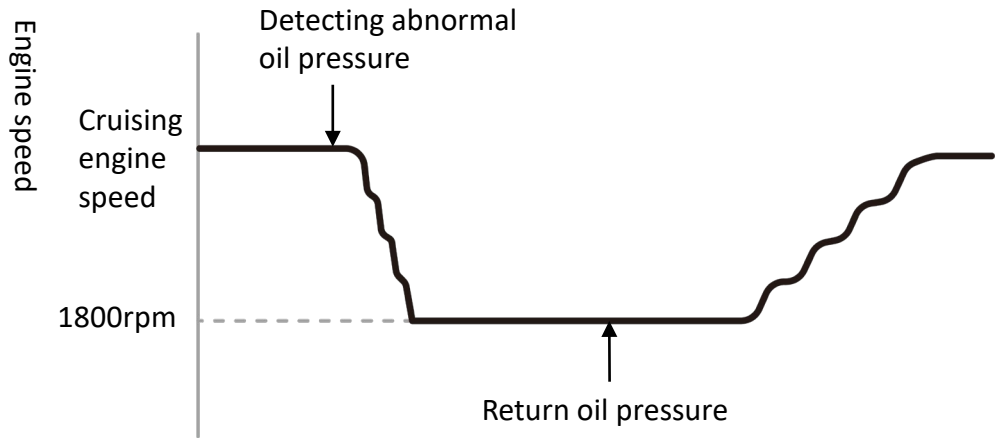




Oil Pressure Alert Control

Role

Oil pressure alert control detects oil pressure decrease from the low pressure and high pressure oil pressure switches, and sends the signal to the ECU. The ECU determines oil pressure abnormalities from the engine operating condition (speed and temperature). When detected, the oil pressure lamp (green) turns OFF and intermittent buzzes produced to warn the operator.



With the exception of a few models, the engine speed is maintained at 1,800 rpm during oil pressure alert.

Detection at low pressure oil pressure switch

1. When the low pressure oil switch detects a pressure decrease, it sends a signal to the ECU.
2. Regardless of the engine speed and engine temperature, when the ECU detects an oil pressure abnormality, it cuts off the fuel supply and cuts the ignition spark at all cylinders, to lower the engine speed to 1,800 rpm.
3. When oil pressure continues to decrease, The ECU keeps the engine speed at 1,800 rpm even if the operator opens the throttle lever.
4. When oil pressure goes back to normal, it gradually shifts to normal control, raising the engine speed and returns to normal operation.

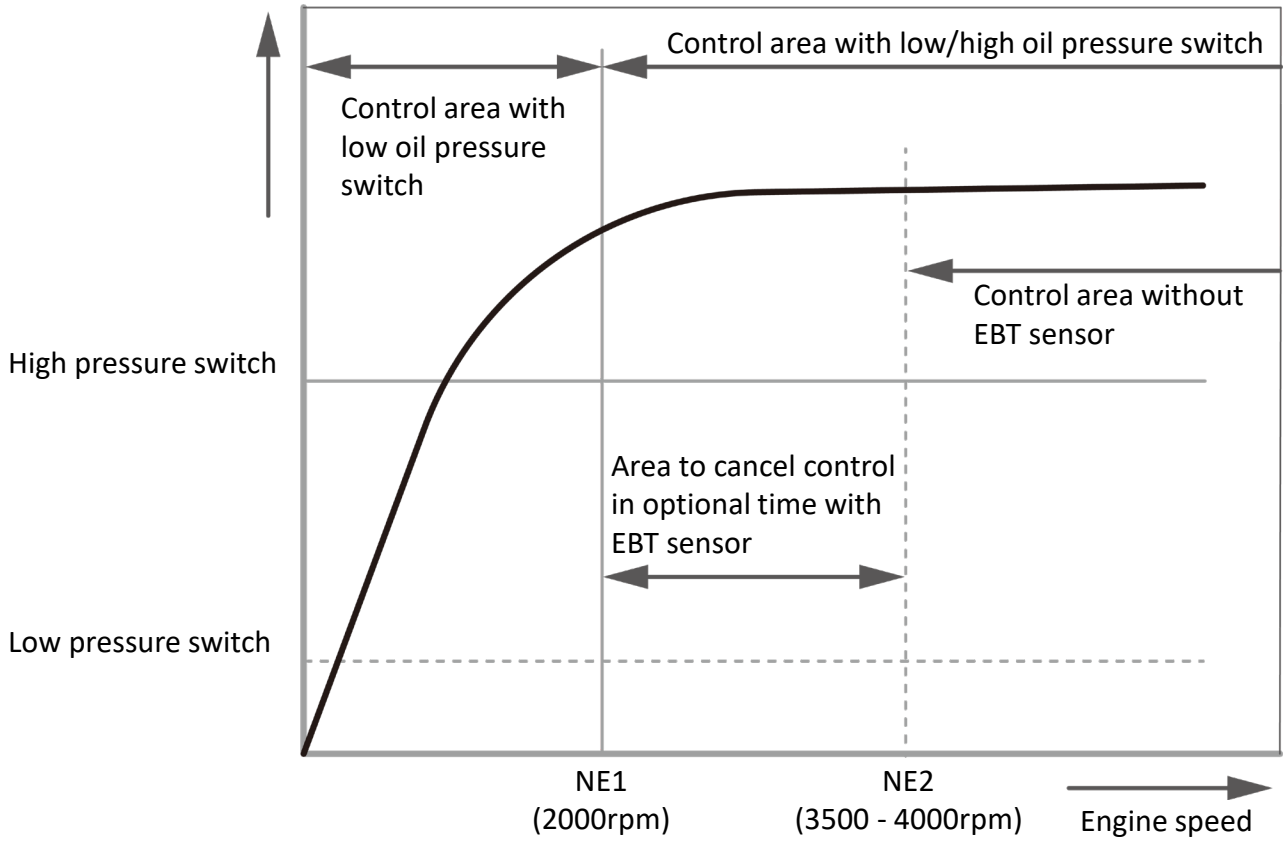
Detection at high pressure oil pressure switch

1. When the high pressure oil switch detects a pressure decrease, it sends signal to the ECU.
2. At engine speeds higher than specified, regardless of the engine temperature, ECU detects oil pressure abnormality, cuts off fuel supply and cuts the ignition sparks at all cylinders, to lower the engine speed to 1,800 rpm. If at that time, engine speed is within a certain range, threshold level is changed by the EBT sensor, and starts the alert control.
3. If engine speed is lower than specified, alert control doesn't activate, even if high pressure switch detects pressure decrease.
4. If oil pressure continues to decrease, The ECU keeps the engine speed at 1,800 rpm even if the operator opens the throttle lever.
5. When oil pressure goes back to normal, it gradually shifts to normal control, raising the engine speed and returns to normal operation.

Oil Pressure Alert Control

When Oil Pressure Alert Has Operated

- Stop the engine immediately, check oil level and supply oil if insufficient.
- If engine oil volume is normal, restart engine, operate it at idling speed for 30 seconds. If alert operation stops, it is normal.
- If the alert operation continues after the 30-second idle operation, perform troubleshooting according to the trouble diagnosis graph in the shop manual.



Overheat Alert Control

Role

For overheat alert control, voltage signals from the temperature taken by EMT sensor installed on the top of both sides of the exhaust manifold are sent to the ECU. When The ECU detects overheating, the overheat lamp (red) lights up and the warning buzzer produces a continuous buzz to inform the operator.

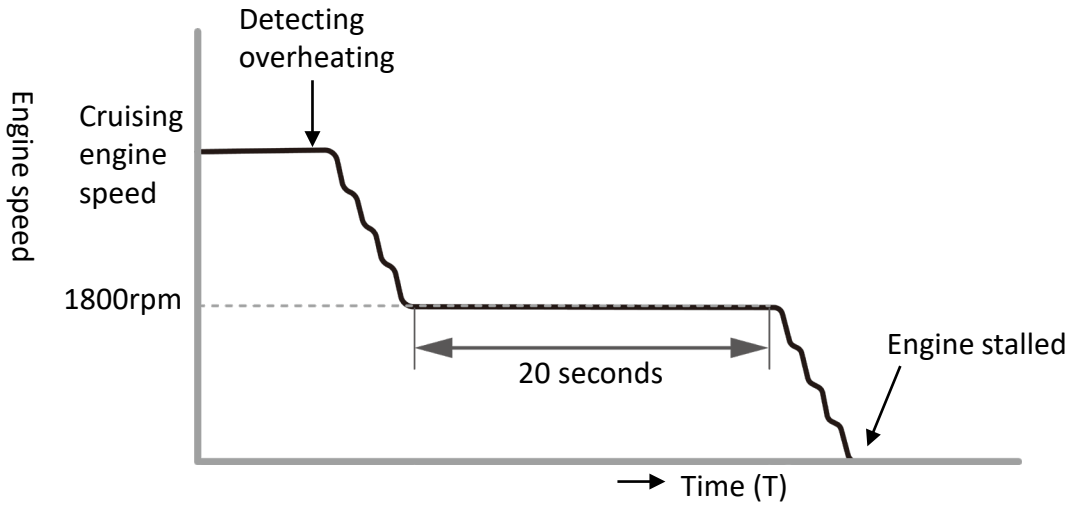
Control

1. The ECU receives signal from the EMT sensor to detect overheating.
2. If the ECU determined overheating, it cuts off fuel supply and cuts the ignition spark at all cylinders, to lower the engine speed to 1,800 rpm.
3. If overheat continues, the ECU keeps the engine speed at 1,800 rpm even if the operator opens the throttle lever.
4. If temperature goes back to normal, it gradually shifts to normal control, raising the engine speed and returns to normal operation.
5. If the overheat condition continues after certain period, the ECU cuts off fuel supply and cuts the ignition spark at all cylinders to stop the engine.

- Restarting is possible even if engine stopped, but it will stop again if overheating resurfaces.
- With the exception of a few models, the engine speed is maintained at 1,800 rpm during oil pressure alert.

If Overheat Alert Has Activated

- Stop the engine immediately; check if water screen is not clogged. Remove dirt if clogged.
- Start the engine; check if coolant steadily comes out from the test water opening. If water doesn't flow,
- inspect the water pump, water tube, and thermostat.
- If coolant flows steadily, operate at idling speed. It should be normal If alert operation stops.
- If the alert system continues to operate, perform troubleshooting according to the trouble diagnosis graph in the shop manual.

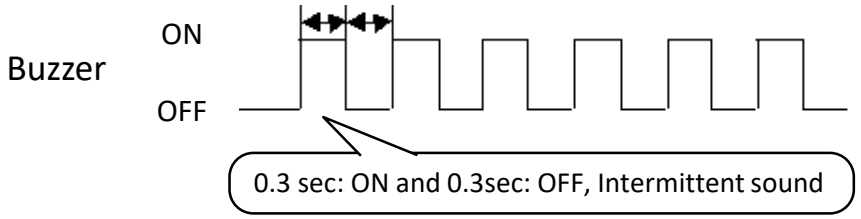


Water Separator Level Sensor Full-water Level Warning

Role

Installed at the water separator along the fuel supply path, water position sensor (Float-style) detects full-water level at the water separator and sends the signal to the ECU. The program in the ECU will command short intermittent buzzes.

Buzzer pattern at full-water level warning



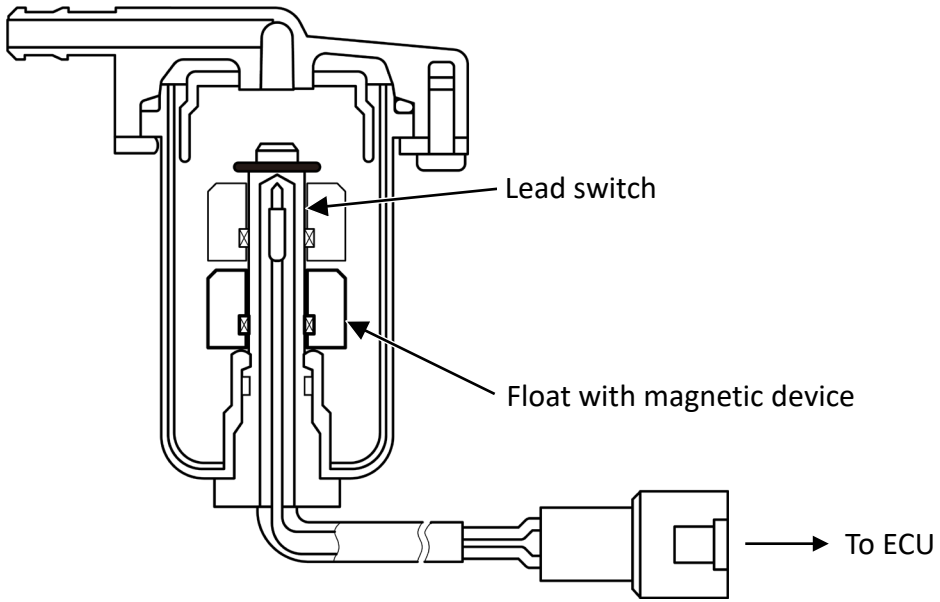
If Full-water Level Warning is Detected

1. Stop the engine immediately.
2. Inspect and clean the water separator.
3. Inspect and clean the low pressure fuel filter.

If the engine continues to operate while the full-water level warning is activated, water goes to the vapor separator, high pressure fuel pump, and into the injector to cause engine malfunction. If this happens, perform draining of the vapor separator gas drain and other procedures before operating the engine.

Water Separator Level Sensor

To detect the water volume in the water separator, the water position separator level sensor consists of lead switch in the chamber and plastic float with magnet; this float floats on water but sinks in fuel.
The plastic float is equipped with magnets and when water gathers in the water separator, and it reached the prescribed position, it turns ON the lead switch.

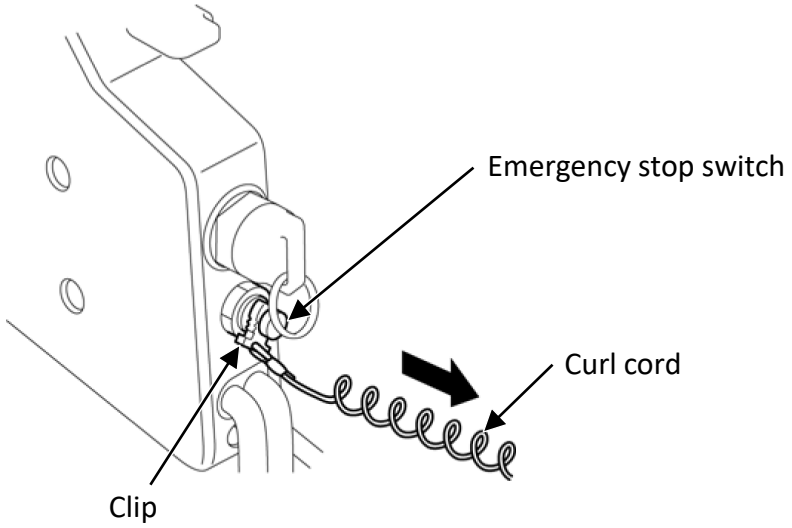


Emergency Stop Switch

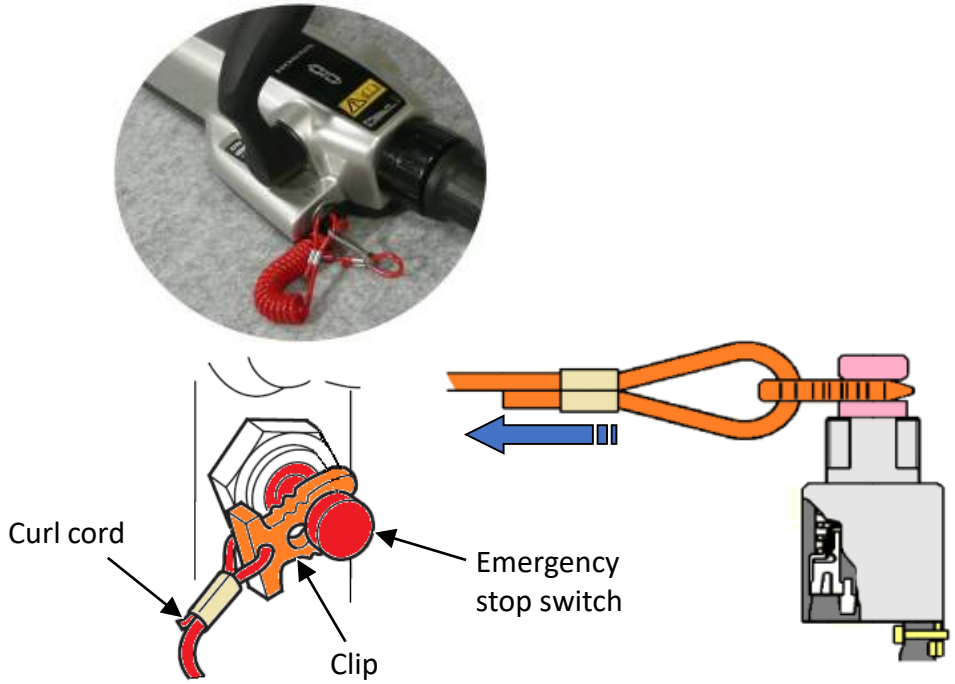
Role

The emergency stop switch stops the engine when the clip attached to the switch is detached.
During normal operation, the curled cord extending from the switch is wrapped around a part of the operator's body to stop the engine and prevent the boat from running out of control in the event of falling overboard.
If the switch is not clipped on, the engine cannot be started.

Remote-control type



Bar handle type



Necessity of Maintenance

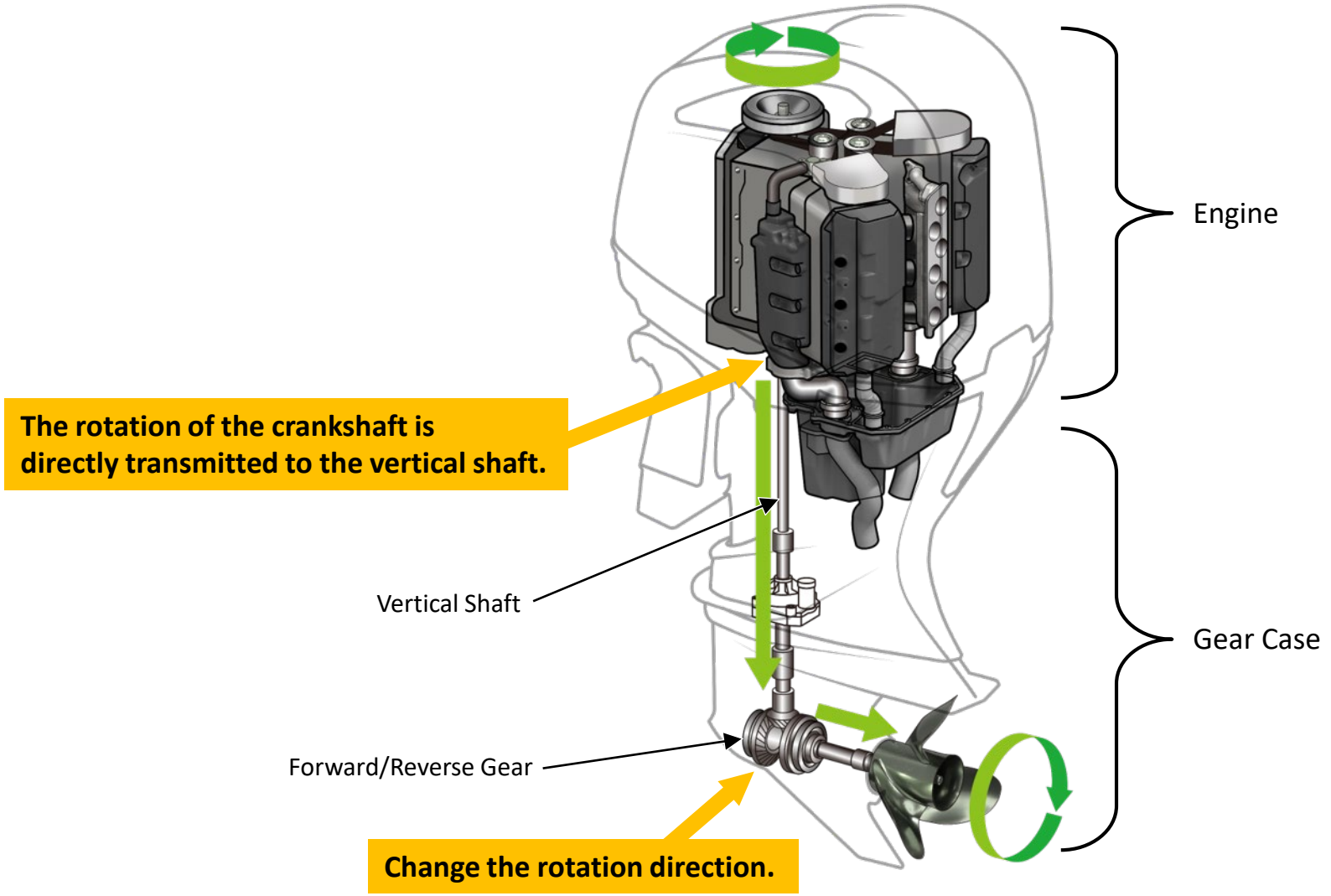
Start the engine and confirm that the engine always stops when the clip comes off.

Power Transmission System

- Power Transmission System Overview
- Gear Case
- Propeller

Power Transmission Flow

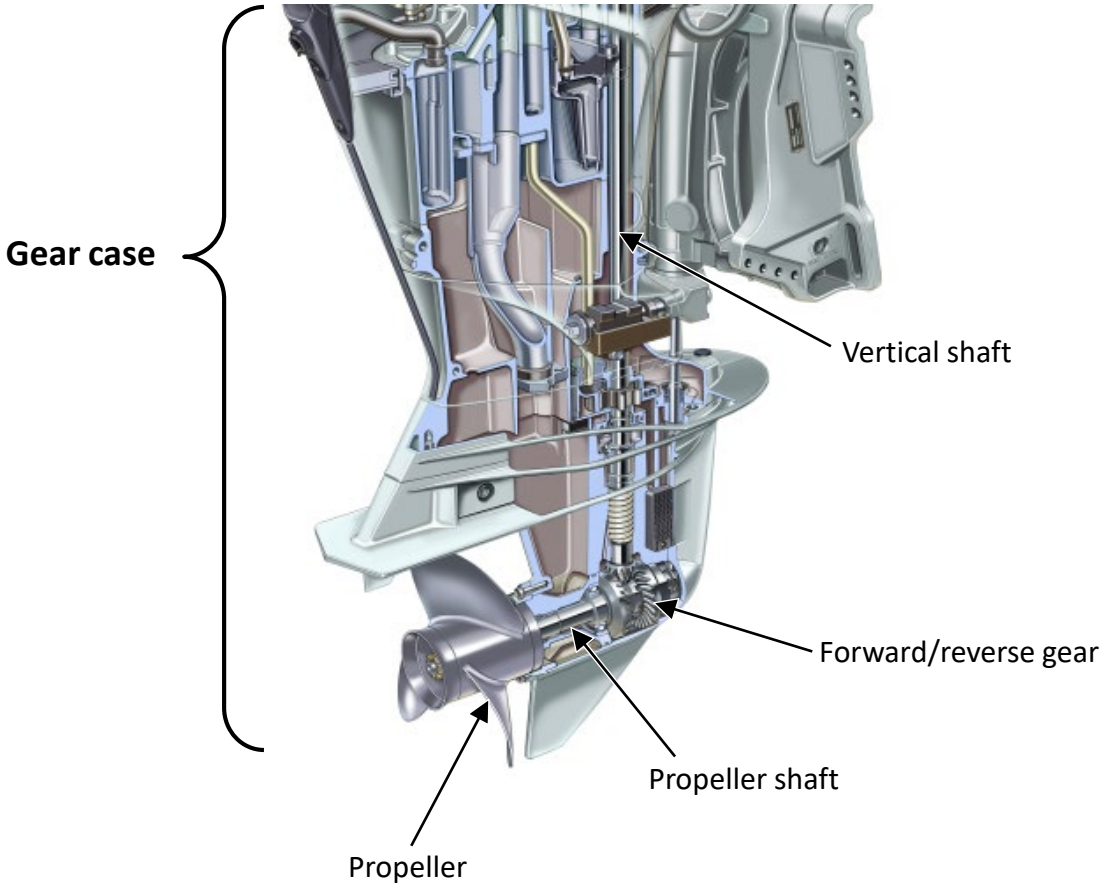
In the power transmission flow, the crankshaft rotation is transmitted to the vertical shaft, and the forward/reverse gears change the direction of rotation to rotate the propeller.

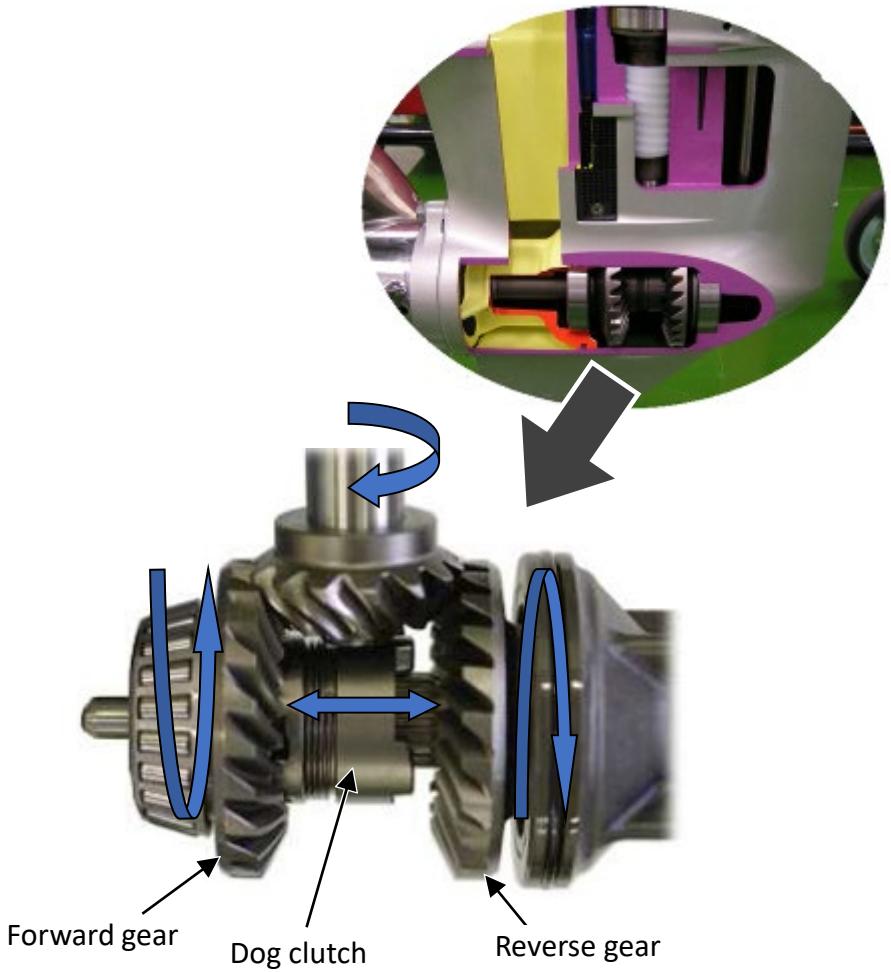


Gear Case Structure/Operation

When the engine runs, it drives a vertical shaft connected to the crankshaft and turns the forward/reverse gears.

A dog clutch is installed between the forward/reverse gears, and the dog clutch moves to the forward/reverse side when the shift lever is operated, transmitting the vertical shaft rotation to the propeller shaft.





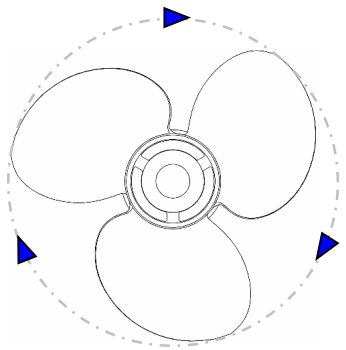
Counter Rotation

When two outboard motors are mounted, one of them is to be of counter rotation type to cancel reaction torque caused by the propeller rotation.
Their propeller of the counter rotation type rotates in counter-clockwise when viewed from the back.

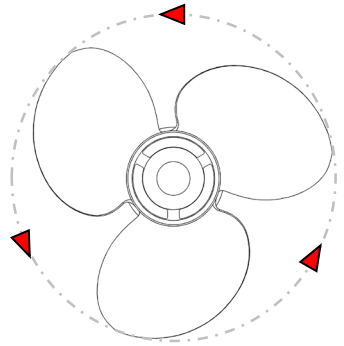
Standard rotation type outboard motor has a trim tab, while counter rotation type does not.
The counter rotation type can also be identified by a groove on the propeller shaft.

Rotating direction:

Standard rotation

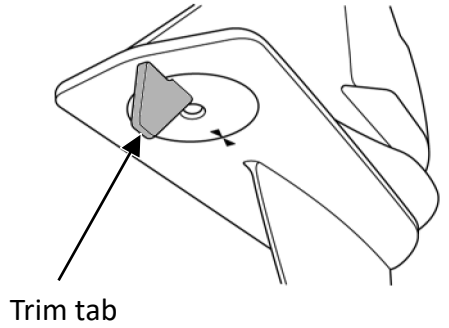


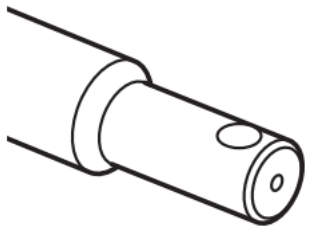
Counter rotation



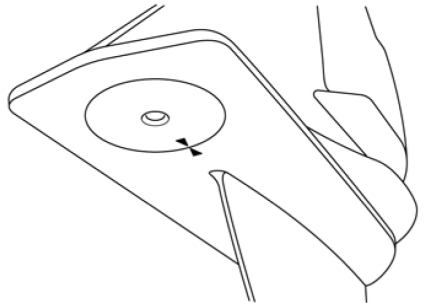
Identification:

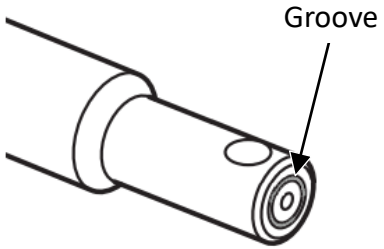
Standard rotation





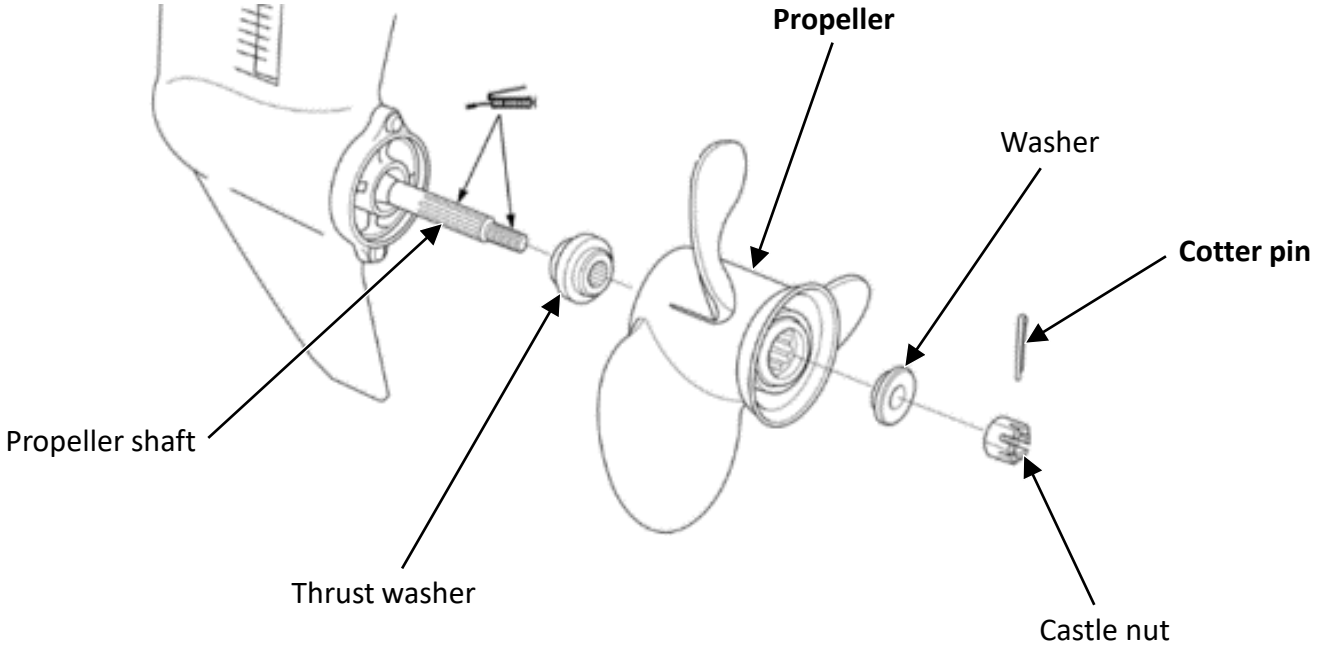
Counter rotation





How to Install the Propeller

The propeller is fixed to the propeller shaft with a thrust washer, washer, and castle nut. The castle nut is held in place with a cotter pin to prevent it from loosening, preventing the rubber bushing from slipping and the propeller from falling off.



Propeller

Necessity of Maintenance

The propeller is one of the most important parts of an outboard motor.

Even if the engine is running well, if the propeller is damaged, it will not be able to provide propulsion, which will affect the performance of the boat and cause vibrations and increased fuel consumption.

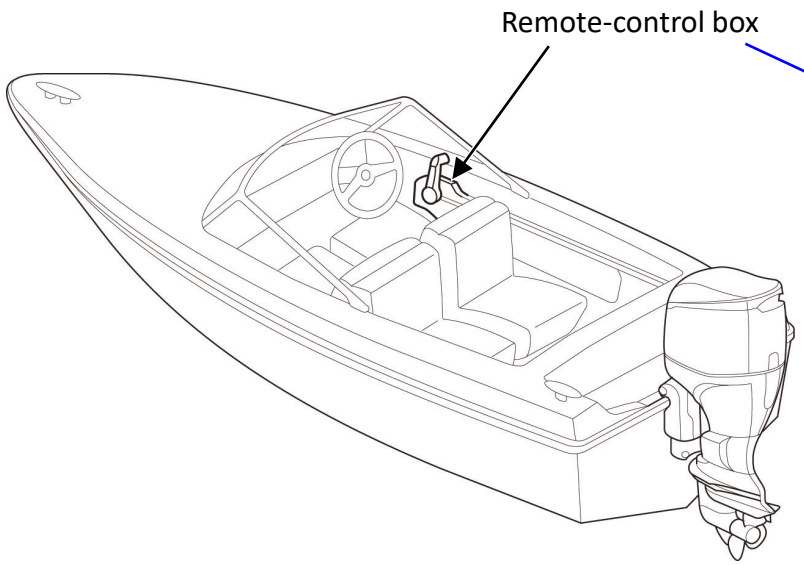
If the engine is running well but the speed is not increasing, the rubber bushing of the propeller may be slipping.

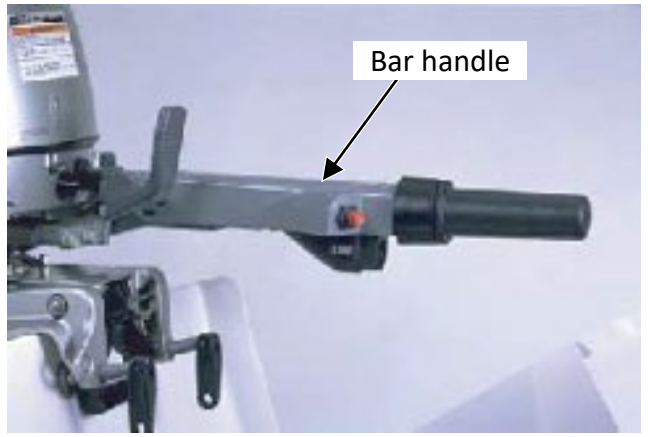
Control System

- Throttle/Shift Control
- Steering Control

Throttle/Shift Control Overview

The throttle (engine power) and gear shift (forward/backward) of the outboard motor are controlled by a remote-control box in the cockpit or by a bar handle attached to the outboard motor itself.
The remote-control box contains trim and tilt controls as well as throttle and shift operations.



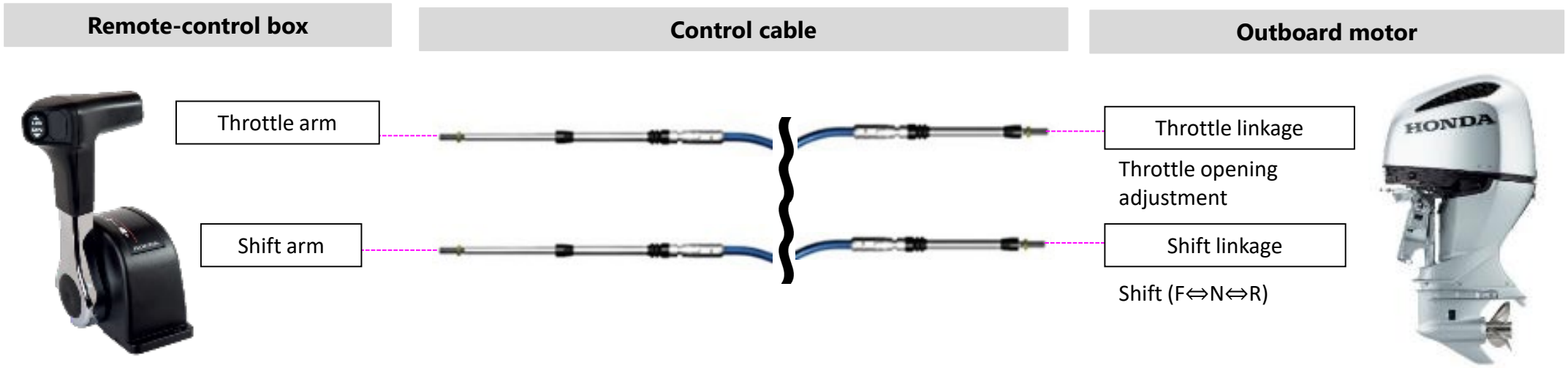


Throttle/Shift Control Overview

There is a difference in the way the lever operation of the remote-control box is transmitted to the outboard motor between the mechanical model and the DBW model.

In the mechanical model, the remote-control box is connected to the throttle linkage and shift linkage on the engine side via push-pull control cables to control the throttle opening and shift operation.

Mechanical model

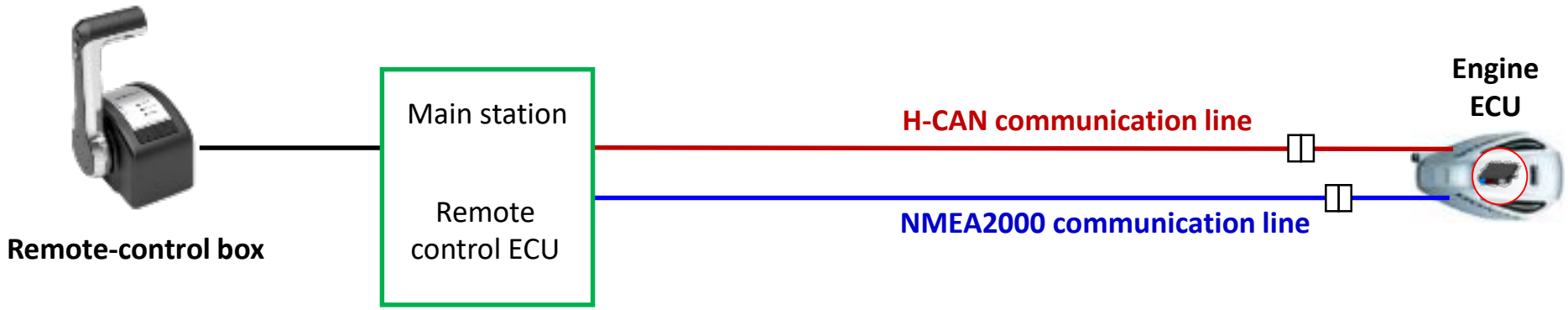


Throttle/Shift Control Overview

The DBW model system does not use a control cable but uses two communication lines between the remote-control ECU and the engine ECU to operate the outboard motor.

The communication lines are the H-CAN (Honda CAN) communication line and the NMEA2000 communication line.

DBW model



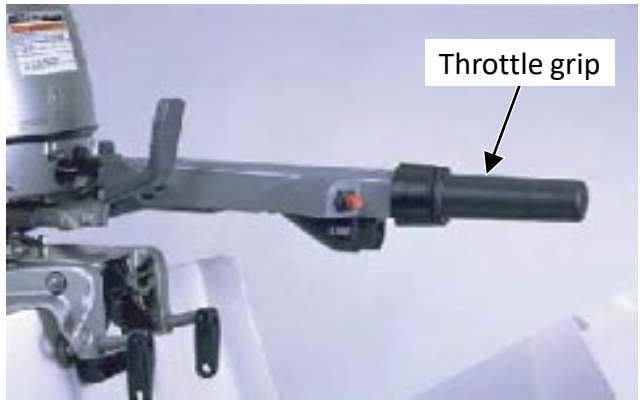
The DBW (drive-by-wire) system is a system that computerizes the throttle and shift mechanisms of the outboard motor and improves the operability of the boat with an electronic remote-control box.

Steering Control Overview

Each outboard motor model is available with either a tiller handle or a remote-control type steering system.
(Tiller only for 2 to 5ps)

Tiller Handle Type (H)

The tiller handle is used to control the boat directly from the seat position at the rear of the boat. Compared to the remote-control type, the tiller handle is characterized by its ability to make boat handling faster and is mostly used with low-horsepower engines. In the case of Honda, tiller handles are available for up to mid-sized models.



Remote-Control Type (R)

It is operated by remote-control and steering wheel from the seat position near the center of the boat.
It is used in a wide range of horsepower for small size to large size, and rigging requires the process of attaching various equipment to the boat.

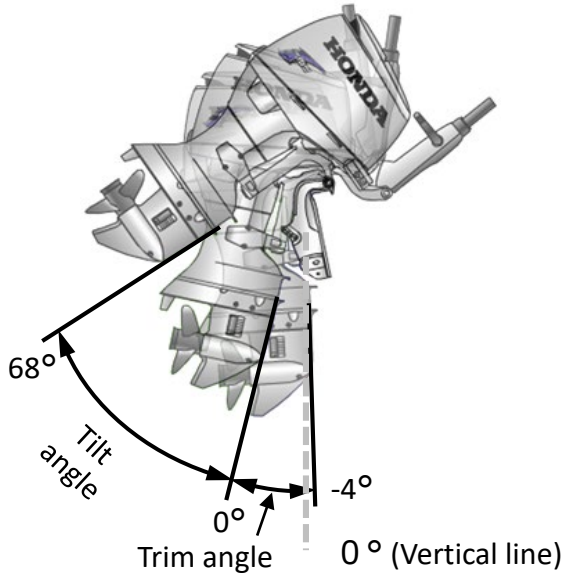
Power Trim/Tilt System

- Power Trim/Tilt System Overview
- Types of Power Trim/Tilt System
- Structure and Function of Power Trim/Tilt System

Power Trim/Tilt System Overview

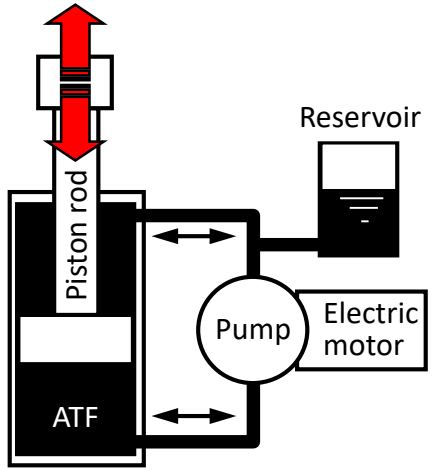
Honda outboard motors of 60 horsepower and above are equipped with a Power Trim/Tilt (PTT).
This is an important unit that adjusts the trim angle of the outboard motor in order to ensure that the boat travels stably, and also tilts up the outboard motor in order to support it when the boat is berthed or maintenance is being carried out on it.

- Trim function (-4° - 16°):
  The propeller angle can be changed while the boat is in motion to keep the boat in optimal posture for improved running performance.
- Tilt function (16° - 68°):
  Helps protect the outboard motor. (Pull the outboard motor up out of the water)



Because a large force is required to move the outboard motor to a given position and support it there, the piston rod inside the cylinder is operated by hydraulic pressure. This hydraulic pressure is generated by a motor-driven pump. Automatic Transmission Fluid (ATF) is used for the hydraulic fluid.

Power trim/tilt

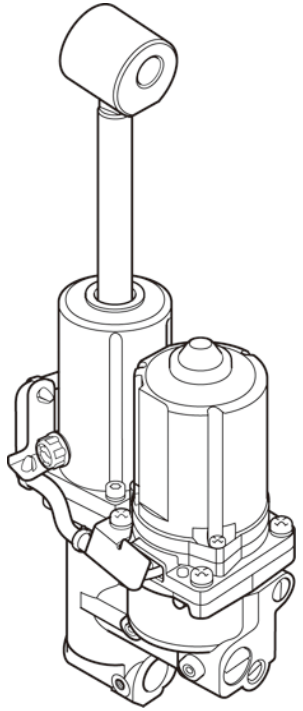


Instead of PTT, the tilt system for outboard motors between 2 and 20 horsepower is manual, while the gas-assisted system is used for outboard motors between 25 and 50 horsepower.

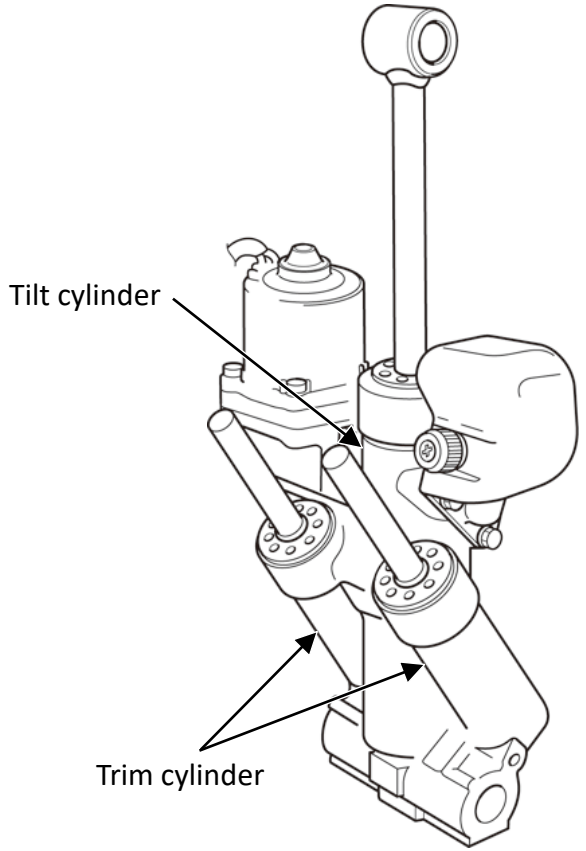
Types of Power Trim/Tilt System

The types of PTT for Honda's outboard motors are broadly divided into a 1-cylinder type (for medium-size outboard motors) and a 3-cylinder type (for large-size outboard motors).

The 3-cylinder type is provided with two cylinders specially used for trim range to improve the stability of the outboard motor while the boat is travelling.



1-cylinder type

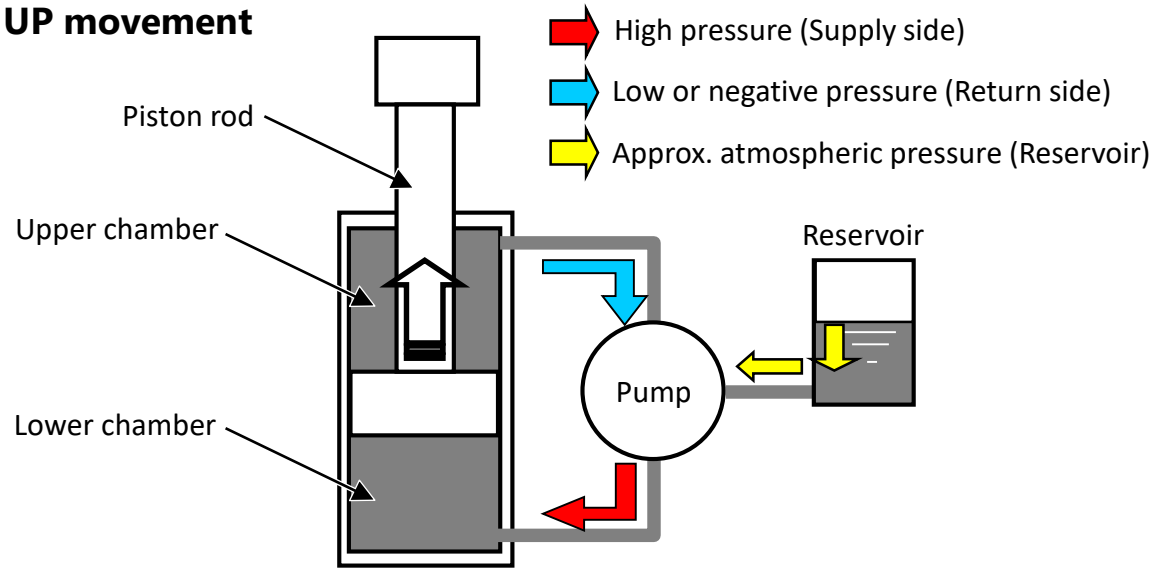


3-cylinder type

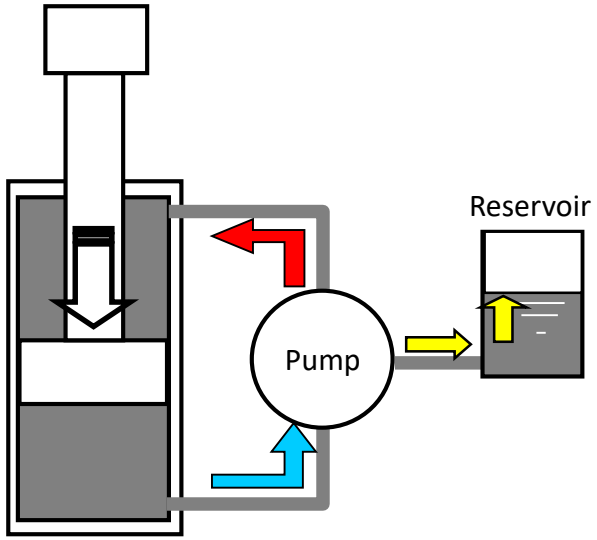
Working Principle

The system for circulating the hydraulic fluid (ATF) contains the following three chambers: an upper chamber, a lower chamber and a reservoir. It also contains passages which connect the chambers to a pump.
As shown in the figure on the right, the pump circulates the fluid in the upper chamber and the lower chamber, causing the piston rod in the cylinder to move up and down.
Here, because the volume of the upper chamber is smaller than that of the lower chamber by an amount exactly equal to the volume of the piston rod, fluid in the reservoir is used to compensate for any excess or deficiency of fluid.
As a result, the level of the fluid inside the reservoir changes along with the motion of the piston rod.
The level of the fluid inside the reservoir becomes the lowest when the piston rod is in the topmost position, and become the highest when it is in the bottommost position.

UP movement

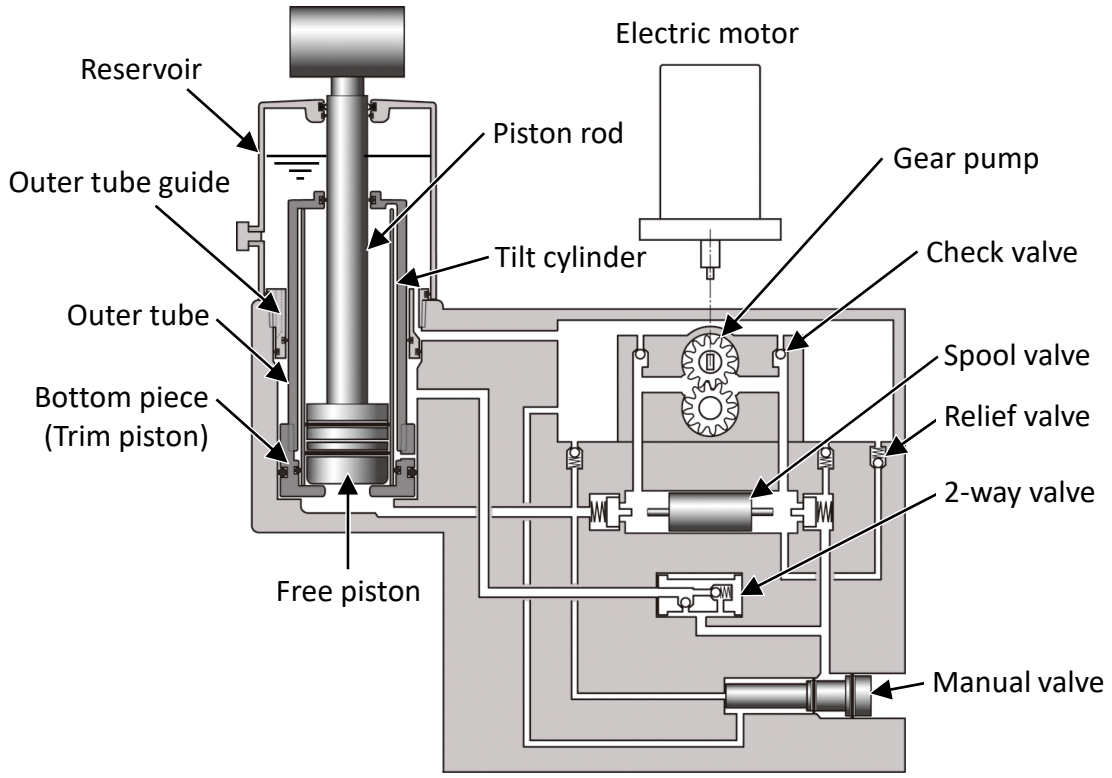


DOWN movement



1-Cylinder Type

The cylinder is of a double structure, and in the trim range the outer tube and the bottom piece (trim piston) stroke as one-piece.
When the bottom piece comes in contact with the outer tube guide, the trim range changes over to the tilt range, and the free piston and the piston rod inside the tilt cylinder, which is on the inner side of the outer tube, stroke as one-piece.
The reservoir is installed on the upper part of the cylinder in such a way that it covers the outer tube.
A gear pump is used to deliver the hydraulic fluid (ATF) to the cylinder.
The moving direction (up or down) of the piston rod is determined by the direction of the gear rotation.
The fluid circulation passages contain various valves for controlling the flow and the pressure of the fluid.
Also, a manual valve is installed to enable it to be operated manually in the event that the pump cannot be driven or if the rod does not operate due to air in the system.



3-Cylinder Type

Two trim cylinders are provided on both sides of a single tilt cylinder. In the trim range, the trim piston rods of these two cylinders operate to adjust the trim angle.
When the trim piston rods lift and contact the rod guides, it shifts to the tilt range and the tilt piston rod begins to stroke.
The reservoir is installed independently alongside the tilt cylinder, and is connected to the upper chamber passage of the trim cylinder.
Like the case of a 1-cylinder type, the fluid is delivered by a gear pump.

The valves which control the flow and the pressure of the fluid work similarly to that of the 1-cylinder type, but differ structurally in respect of the following two points.

1. There are spool valves divided into two pieces, and passages connecting them.
2. A 2-way valve is not used.