WSM

WORKSHOP MANUAL
GASOLINE/LPG ENGINE

WG750-B,WG750-E,
DG750-E,DF750-E

Kubota

KiSC issued 07, 2006 A

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of KUBOTA Gasoline / LPG fuel Engines (WG750, DG750 and DF750). It is divided into two parts, "Mechanism" and "Disassembling and Servicing".

■ **Mechanism**

Information on the construction and function are included for each engine section. This part should be understood before proceeding with trouble-shooting, disassembling and servicing.

■ **Disassembling and Servicing**

The heading "General" includes general precautions, check and maintenance and special tools. For each engine section, there are trouble-shooting, servicing specification lists, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information, illustrations and specifications contained in this manual are based on the latest production information available at the time of publication.

The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, illustration or picture being used have not been specified as one model.

September '88

CONTENTS

M. MECHANISM

S. DISASSEMBLING AND SERVICING

⚠ SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and decals on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.
It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

⚠ **DANGER** : Immediate hazards which **WILL** result in severe personal injury or death.

⚠ **WARNING** : Hazards or unsafe practices which **COULD** result in severe personal injury or death.

⚠ **CAUTION** : Hazards or unsafe practices which **COULD** result in minor personal injury.

■ **IMPORTANT** : Indicates that equipment or property damage could result if instructions are not followed.

■ **NOTE** : Gives helpful information.

SAFETY SERVICING AND REPAIRING

(1) Before working on the machine :
- Stop the engine, and remove the key.
- Allow the engine to cool before proceeding.
- Place the engine on a firm and level surface.
- Disconnect the battery's ground cable.
- Clean the work area and engine.

(2) Do not work on the engine while under the influence of alcohol, medication, or other substances or while fatigued.

(3) Do not wear a necktie, scarf, necklace, loose or bulky clothing when you work near machine tools or moving parts.

(4) Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

(5) Use tools appropriate to the work. Makeshift tools, parts, and procedures will not make good repairs.

(6) When servicing is performed together by two or more persons, take care to perform all work safely.

(7) If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

(8) Do not touch the rotating or hot parts while the engine is running.

(9) Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.

(10) To avoid sparks from an accidental short circuit, always disconnect the battery's ground cable first and connect it last.

(11) Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

(12) Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.

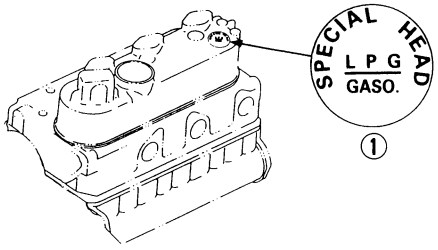
(13) Never remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.

(14) Escaping fuel fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel lines. Tighten all connections before applying pressure.

(15) Do not start the engine by shorting across starter terminals.

(16) Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

PRECAUTION FOR LPG FUEL



A166F060

■ **IMPORTANT**

- **The WG750-E with SPECIAL HEAD label (1) can be altered the engine on LPG fuel.**
- **To use the engine with LPG fuel, please you select an LPG version parts kit approved by KUBOTA.**
- **To conform to US.EPA and CARB Regulations the WG750-E must be altered exclusively by the use of KUBOTA's LPG kit.**
- **The engine alteration must be performed by an authorized KUBOTA engine dealer distributor equipment or OEM for quality assurance and your safety.**

⚠ **CAUTION**

- **These non-KUBOTA installed parts, such as hoses piping, shutoff solenoid valve and LPG tank should be approved for LPG use and conform to UL, CSA, NFTA, MSHA, and all other applicable standard.**

SPECIFICATIONS

Model		WG750-B	WG750-E
Type		Vertical, water cooled, 4-cycle gasoline engine	
Number of Cylinders		3	
Bore × Stroke		68 x 68 mm (2.68 x 2.68 in.)	
Total Displacement		740 cc (45.21 cu.in.)	
Brake Horsepower	SAE Net (Cont. H.P.)	14.5 kW/3600 rpm (19.5 HP/3600 rpm)	13.4 kW/3600 rpm (18.0 HP/3600 rpm)
	SAE Net (Intermittent H.P.)	17.2 kW/3600 rpm (23.0 HP/3600 rpm)	16.4 kW/3600 rpm (22.0 HP/3600 rpm)
	SAE Gross (Intermittent H.P.)	18.3 kW/3600 rpm (24.5 HP/3600 rpm)	17.7 kW/3600 rpm (23.8 HP/3600 rpm)
Maximum Bare Speed		3850 rpm	
Minimum Bare Idling Speed		1200 rpm	
Cylinder Head		Overhead-Valve	
Ignition System		Full-Transistor	
Governor		Centrifugal Ball Type Mechanical Governor	
Direction of Rotation		Counter-Clockwise (Viewed From Flywheel)	
Spark Plug		NGK BKR4E-11	
Ignition Timing		B.T.D.C. 18°	
Firing Order		1-2-3	
Compression Ratio		9.0 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indication		Electrical Type Switch	
Lubricating Filter		Full Flow Paper Filter (Cartridge Type)	
Cooling System		Pressurized Radiator (not included in the basic model), Forced Circulation with Water Pump	
Starting System		Electric Starting with Cell Starter (12V, 0.7 kW)	
Battery		12V, 35AH or equivalent	
Alternator		12V, 150W	
Fuel		* Standard Automobile Gasoline	* Unleaded Automobile Gasoline
Lubricating Oil		Better Than SF Class (API)	
Lubricating Oil Capacity		3.25 ℓ (3.4 u.s. qts)	
Weight (Dry)		61.7 kg (136.0 lbs)	
Application		General Power Source	

* Do not use gasoline blended with methyl alcohol.

KiSC issued 07, 2006 A

SPECIFICATIONS

Model		DG750-E
Type		Vertical, water cooled, 4-cycle LPG engine
Number of Cylinders		3
Bore × Stroke		68 x 68 mm (2.68 x 2.68 in.)
Total Displacement		740 cc (45.21 cu.in.)
Brake Horsepower	SAE Net (Cont. H.P.)	12.7 kW/3600 rpm (17.0 HP/3600 rpm)
	SAE Net (Intermittent H.P.)	15.7 kW/3600 rpm (21.0 HP/3600 rpm)
	SAE Gross (Intermittent H.P.)	17.0 kW/3600 rpm (22.8 HP/3600 rpm)
Maximum Bare Speed		3850 rpm
Minimum Bare Idling Speed		1500 rpm
Cylinder Head		Overhead-Valve
Ignition System		Full-Transistor
Governor		Centrifugal Ball Type Mechanical Governor
Direction of Rotation		Counter-Clockwise (Viewed From Flywheel)
Spark Plug		NGK BKR4E-11
Ignition Timing		B.T.D.C. 18°
Firing Order		1-2-3
Compression Ratio		9.0 : 1
Lubricating System		Forced Lubrication by Trochoid Pump
Oil Pressure Indication		Electrical Type Switch
Lubricating Filter		Full Flow Paper Filter (Cartridge Type)
Cooling System		Pressurized Radiator (not included in the basic model), Forced Circulation with Water Pump
Starting System		Electric Starting with Cell Starter (12V, 0.7 kW)
Battery		12V, 35AH or equivalent
Alternator		12V, 150W
Fuel		Standard Commercial Liquid Propane Gas
Lubricating Oil		Better Than SF Class (API)
Lubricating Oil Capacity		3.25 ℓ (3.4 u.s. qts)
Weight (Dry)		61.7 kg (136.0 lbs)
Application		General Power Source

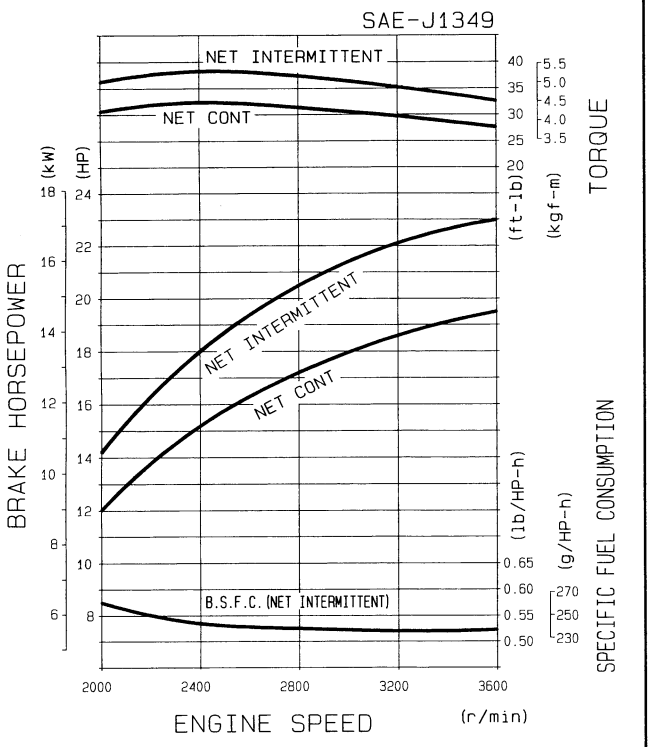
SPECIFICATIONS

Model		DF750-E	
Type		Vertical, water cooled, 4-cycle Dual Fuel (Gasoline / LPG) engine	
		Gasoline fuel	LPG fuel
Number of Cylinders		3	
Bore × Stroke		68 x 68 mm (2.68 x 2.68 in.)	
Total Displacement		740 cc (45.21 cu.in.)	
Brake Horsepower	SAE Net (Cont. H.P.)	13.4 kW/3600 rpm (18.0 HP/3600 rpm)	12.7 kW/3600 rpm (17.0 HP/3600 rpm)
	SAE Net (Intermittent H.P.)	16.4 kW/3600 rpm (22.0 HP/3600 rpm)	15.7 kW/3600 rpm (21.0 HP/3600 rpm)
	SAE Gross (Intermittent H.P.)	17.7 kW/3600 rpm (23.8 HP/3600 rpm)	17.0 kW/3600 rpm (22.8 HP/3600 rpm)
Maximum Bare Speed		3850 rpm	
Minimum Bare Idling Speed		1500 rpm	
Cylinder Head		Overhead-Valve	
Ignition System		Full-Transistor	
Governor		Centrifugal Ball Type Mechanical Governor	
Direction of Rotation		Counter-Clockwise (Viewed from Flywheel)	
Spark Plug		NGK BKR4E-11	
Ignition Timing		B.T.D.C. 18°	
Firing Order		1-2-3	
Compression Ratio		9.0 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indication		Electrical Type Switch	
Lubricating Filter		Full Flow Paper Filter (Cartridge Type)	
Cooling System		Pressurized Radiator (not included in the basic model), Forced Circulation with Water Pump	
Starting System		Electric Starting with Cell Starter (12V, 0.7 kW)	
Battery		12V, 35AH or Equivalent	
Alternator		12V, 150W	
Fuel		* Unleaded Automobile Gasoline	Standard Commercial LP Gas
Lubricating Oil		Better Than SF Class (API)	
Lubricating Oil Capacity		3.25 ℓ (3.4 u.s. qts)	
Weight (Dry)		61.7 kg (136.0 lbs)	
Application		General Power Source	

* Do not use gasoline blended with methyl alcohol.

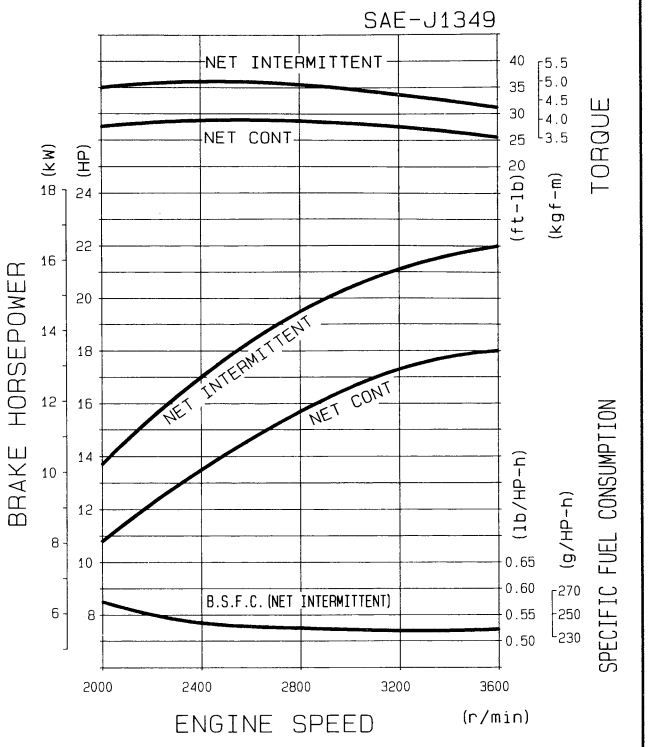
PERFORMANCE CURVES

WG750-B



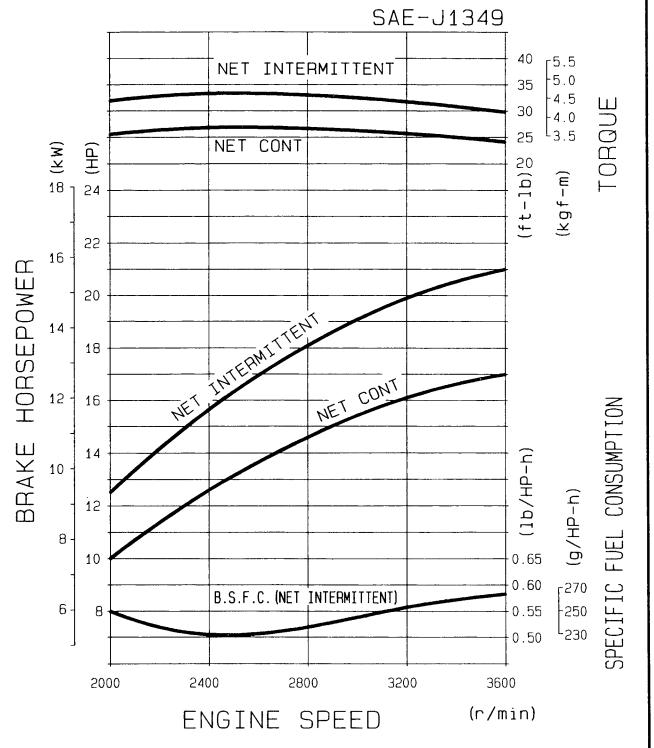
A166F062

WG750-E



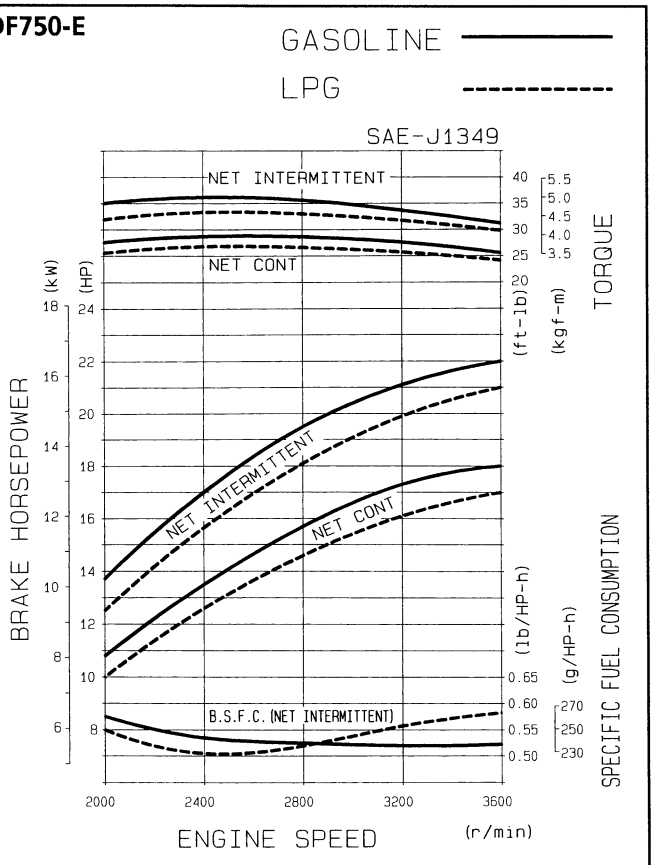
A166F063

DG750-E



A166F001

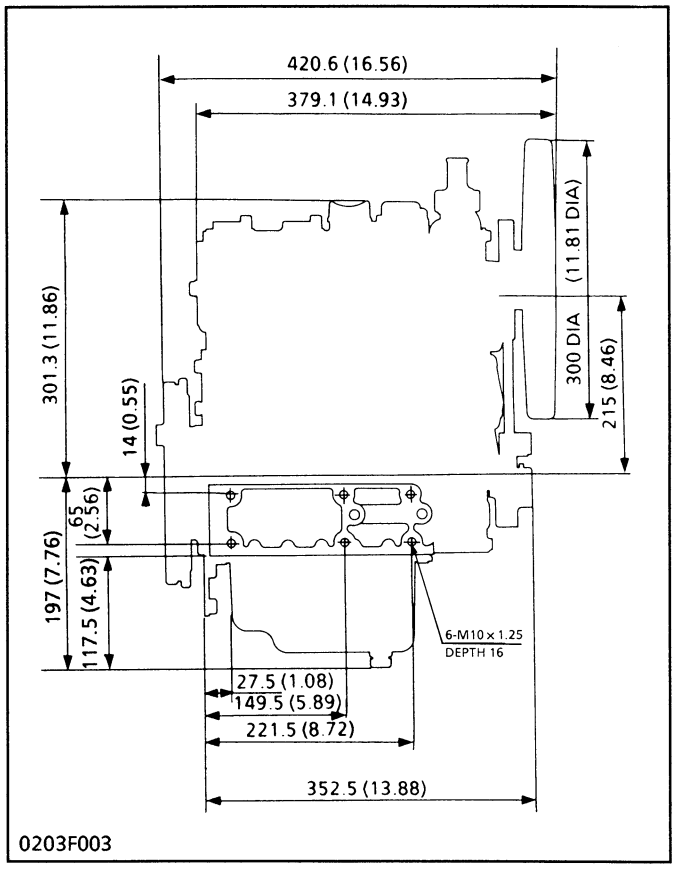
DF750-E

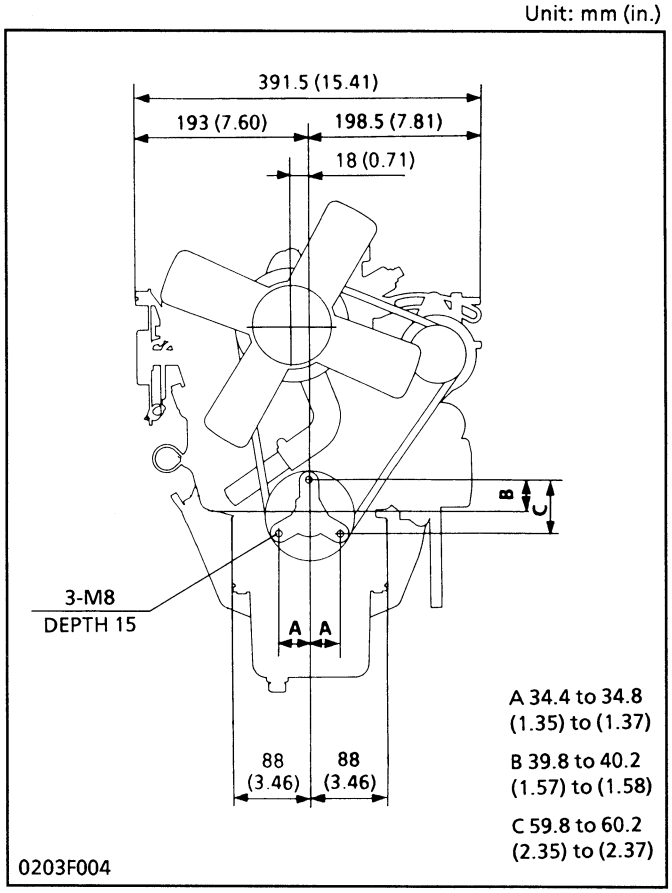


A166F050

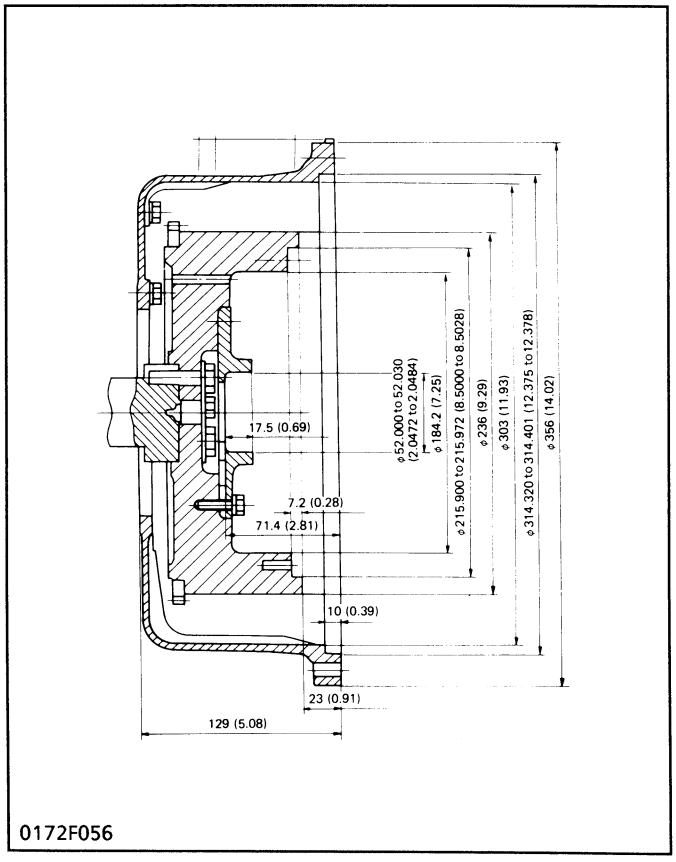
DIMENSIONS

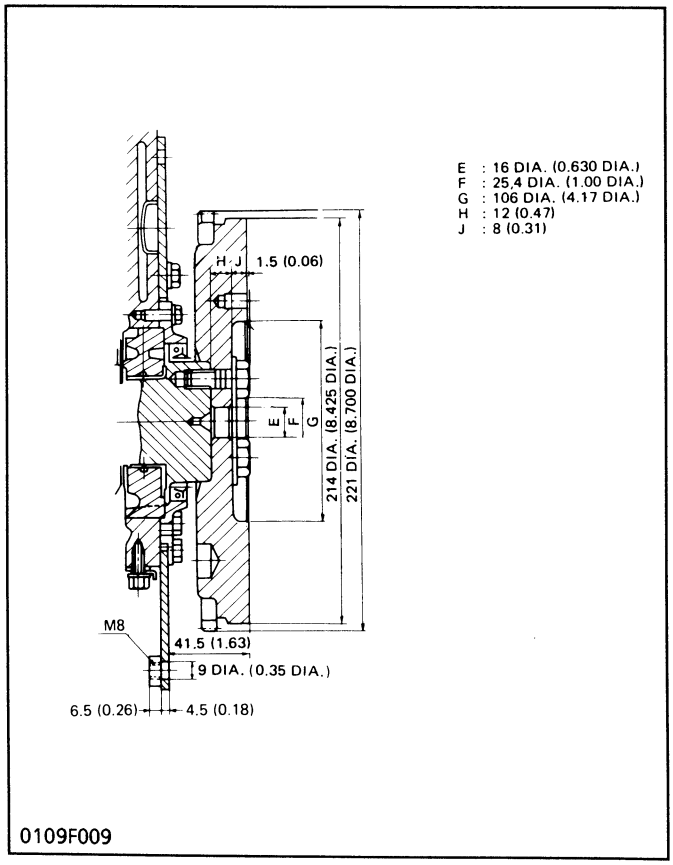
Unit: mm (in.)





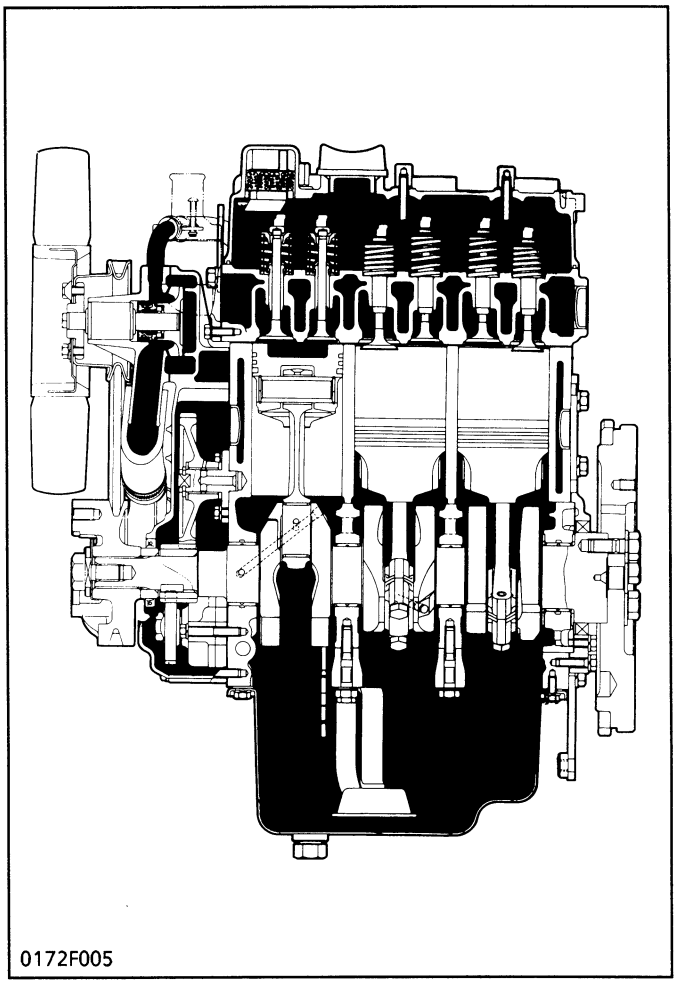
Flywheel Housing SAE No.5 (Clutch No.6-1/2)

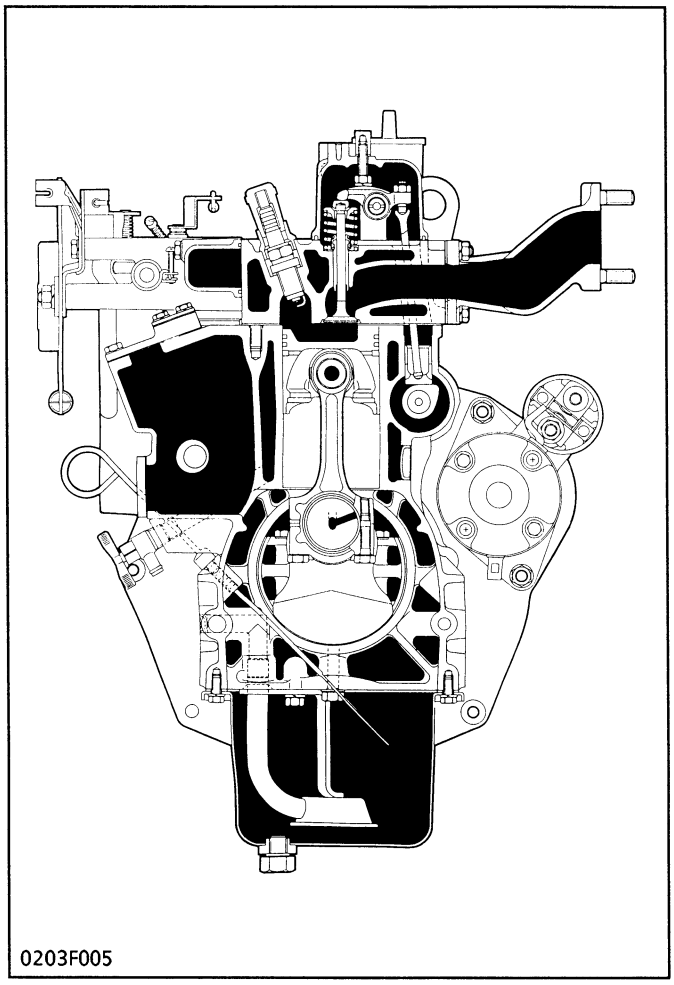




M. MECHANISM

F FEATURE


0172F005


0203F005

KUBOTA's liquid-cooled gasoline / LP Gas engine models WG750-B (-E), DG750-E and DF750-E are designed to emit less noxious fumes into the air while meeting the exact same durability standards maintained by our world - renowned diesel engines.

WG750-B(-E); This is a gasoline engine. To make a good thing even better, KUBOTA LPG kit (vaporizer and gas mixer) permits operation an Liquid Petroleum Gas.

DG750-E; This is a liquid petroleum gas engine

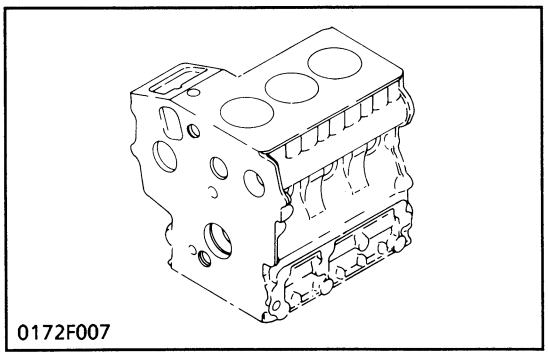
DF750-E; This is a Dual Fuel (gasoline/LPG) engine.

(-E) model was developed with an eye torward clean exhaust gas which is more environmentally friendly.

KiSC issued 07, 2006 A

1 ENGINE BODY

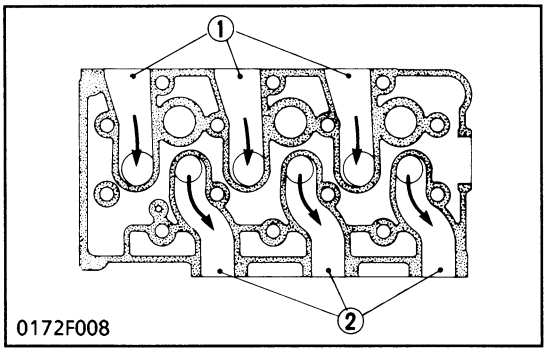
[1] CYLINDER BLOCK



The engine has a highly durable tunnel-type cylinder block in which the bearings, pistons, crankshaft and camshaft are installed.

[2] CYLINDER HEAD

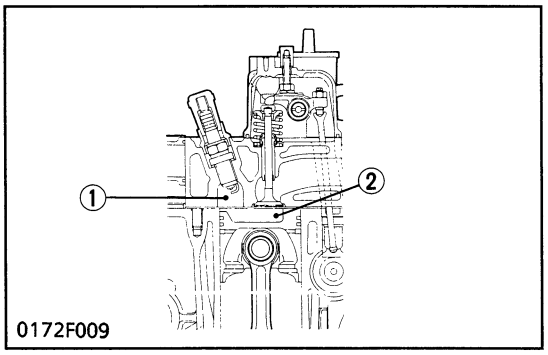
(1) Intake and Exhaust Port



The cross-flow type intake/exhaust ports, which lower the heat conduction from the exhaust port to the intake port. The low heat conduction keeps the intake air from being heated and expanded by the exhaust gas.

(1) Intake Port (2) Exhaust Port

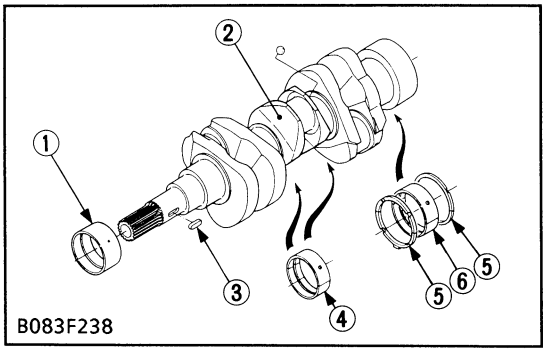
(2) Combustion System



The air/fuel mixtuer gas in the sub-combustion chamber (1) forms a vortex in the main combustion chamber (2), which improves combustion efficiency.

(1) Sub-Combustion Chamber (2) Main Combustion Chamber

[3] CRANKSHAFT



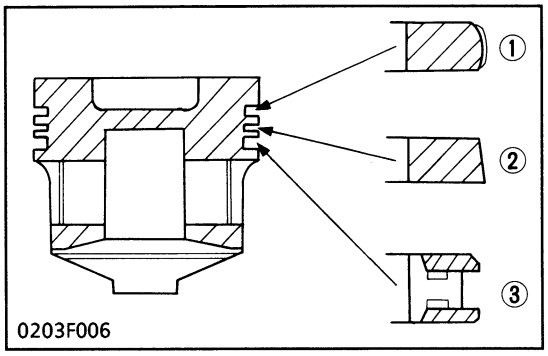
The crankshaft with the connecting rod converts the reciprocating motion of the piston into rotating motion.

The crankshaft (2) has oil passages drilled so that oil can flow from the main bearings to the crank pin bearings.

The front journal is supported by a sleeve type bearing (crankshaft bearing 1) (1), the intermediate journal by a split type (crankshaft bearing 3) (4), and the rear by a split type (crankshaft bearing 2) (6) with thrust bearings (5).

(1) Crankshaft Bearing 1
(2) Crankshaft
(3) Feather Key
(4) Crankshaft Bearing 3
(5) Thrust Bearing
(6) Crankshaft Bearing 2

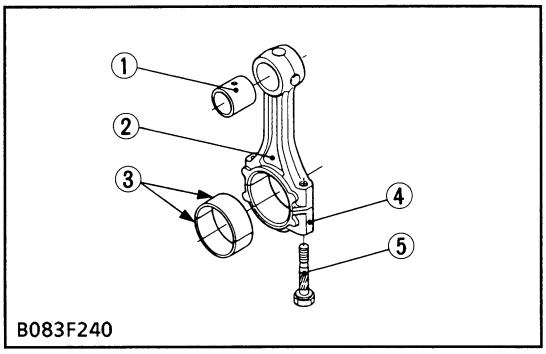
[4] PISTON AND PISTON RINGS



The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a concave head. Three rings are installed in grooves in the piston.

(1) Top Compression Ring (Barrel Faced Type)
(2) Second Compression Ring (Taper Faced Type)
(3) Oil Ring (Combined Steel Type)

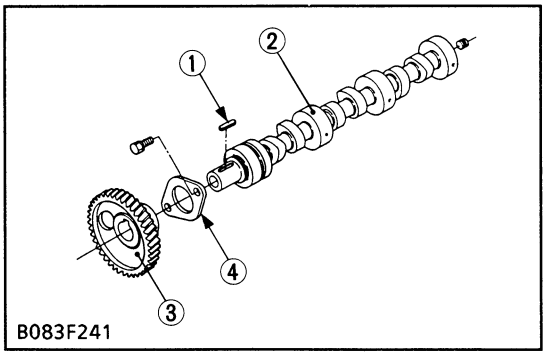
[5] CONNECTING ROD



The connecting rod (2) is used to connect the piston with the crankshaft. The big end of the connecting rod has a crank pin bearing (3) (split type) and the small end has a small end bushing (1) (solid type).

(1) Small End Bushing
(2) Connecting Rod
(3) Crank Pin Bearing
(4) Connecting Rod Cap
(5) Connecting Rod Screw

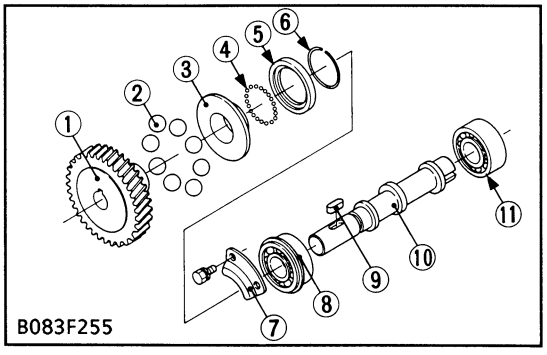
[6] CAMSHAFT



The camshaft (2) is made of special cast iron, and the journal and cam sections are chilled to resist wear.
The cams on the camshaft cause the intake and exhaust valves to open as the camshaft rotates. The bearing and journals are force-lubricated.

(1) Feather Key
(2) Camshaft
(3) Cam Gear
(4) Camshaft Stopper

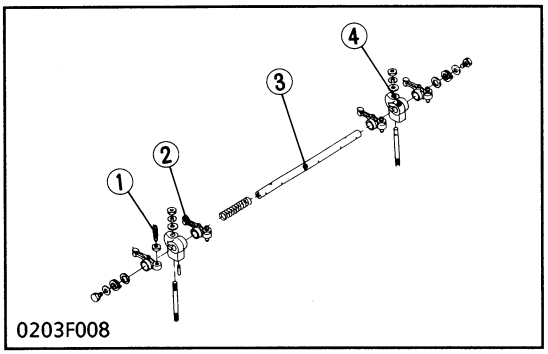
[7] DISTRIBUTOR DRIVESHAFT



The distributor drive shaft (10) controls the ignition timing of the distributor and is equipped with steel ball (2) to control the governor.

(1) Distributor Drive Gear
(2) Steel Ball
(3) Governor Sleeve
(4) Steel Ball
(5) Governor Ball Case
(6) Governor Sleeve Snap Ring
(7) Stopper
(8) Ball Bearing
(9) Feather Key
(10) Distributor Drive Shaft
(11) Ball Bearing

[8] ROCKER ARM ASSEMBLY

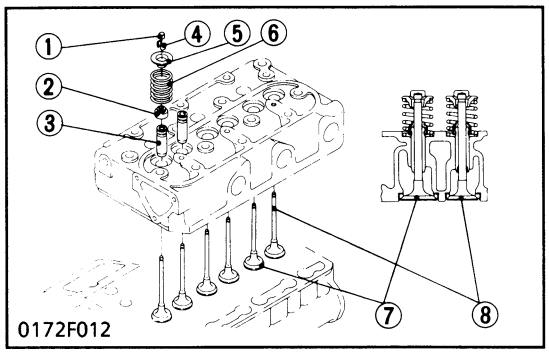


The rocker arm assembly includes the rocker arms (2) and adjusting screws (1), the end of which rests on the push rods, rocker arm brackets (4) and rocker arm shaft (3).

The rocker arms swing and transmits the reciprocating motion of the push rods to the inlet and exhaust valves to open and close them.

(1) Adjusting Screw
(2) Rocker Arm
(3) Rocker Arm Shaft
(4) Rocker Arm Bracket

[9] INLET AND EXHAUST VALVES

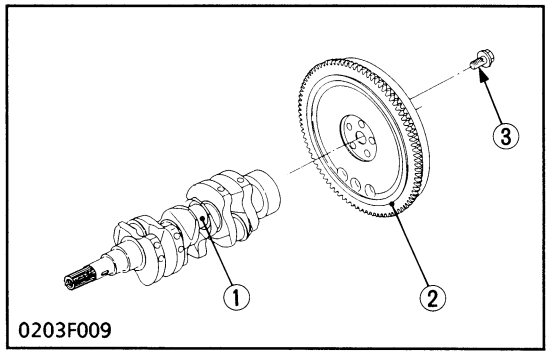


The valve and its guide for the inlet are different from those for the exhaust.

Other parts, such as the spring (6), spring retainer (5), collet (4), stem seal (2), and cap (1) are the same for both the inlet and exhaust.

(1) Valve Cap
(2) Stem Seal
(3) Valve Guide
(4) Collet
(5) Spring Retainer
(6) Spring
(7) Inlet Valve
(8) Exhaust Valve

[10] FLYWHEEL



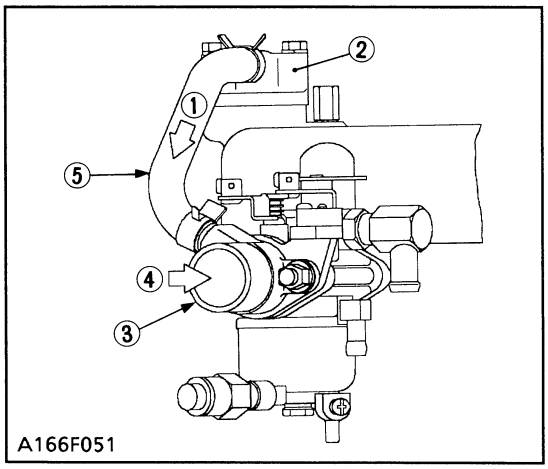
The flywheel (2) is connected with the crankshaft (1), it stores the rotating force in the combustion stroke as inertial energy to rotate the crankshaft smoothly.

The flywheel periphery is provided with marks showing fuel injection timing and top dead center.

The flywheel has gear teeth around its outer rim, which mesh with the drive pinion of the starter.

(1) Crankshaft
(2) Flywheel
(3) Flywheel Mounting Screw

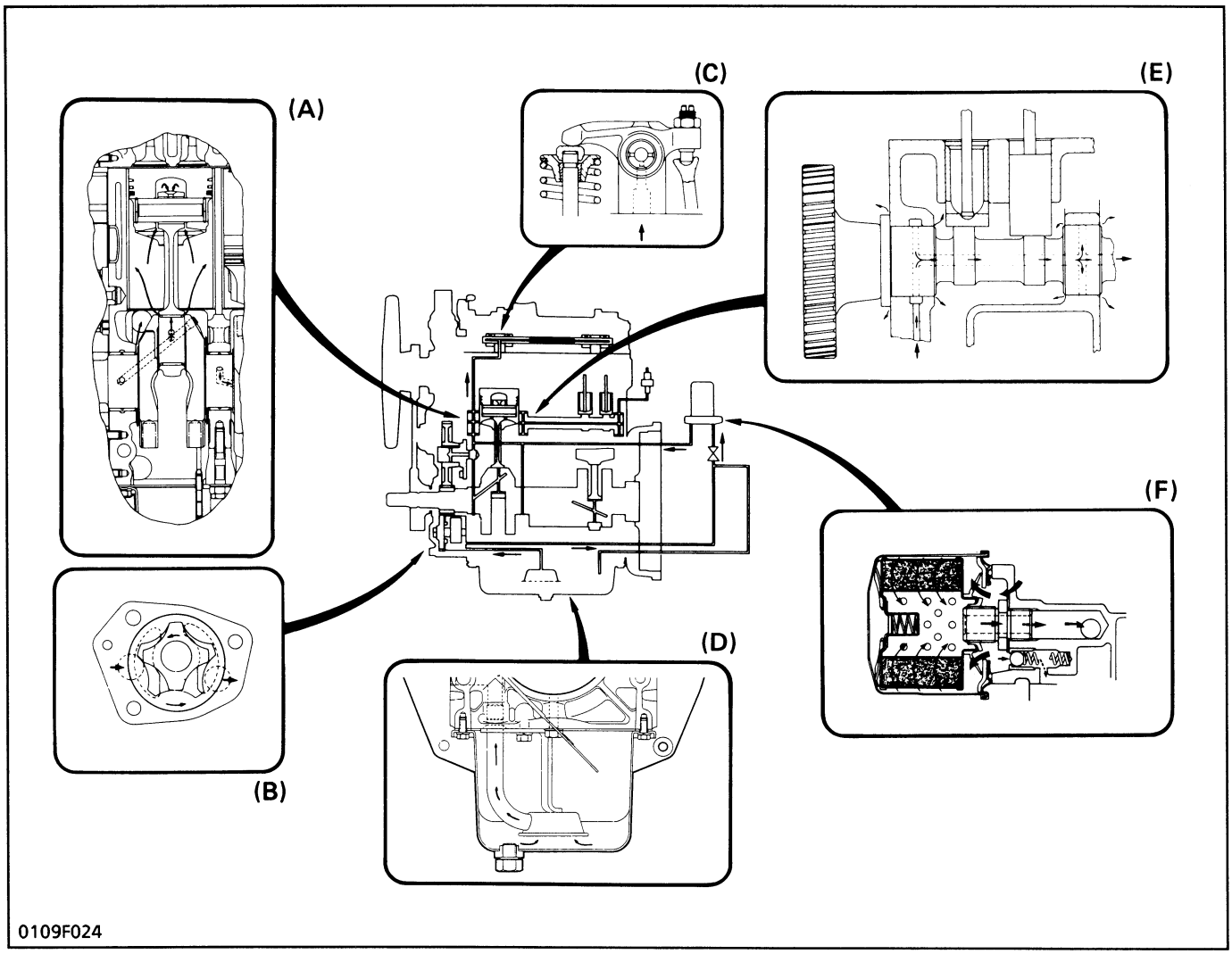
[11] CLOSED BREATHER



Blow-by gas (1) from crankcase is deoiled in the breather assembly (2) and sends to the air cleaner flange (3) where the blow-by gas (1) is mixed with the intake air (4).

(1) Blow-by Gas
(2) Breather Assembly
(3) Air Cleaner Flange
(4) Intake Air
(5) Breather Pipe

2 LUBRICATING SYSTEM



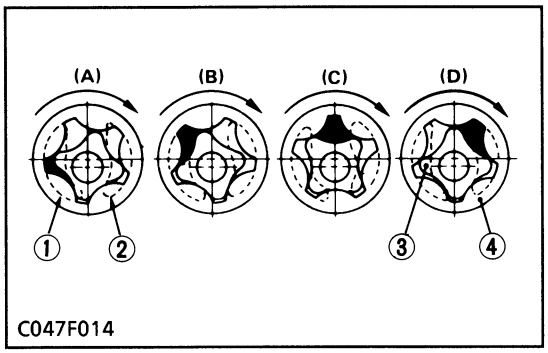
The lubricating system consists of an oil strainer, an oil pump, a relief valve, an oil filter cartridge and an oil pressure switch. The oil pump sucks the lubricating oil in the oil pan through the strainer and sends it to the oil filter cartridge, where the oil is further filtered.

The filtered oil is forced to the crankshaft, the connecting rods, the idle gear, the camshaft and the rocker arm shaft through the oil passage in the cylinder block and the shafts to lubricate the bearings.

Some oil, splashed by the crankshaft or thrown off from the bearings, lubricates other engine parts: the pistons, the cylinder walls, the piston pins, the tappets, the push rods, the timing gears, and the inlet and exhaust valves.

[A] Piston
[B] Oil Pump
[C] Rocker Arm and Rocker Arm Shaft
[D] Oil Strainer
[E] Camshaft
[F] Oil Filter Cartridge and relief Valve

[1] OIL PUMP



(1) Inlet Port
(2) Outlet Port
(3) Inner Rotor
(4) Outer Rotor

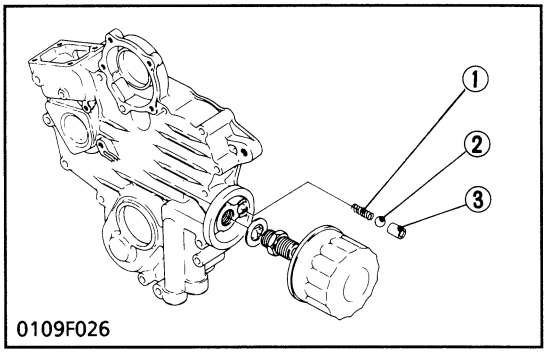
The oil pump is a trochoid pump, whose rotors have trochoid lobes. The inner rotor (3) has 4 lobes and the outer rotor (4) has 5 lobes, and they are eccentrically engaged with each other. The inner rotor, which is driven by the crankshaft through the gears, rotates the outer rotor in the same direction, varying the space between the lobes.

While the rotors rotate from (A) to (B), the space leading to the inlet port increases, which causes the vacuum to suck in the oil from the inlet port.

When the rotors rotate to (C), the space between both rotors switches from the inlet port to the outlet port.

At (D), the space decreases and the sucked oil is discharged from the outlet port.

[2] RELIEF VALVE



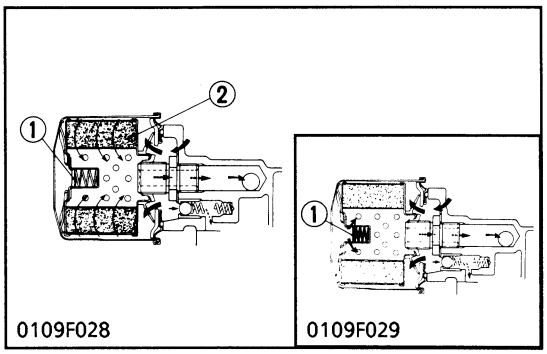
(1) Spring
(2) Ball
(3) Valve Seat

The relief valve prevents the damage to the lubricating system due to the high pressure of the oil.

The relief valve is ball direct acting type, and is best suited for low pressures.

When the pressure of the oil, forced by the pump, exceeds the specified value, the oil pushes back the ball (2) and escapes to the oil pan.

[3] OIL FILTER CARTRIDGE

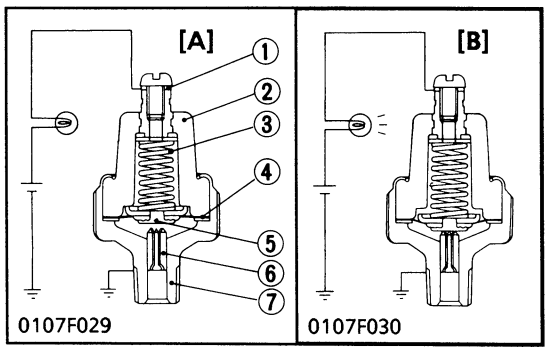


(1) Bypass Valve
(2) Filter Element

After lubricating, the lubricating oil brings back various particles of grit and dirt to the oil pan. Those particles and the impurities in the lubricating oil can cause wear or seizure of the engine parts. It may also impair the physical and chemical properties of the oil itself.

The lubricating oil which is force-fed by the pump, is filtered by the filter cartridge with the filter element (2). When the filter element accumulates on excessive amount of dirt and the oil pressure in the inlet line builds up by 98 kPa (1.0 kgf/cm^2, 14 psi) more than the outlet line, the bypass valve (1) opens to allow the oil to flow from the inlet into the outlet line, bypassing the filter element.

[4] OIL PRESSURE SWITCH



[A] At the proper oil pressure

(1) Terminal
(2) Insulator
(3) Spring
(4) Rubber gasket

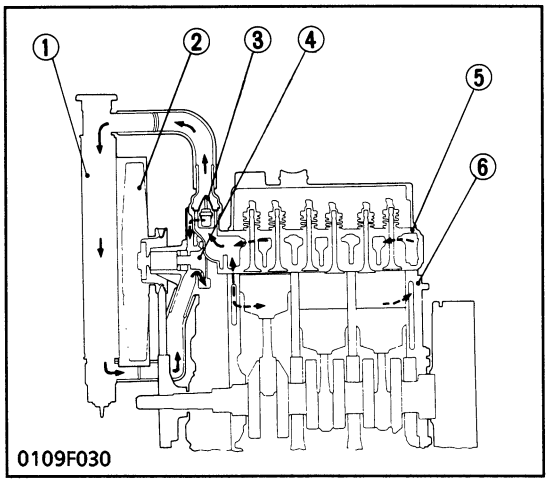
[B] At lower oil pressure, 49 kPa (0.5 kgf/cm^2, 7 psi) or less

(5) Contact rivet
(6) Contact
(7) Oil Switch Body

The oil pressure switch is mounted on the cylinder block and is led to the lubricating oil passage.

When the oil pressure falls below the specified value, the oil pressure warning lamp lights.

3 COOLING SYSTEM



0109F030

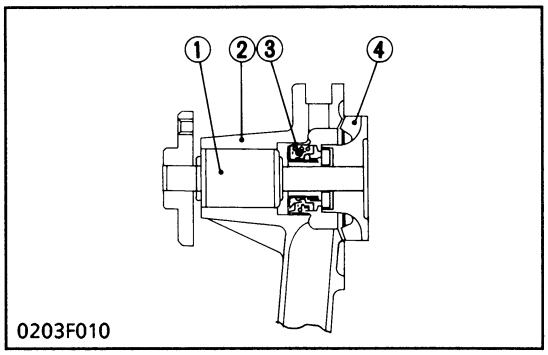
The cooling system consists of a radiator (1), a centrifugal water pump (4), a suction fan (2) and a thermostat (3).
The water is cooled through the radiator core, and the fan behind the radiator pulls the cooling air through the core to improve cooling.

The water pump sucks the water from the radiator or from the cylinder head and forces it into the cylinder block.
The thermostat opens or closes according to the water temperature, to allow the water to flow from the cylinder block to the radiator while open, or only to the water pump while closed.

Thermostat opening temperature	Approx. 82°C(179.6°F)

(1) Radiator
(2) Cooling Fan
(3) Thermostat
(4) Water Pump
(5) Cylinder Head
(6) Cylinder Block

[1] WATER PUMP



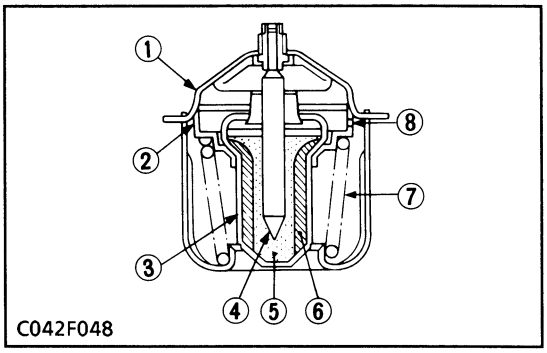
0203F010

The water pump is driven by the crankshaft and a V belt. The rotating impeller (4) in the water pump sucks the cooled water from the radiator and sends it into the water jacket in the cylinder block.

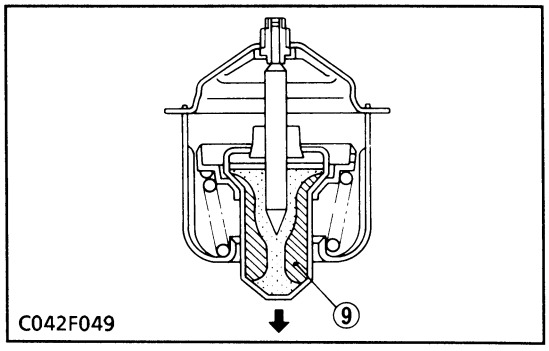
The mechanical seal (3) prevents the water from entering the bearing unit (1).

(1) Bearing Unit
(2) Water Pump Body
(3) Mechanical Seal
(4) Water Pump Impeller

[2] THERMOSTAT



C042F048



C042F049

The thermostat is of the wax pellet type.

The thermostat controls the flow of the cooling water to the radiator to keep the proper temperature.
The case (1), which serves as a valve seat (1), has a spindle inserted in the pellet (3) which is installed to the valve (2). The spindle is covered with the synthetic rubber (5) in the pellet. The wax is charged between the pellet and the rubber.

■ At low temperatures (lower than 82°C)

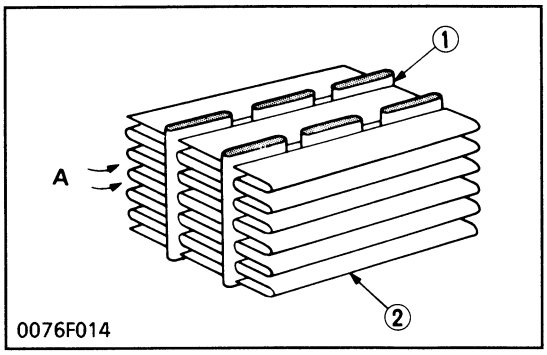
The valve (2) is seated by the spring (7) and the cooling water circulates in the engine through the water return pipe without running into the radiator.
Only the air in the water jacket escapes to the radiator through the leak hole (8) on the thermostat.

■ At high temperatures (higher than 82°C)

As the water temperature rises, the wax in the pellet (3) turns liquid and expands, repelling the spindle, which causes the pellet to lower.
The valve (2) opens to send the cooling water to the radiator.

(1) Seat
(2) Valve
(3) Pellet
(4) Spindle
(5) Synthetic Rubber
(6) Wax (solid)
(7) Spring
(8) Leak Hole
(9) Wax (liquid)

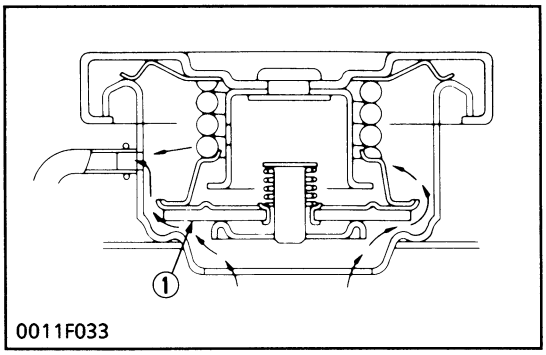
[3] RADIATOR

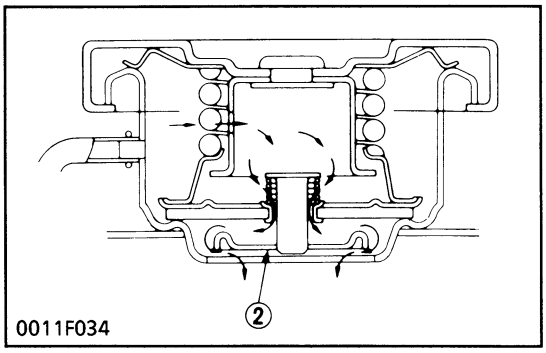


The radiator core consists of water carrying tubes (1) and fins (2) meeting at a right angle with the tubes. The fin is a louverless, corrugated type which is light in weight, high in heat exchange ratio and less apt to clog.
The water in the tubes is cooled by the air flowing through the tube walls and fins.

(A) Cooling Air
(1) Tube (2) Fin

[4] RADIATOR CAP

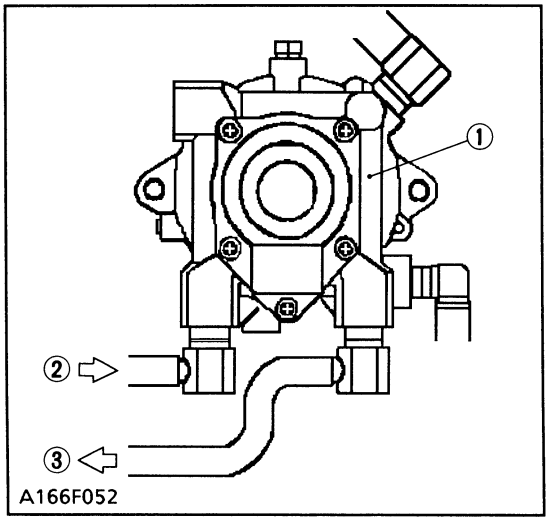




The pressure type radiator cap prevents differences in pressure between the inside and the outside of the radiator from deforming the radiator.
When the water temperature rises and the pressure in the radiator increases above the specified pressure, the pressure valve (1) opens to reduce the internal pressure. When the water temperature falls and a vacuum forms in the radiator, the vacuum valve (2) opens to introduce the air into the radiator.

(1) Pressure Valve (Opening pressure 12.8 psi) (2) Vacuum Valve

[5] VAPORIZER (for LPG Fuel model)

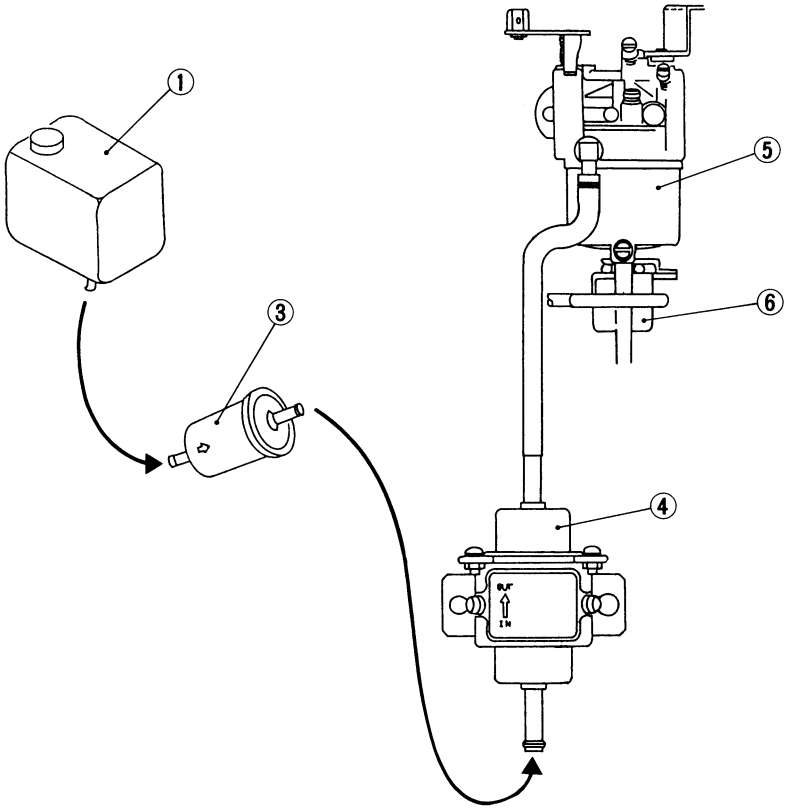


When evaporating by primary chamber of vaporizer liquid LPG needs the evaporation heat.
This vaporizer installs the water jacket, throws the cooling water of engine, heats primary chamber, promotes evaporation, and prevents valves being frozen.

(1) Vaporizer (3) Hot Water Out
(2) Hot Water In

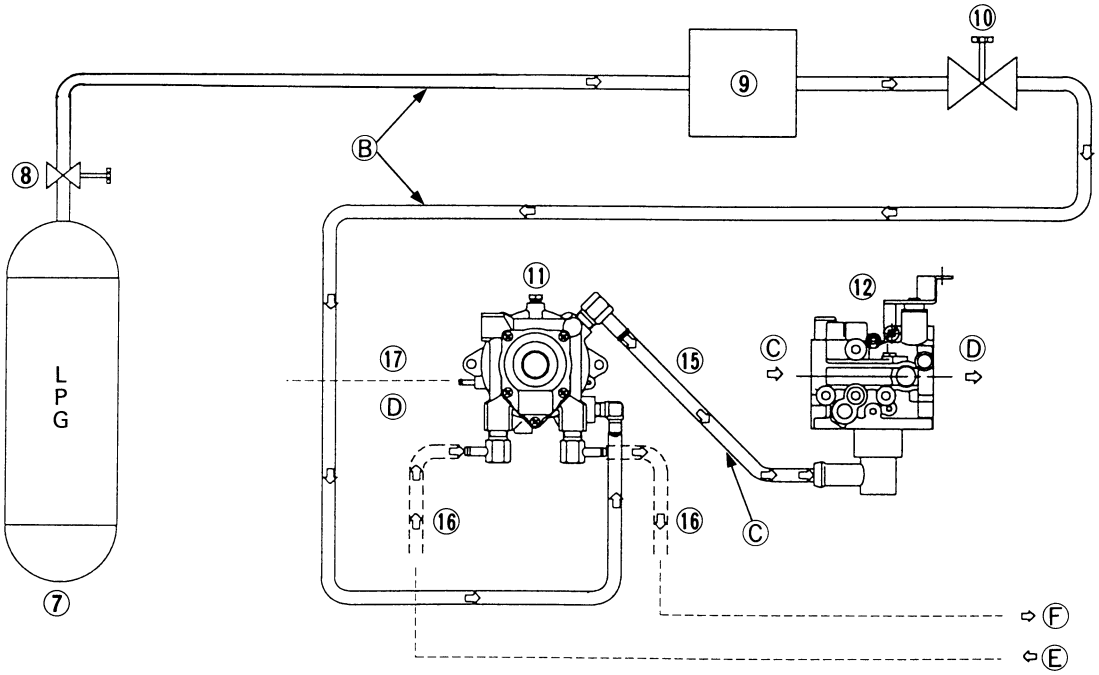
4 FUEL SYSTEM

WG750-B, -E



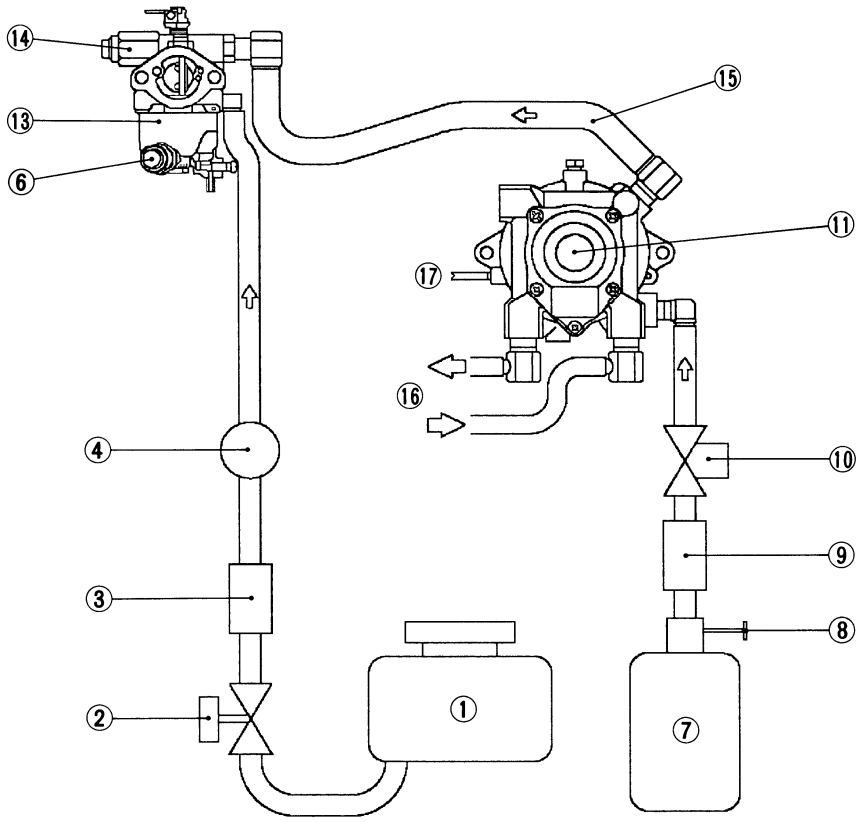
0203F011

DG750-E



A166F003

DF750-E



A166F053

*(1) Gasoline Tank
*(2) Gasoline Cock
(3) Fuel Filter
(4) Fuel Feed Pump
(5) Carburetor
(6) Gasoline Cut Off Solenoid
*(7) LPG Tank
*(8) LPG Manual Valve
*(9) LPG Filter
*(10) LPG Shut Off Valve
(11) Vaporizer / Reguretor
(12) LPG Mixer
(13) DF. Carburetor
(14) LPG Cut Off Solenoid
*(15) Vapor Hose
*(16) Water Hose
*(17) Vacuum Hose

(A) Gasoline Line
(B) Liquid Propane Line
(C) Gaseous Propane Line
(D) Vacuum Line
(E) Hot Water In Line
(F) Hot Water Out Line

Component marked* is not provided by KUBOTA

WG750: The fuel is fed from the fuel tank (1) (not included in the basic model) through the fuel filter (2) to the carburetor (4) by the fuel feed pump (3).

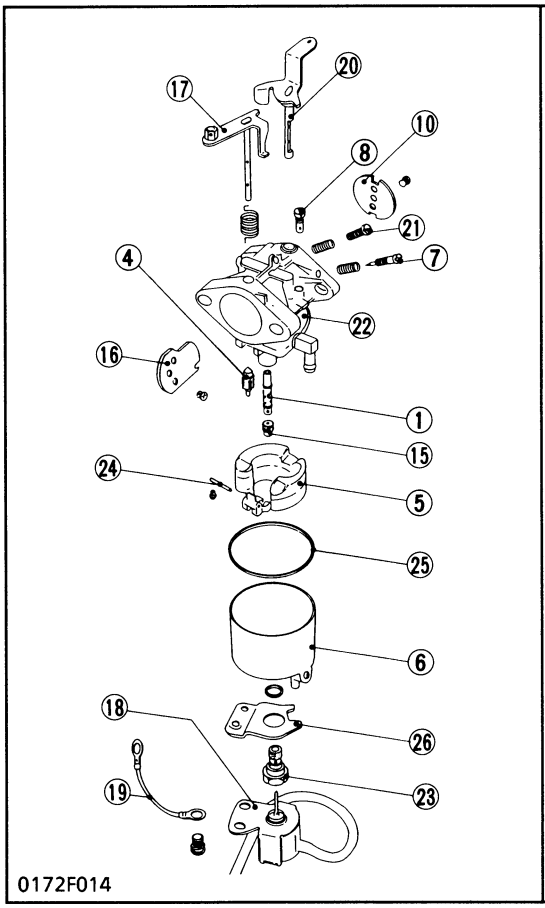
DG750: The liquid fuel stored in the LPG tank(7) is sent to vaporizer (11) by pressure in the gaseous phase in the tank through the fuel filter (9) and shut off valve (10) .

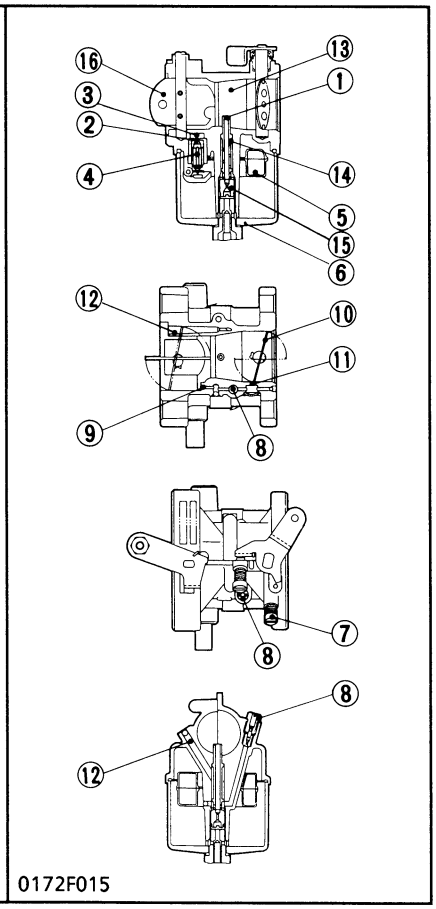
The liquid fuel is evaporated in vaporizer and is sent to the LPG mixer (12) as a gaseous fuel of gas presure near the atmospheric pressure.

The LPG mixer (12) mixes the gas and air is supplied in the cylinder.

DF750: This fuel system operates as both a gasoline (WG750) and LPG (DG750).

[1] CARBURETOR (for Gasoline fuel)





(1) Main Nozzle
(2) Valve Seat
(3) Inlet Port
(4) Needle Valve
(5) Float
(6) Float Chamber
(7) Pilot Screw
(8) Pilot Jet
(9) Pilot Air Jet
(10) Throttle Valve
(11) Pilot Outlet
(12) Main Air Jet
(13) Venturi
(14) Bleeder Hole
(15) Main Jet
(16) Choke Valve
(17) Choke Lever
(18) Solenoid Valve Assembly
(19) Earth Cord
(20) Throttle Shaft
(21) Throttle Stopper Adjusting Screw
(22) Carburetor Body
(23) Jet Holder
(24) Float Pin
(25) Float Chamber Gasket
(26) Plate

Designed for general purpose use, this carburetor provides engines with the ideal fuel-air mixture for all speed ranges.

1) Float Chamber

When the gasoline in the fuel tank flows into the float chamber (6), the float (5) rises and, when a predetermined amount of gasoline is in the chamber, it pushes the needle valve (4) against the valve seat (2) to stop additional gasoline from entering through the inlet port (3). As the gasoline is consumed, the float goes down and more gasoline is led into the chamber to maintain a constant distance between the main nozzle (1) and the level of the gasoline.

2) Starting System

To start an engine in cold weather, the fuel-air mixture must be richer than normal. A choke valve (16) controlled by the choke lever (17) is provided to enrich the mixture.
As the choke valve is closed, the air supply is restricted to make the mixture rich. This rich mixture is then supplied to the intake manifold to facilitate starting.

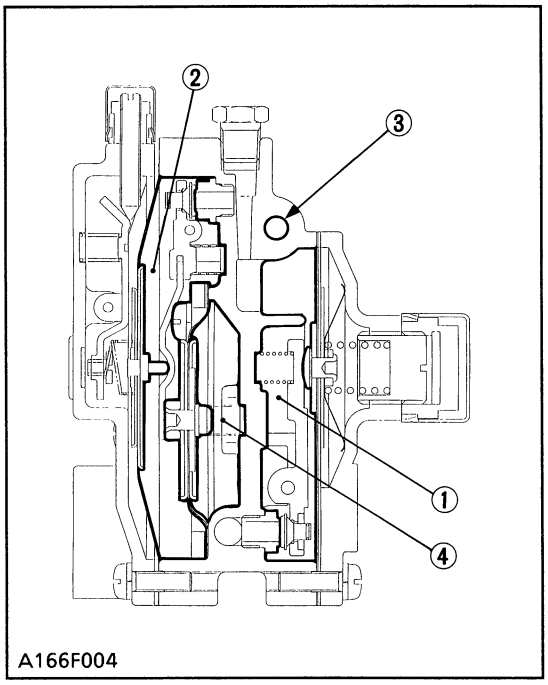
3) Slow System

When the throttle valve (10) closes, air that flows into the cylinder passes along the valve at a high speed. As a result, a negative pressure is crated in the pilot outlet (11) which has an outlet port in the inner wall. This causes gasoline in the main nozzle (1) to flow through the pilot jet (8) to be sucked into the cylinder. air that enters from the pilot air jet (9) is mixed with gasoline in the pilot jet (8), atomized in an appropriate condition, sprayed from the pilot outlet (11) and sucked into the cylinder through the main passage. The slow speed of the engine is controlled by changing the jet area with the pilot screw (7).

4) Main Carburetor System

The speed of air that flows into the cylinder increases when it passes the venturi (13), and the negative pressure increase as a result at the tip of the main nozzle (1). The negative pressure causes the gasoline in the float chamber (6) to flow through the main jet (15) and to be sucked into the main nozzle (1). air which flows from the main air jet (12) into the bleeder hole (14) of the main nozzle (1) is mixed with gasoline, atomized in an appropriate condition, then sprayed from the nozzle tip to the venturi (13) and sucked with the main air into the cylinder.

[2] VAPORIZER (for LPG fuel)



A166F004

(1) Primary Chamber
(2) Secondary Chamber
(3) Water Passage
(4) Vacuum Lock Chamber

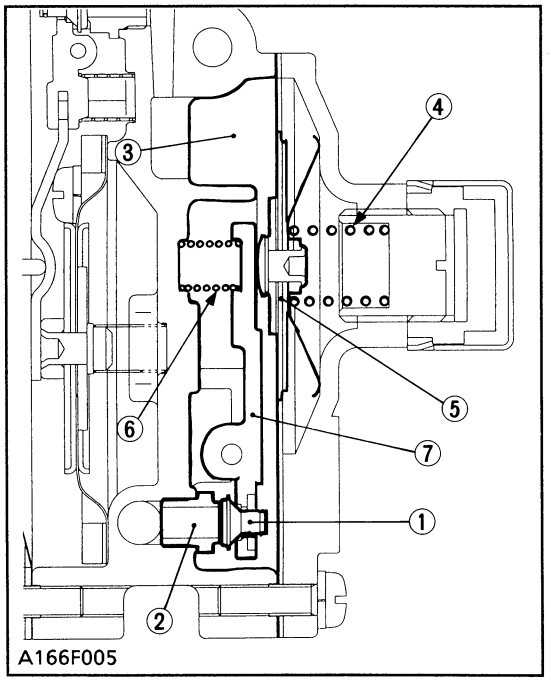
Vaporizer is a device which converts the liquid fuel into the gaseous fuel and the following structures and functions are possessed.

1) Primary Chamber
The liquid fuel is decompressed (the first decompression) and it is evaporated.

2) Secondary Chamber
The fuel which flows in is decompressed from the primary chamber to the vicinity of the atmospheric pressure further (the second decompression).

3) Water Passage
The cooling water of the engine is made to circulate as a heat source to evaporate the LPG.

4) Vacuum Lock Chamber
When the engine stops, the fuel from primary chamber is prevented from flowing out.



A166F005

(1) Primary Valve
(2) Valve Seat
(3) Primary Chamber
(4) Primary Diaphragm Spring
(5) Primary Diaphragm
(6) Primary Valve Lever Spring
(7) Primary Valve Lever

■ Primary Chamber

The liquid fuel which pushes the primary valve (1) open passes between the valve and the valve seat (2), enters primary chamber (3), and decompresses and is evaporated.

When the inflow of the fuel continues and the primary chamber pressure rises more than the specified pressure 32.7 kPa (0.3 kgf/cm^2, 4.3 psi), the tension in the diaphragm spring (4) is overcome and do the push up of primary diaphragm (5).

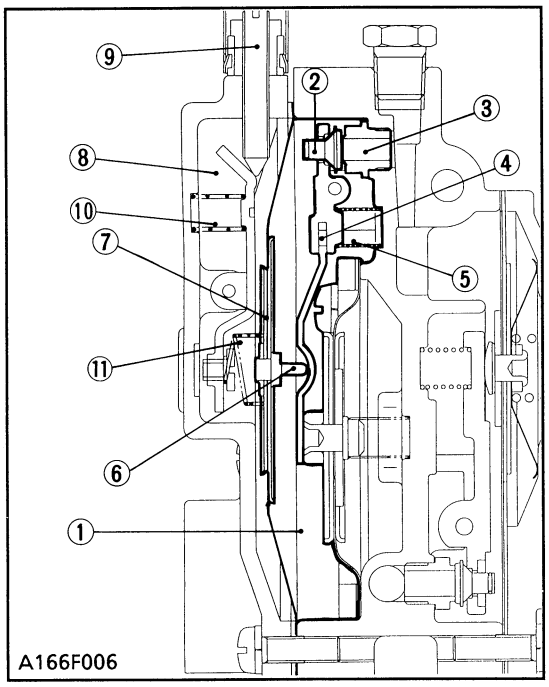
At this time, do the push up of primary valve lever spring(6) of primary valve lever (7), primary valve (1) is shut, and the inflow of the fuel is intercepted.

The tension in the diaphragm spring (4) grows more than the primary chamber pressure when the fuel is consumed and the primary chamber pressure lowers more than a regulated value and a primary diaphragm is depressed below.

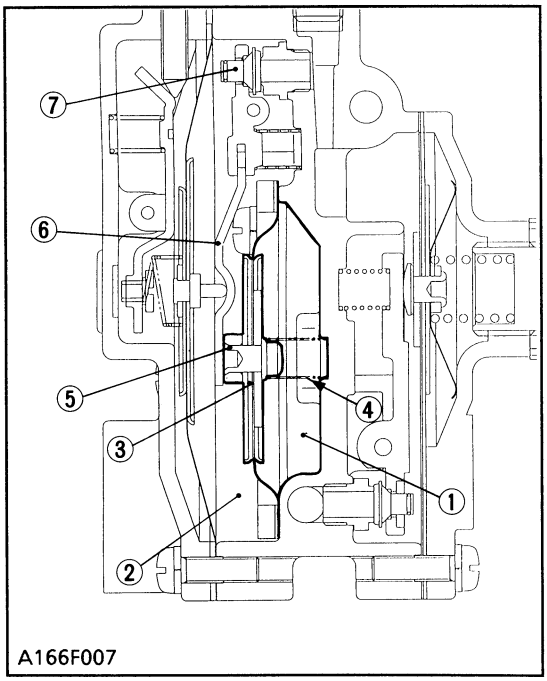
The primary valve lever (7) is depressed at the same time.

A primary valve opens and the fuel flows in again.

When the diaphragm tears by any chance and the fuel flows in the primary diaphragm spring side, the primary diaphragm spring side is connected with second chamber in the balance passage so that the fuel should not flow out outside.



(1) Secondary Chamber
(2) Secondary Valve
(3) Valve Seat
(4) Secondary Valve Lever
(5) Secondary Valve Lever Spring
(6) Diaphragm Pin
(7) Secondary Diaphragm
(8) Atmosphere Chamber
(9) Idle Adjust Screw
(10) Balance Lever Spring
(11) Balance Spring



(1) Vacuum Lock Chamber
(2) Secondary Chamber
(3) Vacuum Lock Diaphragm
(4) Vacuum Lock Diaphragm Spring
(5) Diaphragm Pin
(6) Secondary Valve Lever
(7) Secondary Valve

■ Secondary Chamber

The fuel adjusted with primary chamber to the specified pressure enters secondary chamber (1) between secondary valve (2) and the valve seat (3) and is decompressed to the vicinity of the atmospheric pressure almost.

A secondary valve is assembled to a part of the secondary valve lever (4) supported to body and is shut by the tension of the spring of a secondary valve spring (5).

A secondary diaphragm pin (6) touches the edge besides this lever (4).

The one side of secondary diaphragm (7) is faced in secondary chamber and the other side faces atmosphere chamber (8).

When the engine stops, the atmospheric pressure is led in secondary chamber and a secondary valve is shut by the tension of a secondary valve spring.

When the engine rotates, the negative pressure is generated in the venturi tube of the mixer.

As for this negative pressure, working secondary diaphragm (7) is pulled to the second chamber side by the difference pressure with atmosphere chamber by second chamber.

Do the push up of the secondary valve lever (4) by this working, secondary valve is opened, and the fuel flows in.

When pressure in chamber rises by the fuel which flows in, the diaphragm is pushed to the atmosphere chamber side and narrows the opening of the valve and decreases the supply of the fuel.

Secondary chamber is almost maintained in the atmospheric pressure by the thing to repeat such working.

■ Vacuum Lock Chamber

1) Operation when engine stops

Because pressure on the vacuum lock chamber (1) side and the secondary chamber (2) side is equal, vacuum lock diaphragm (3) is pushed to the second chamber side by the tension of vacuum lock diaphragm spring (4).

Secondary valve and the seat are made to close as vacuum lock diaphragm pin (5) pushes secondary valve lever (6) and the fuel leakage is prevented.

2) Operation at engine starting

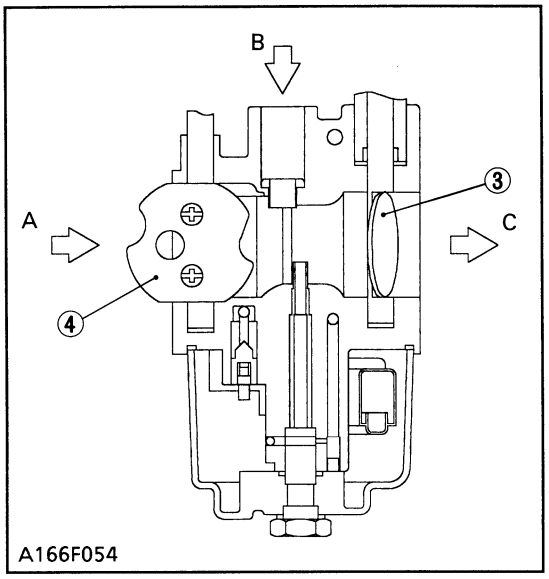
The negative pressure is caused in inlet manifold at the same time as the cranking's beginning.

This negative pressure acts in vacuum lock chamber (1) and vacuum lock diaphragm (3) is drawn to the vacuum lock chamber side.

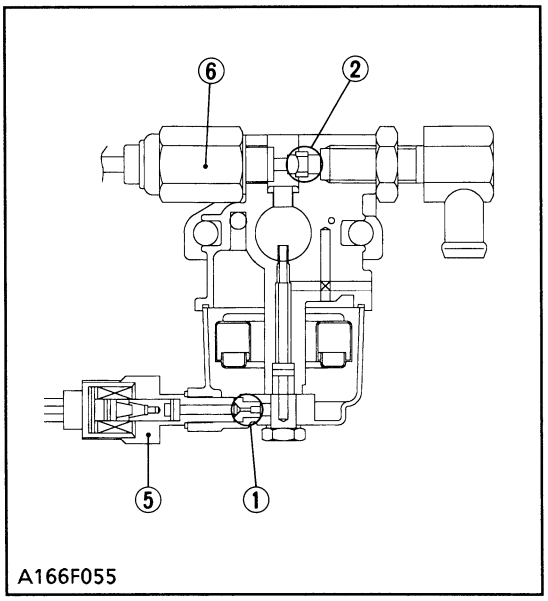
As a result, the movement of secondary valve lever (6) becomes free and the fuel inflow adjustment due to secondary valve (7) becomes possible.

The negative pressure in inlet manifold always works while the engine is rotating and the movement of secondary valve lever is tuned to the movement of secondary diaphragm.

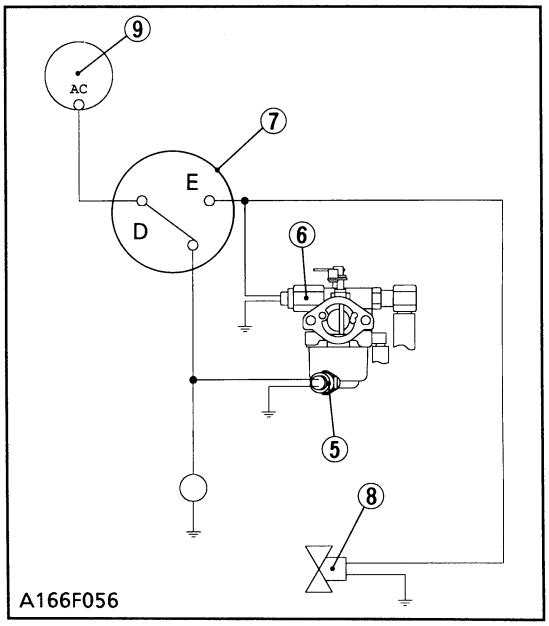
[3] DF CARBURETOR (for Dual Fuel Model)



A166F054



A166F055



A166F056

■ **NOTE**

- **DF Carburetor operates as both a gasoline carburetor (see page M-11) and a LPG mixer (see page M-15).**

With the fuel select switch (7) in the "GASOLINE" position (D) and the main switch in the "ON" position, the battery current flows to the gasoline cut off solenoid (5). Therefore gasoline fuel in the float chamber flows to the mixing chamber.

When the fuel select switch (7) is turned to the "LPG" position (E), the battery current stops to the gasoline cut off solenoid (5) and flows to the LPG cut off solenoid (6) and LPG shut off solenoid valve (8).

Then, the gasoline fuel flow is shut and LPG fuel flows to the mixing chamber.

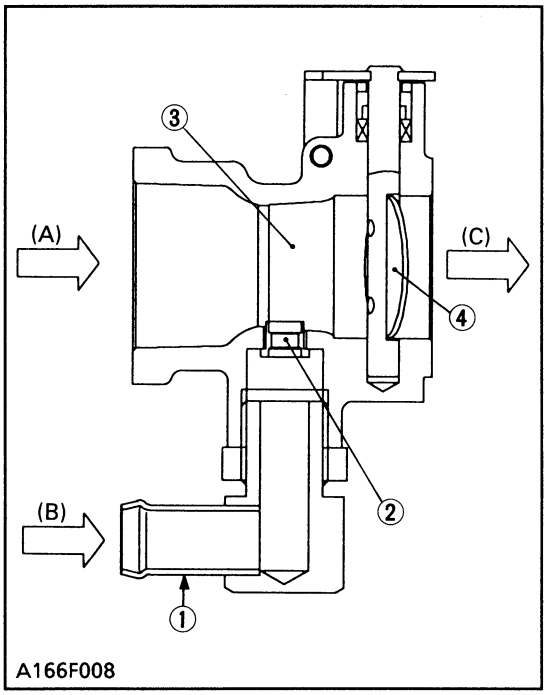
When the main switch (9) turned to the "OFF" position, the battery current stops to the both of solenoids.

Then, both gasoline fuel and LPG fuel can not flow to the mixing chamber.

(1) Gasoline Main Jet
(2) LPG Main Jet
(3) Throttle Valve
(4) Choke Valve
(5) Gasoline Cut Off Solenoid
(6) LPG Cut Off Solenoid
(7) Fuel Select Switch
(8) LPG Shut Off Solenoid Valve
(9) Main Switch

(A) Air
(B) LPG Fuel (gaseous)
(C) Mixture (Air / Fuel)
(D) Gasoline Position
(E) LPG Position

[4] MIXER (DG750-E, LPG KIT)



A166F008

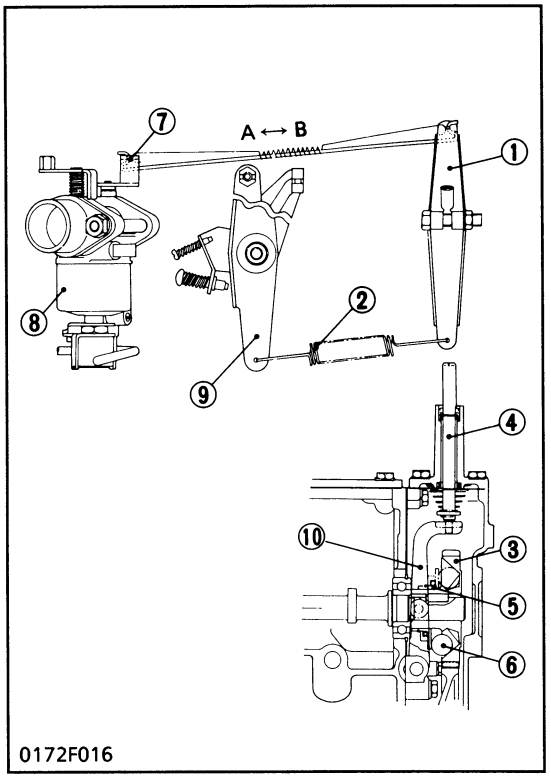
The mixer meters both fuel and air, and procedures an air / fuel mixture that has the proper ratio as required by the engine.

When the engine rotates, the gaseous fuel flows out from main jet (2) to venturi a constant amount and is mixed with air quantity corresponding to the opening of the throttle valve (4) and is supplied to the cylinder.

(1) Fuel Joint
(2) Main Jet
(3) Venturi
(4) Throttle Valve

(A) Air
(B) LPG Fuel
(C) Mixture (Air / LPG Fuel)

[5] GOVERNOR



(1) Governor Lever
(2) Governor Spring
(3) Governor Gear
(4) Governor Lever Shaft
(5) Governor Sleeve
(6) Ball
(7) Throttle Lever
(8) Carburetor / Mixer / DF Carburetor
(9) Speed Control Lever
(10) Fork Lever

The engine is equipped with a centrifugal ball mechanical governor which activates the throttle in response to engine speed.

When the engine is carrying a load and running at rated speed, the speed will drop if the load is increased even slightly. In this case, the governor automatically opens the throttle valve of the carburetor to maintain the original speed.

Dumping the load suddenly will cause a rapid increase in speed. In this case, the governor automatically moves the throttle valve in closing direction to prevent the engine from increasing its speed.

1) When engine is carrying a load and running at rated speed

When there is no change in load, the centrifugal force of the ball (6) which is attached to the governor gear (3) balances with the tensile force of the governor spring (2) via governor sleeve (5), fork lever (10), governor lever shaft (4) and governor lever (1). The engine speed and output are thus kept constant.

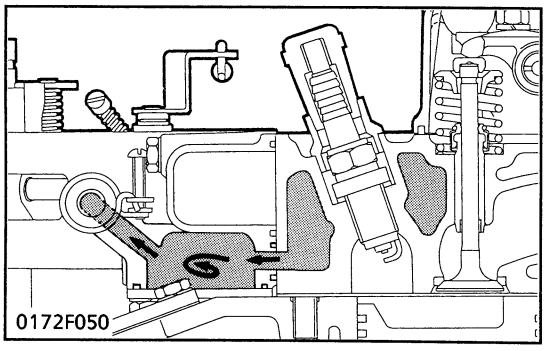
2) When load is applied to engine

When the load is applied to the engine running at rated speed, the speed of the governor gear (3) which is connected to the idle gear decreases. As a result, the centrifugal force of the ball (6) becomes smaller. The tensile force of the spring (2) overcomes the centrifugal force, and the governor lever (1) causes the throttle lever (7) to move in the open direction [B]. The original engine speed is thus maintained.

3) When load is dumped

When the load is dumped suddenly, the centrifugal force of the ball (6) overcomes the tensile force of the spring (2). As a result, the governor lever (1) causes the throttle lever (7) to move in the shut direction [A] and prevents the engine form increasing its speed.

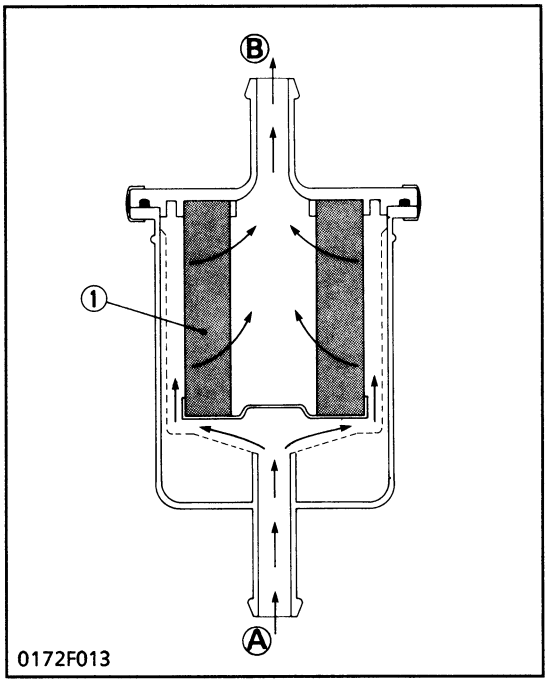
[6] INLET MANIFOLD



Part of water heated in the water jacket is channeled to the inlet manifold, where the hot water heats the fuel-air mixture for better carburetion. Heating effect is particularly good when the engine is running at low speeds and with light load is cold weather, thus improving fuel economy and acceleration.

(1) Intake Manifold

[7] FUEL FILTER (for GASOLINE line)



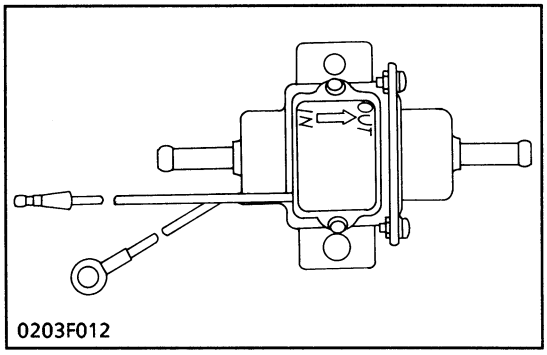
The fuel filter is installed in the fuel line between the fuel tank and the feed pump.

As the fuel flows from the inlet (A) through the filter element (1), the dirt and impurities in the fuel are filtered, allowing only clean fuel to enter the inside of the filter element. The cleaned fuel flows out from the outlet (B).

Type of filter element	Accordion-pleated paper type
Material of filter element	Cotton fiber
Filter mesh	15 μm (0.00059 in.)

(A) Inlet
(B) Outlet
(1) Filter Element

[8] ELECTRO MAGNETIC FUEL FEED PUMP (for GASOLINE line)

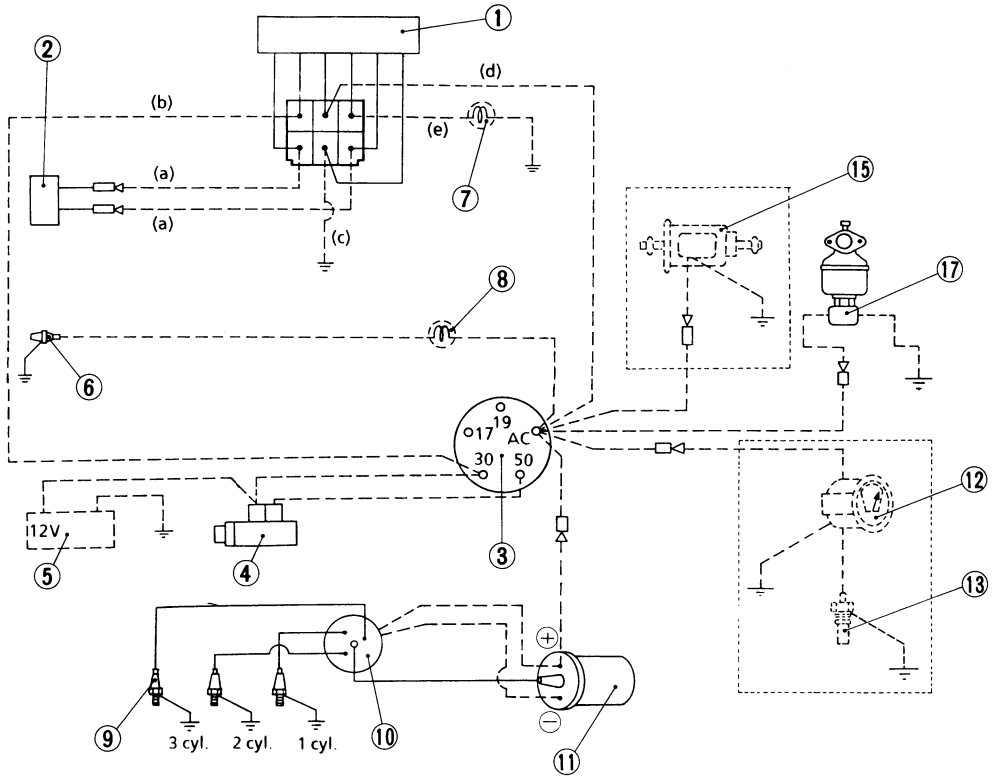


An electro magnetic pump uses a transistor that causes the pump to start pumping fuel when the engine is switched on.

Therefore, fuel is supplied to the carburetor regardless of engine speed. This pump is driven by the battery. It can therefore be operated even with the engine being stopped.

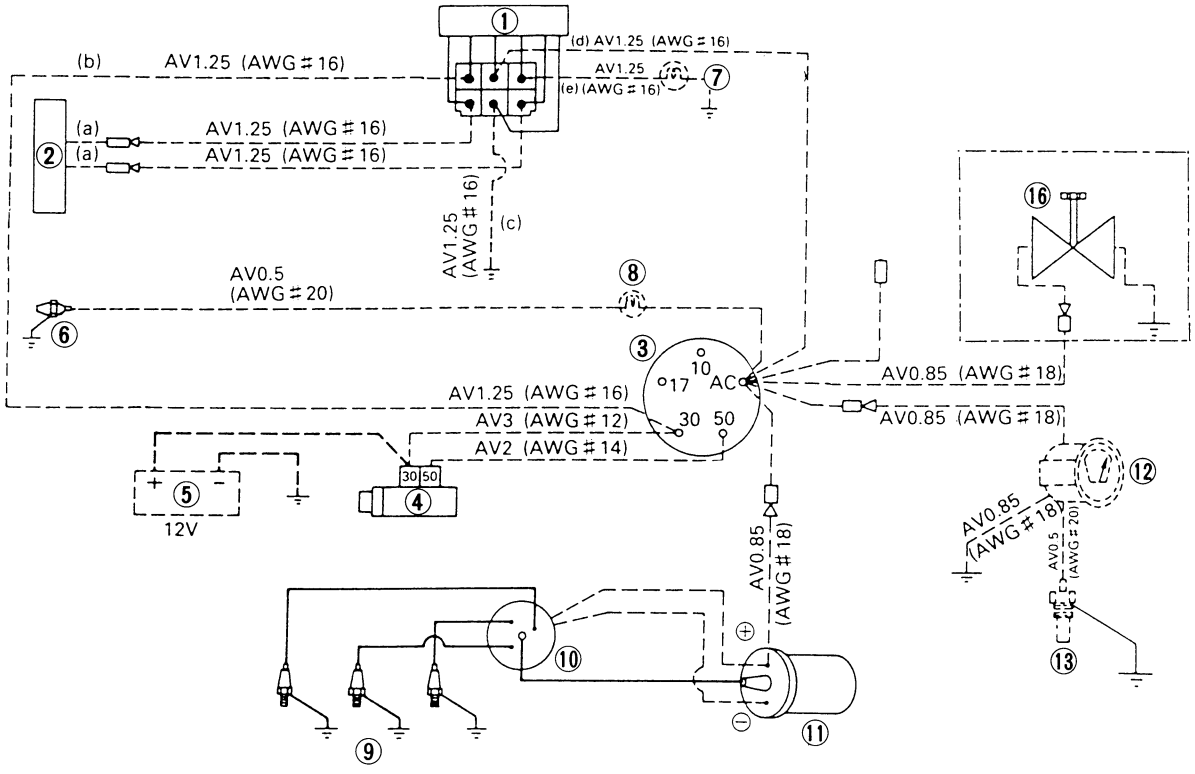
5 ELECTRICAL SYSTEM

WG750



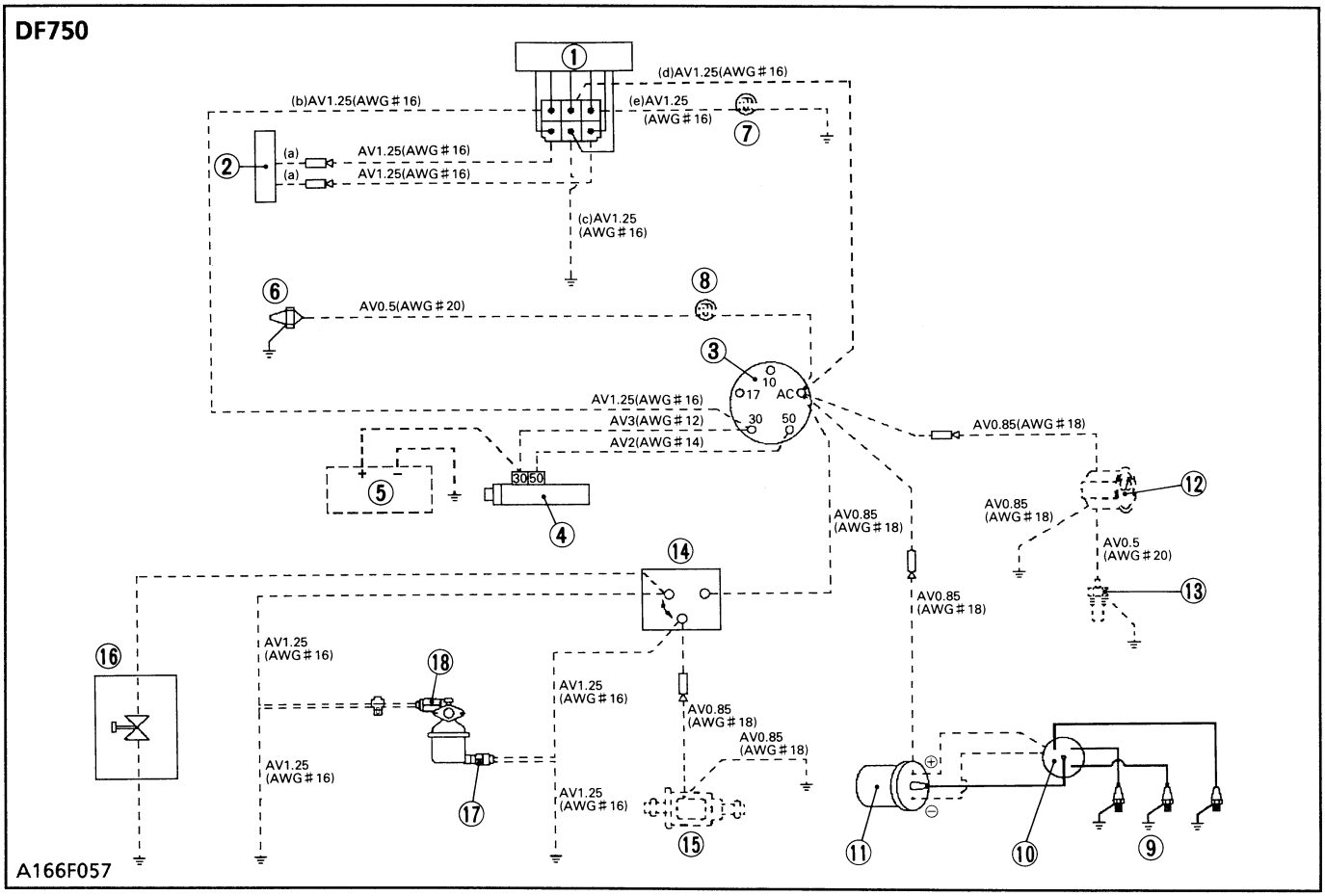
0203F013

DG750



A166F009

DF750



(1) Regulator
(2) Dynamo
(3) Key Switch
(4) Starter
*(5) Battery
(6) Oil Switch
(7) Charge Lamp
(8) Oil Lamp
(9) Spark Plug
(10) Distributor
(11) Ignition Coil
*(12) Temperature Gauge
*(13) Temperature Sensor
**(14) Fuel Selector Switch
*(15) Gasoline Fuel Pump
**(16) LPG Shut Off Solenoid Valve
(17) Gasoline Cut Off Solenoid
(18) LPG Cut Off Solenoid

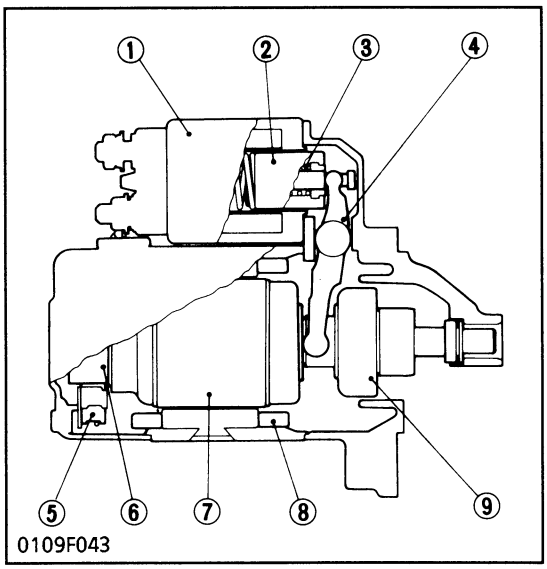
(a) Blue Lead Wire
(b) Red Lead Wire
(c) Black Lead Wire
(d) Yellow Lead Wire
(e) Green Lead Wire

The electrical system of the engine consists of a starting system (including a starter and others), a charging system (including a dynamo, a regulator and others), a battery and an oil switch.

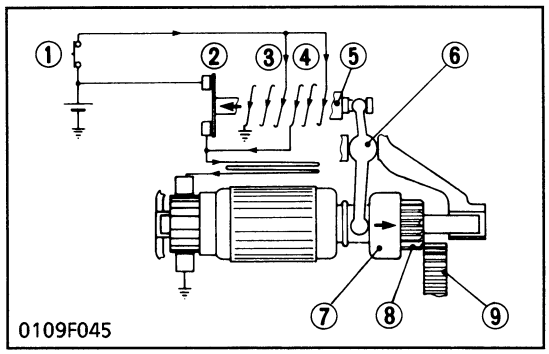
■ **NOTE:**
- **Components marked * are not included in the basic model.**
- **Components marked ** are not provided by KUBOTA.**
- **When no charge lamp is used, do not connect the charge lamp circuit to the ground circuit. Otherwise, a huge current will flow into the charge lamp circuit, damaging the regulator.**

[1] STARTING SYSTEM

(1) Starter



0109F043



0109F045

(1) Key Switch
(2) Solenoid Switch
(3) Holding Coil
(4) Pull-in Coil
(5) Plunger
(6) Shift Lever
(7) Overrunning clutch
(8) Pinion
(9) Ring Gear

The starter is the electromagnetic drive type.

Type of motor	DC, Series-wound, Electromagnetic drive
Nominal output	12V
Nominal output	0.7 kW
Nominal output	30 seconds (Do not rotate continuously for longer periods.)
Direction of rotation	Clockwise as viewed from pinion side

(1) Solenoid Switch
(2) Plunger
(3) Spring
(4) Shift Lever
(5) Brush
(6) Commutator
(7) Armature
(8) Field Coil
(9) Overrunning Clutch

1) Operation of Starter

■ When key switch is turned to "START" position

The contacts of key switch (1) close and the holding coil (3) is connected to the battery to pull the plunger (5).

The pull-in coil (4) and the starting motor are also connected to the battery.

The pinion (8) is pushed against the ring gear (9) with the overrunning clutch (7) by the shift lever (6) and the magnetic switch is closed.

■ When the solenoid switch is closed

The current from the battery flows through the solenoid switch (2) to the starting motor.

The pinion (8), which is pushed against the ring gear (9) and rotated along the spline, meshes with the ring gear to crank the engine.

The engine starts and increases its speed.

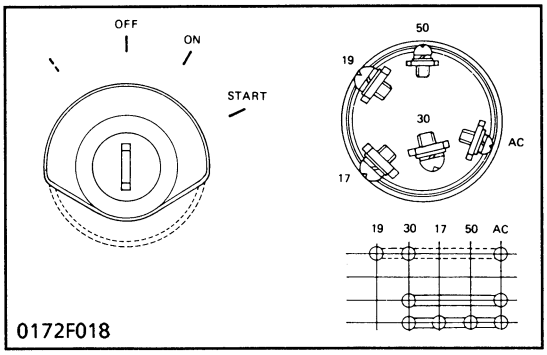
While the pinion spins faster than the armature, the overrunning clutch (7) allows the pinion to spin independently from the armature.

The pull-in coil (4) is short-circuited through the solenoid switch (2) and the key switch (1).

■ When the key switch is released

The current from the battery flows to the holding coil (3) through the pull-in coil (4) to diminish the magnetism between them.

The plunger (5) is pushed by the spring to pull in the pinion.



2) Key Switch (not included in the basic model)

The key switch has 4 positions. The terminal "30" is connected to the battery.
It is released at the "START" position and returns to the "ON" position.

■ START

When the key is turned to the "START" position, through the "ON" position the current is supplied to the starter.

50 To Starter
30 From Battery
AC To Regulator, Oil Lamp and Accessory

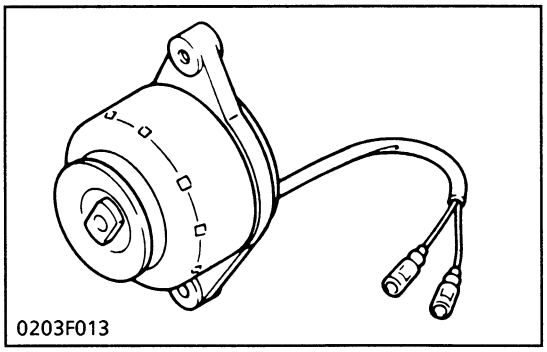
■ ON

Only the terminal "AC" is connected to the battery.
At any position of the key except the "OFF" position, the terminal "AC" is connected to the "30" terminal.

30 From Battery
AC To Regulator, Oil Lamp and Accessory

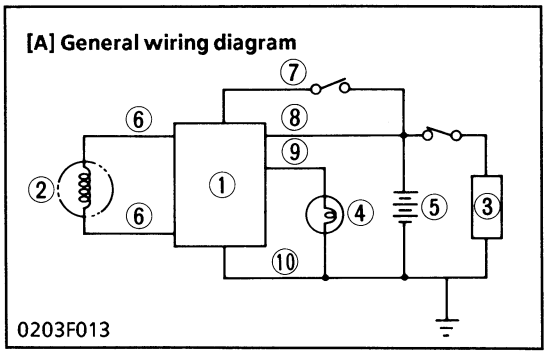
[2] CHARGING SYSTEM

(1) Alternator



This alternator is an 8-8 pole rotating magnet type generator. It is simple in construction, consisting of a stator and rotor. The rotor is made up of eight permanent magnet pole pieces assembled on a shaft and rotates on the center of the stator around which eight electromagnetic coils are provided for. This alternator produces higher voltage in slow speed rotation, and charges electric current to the battery during engine idling.

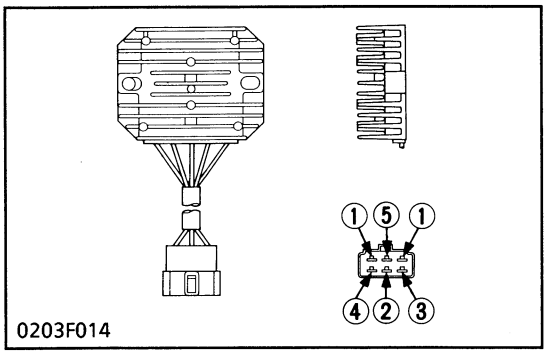
(2) Regulator



(1) Regulator
(2) Alternator
(3) Load
(4) Charge Lamp
(5) Battery
(6) Blue Lead wire
(7) Yellow Lead Wire
(8) Red Lead Wire
(9) Green Lead Wire
(10) Black Lead Wire

The regulator performs rectification and voltage regulation. The regulator converts AC into DC which flows through the power consuming circuits and the battery, and also charges the battery. If however, the battery voltage exceeds a certain level. The DC current is cut off from the charging circuit to prevent overcharging.

Model	RS5130
Part No.	19267-6460-1
Weight	Approx.250 g
Regulated voltage	14 to 15V
Battery to be used	12V
Charge indication lamp	12V, 3.4W
Alternator to be used	Under 70V of peak value of no-load voltage Under 16A of output current



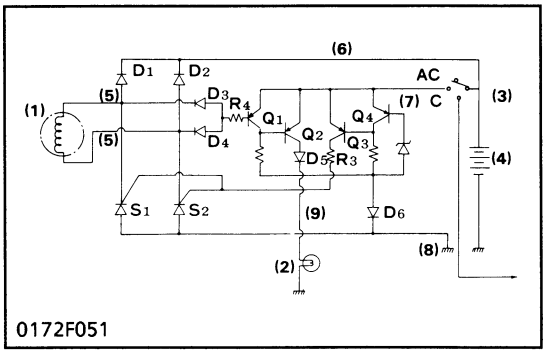
0203F014

■ Features

1. This small-sized regulator can control large output current because charging current is supplied and stopped by thyristor (Series system).
2. Built-in AC diode generation detecting circuit permits a charge indication lamp (12V, 3.4W) to be easily connected.
3. Protection diode protects regulator when battery is wrongly connected.

(1) Blue Lead Wire
(2) Yellow Lead Wire
(3) Red Lead Wire
(4) Green Lead Wire
(5) Black Lead Wire

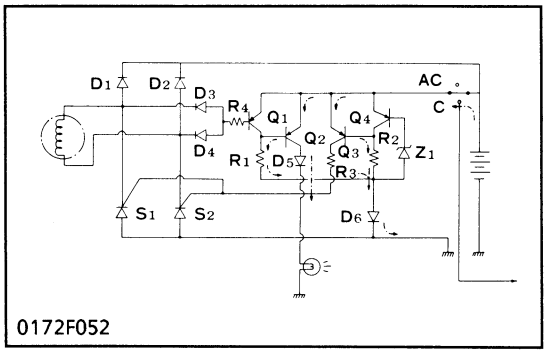
(3) Charging Mechanism



0172F051

The charging mechanism is described in four sections:
1. When key switch is ON
2. At starting
3. In charging
4. Over-charge protection

(1) GEN; Magnet type AC generator
(2) LAMP: Charge indication lamp (not included in the basic engine)
(3) KEY SW: Key switch (not included in the basic engine)
(4) BATT: Battery (not included in the basic engine)
(5) Blue; GEN connecting terminal
(6) Red: BATT + connecting terminal
(7) Yellow: BATT voltage test terminal
(8) Black: BATT –connecting terminal
(9) Green: LAMP connecting terminal
S_1, S_2 : Output control/rectification thyristor (SCR)
D_1, D_2 : Output rectifying diode
D_3, D_4 : GEN generation detecting diode
D_5, D_6 : Protection diode for wrong connecting of BATT
Z_1 : BATT terminal voltage setting diode
Q_1 : GEN generation detecting transistor
Q_2 : LAMP on/off transistor
Q_3 : Gate current control transistor
Q_4 : BATT voltage detecting transistor

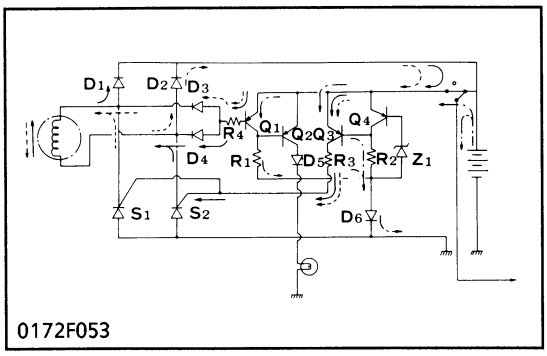


0172F052

1) When Key Switch is "ON"

When the engine is at standstill with key switch set at position 1, the circuit functions to light LAMP, as shown in Fig. 1. With key switch at position 1, current flows to base of Q_2 through the route of BATT → emitter/base of Q_2 → R_1 → D_6 → BATT and collector of Q_2 is then turned on. As a result, current also flows to LAMP though the route of BATT → emitter/collector of Q_2 → D_5 → LAMP → BATT lighting LAMP to indicate that charging is not carried out. At this time, though current flows to base of Q_3 through the route of BATT → emitter/base of Q_3 → R_2 → D_6 → BATT, collector of Q_3 has no current because GEN is stationary.

KiSC issued 07, 2006 A

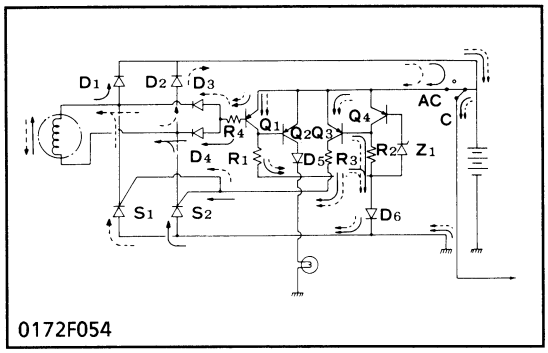


0172F053

2) At Starting

When key switch is turned to position 2, coil of starter relay is energized and starter starts engine. GEN also starts generation for charing and LAMP is turned off.

In detail, with GEN starting, current flows to base of Q_1 through the route of GEN → D_1 → emitter/base of Q_1 → R_4 → D_4 → GEN, or GEN → D_2 → emitter/base of Q_1 → R_4 → D_3 → GEN, and therefore current also flows through Q_1, short-circuiting emitter and base of Q_2. As a result, base current of Q_2 is interrupted, Q_2 is turned off and accordingly current to LAMP is also interrupted.



0172F054

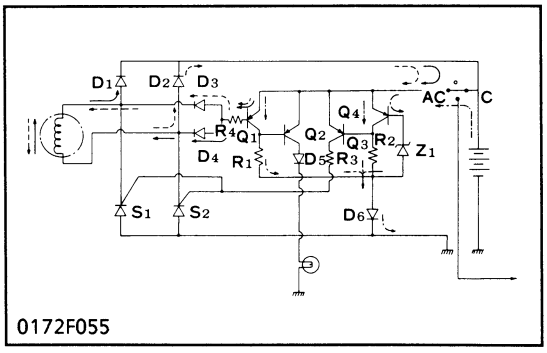
3) In Charging

Because BATT terminal voltage just after engine start is lower than setting value (14 to 15V), or lower than zener level of Z_1, current is not supplied to base of Q_4 and Q_4 is off, as shown in Fig. 2. Q_3 is on with base current which flows through the route of BATT → emitter/base of Q_3 → R_2 → D_6 → BATT, and gate current is supplied to S_1 or S_2 through the route of GEN → D_1 → emitter/collector of Q_3 → R_3 → gate/cathode of S_2 → GEN, or GEN → D_2 → emitter/collector of Q_3 → R_3 → gate/cathode of S_1 → GEN.

When engine speed is increased so that GEN generation voltage becomes higher than BATT terminal voltage, S_1 or S_2 is turned on and, as shown in Fig.3, charge current is supplied to BATT through the route of GEN → D_1 → BATT → anode/cathode of S_2 → GEN, or GEN → D_2 → BATT → anode/cathode of S_1 → GEN.

After S_1 or S_2 is turned on, collector current of Q_1 and base current of Q_3 are supplied by GEN, not BATT.

When key switch is turned to position 1 after engine is started, BATT is charged, if BATT terminal voltage is lower than the setting value, or zener level of Z_1.



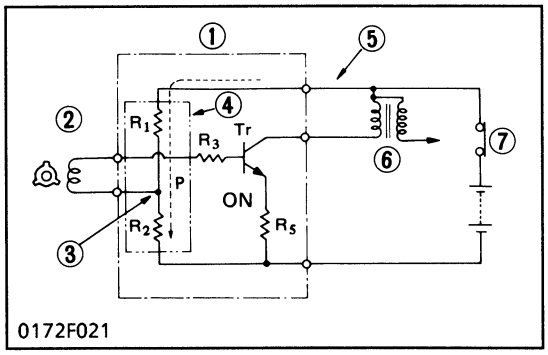
0172F055

4) Over-Charge Protection

When BATT terminal voltage is higher than the setting value or zener level of Z_1, BATT is not charged by the function of circuit as shown in Fig.4. That is, Q_4 is on with base current which flows through the route of BATT → emitter/base of Q_4 → Z_1 → D_6 → BATT, shortcircuiting emitter and base of Q_3. Therefore, Q_3 is off with no base current and gate current is not supplied to S_1 and S_2. Consequently S_1 and S_2 are off and BATT is not charged.

[3] IGNITION SYSTEM

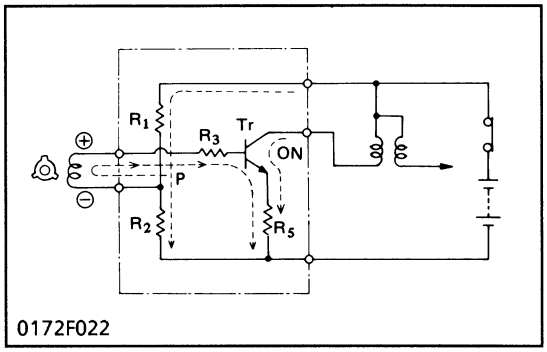
(1) When the engine is off



When the ignition switch is turned on, the fixed bias voltage – the voltage at point P (the voltage supplied by the battery and divided by resistors R1 and R2) – is slightly higher than the operating voltage of transistor. The transistor thus turns on and delivers a current to the primary coil of the ignition coil.

(1) Igniter
(2) Pick-up Coil
(3) Voltage at Point P is low.
(4) Fixed Bias Circuit
(5) With No Externally-Connected Resistor
(6) Ignition Coil
(7) Ignition Switch

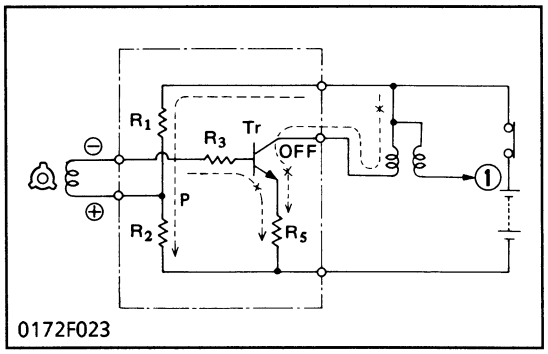
(2) When the voltage produced by the pick-up coil is positive

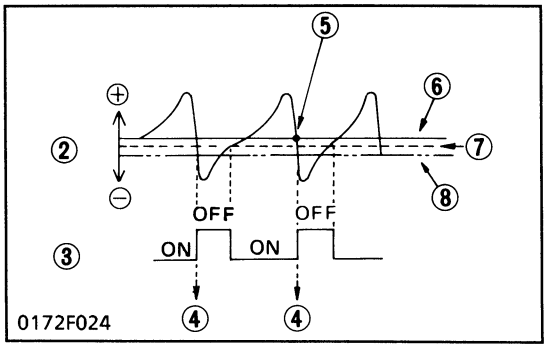


After the engine is started, the signal rotor of the distributor rotates and an AC voltage develops in the pick-up coil.

When the output voltage of the pick-up coil is positive, the voltage at point P combined with this output voltage is applied to the base of the transistor. The combined voltage is higher than the operating voltage of the transistor so that the transistor remains on and the current to the primary coil of the ignition coil continues to flow.

(3) When the voltage produced by the pick-up coil is negative





When the output voltage of the pick-up coil is negative, the voltage at point P falls below the operating voltage of the transistor. The transistor then turns off and cuts the current flowing to the primary coil of the ignition coil. As a result, a high-voltage is produced by the secondary coil of the ignition coil. The transistor remains off as long as the output voltage of the pick-up coil is negative.

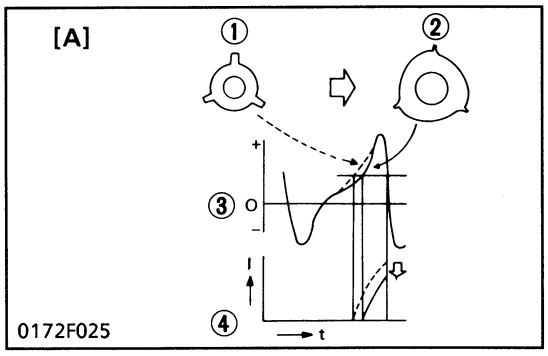
As the engine runs, the transistor turns on and off repeatedly as described above. Every time it turns off, a high voltage is produced in the secondary coil of the ignition coil. This is the current that ignites the spark plug.

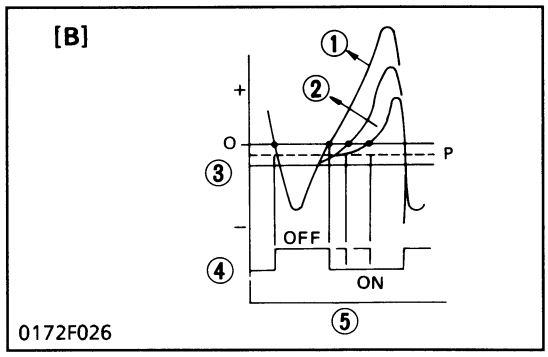
Described above is a conventional fully-transistorized ignition circuit. In such circuits, the transistor does not turn off until coil. The secondary voltage tends to decrease as the engine speed increases. To prevent this, the dwell (the amount of time the transistor is turned on) must be controlled.

Items (1) (2), and (3) above describes so far the conventional fully-transistorized ignition system.

(1) High Voltage Generation
(2) Voltage Waveform of the Ignition Signal
(3) Transistor Operation
(4) Ignition
(5) When the teeth on the signal coil pass a projection leading from the pick-up tube.
(6) DC Voltage at Point P
(7) Operating Voltage of the Transistor
(8) Ground Potential

(4) Dwell control by the pick-up coil waveform





This ignition system of this engine features a unique dwell control method which utilizes changes in the output waveform of the pick-up coil. In order for the waveform to have a sharper rising edge, the teeth of the distributor's signal rotor are designed as shown in Fig A.

Unlike conventional fully-transistorized ignition circuits, the fixed bias voltage "P" of this ignition circuit is set at a lower level than the operating voltage of the transistor. For this reason, a voltage does not develop in the pick-up coil even when the key switch is turned on, preventing a current from flowing into the ignition coil.

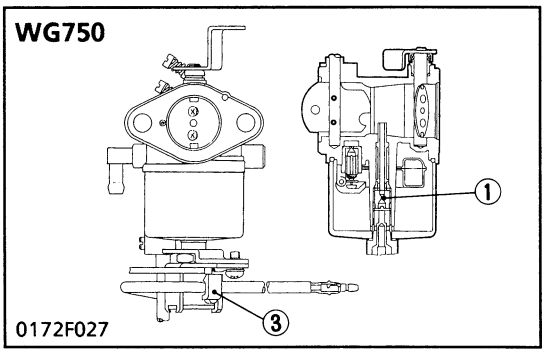
Therefore, as the signal rotor increases in speed, the output voltage of the pick-up coil becomes greater and the rising edge of the waveform becomes sharper. (See Fig. B.) As a result, the transistor turns on faster than in a conventional fully-transistorized ignition circuit. Yet it turns off at the same time as the transistor in a conventional circuit. Consequently, the amount of time the transistor is turned on increases (the dwell becomes wider).

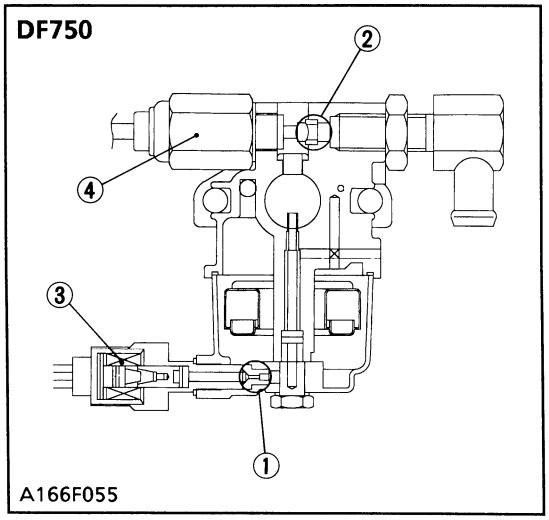
As explained above, this ignition system makes use of changes in the output waveform of the pick-up coil to increase the closing angle at high engine speeds.

[A] (1) Ordinary Shape
(2) Dwell Controlled Shape
(3) Waveform of the Pick-up Coil
(4) Waveform of the Primary Current

[B] (1) Output Waveform of the Pick-up Coil
(2) Increase in RPM
(3) Operating Level of Tr 1
(4) Tr 1 Operation
(5) Rotor Angle

[4] SOLENOID





When the key switch is turned on, a current flows to the solenoid, which in turn opens the solenoid valve.

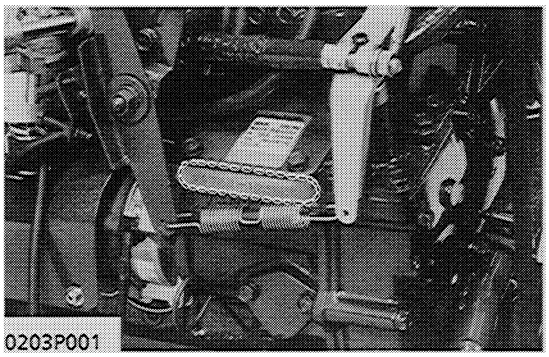
When the key switch is turned off, the solenoid valve closes, blocking the gasoline main jet (1) / LPG main jet (2).

(1) Gasoline Main Jet
(2) LPG Main Jet
(3) Gasoline Solenoid Valve
(4) LPG Solenoid Valve

S. DISASSEMBLING AND SERVICING

G GENERAL

[1] ENGINE IDENTIFICATION

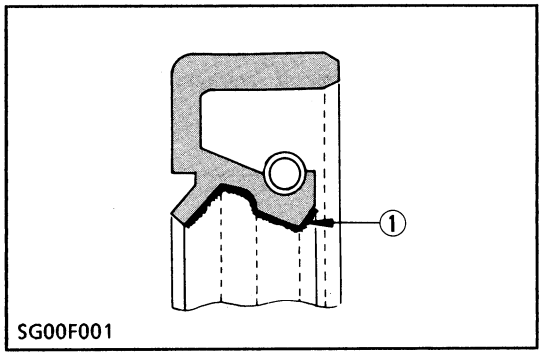


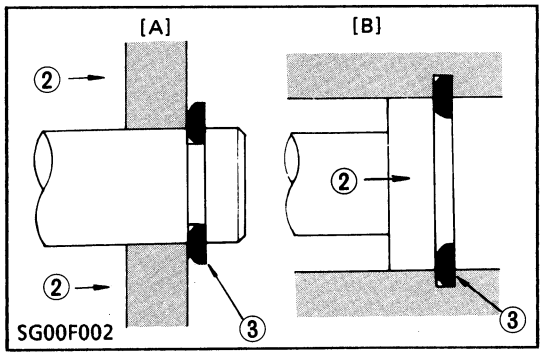
When contacting your local KUBOTA dealer, always specify the engine serial number.

■ **NOTE**

- **The serial number is marked on specified position shown in the photo.**

[2] GENERAL PRECAUTIONS





(1) Grease
(2) Force
[A] External Snap Ring
(3) Place the Sharp Edge against the Direction of Force
[B] Internal Snap Ring

- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use Kubota's genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only Kubota genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external snap or internal rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform break-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

[3] TROUBLESHOOTING

(1) For Gasoline Fuel

Symptom	Probable Cause	Solution	Reference Page
Engine Will Not Turn Over	• Engine jammed	Check engine to find the problem and repair it	
	• Battery discharged	Charge	
	• Starter malfunctioning	Repair or replace	S-54
	• Wires disconnected	Reconnect	
Engine Turns Over Slowly but Does Not Start	• Increased resistance of moving parts	Repair or replace	
	• Excessively high viscosity engine oil at low temperature	Use specified engine oil	S-13
Engine Turns Over at Normal Speed but Does Not Start	• No fuel	Replenish fuel	
	• Compression leak	Check the compression pressure and repair	S-26
	• Improper valve clearance	Adjust	S-27
	• Defective ignition unit	Replace	
	• Defective spark plug	Adjust spark plug gap or replace	S-14, 58
	• Defective fuel system	Check fuel line and carburetor and repair	
	• Over choked	Clean spark plug	
	• Flooding from carburetor	Check carburetor and repair	
	• Clogged air cleaner	Clean or replace	S-14
Rough Low-speed Running and Idling	• Defective ignition unit	Replace	
	• Defective spark plug	Adjust spark plug gap or replace	S-14, 58
	• Defective spark plug cords	Replace	S-60
	• Defective distributor	Check distributor and clean the rotor	S-58
	• Incorrect carburetor idle adjustment	Adjust	S-43
	• Incorrect governor adjustment	Adjust	S-43
	• Improper valve clearance	Adjust	S-27
Rough High-speed running	• Defective ignition unit	Replace	
	• Defective spark plug	Adjust spark plug gap or replace	S-14, 58
	• Defective spark plug cords	Replace	S-60
	• Defective distributor	Check the distributor and clean the rotor	S-58
	• Incorrect governor adjustment	Adjust	S-43
Engine Speed Does Not Increase	• Incorrect governor adjustment	Adjust	S-43
	• Defective ignition unit	Replace	
	• Incorrect carburetor adjustment	Adjust	S-43
	• Clogged air cleaner	Clean or replace	S-14

Symptom	Probable Cause	Solution	Reference Page
Defection Output	• Improper intake or exhaust valve sealing	Replace	
	• Incorrect governor adjustment	Adjust	S-43
	• Excessive carbon in engine	Remove carbon	
	• Improper valve clearance	Adjust	S-27
	• Piston ring and cylinder worn	Replace	S-37, 38
	• Clogged air cleaner	Clean or replace	S-14
Engine Noise	• Improper valve clearance	Adjust	S-27
	• Spark knock due to low-octane fuel or carbon	Use higher-octane fuel and remove carbon	
	• Rattles from loosely mounted external components	Retighten	

(2) For LPG Fuel

Engine Turns Over at Normal Speed but Does Not Start	• No LPG fuel	• Replenish LPG fuel • Check of taking valve of LPG tank	
	• Vacuum lock system is defective	• Check of shut off valve • Check of vacuum hose • Clean or replace of vacuum lock diaphragm	S-16
	• Mistake of throttle lever position	• Set the throttle lever to the low idle position	
Rough Low-speed Running and Idling	• Lack of amount of gas supply	• Replenish LPG fuel • Check of shut off valve	
	• Idling is defective	• Fuel tight adjustment of each valve of vaporizer	S-47, 48
		• Cleaning or replace of each diaphragm of vaporizer	S-18
		• Cleaning in the vaporizer	S-16
Defection Output	• Density of the LPG is rich	• Fuel tight adjustment of each valve of vaporizer	S-47, 48
		• Replace of primary diaphragm	S-18
	• LPG shortage	• Repair or replace of fuel system	
		• Replace of secondary diaphragm	S-18

[4] SERVICING SPECIFICATIONS

1. ENGINE BODY

Cylinder Head

Item		Factory Specification	Allowable Limit
Cylinder head surface flatness		–	0.05 mm (0.0019 in.)
Top clearance		0.85 to 1.30 mm (0.0335 to 0.0511 in.)	–
Gasket thickness	Free	1.20 to 1.40 mm (0.0472 to 0.0551 in.)	–
	Tightened	1.05 to 1.15 mm (0.0413 to 0.0453 in.)	–
Compression pressure		1.27 MPa (13.0 kgf/cm^2, 185 psi)	0.88 MPa (9.0kgf/cm^2,128 psi)
Variance among cylinders		–	10%

Valve (IN., EX.)

Valve clearance (cold)	0.145 to 0.185 mm (0.0057 to 0.0072 in.)	–
Valve seat width	2.12 mm (0.0835 in.)	–
Valve seat angle	0.785 rad. (45.0°)	–
Valve face angle	0.785 rad. (45.0°)	–
Valve recessing	0.75 to 0.95 mm (0.0295 to 0.0374 in.)	1.2 mm (0.047 in.)
Clearance between valve stem and guide	0.030 to 0.057 mm (0.0018 to 0.00224 in.)	0.10 mm (0.0039 in.)
Valve stem O.D.	5.968 to 5.980 mm (0.23496 to 0.23543 in.)	–
Valve guide I.D.	6.010 to 6.025 mm (0.23661 to 0.23721 in.)	–

Valve Timing

Inlet valve	Open	0.35 rad. (20°) before TDC	–
	Close	0.79 rad (45°) after BDC	–
Exhaust valve	Open	0.87 rad. (50°) before BDC	–
	Close	0.26 rad. (15°) after TDC	–

Valve Springs

Item	Factory Specification	Allowable Limit
Free length	3.16 mm (1.244 in.)	28.4 mm (1.118 in.)
Tilt	–	1.2 mm (0.047 in.)
Tension	64.7 N/27 mm (6.6 kgf/27 mm, 14.6 lbs/1.063 in.)	59.4 N/27 mm (5.6 kgf/27 mm, 12.3 lbs/1.063 in.)

Rocker Arm

Clearance between rocker arm shaft and bearing I.D.	0.016 to 0.045 mm (0.00063 to 0.00177 in.)	0.15 mm (0.0059 in.)
Rocker arm shaft O.D.	10.473 to 10.484 mm (0.41232 to 0.41276 in.)	–
Rocker arm bearing I.D.	10.500 to 10.518 mm (0.41338 to 0.41409 in.)	–

Camshaft

Camshaft alignment	–	0.01 mm (0.0004 in.)
Cam height (IN., EX.)	26.88 mm (1.0583 in.)	26.83 mm (1.0563 in.)
Oil clearance of camshaft	0.050 to 0.091 mm (0.00197 to 0.00358 in.)	0.15 mm (0.0059 in.)
Camshaft journal O.D.	32.934 to 32.950 mm (1.29662 to 1.29725 in.)	–
Camshaft bearing I.D.	33.000 to 33.025 mm (1.2992 to 1.3002 in.)	–

Timing Gear

Timing gear backlash	0.04 to 0.12 mm (0.0016 to 0.0047 in.)	0.15 mm (0.0059 in.)
Idle gear side clearance	0.20 to 0.51 mm (0.0079 to 0.0201 in.)	0.6 mm (0.024 in.)
Clearance between idle gear shaft and idle gear bushing	0.02 to 0.054 mm (0.00079 to 0.00213 in.)	0.10 mm (0.0039 in.)
Idle gear shaft O.D.	19.967 to 19.980 mm (0.78614 to 0.78661 in.)	–
Idle gear bushing I.D.	20.000 to 20.021 mm (0.7874 to 0.7882 in.)	–

Cylinder

Cylinder I.D.	68.000 to 68.019 mm (2.67717 to 2.67791 in.)	+ 0.15 mm (0.0059 in.) of wear
Oversize of cylinder	68.500 to 68.519 mm (2.6968 to 2.6976 in.)	+ 0.15 mm (0.0059 in.) of wear

Piston / Piston Ring

Item		Factory Specification	Allowable Limit
Piston pin hole I.D.		18.000 to 18.011 mm (0.70866 to 0.70910 in.)	18.05 mm (0.7106 in.)
Piston ring clearance	Compression ring 1, 2	0.02 to 0.06 mm (0.0008 to 0.0024 in.)	0.15 mm (0.0059 in.)
	Oil ring	0.02 to 0.06 mm (0.0008 to 0.0024 in.)	0.15 mm (0.0059 in.)
Ring gap	Compression ring 1, 2	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	1.25 mm (0.0492 in.)
	Oil ring	0.20 to 0.40 mm (0.0079 to 0.0157 in.)	1.25 mm (0.0492 in.)
Oversize of piston rings		+ 0.5 mm (+ 0.020 in.)	–

Crankshaft

Crankshaft alignment		–	0.02 mm (0.0008 in.)
Oil clearance between crankshaft journal and bearing	Front	0.034 to 0.106 mm (0.00134 to 0.00417 in.)	0.20 mm (0.0079 in.)
	Intermediate and rear	0.034 to 0.092 mm (0.00134 to 0.00417 in.)	0.20 mm (0.0079 in.)
Journal O.D	Front and intermediate	39.934 to 39.950 mm (1.57221 to 1.57284 in.)	–
	Rear	43.934 to 43.950 mm (1.72969 to 1.73032 in.)	–
Bearing I.D.	Front	39.984 to 40.040 mm (1.57418 to 1.57638 in.)	–
	Intermediate	39.984 to 40.026 mm (1.57418 to 1.57583 in.)	–
	Rear	43.984 to 44.026 mm (1.73166 to 1.73331 in.)	–
Oil clearance between crank pin and bearing		0.019 to 0.081 mm (0.00075 to 0.00319 in.)	0.15 mm (0.0059 in.)
Crank pin O.D.		33.959 to 33.975 mm (1.33697 to 1.33760 in.)	–
Crank pin bearing I.D.		33.994 to 34.040 mm (1.33835 to 1.34016 in.)	–
Crankshaft side clearance		0.15 to 0.31 mm (0.0059 to 0.0122 in.)	0.5 mm (0.020 in.)
Under sizes of crankshaft bearing and crank pin bearing		–0.2 mm, –0.4 mm (–0.008 in., –0.016 in.)	–
Oversizes of thrust bearing		+ 0.2 mm, + 0.4 mm (+ 0.008 in., + 0.016 in.)	–

Connecting Rod

Item	Factory Specification	Allowable Limit
Connecting rod alignment	–	0.05 mm (0.0020 in.)
Oil clearance between piston pin and small end bushing	0.02 to 0.04 mm (0.0008 to 0.0016 in.)	0.10 mm (0.0039 in.)
Piston Pin O.D.	18.000 to 18.005 mm (0.7087 to 0.7089 in.)	–
Small end bushing I.D. (fitting)	18.025 to 18.040 mm (0.70965 to 0.71024 in.)	–

2. LUBRICATING SYSTEM

Oil pressure	At idle speed	69 kPa (0.7 kgf/cm^2, 10 psi)	–
	At rated speed	196 to 441 kPa (2.0 to 4.5 kgf/cm^2, 28 to 64 psi)	186 kPa (1.9 kgf/cm^2, 27 psi)

Oil Pump

Rotor lobe clearance	–	–
Radial clearance between outer rotor and pump body	0.07 to 0.15 mm (0.0028 to 0.0059 in.)	–
End clearance between rotor and cover	0.075 to 0.135 mm (0.0029 to 0.0053 in.)	–

Oil Filter

Opening pressure of bypass valve	98 kPa (1.0 kgf/cm2, 14.2 psi) of pressure difference	–

3. COOLING SYSTEM

Fan Belt

Belt deflection under load of 98 N (10 kgf, lbs.)	7 to 9 mm (0.28 to 0.35 in.)	–

Radiator

Radiator water tightness	Water tightness at specified pressure (137 kPa, 1.4 kgf/cm^2, 20 psi)	–
Radiator cap opening pressure	10 seconds or more of pressure falling time from 88 to 59 kPa (0.9 to 0.6 kgf/cm^2, 13 to 9 psi)	–

Thermostat

Item	Factory Specification	Allowable Limit
Thermostat's valve opening temperature	80.5 to 83.5°C (176.9 to 182.3°F)	–
Temperature at which thermostat completely opens	95°C (203°F) at 6 mm (0.236 in.) of opening	–

4. ELECTRICAL SYSTEM

Starter

Commutator O.D.	32.0 mm (1.260 in.)	31.0 mm (1.220 in.)
Difference of O.D.'s	less than 0.05 mm (0.002 in.)	0.4 mm (0.016 in.)
Mica undercut	0.5 to 0.8 mm (0.020 to 0.031 in.)	0.4 mm (0.008 in.)
Brush length	17.0 mm (0.669 in.)	11.5 mm (0.453 in.)

Alternator

No-load output	AC 20 volt or more at 5200 rpm	–

Regulator

Regulating voltage	14 to 15 volt	–

Spark Plug

Spark plug gap	1.0 to 1.1 mm (0.039 to 0.043 in.)	–

Ignition Coil

Primary coil resistance	1.3 to 1.6 Ω	–
Secondary coil resistance	10.7 to 14.5 kΩ	–
Power source line voltage	Approx. 12 V	–

Distributor

Air gap		0.2 to 0.4 mm (0.008 to 0.016 in.)	–
High tension cord resistance	Center Cord	3.1 to 5.2 kΩ	–
	Cord 1	2.5 to 4.2 kΩ	
	Cord 2	3.0 to 5.1 kΩ	
	Cord 3	3.1 to 5.4 kΩ	
Ignition timing		0.315 rad (18°C) before TDC	–

[5] TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench. Several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and at the proper torque.

(1) Tightening torques for special use bolts and nuts

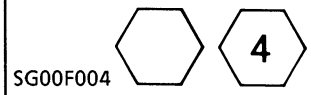
Item	Size x Pitch	N·m	kgf·m	ft-lbs
* Head cover cap nuts	M6 x 1.0	3.9 to 5.9	0.4 to 0.6	2.9 to 4.3
* Head bolts	M8 x 1.25	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
* Bearing case bolts 1	M6 x 1.0	12.7 to 15.7	1.3 to 1.6	9.4 to 11.6
* Bearing case bolts 2	M7 x 1.0	26.5 to 30.4	2.7 to 3.1	19.6 to 22.5
* Flywheel bolts	M10 x 1.25	53.9 to 58.8	5.5 to 6.0	39.8 to 43.4
* Connecting rod bolts	M6 x 0.75	26.5 to 30.4	2.7 to3.1	19.6 to 22.5
* Rocker arm bracket nuts	M6 x 1.0	9.81 to 11.28	1.00 to 1.15	7.23 to 8.32
* Idle gear shaft bolts	M6 x 1.0	9.81 to 11.28	1.00 to 1.15	7.23 to 8.32
Spark plug	M14 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Drain plug	M12 x 1.25	32.4 to 37.3	3.3 to 3.8	23.9 to 27.5
Oil switch taper bolt	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
* Fan drive pulley bolt	M12 x 1.5	117.7 to 127.5	12.0 to 13.0	86.8 to 94.0

■ **NOTE**

- **For "*" marked bolts and nuts in the tale, apply engine oil to their threads and seats before tightening.**

(2) Tightening Torques for general use screws, bolts and nuts

When the tightening torques are not specified, tighten the bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	No-grade or 4T  SG00F004 SS41, S20C			7T  S43C, S48C			9T  SCr435, SCM435		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M 6 (6 mm, 0.24 in.)	7.85 to 9.32	0.80 to 0.95	5.79 to 6.87	9.81 to 11.28	1.00 to 1.15	7.23 to 8.32	12.26 to 14.22	1.25 to 1.45	9.04 to 10.49
M 8 (8 mm, 0.31 in.)	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
M10 (10 mm, 0.39 in.)	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2	60.8 to 70.6	6.2 to 7.2	44.8 to 52.1
M12 (12 mm, 0.47 in.)	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5	103.0 to 117.7	10.5 to 12.0	75.9 to 86.8

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads.

[6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

(1) For WG750

Item \ Interval		Every 50 hours	Every 100 hours	Every 200 hours	Every 800 hours	Yearly	Each 2 years	Reference page
Engine oil	Change	*	○					S-13
Oil filter cartridge	Change	*		○				S-15
Spark plug	Clean		○					S-14
	Change				○			S-15
Ignition wires	Change						○	
Air cleaner element	Clean	○						S-14
	Change					○		S-17
Intake pipe / clamp bands	Change						○	
Fuel pipe / clamps	Check	○						S-13
	Change					○		S-16
Carburetor	Clean						○	
Radiator coolant	Change					○		
Radiator horses and clamp bands	Check			○				S-15
	Change						○	
Radiator and water jacket	Clean					○		S-17
Fan belt tension	Check		○					S-14
Valve clearance	Adjust				○			S-25
Valve seats	Check				○			
Cylinder head	Clean				○			

* Change engine oil and oil filter after the first 50 hours of operation.

⚠ CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ NOTE

- **Regarding the daily check items, see the operator's manual.**

(2) For DG750

Item \ Interval		Every 50 hours	Every 100 hours	Every 200 hours	Every 800 hours	Yearly	Each 2 years	Reference page
Engine oil	Change	*		○				S-13
Oil filter cartridge	Change	*		○				S-15
Spark plug	Check		○					S-14
	Change				○			S-15
Ignition wires	Change						○	
Air cleaner element	Check	○						S-14
	Change					○		S-17
Intake pipe / clamp bands	Change						○	
Fuel pipe / clamps	Check fuel leakage	○						S-13
	Change						○	
LPG mixer	Clean					○		
Vaporizer	Draining Tar				○			S-16
	Check						○	S-18
Radiator coolant	Change					○		
Radiator horses and clamp bands	Check			○				S-15
	Change						○	
Radiator and water jacket	Clean					○		S-17
Fan belt tension	Check		○					S-14
Valve clearance	Adjust				○			S-25
Valve seats	Check				○			

* Change engine oil and oil filter after the first 50 hours of operation.

⚠ CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ NOTE

- **Regarding the daily check items, see the operator's manual.**

(3) For DF750

Item \ Interval		Every 50 hours	Every 100 hours	Every 200 hours	Every 800 hours	Yearly	Each 2 years	Reference page
Engine oil	Change	*	○					S-13
Oil filter cartridge	Change	*		○				S-15
Spark plug	Check		○					S-14
	Change				○			S-15
Ignition wires	Change						○	
Air cleaner element	Check	○						S-14
	Change					○		S-17
Intake pipe / clamp bands	Change						○	
Fuel pipe / clamps (Gasoline Fuel)	Check fuel leakage	○						S-13
	Change					○		S-16
Fuel pipe / clamps (LPG Fuel)	Check fuel leakage	○						S-13
	Change						○	
LPG mixer	Clean					○		
Vaporizer	Draining Tar				○			S-16
	Check						○	S-18
Radiator coolant	Change					○		
Radiator horses and clamp bands	Check			○				S-15
	Change						○	
Radiator and water jacket	Clean					○		S-17
Fan belt tension	Check		○					S-14
Valve clearance	Adjust				○			S-25
Valve seats	Check				○			

* Change engine oil and oil filter after the first 50 hours of operation.

⚠ CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ NOTE

- **Regarding the daily check items see the operator's manual.**

[7] CHECK AND MAINTENANCE

(1) Check Points of Every 50 Hours

Checking Fuel Leakage (LPG Fuel Line)

■ **IMPORTANT**
- **Never test for gas leaks with a FLAME.**

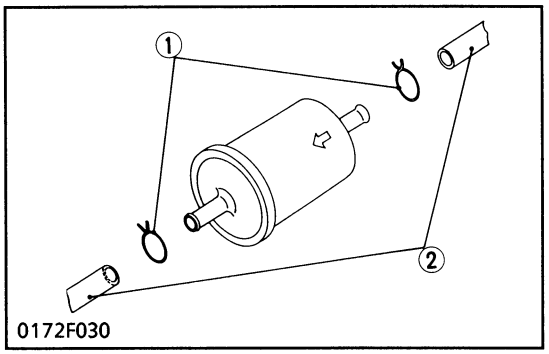
■ **NOTE**
- **Check for fuel leakage by using soapy water or gas-ditector, if leakage is found, correct leakage.**

Liquid Fuel Check

1. Open the shutoff valve on the tank.
2. Check for
   a : Fuel tank to filter
   b : Filter to shutoff valve
   c : Shutoff valve to vaporizer.

Gaseous Fuel Check

1. Check the hose clamp and vapor hose .
2. Confirm that there is no leakage form the vapor hose.



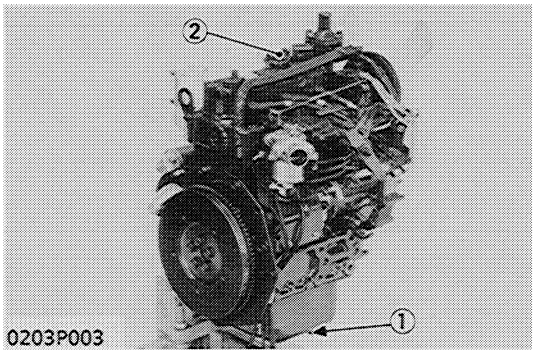
(1) Clamp (2) Fuel Pipe

Checking Fuel Pipe (Gasoline Fuel Line)

Check the fuel pipes every 100 hours of operation.
1. Since the fuel pipe (2) is made of rubber, it ages regardless of the period of service.
   Change the fuel pipe together with the clamp every two years.
2. However, if the fuel pipe and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
3. After the fuel pipe and the clamp have been changed, bleed the fuel system.

⚠ **CAUTION**
- **Stop the engine when attempting the check and change prescribed above.**

(2) Check Points of Every 100 Hours

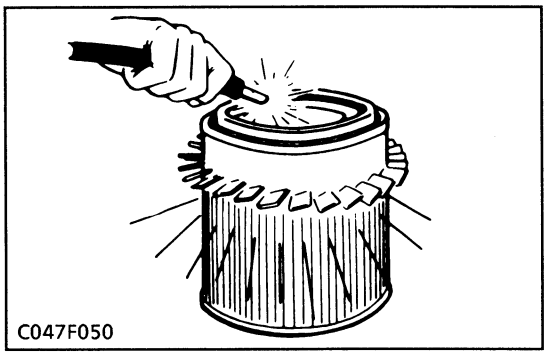


(1) Drain Plug (2) Oil Filler Plug

Changing Engine Oil

1. After warming up, stop the engine.
2. To change the used oil, remove the drain plug (1) at the bottom of the engine and drain off the oil completely.
3. Reinstall the drain plug.
4. Fill the new oil up to the upper notch on the dipstick.

■ **IMPORTANT**
- **The API classification of the engine oil should be SF class grade.**
- Change the type of engine oil according to the ambient temperature according to SAE viscosity grade.
  Above 25°C(77°F) .....SAE 30 or SAE 10W-30
  0°C to 25°C(32°F to 77°F) ..... SAE 20 or SAE 10W-30
  −12°C to 0°C(10°F to 32°F) ..... SAE 10W or SAE 10W-30
  Below −12°C(10°F) .....SAE 5W-30


C047F050

Cleaning Air Cleaner

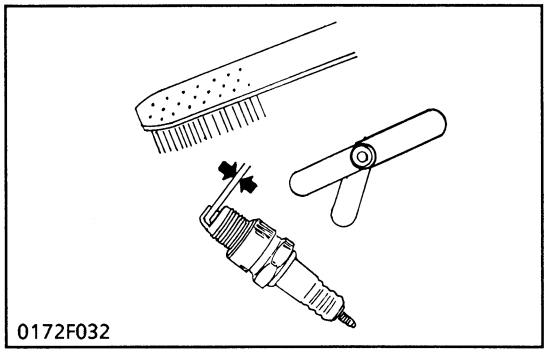
1. To clean the element, use clean dry compressed air on the inside of the element.
   Air pressure at the nozzle must not exceed 205 kPa(2.1 kgf/cm2, 30 psi).
2. If the element is stained with carbon or oil, replace the element.

■ IMPORTANT

- **Make sure the wing bolt for the element is tight enough. If it is loose, dust and dirt may be sucked, wearing down the cylinder liner and piston ring earlier and thereby resulting in poor power output.**

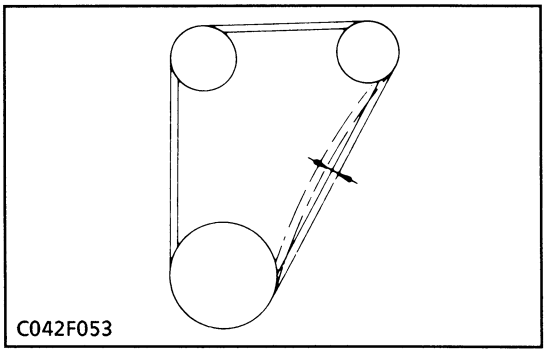
■ NOTE

- **Change the element once a year or every 6th cleaning.**


0172F032

Checking Spark Plug Gap

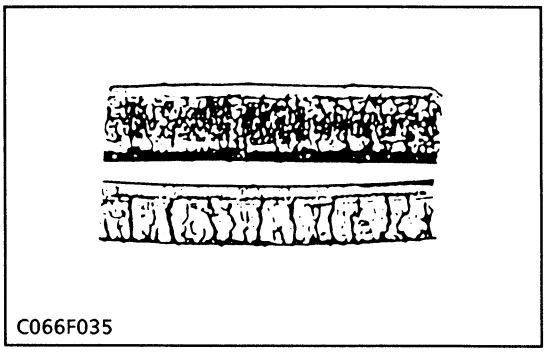
1. Remove the spark plug, and remove carbon from the electrode with a wire brush or other tools.
2. Measure the spark plug gap with a feeler gauge, and repair or replace the plug if the measured gap differs from the factory specification.
3. Replace the plug if the electrode or the insulator is deformed or cracked.
4. Tighten the plug with a plug wrench.


C042F053

Fan Belt Tension

1. Measure the deflection, depressing the belt halfway between the fan drive pulley and the alternator pulley at 98 N (10 kgf, 22 lbs) of force.
2. If the measurement is not the specified value, loosen the bolts and the nuts, and relocate the alternator to adjust.

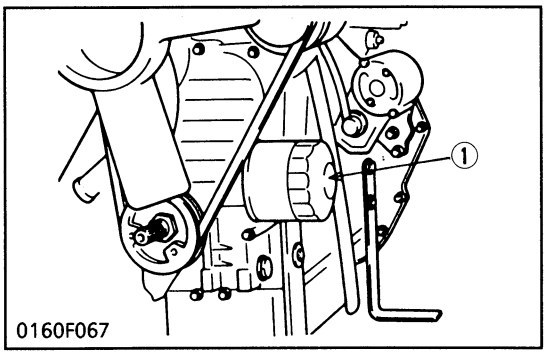
Fan belt tension	Factory specification	7 to 9 mm 0.273 to 0.351 in.


C066F035

Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(3) Check Points of Every 200 Hours



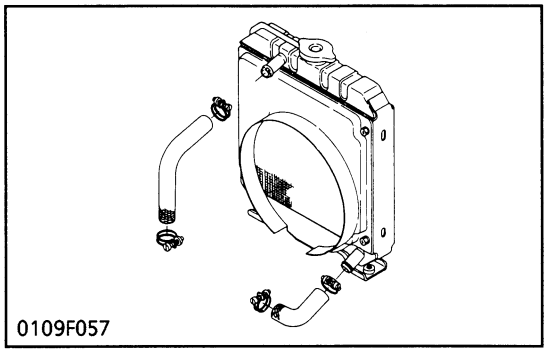
(1) Filter Cartridge

Changing Engine Oil Filter Cartridge

1. Remove the oil filter cartridge (1) with a filter wrench.
2. Apply engine oil to the rubber gasket on the new cartridge.
3. Screw in the new cartridge in by hand.

■ NOTE

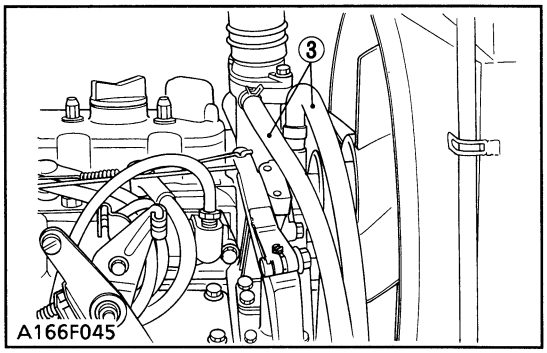
- **Over-tightening may cause deformation of the rubber gasket.**
- **After the cartridge has been replaced, engine oil normally decreases a little.**
  Check the oil level and add new oil to the specified level.



Checking the Water Pipe

1. Check to see if the water pipes are properly fixed every 200 hours of operation of every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water pipe is made of rubber and tends to age. It must be changed every two years. Also change the clamp and tighten it securely.

(1) Upper Hose
(2) Lower Hose
(3) Water Hose for Vaporizer

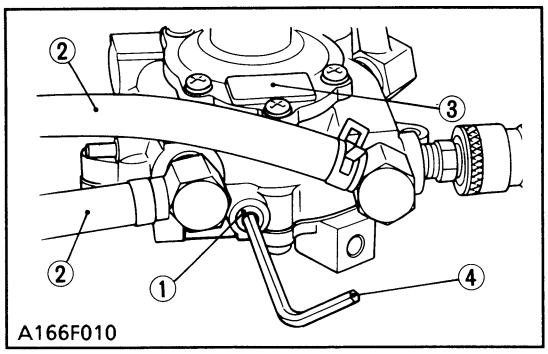


(4) Check Points of Every 800 Hours

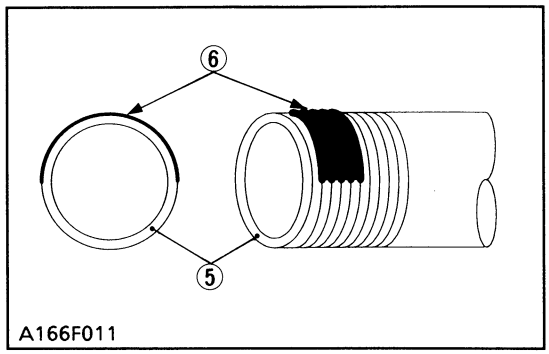
Changing Spark Plug

See page S-14.

Spark Plug	NGK BKR4E-11



A166F010



A166F011

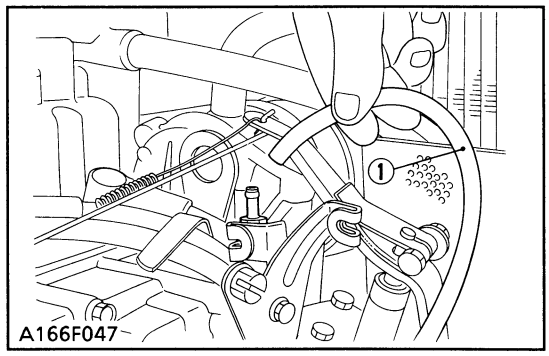
Draining Tar (Vaporizer for LPG Fuel)

1. Run the engine until it is warmed up.
2. The shut off valve is shut and the engine is stopped naturally.
3. Place an oil pan underneath the drain port.
4. Remove the drain plug (1), and drain tar.
5. Tighten the plug.

■ **NOTE**

- **Apply a liquid gasket (Three Bond #1104 or equivalent) to the thread of the plug.**

(1) Drain Plug
(2) Water Hose
(3) Vaporizer
(4) Wrench
(5) Joint
(6) Liquid Gasket



A166F047

Vacuum Lock Pipe (for LPG Fuel)

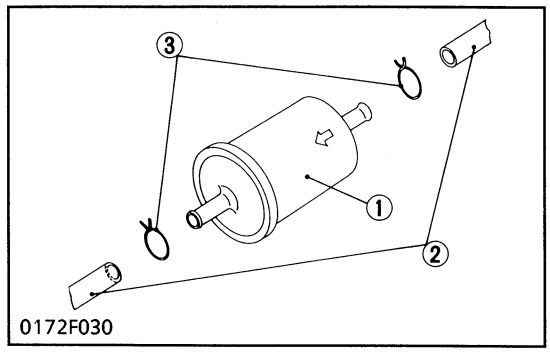
1. Check the vacuum lock pipe (1) for damage.
2. If the pipe is damaged, replace it.

(1) Vacuum Lock Pipe

Valve Clearance

See page S-25.

(5) Check Points of Every Year

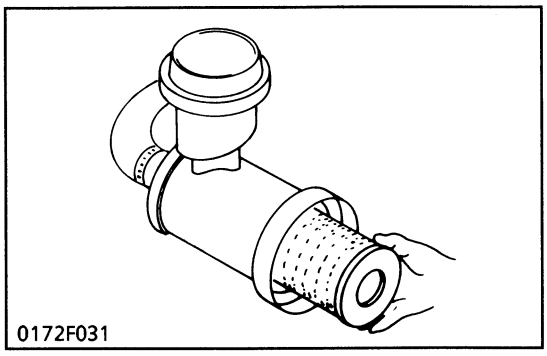


0172F030

Changing Fuel Filter and Fuel Pipe (for Gasoline Fuel)

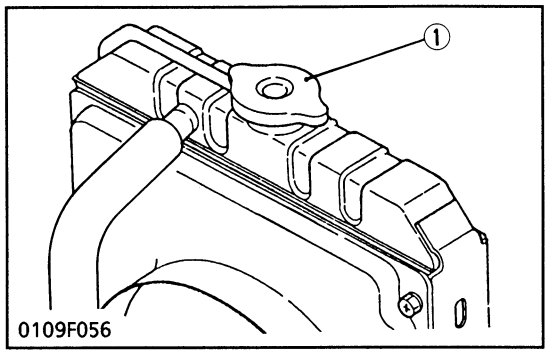
1. Close the fuel tank cock.
2. Replace the fuel filter (1) with a new one.
3. Replace the pipe (2) and clamp (3).

(1) Fuel Filter
(2) Fuel Pipe
(3) Clamp

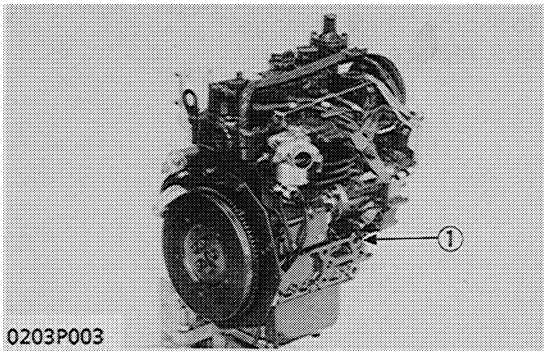


Changing Air Cleaner Element

1. Replace the air cleaner element (1).



(1) Radiator Cap



(1) Drain Cock

Cleaning of Water Jacket (Radiator Interior)

1. The cooling system should be cleaned on the following occasions:
   - Every one year service.
   - When adding antifreeze.
   - When changing from water containing antifreeze to pure water.

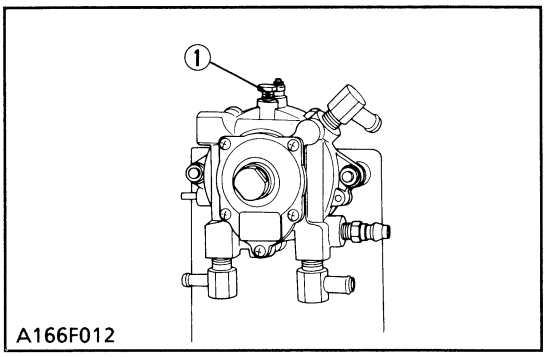
⚠ CAUTION

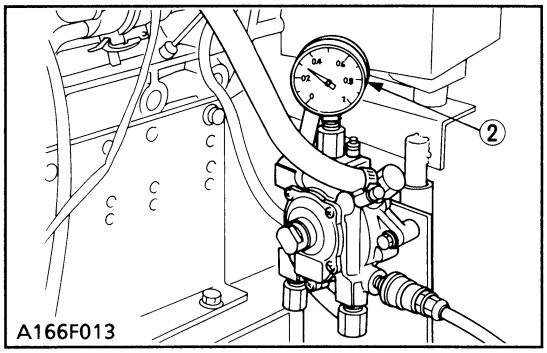
- **Do not remove the radiator cap until cooling water temperature is enoughly cooled. Then loosen the cap sightly to relieve any excess pressure before removing the cap completely.**

■ IMPORTANT

- **Use clean, fresh water to fill the radiator.**
- **To drain the used coolant completely, open the radiator drain cocks and remove the radiator cap.**
- **Do not use the antifreeze during hot weather to maintain engine performance since the boiling point of coolant rises.**
- **The radiator should be filled with part antifreeze and part water at all times as recommended by the antifreeze manufacturer.**
- **Do not use an antifreeze and scale inhibitor at the same time.**

(6) Check Points of Each 2 Years





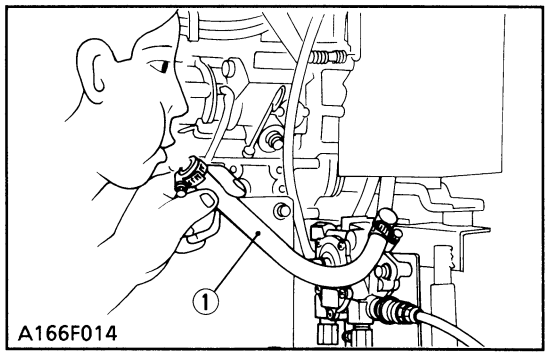
Primary Chamber (Vaporizer for LPG Fuel)

■ **IMPORTANT**
- **When checking the fuel system after completely consuming the fuel in piping.**
- **Treat a seal tape or liquid gasket when install each connector.**

1. Run the engine until it is warmed up.
2. The shut off valve is shut and the engine is stopped naturally.
3. Disconnect the plug (1).
4. Set the presser gauge (2).
5. The shut off valve is opened and the engine is started, and check the presser.
6. If the presser is not within the factory specification, readjust the primary presser adjust screw (See page S-44,45).
7. If the presser is not still within the specification, check inside vaporizer (See page S-46, 47, 48).
- Air tight of the primary valve.
- Height of the primary valve lever.
- Primary diaphragm.
- Air tight of the secondary valve.
- Leakage from each gasket.

Presser	Factory spec.	24.5 to 34.3 kPa 0.25 to 0.35 kgf/cm^2 3.5 to 4.9 psi

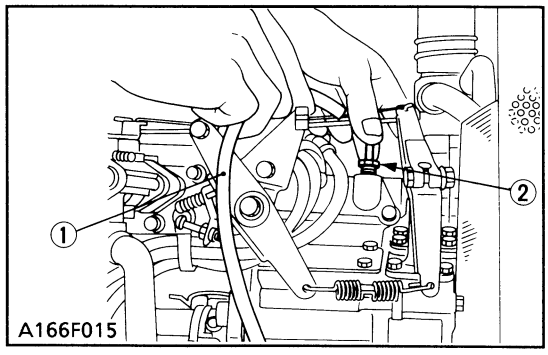
(1) Plug (2) Presser Gauge



Air Tight of Secondary Chamber (Vaporizer for LPG Fuel)

1. Disconnect the vapor hose (1) on the mixer side.
2. Breath is blown lightly or compressed air (9.8 kPa, 0.1 kgf/cm^2, 1.4 psi).
3. It is confirmed that the air does not leak.
4. If there is a leakage, check the following parts.
- Vacuum lock diaphragm.
- Secondary diaphragm.
- Leakage from each gasket.

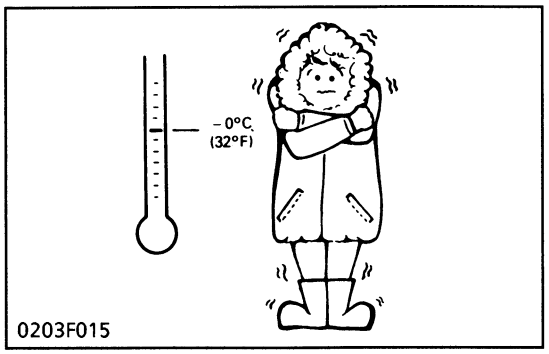
(1) Vapor Hose



Vacuum Lock System

1. After warming up, and set the low idling speed.
2. Disconnect the vacuum lock hose (1), and close the joint manifold by finger (A).
3. The thing that the engine stops is confirmed.

(1) Vacuum Lock Hose (2) Joint



Anti-freeze

If it freezes, coolant can damage the cylinders and radiator. It is necessary, if the ambient temperature falls below 0°C (32°F), to remove coolant after operating or to add anti-freeze to it.

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Befor adding anti-freeze for the first time, clean the radiator interior by pouring fresh water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with water, andthen fill into the radiator.

■ IMPORTANT

- **When the anti-freeze is mixed with water, the anti-freeze mixing ratio must be less than 50%.**

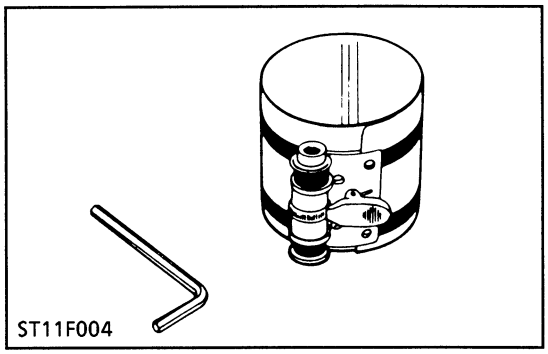
Vol % antifreeze	Freezing point		Boiling point	
	°C	°F	°C	°F
40	–24	–12	106	222
50	–37	–34	108	226

*At 1.013×10^5PA (760mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ NOTE

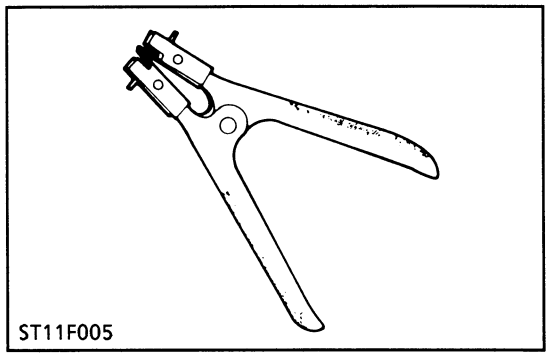
- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated antifreeze.**
- **When the coolant level drops due to evaporation, add water only to keep the anti-freeze mixing ratio less than 50%. In case of leakage, add antifreeze and water in the specified mixing ratio.**
- **Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when anti-freeze has been added to the coolant.**
  (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

[8] SPECIAL TOOLS


ST11F004

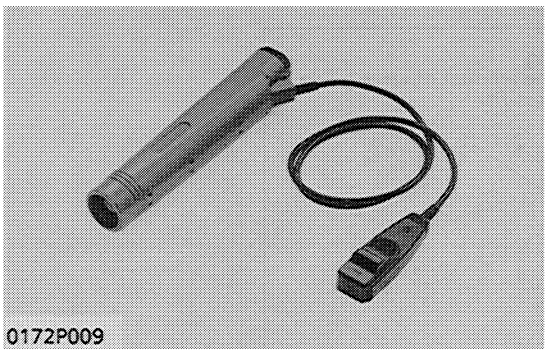
Piston Ring Compressor

Code No: 07909-32111
Application: Use exclusively for pushing in the piston with ease.


ST11F005

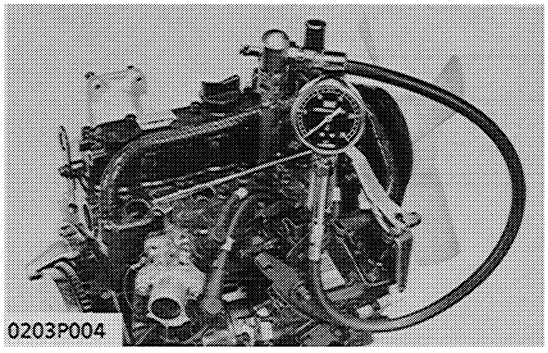
Piston Ring Tool

Code No: 07909-32121
Application: Use exclusively for removing or installing the piston ring with ease.


0172P009

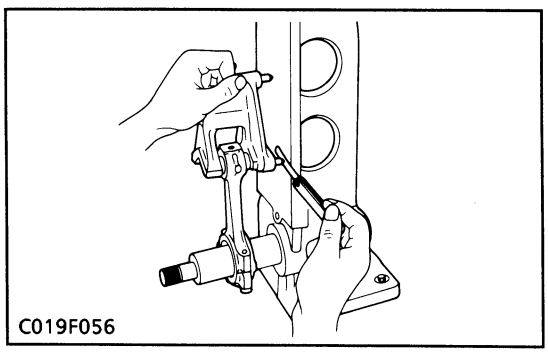
Timing Light

Application: Use to adjust the ignition timing.


0203P004

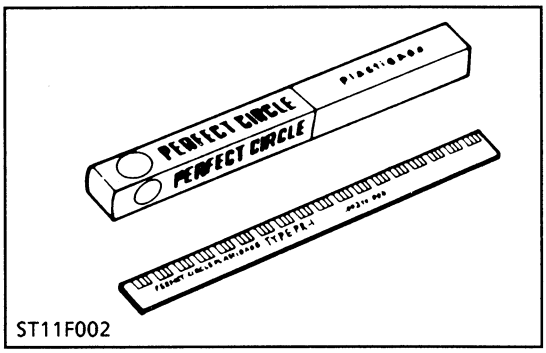
Compression Tester

Code No: 07909-30251
Application: Use to measure gasoline engine compression and to diagnose the engine for a major overhaul.


C019F056

Connecting Rod Alignment Tool

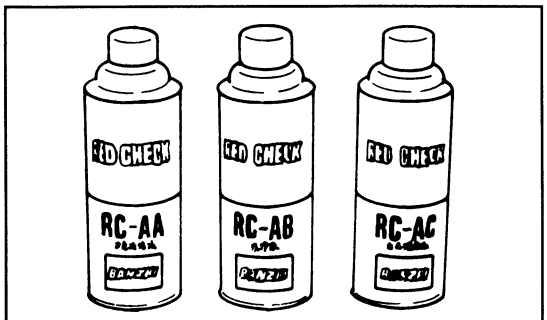
Code No: 07909-31661
Application: Use to check the connecting rod alignment.
Applicable range: Connecting rod large and I.D. 30 to 75 mm (1.18 to 2.95 in dia.).
Connecting rod length.
65 to 330 mm (2.56 to 12.99 in.)



ST11F002

Press Gauge

Code No: 07909-30241
Application: Use to check the oil clearance between crankshaft and bearing, etc.
Measuring range: Green — 0.025 to 0.076 mm (0.01 to 0.032 in.)
Red — 0.051 to 0.152 mm (0.02 to 0.06 in.)
Blue — 0.102 to 0.229 mm (0.04 to 0.09 in.)

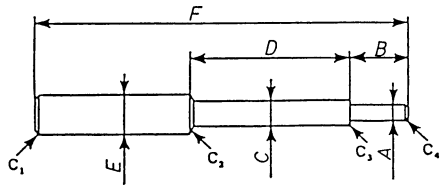


ST11F001

Red Check (Crack check liquid)

Code No: 07909-31371
Application: Use to check cracks on cylinder heads, crankcases, etc.

① Press-fit tool
Used to press in or remove the valve guides.

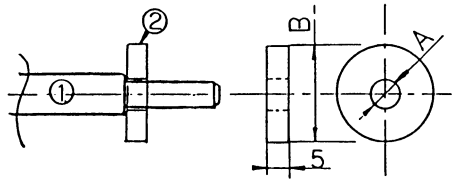


0203F018

mm (in.)

A	B	C	D	E	F
$\phi 6^{-0.3}_{-0.5}$ (0.224)	40 (1.6)	$\phi 10^{-0.04}_{-0.02}$ (0.394)	80 (3.15)	$\phi 20$ (0.8)	200 (8)

② Auxiliary fitting
Used to press the valve guides in.



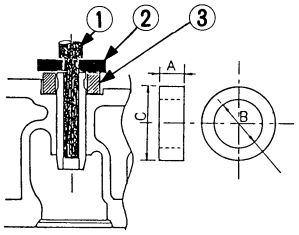
0203F019

mm (in.)

A	B
6 ± 8.1 (0.24)	15 ± 0 (0.59)

Valve Guide Replacing Tool

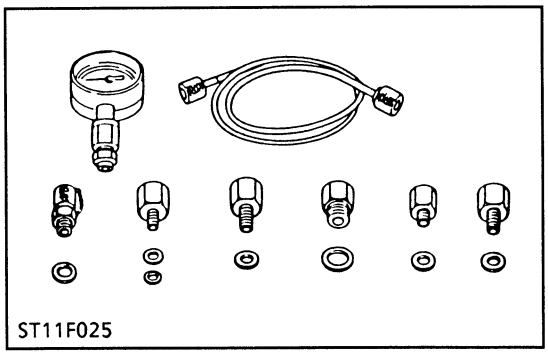
③ Margin adjustment jig
Used to determine the amount of valve guide protrusion during press-fit.



0203F020

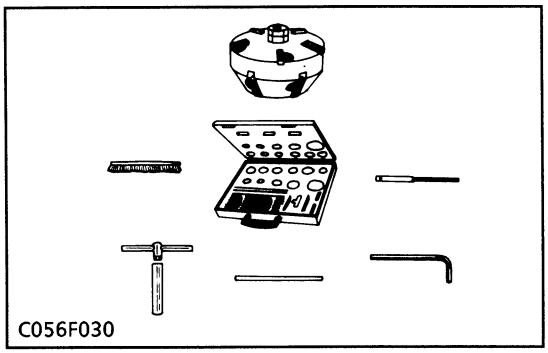
mm (in.)

A	B	C
7 ± 0 (0.276)	$10.5^{+0.2}_{+0.1}$ (0.7)	$18^{+0}_{-0.1}$ (0.7)


ST11F025

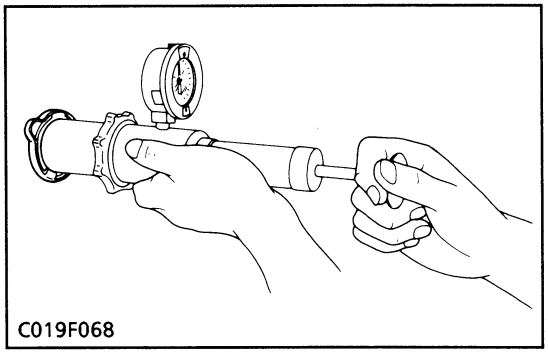
Oil Pressure Tester

Code No: 07916-32031
Application: A tester to measure lubricating oil pressure.


C056F030

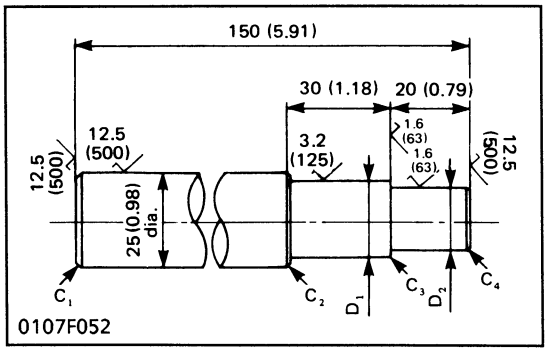
Valve Seat Cutter

Code No: 07909-33102
Application: Use to reseat valves.
Angle: 0.785 rad. (45°)
0.262 rad. (15°)
Diameter: 28.6 mm (1.126 in.)
31.6 mm (1.244 in.)
35.0 mm (1.378 in.)
38.0 mm (1.496 in.)
41.3 mm (1.626 in.)
50.8 mm (2.000 in.)


C019F068

Radiator Tester

Code No: 07909-31551
Application: Use for checking radiator water leakage and radiator cap opening pressure.

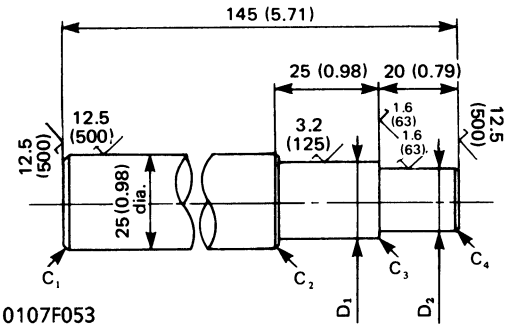


0107F052

Idle Gear Bushing Replacing Tool

Application: Use to press out and to press fit the idle gear bushing.

O.D.	mm	in.
D_1	21.90 to 21.95	0.8622 to 0.8642
D_2	19.90 to 19.95	0.7835 to 0.7854



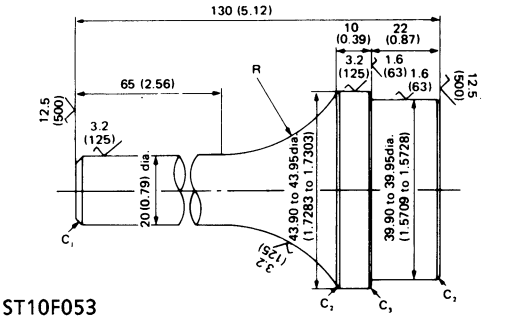
0107F053

Chamfer	mm	in.
C_1	2.0	0.079
C_2	1.0	0.039
C_3	0.2	0.0079
C_4	1.0	0.039

Small End Bushing Replacing Tool

Application: Use to press out and to press fit the small end bushing.

O.D.	mm	in.
D_1	19.90 to 19.95	0.7835 to 0.7854
D_2	17.90 to 17.95	0.7047 to 0.7067



ST10F053

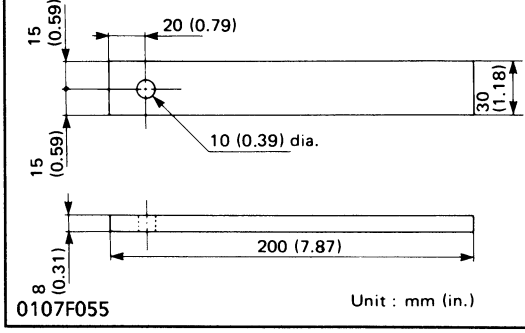
Chamfer	mm	in.
C_1	2.0	0.079
C_2	1.0	0.039
C_3	0.2	0.0079

Radius	mm	in.
R	40	1.57

Unit: mm (in.)

Crankshaft Bearing 1 Replacing Tool

Application: Use to press out and to press fit the cranks bearing 1.



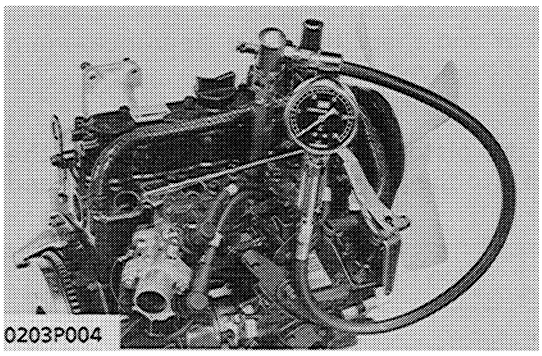
0107F055

Flywheel Stopper

Application: Use to loosen and tighten the flywheel bolts.

1 ENGINE BODY

CHECKING AND ADJUSTING


0203P004

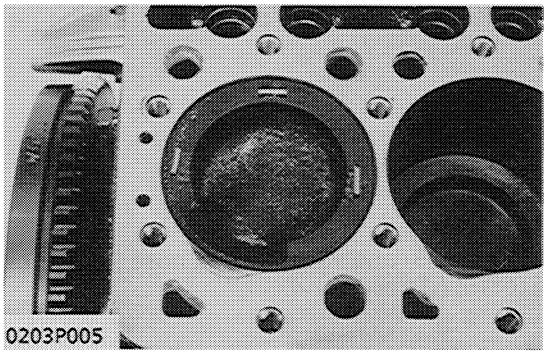
Compression Pressure

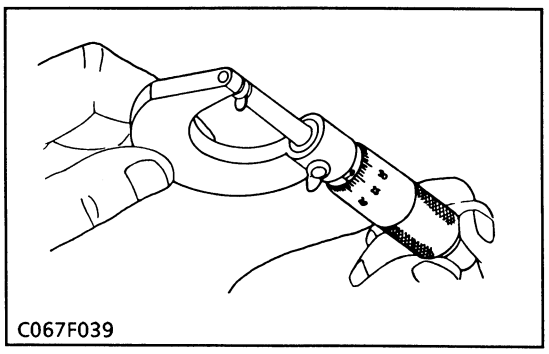
1. Run the engine until it is warmed up.
2. Stop the engine and remove the air cleaner, the muffler and all spark plugs.
3. Set a compression test (Code No.: 07909-30251) with the adaptor to the spark plug hole.
4. Run the engine with the starter at 450 rpm for 5 to 10 seconds keeping throttle valve fully open and read the maximum compression pressure.
5. Measure the compression pressure several times.
6. If the measurement does not reach the allowable limit, apply a small amount of oil to the cylinder wall through the spark plug hole and measure the compression pressure again.
7. If the pressure is still less than the allowable limit, check the top clearance, valve and cylinder head.
8. If the pressure increases after applying oil, check the cylinder wall and piston rings.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- Variances in cylinder compression values should be under 10%.

Compression pressure	Factory specification	12.7 MPa 13.0 kgf/cm² 185 psi
	Allowable limit	0.88 MPa 9.0 kgf/cm² 128 psi

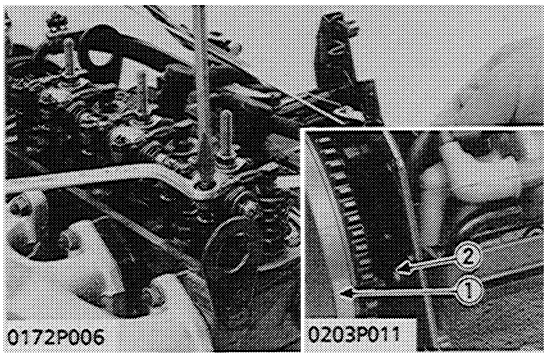

0203P005


C067F039

Top Clearance

1. Remove the cylinder head and the head gasket completely.
2. Bring the piston to it TDC, and fasten 1.5mm dia 5 to 7mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valve and combustion chamber ports.
3. Bring the piston to its middle position, install the cylinder head, and tighten the cylinder head bolts to specification. (Head gasket must be changed to new one)
4. Turn the flywheel until the piston passes through the TDC.
5. Remove the cylinder head, and measure the thickness of the fuses.
6. If the measurement is not within the factory specification, check the oil clearance between the crankpin and bearing and between the piston pin and bushing.

Top clearance	Factory specification	0.85 to 1.30 mm 0.0335 to 0.0511 in.
Tightening torque	Cylinder head bolt	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs



(1) TC Mark (2) Punch Mark Line

Valve Clearance

1. Loosen the lock nut and the adjusting screw on the rocker arm.
2. Turn the adjusting screw to adjust the valve clearance at the top dead center (T.D.C.) during the compression stroke of the piston.
3. Tighten the lock nut and check the valve clearance again after several turns of the flywheel.

■ **NOTE**

- **To get T.D.C. of the piston, find its "TC" mark on the flywheel and align it to the punch mark line on the rear end plate.**

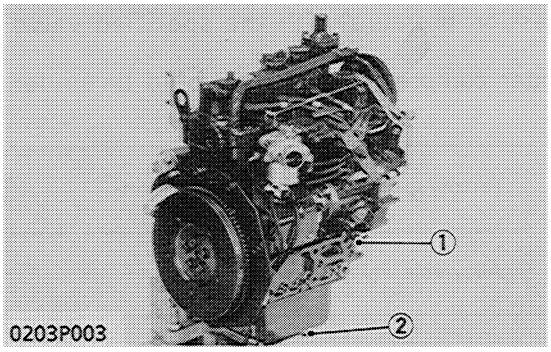
Valve clearance	Factory specification	0.145 to 0.185 mm 0.0057 to 0.0073 in.

DISASSEMBLING AND ASSEMBLING

■ **IMPORTANT**

- **When reassembling, replace all of the O-rings and gaskets by new ones.**
- **When disassembling the LPG engine after completely consuming the fuel in piping.**

[1] DRAINING WATER AND OIL



(1) Drain Cock (2) Drain Plug

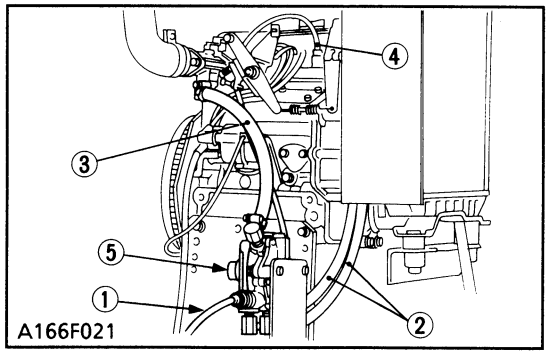
Draining Cooling Water and Engine Oil

⚠ **CAUTION**

- **Never remove radiator cap until cooling water temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Prepare a bucket. Open the drain cock to drain cooling water.
2. Prepare an oil pan. Remove the drain plug to drain engine oil in the pan.

[2] EXTERNAL COMPONENTS



LPG Hose and Water Pipe (for LPG Fuel Model)

1. Disconnect the LPG hose (1).
2. Disconnect the water hose (2).
3. Disconnect the vapor hose (3) and vacuum lock hose (4).
4. Remove the vaporizer (5) (if necessary).

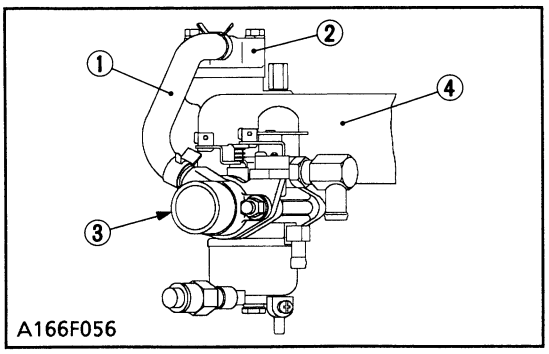
■ **IMPORTANT**

- **When disassembling the fuel system, make sure that the fuel valve is closed.**

(When reassembling)

- See page S-52.

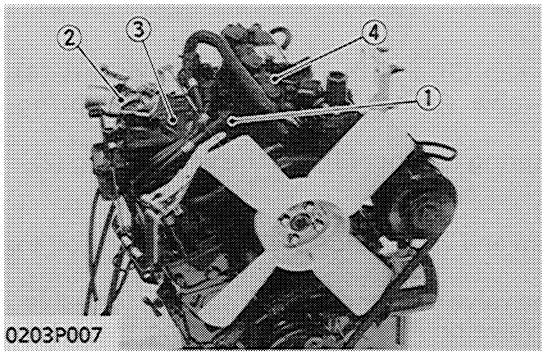
(1) LPG Hose
(2) Water Hose
(3) Vapor Hose
(4) Vacuum Lock Hose
(5) Vaporizer



Closed Breather (for Closed Breather Model)

1. Disconnect the breather hose (1).

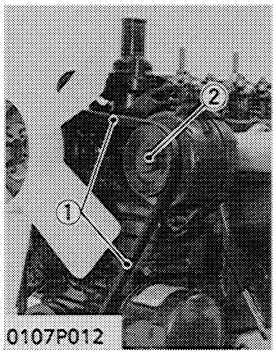
(1) Closed Breather Hose
(2) Closed Breather Assy
(3) Air Cleaner Flange
(4) Head Cover

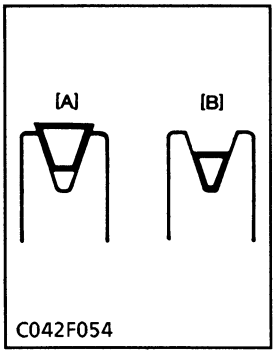


Ignition Cords, Inlet Manifold and Cylinder Head Cover

1. Remove the spark plug cap and the spark plug (1).
2. Remove the carburetor (2).
3. Remove the inlet manifold (3).
4. Remove the cylinder head cover (4).

(1) Spark Plug
(2) Carburetor
(3) Inlet Manifold
(4) Cylinder Head Cover





Alternator and Fan Belt

1. Remove the alternator (1).
2. Remove the fan belt (2).

(When reassembling)

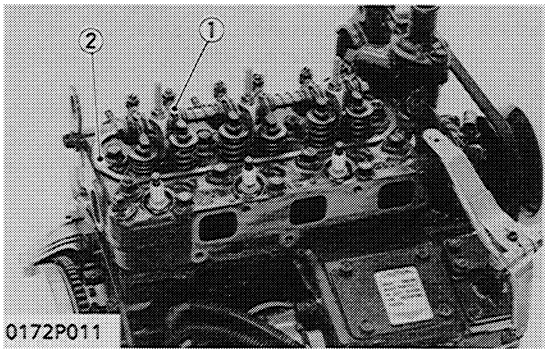
- Check to see that there are no cracks on the belt surface.

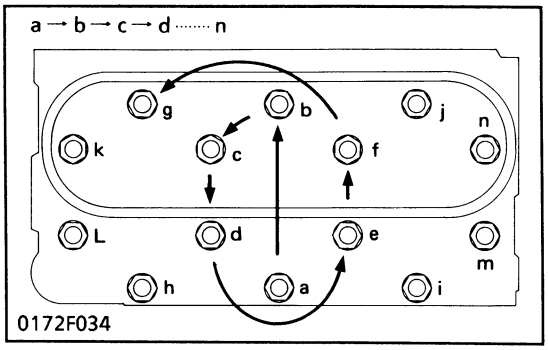
■ IMPORTANT

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**

(1) Fan Belt
(2) Alternator
[A] Good
[B] Bad

[3] CYLINDER HEAD AND VALVES





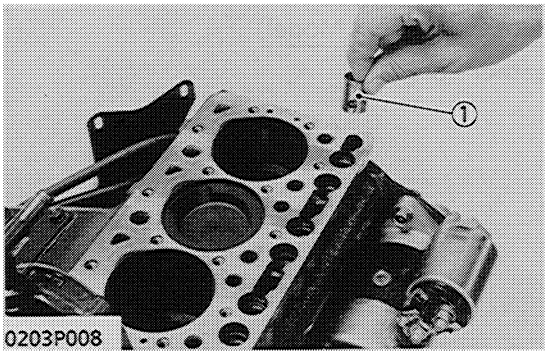
Rocker Arm and Cylinder Head

1. Remove the rocker arm bracket mounting nuts.
2. Remove the rocker arm assy.
3. Remove the push rods.
4. Remove the head bolts, and the cylinder head.

(When reassembling)

- Apply engine oil to the head bolts and tighten them in the specified sequence (See figure), in several steps and to the specified torque.
- After tightening all the bolts run the engine until if warms up and tighten them again to the specified torque.

(1) Rocker Arm
(2) Cylinder head



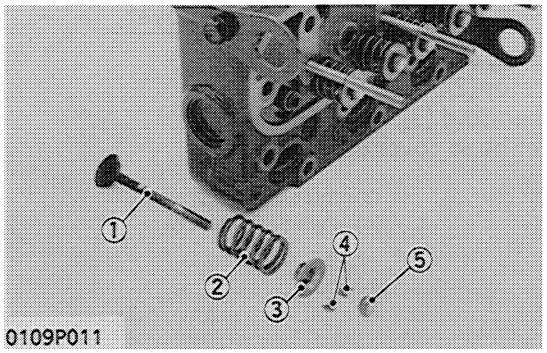
Tappets

1. Remove the tappets from the crankcase.

(When reassembling)
- Before installing the tappets, apply engine oil thinly around them.

■ NOTE
- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet



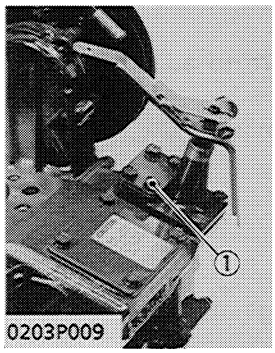
(1) Valve
(2) Valve Spring
(3) Valve Spring Retainer
(4) Collet
(5) Valve Cap

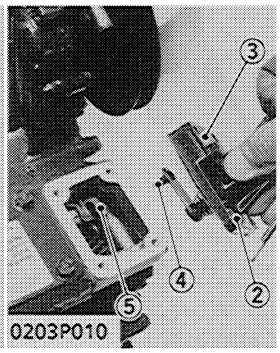
Valve

1. Remove the valve cap (5) and the valve spring collets (4) compressing the valve spring (2) with the valve spring retainer (3).
2. Remove the valve spring retainer (3) and the valve spring (2).

(When reassembling)
- Clean the valve stem and valve guide and apply engine oil to them.
- Be sure to adjust the valve clearance after installing the valve
- Be sure to lap the valve on its seat after replacing the valve, referring to "Correcting Valve and Seat".

[4] SPEED CONTROL LEVER AND DISTRIBUTOR



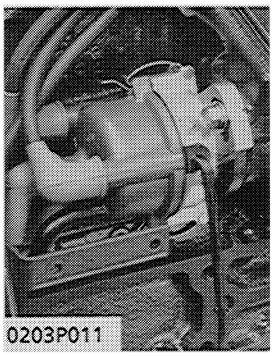


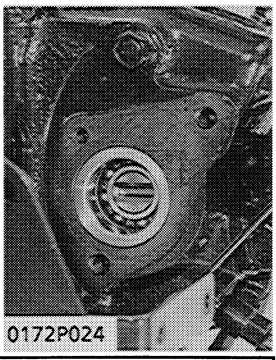
Speed Control Plate

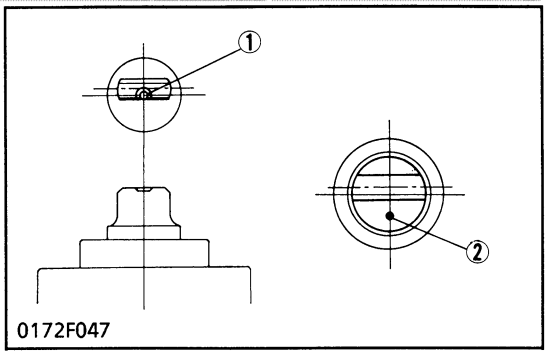
1. Remove the screws (1) and separate the speed control plate (2).

(When reassembling)
- Remove the speed control plate (3) and make sure that the governor lever shaft (4) is correctly set in the governor fork (5).

(1) Screws and Copper Washers
(2) Speed Control Plate
(3) Speed Control Plate Cover
(4) Governor Lever Shaft
(5) Governor Fork







Distributor

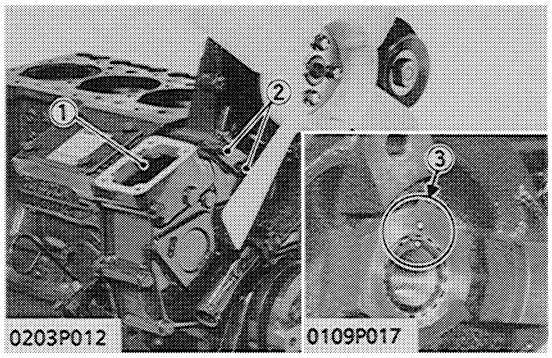
1. Remove the distributor.

(When reassembling)

- When placing the distributor over the distributor drive shaft, make sure that the distributor drive groove is horizontal when the first cylinder is at its highest position. At the same time, the mating mark should be at the bottom.

(1) Mating Mark on the Distributor
(2) Mating Mark on the Distributor Drive Shaft

[5] GEAR CASE AND TIMING GEARS



(1) Bolt
(2) Bolts
(3) Aligning Mark

Pulley and Gear Case

1. Prepare the stopper and install it to the flywheel so that the crankshaft does not turn.
2. Remove the fan drive pulley bolt and pull out the pulley with a puller.
3. Remove the screws and disconnect the speed control lever, and remove the gear case.

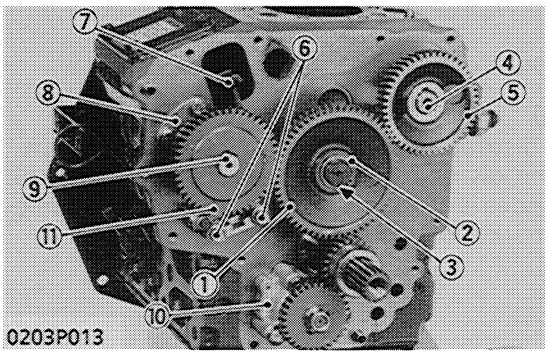
■ NOTE

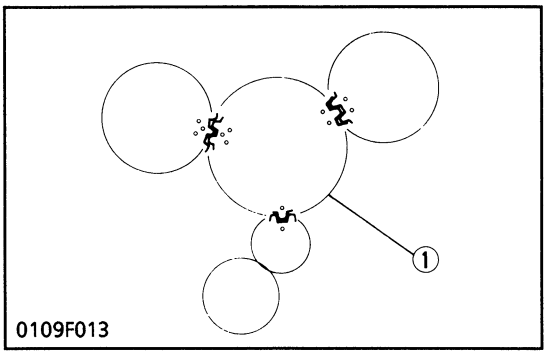
- **Be sure to remove the bolts (2) behind the fan and the bolt (1) inside the gear case.**

(When reassembling)

- Be sure to tighten the screws (1) and (2).
- Install the pulley to the crankshaft, aligning the marks (3) on them.
  Apply engine oil to the lock screw and tighten it to the specified torque.

Tightening torque	Fan drive pulley bolt	117.7 to 127.5 N·m 12.0 to 13.0 kgf·m 86.8 to 94.0 ft-lbs





Idle Gear, Distributor Drive Shaft and Oil Pump

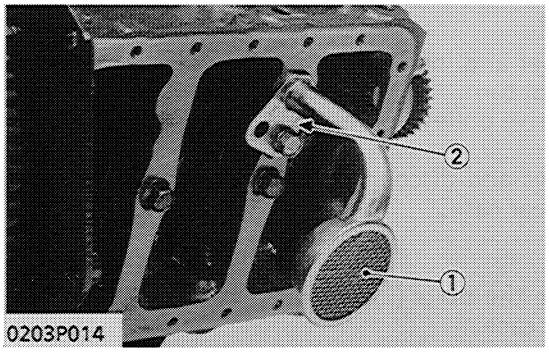
1. Remove the external snap ring (3).
2. Remove the idle collar 2 (2) and idle gear (1).
3. Remove the camshaft stopper mounting screws.
4. Remove the camshaft (4) with camgear (5).
5. Remove the fork lever mounting screws (6).
6. Remove the fork lever (7).
7. Remove the distributor drive shaft stopper (8).
8. Remove the distributor drive shaft (9).
9. Remove the oil pump gear and oil pump (10).

(When reassembling)

- Install the idle gear, aligning the marks on the gears referring the figure.

(1) Idle Gear
(2) Idle Collar 2
(3) External Snap Ring
(4) Camshaft
(5) Camgear
(6) Mounting Screw
(7) Fork Lever
(8) Stopper
(9) Drive Shaft
(10) Oil Pump
(11) Distributor Drive Gear

[6] PISTON AND CONNECTING ROD



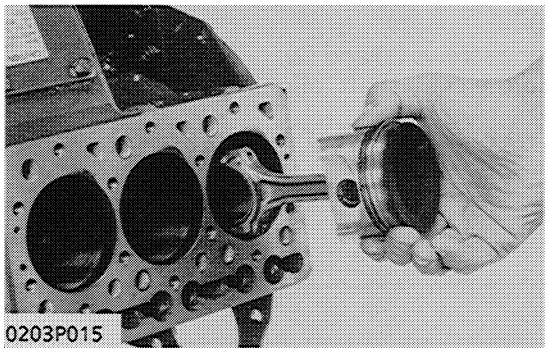
Oil Pan and Strainer

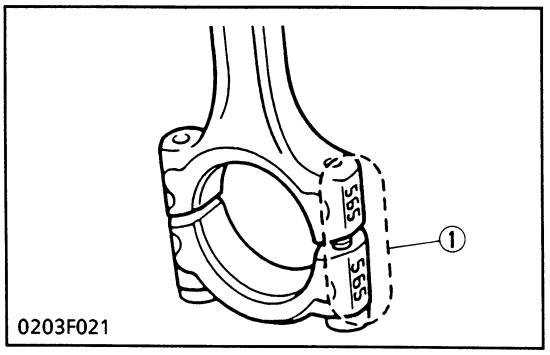
1. Remove the oil pan .
2. Remove the oil strainer.

(When reassembling)

- After cleaning the oil strainer, install it.
  Install the oil strainer, using care not to damage the O-ring.

(1) Oil Strainer
(2) Mounting Position MARK: 3





Piston and Connecting Rod

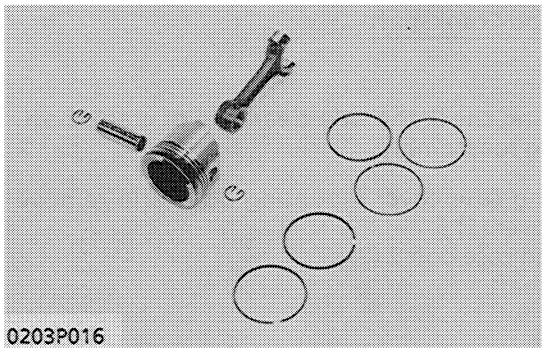
1. Remove the connecting rod screws.
2. Remove the connecting rod caps.
3. Turn the flywheel, and bring the piston to the top dead center.
4. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

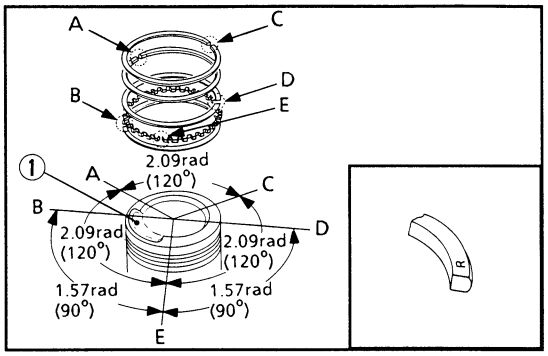
(When reassembling)

- Before inserting the piston into the cylinder, apply enough engine oil to the cylinder.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the speed control plate side.
- Apply engine oil to the crank pin bearings.
- Apply engine oil to the connecting rod bolts.
- Align the marks (1) on the connecting rod and connecting rod cap.

Tightening torque	Connecting rod bolts	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs

(1) Connecting Rod Manufacture's Number





Piston Ring and Connecting Rod

1. Remove the retaining ring and the piston pin.
2. Remove the piston rings using a piston ring tool (Code No.: 07909-32121).

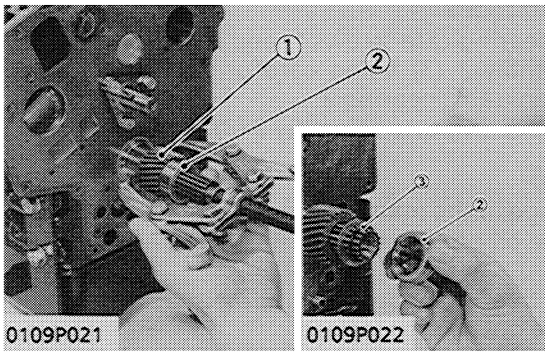
(When reassembling)

- When inserting the piston into the cylinder, place the gap (C) of the top compression ring on the opposite side of the slant portion (1), and stagger the gaps (A), (E) of the second compression ring and spacer making 2.09 rad. (120°) from the gap of the top compression ring. Further, stagger the gaps (D), (B) of the upper and lower side rail making 1.57 rad. (90°) from the gap of the spacer.
- Apply engine oil to the piston pin and the bushing. On reassembling the piston and the connecting rod, set the recess of the piston facing towards the alignment marks on the connecting rod.
- When inserting the piston pin to the piston, heat the piston in oil (80°C. 176°F) for 10 to 15 minutes.

(1) Slant Portion

[A] Second Compression Ring Gap
[B] Side Rail Gap
[C] Top Compression Ring Gap
[D] Side Rail Gap
[E] Spacer Gap

[7] FLYWHEEL AND CRANKSHAFT



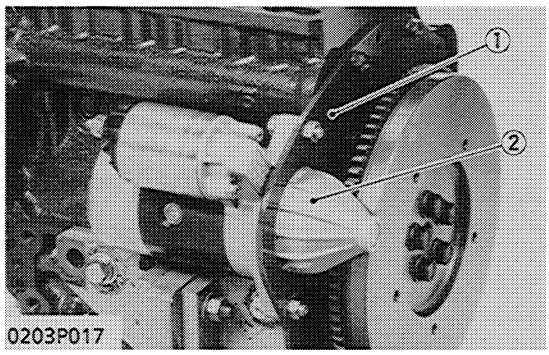
Oil Seal Sleeve and Gear

1. Remove the oil seal sleeve (2) and O-ring (3).
2. Pull out the crank gear (1) using a gear puller.

(When reassembling)

- Install the crank gear before installing the sleeve.
- Be sure to place the O-ring (3) before installing the sleeve (2).

(1) Crank Gear
(2) Sleeve
(3) O-ring



(1) Rear End Plate (2) Starter

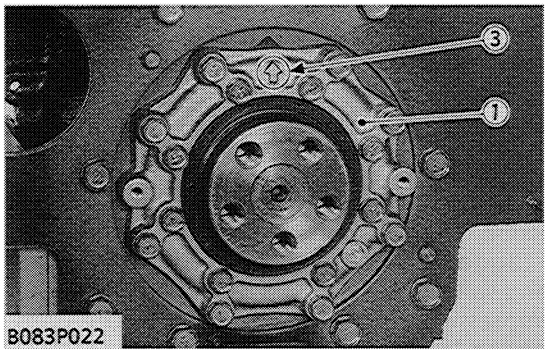
Flywheel

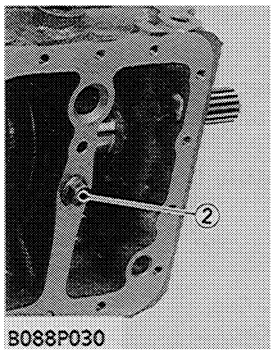
1. Install the stopper to the flywheel so that the flywheel does not turn.
2. Remove the bolts and the flywheel.
3. Remove the starter and rear end plate.

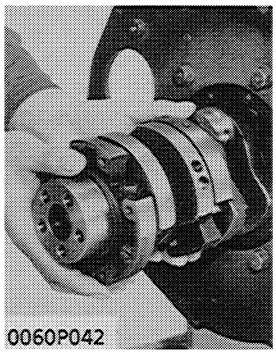
(When reassembling)

- Apply engine oil to the flywheel bolts.

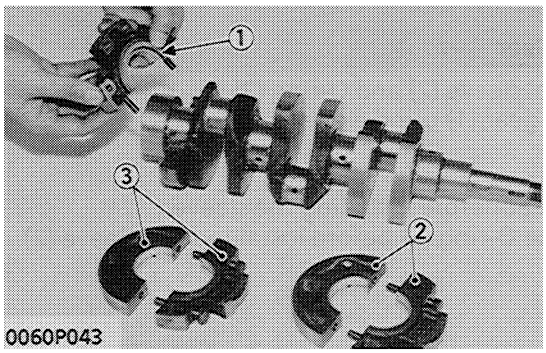
Tightening torque	Flywheel bolts	53.9 to 58.8 N·m 5.5 to 6.0 kgf·m 39.8 to 43.4 ft·lbs

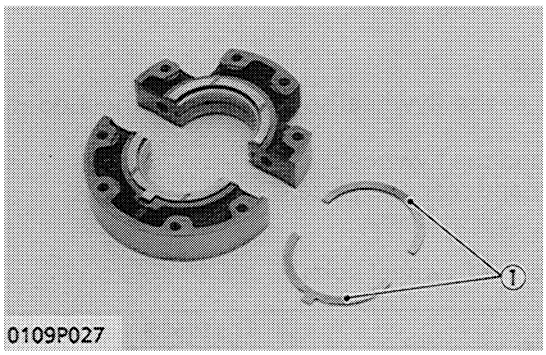






(1) Bearing Case Cover
(2) Bearing Case Bolt 2
(3) Casting Mark





(1) Thrust Bearing
(2) Main Bearing Assembly 1
(3) Main Bearing Assembly 2

Bearing Case Cover and Crankshaft

■ **NOTE**

- **Before disassembling check the side clearance of crankshaft. Also check it during reassembly.**

1. Remove the bearing case cover mounting bolts and remove the bearing case cover (1).
2. Remove the bearing case bolt 2 (2).
3. Pull out the crankshaft.

(When reassembling)

■ **IMPORTANT**

- **Install the crankshaft sub assembly, aligning the bolt hole of main bearing case 2 with the bolt hole of cylinder block.**
- **Apply engine oil to the seat and thread of bearing case bolt 2.**
- **Install the bearing case cover (1) to position the casting mark " " (3) on it upward.**
- **Tighten the bearing case cover mounting screws with even force on the diagonal line.**

Tightening torque	Bearing case screw 2	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs

Main Bearing Case Assembly

1. Remove the two bearing case screws 1. and remove the main bearing case assembly 1 (3) being careful with the thrust bearing (2) and cranksahft bearing 2.
2. Remove the main bearing case assembly 2 (3) as above.

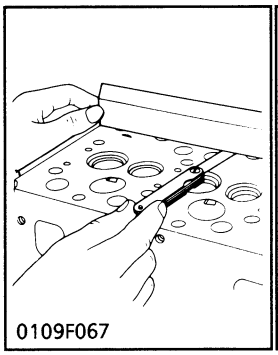
(When reassembling)

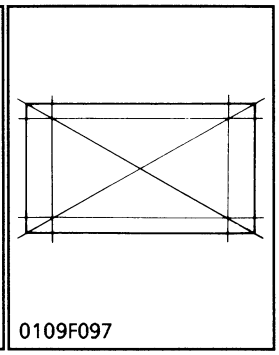
- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the crankshaft bearing 2 and thrust bearings.
- Install the main bearing case assemblies in the original positions. They are not interchangeable.
- When installing the main bearing case assemblies 2 (3) face the mark " " to the flywheel.
- Be sure to install the thrust bearing with its oil groove facing outward.

Tightening torque	Bearing case screws 1	12.74 to 15.68 N·m 1.3 to 1.6 kgf·m 9.4 to 11.5 ft-lbs

SERVICING

[1] CYLINDER HEAD


0109F067


0109F097

Cylinder Head Surface Flatness

1. Thoroughly clean the cylinder head surface.
2. Place a straight-edge on the cylinder head's four sides and two diagonal as shown in the figure.
   Measure the clearance with a feeler gauge.
3. If the measurement exceeds the allowable limit, correct it with a surface grinder.

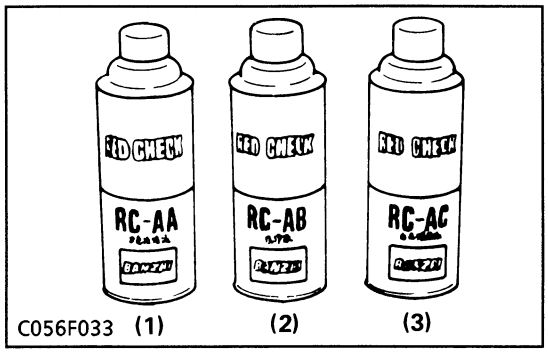
■ **NOTE**

- **Do not place the straight-edge on the combustion chamber.**

■ **IMPORTANT**

- **Be sure to check the valve recessing after correcting.**

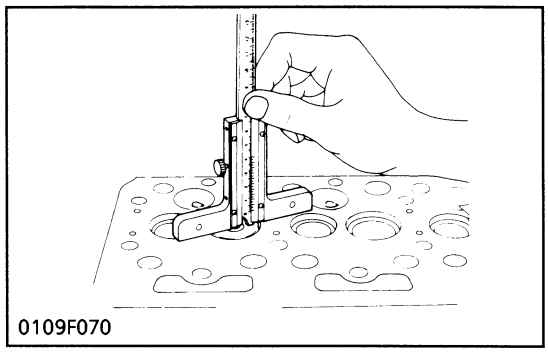
Flatness	Allowable limit	0.05 mm (0.0020 in.)



C056F033 (1) (2) (3)

Cylinder Head Flaw

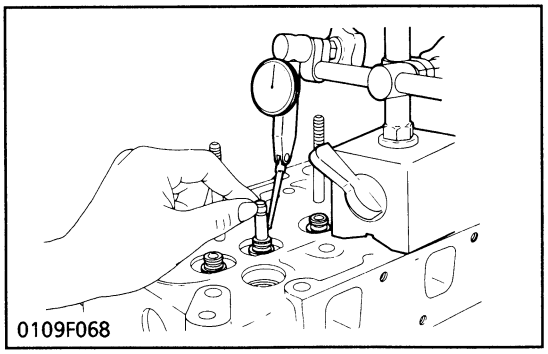
1. Prepare a red check (Code no: 07909-31371).
2. Clean the surface of the cylinder head with detergent (1).
3. Spray the cylinder head surface with the red permeative liquid (2).
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (1).
5. Spray the cylinder head surface with white developer (3). If flawed, it can be identified as red marks.


0109F070

Valve Recessing

1. Clean the cylinder head, the valve face and seat.
2. Insert the valve into guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
   If it still exceeds the allowable limit after replacing the valve, correct the valve seat face of the cylinder head with a valve seat cutter (Code No: 07909-33102) or valve seat grinder. Then, correct the cylinder head surface with a surface grinder, or replace the cylinder head.

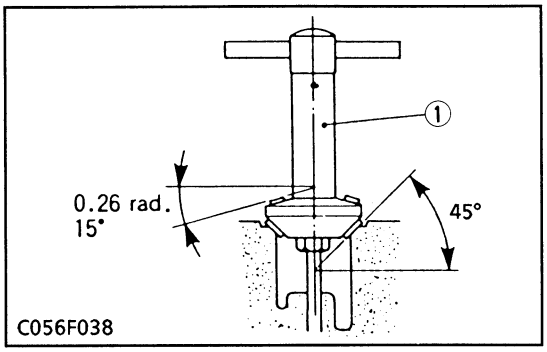
Valve recessing	Factory specification	0.75 to 0.95 mm 0.0295 to 0.0374 in.
	Allowable limit	1.2 mm 0.047 in.


0109F068

Clearance between Valve Stem and Guide

1. Remove carbon from the valve guide.
2. Make sure that the valve stem is straight and insert the valve into the valve guide.
3. Set the dial indicator with its tip on the stem near the end of the valve guide.
4. Measure the clearance, moving the valve sideways.
   If the measurement exceeds the allowable limit, replace the valve guide or the valve.

Clearance between valve stem and valve guide.	Factory specification	0.030 to 0.057 mm 0.00118 to 0.00224 in.
	Allowable limit	0.1 mm 0.004 in.



C056F038

Correcting Valve and Valve Seat

■ **NOTE**

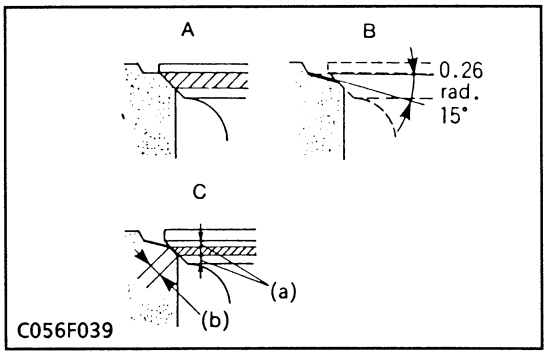
- **Before correcting the valve and seat, check the valve stem and the I.D. of the valve guide section, and repair them if necessary.**
- **After correcting the valve set, be sure to check the valve recessing.**

1) Correcting Valve

1. Correct the valve with a valve refacer.

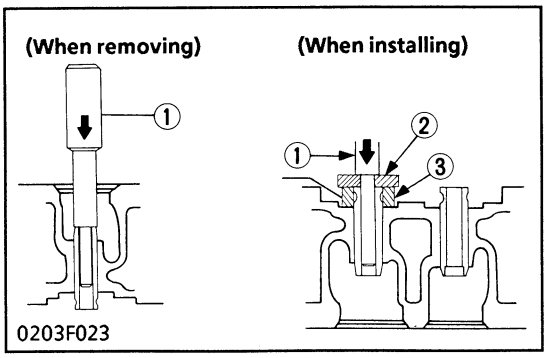
2) Correcting Valve Seat

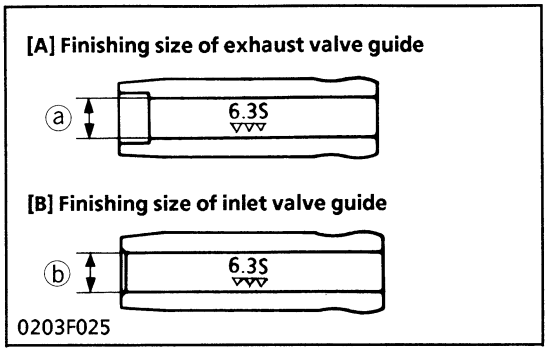
1. Slightly correct the seat surface with a 45° valve seat cutter (1) (Code No: 07909-33102).
2. Fitting the valve, check the contact position of the valve face and seat surface with red lead. (Visual check) [If the valve is used for a long period of time, it deviates to the upper part of the valve face, causing the seat to contact.]
3. Grind the seat surface with a 15° valve seat cutter so that the valve seat width contacts in the same dimensions from the center of the valve face width.
4. Repeatedly lap the valve and seat until the seated rate is more than 70%.

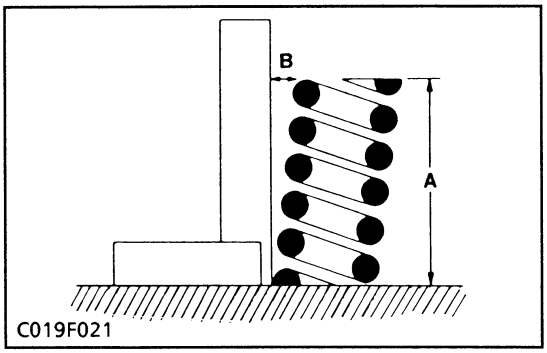


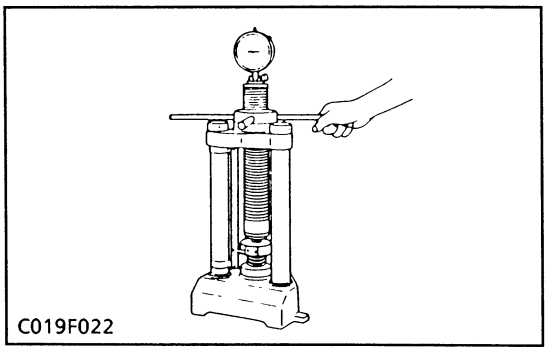
C056F039

[A] Check Contact
[B] Correct Seat Width
(a) Identical Dimensions
[C] Check Contact
(b) Valve Seat Width









Replacing Valve Guide

(When removing)

1. Using a valve guide replacing tool (See page S-31), press out the used valve guide.

(When installing)

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

■ NOTE

- **Be careful not to strike valve guide with a hammer, etc during replacement.**

■ IMPORTANT

- **When changing the valve guide, be sure to ream as the figure indicates after inserting the valve guide.**

(a) 6.010 to 6.025 mm
0.2366 to 0.2372 in.
(b) 6.010 to 6.025 mm
0.2366 to 0.2372 in.

① Press-fit tool
② Auxiliary fitting
③ Margin adjusting jig

Free Length and Tilt of Valve Spring

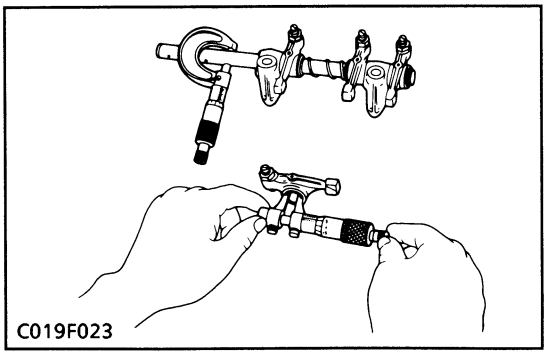
1. Measure the length A with vernier calipers. If the measurement is less than the allowable limit, replace.
2. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is in contact with the square. Rotate the spring and measure the maximum B.
   If the measurement exceeds the allowable limit, replace.
3. Check the entire surface of the spring for scratches, replace it, if any.

Free length	Factory spec.	31.6 mm 1.244 in.
	Allowable limit	28.4 mm 1.118 in.
Tilt B	Allowable limit	1.2 mm 0.047 in.

Valve Spring Setting Load

1. Replace the spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement exceeds the allowable limit, replace it.

Spring tension	Factory spec.	64.7 N (27 mm) 6.6 kgf (27 mm) 14.6 lbs (1.063 in.)
	Allowable limit	54.9 N (27 mm) 5.6 kgf (27 mm) 12.3 lbs (1.063 in.)

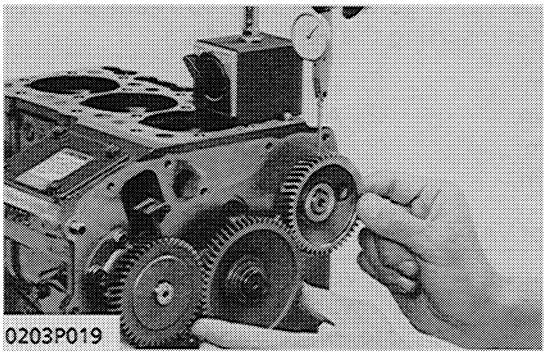

C019F023

Oil Clearance of Rocker Arm Shaft and Rocker Arm Bearing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Rocker arm hole and Rocker arm shaft	Factory specification	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.15 mm 0.0059 in.

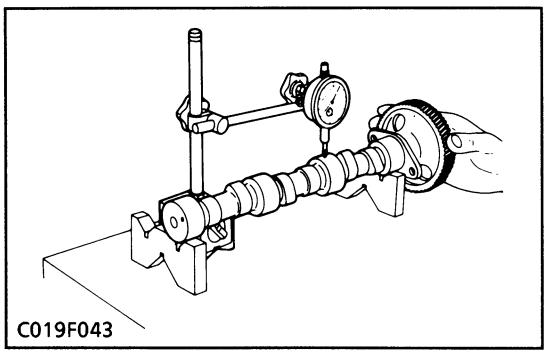
[2] TIMING GEAR AND CAMSHAFT


0203P019

Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and gear.
4. If the oil clearance is proper, replace the gear.

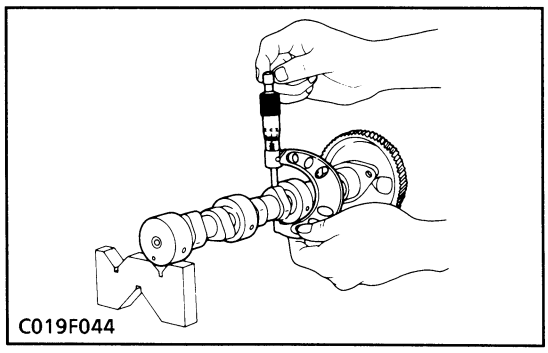
Idler gear to Crank Gear	Factory specification	0.043 to 0.124 mm 0.00169 to 0.00488 in.
	Allowable limit	0.15 mm 0.0059 in.
Idler gear to Cam Gear	Factory specification	0.047 to 0.123 mm 0.00185 to 0.00484 in.
	Allowable limit	0.15 mm 0.0059 in.


C019F043

Camshaft Alignment

1. Support the camshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
   Rotate the camshaft on the V-blocks and get the misalignment (half of the measurement).
   If the misalignment exceeds the allowable limit, replace the camshaft.

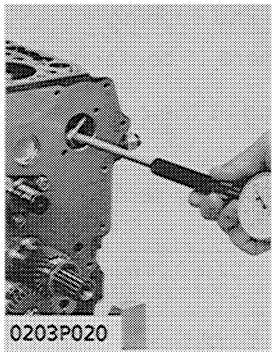
Camshaft alignment	Allowable limit	0.1 mm 0.0004 in.

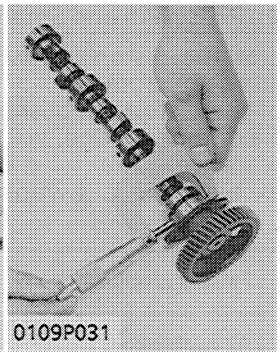

C019F044

Intake and Exhaust Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace it.

Cam height	Factory specification	26.88 mm 1.0583 in.
	Allowable limit	26.83 mm 1.0563 in.

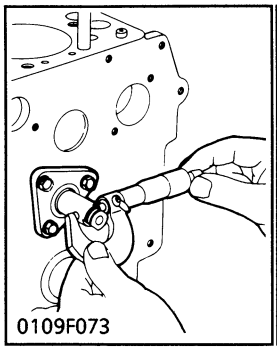

0203P020

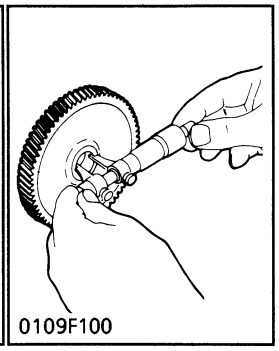

0109P031

Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the camshaft.

Oil clearance	Factory specification	0.050 to 0.091 mm 0.00197 to 0.00358 in.
	Allowable limit	0.15 mm 0.0059 in.

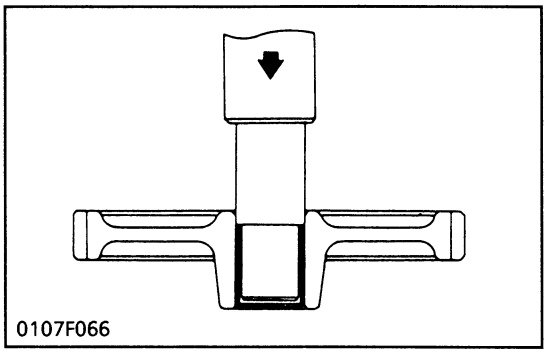

0109F073


0109F100

Clearance between Idle Gear Shaft and Idle Gear Bushings

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushings I.D. with an inside micrometer, and calculate the clearance.
3. If the clearance exceeds the allowable limit, replace the bushing.

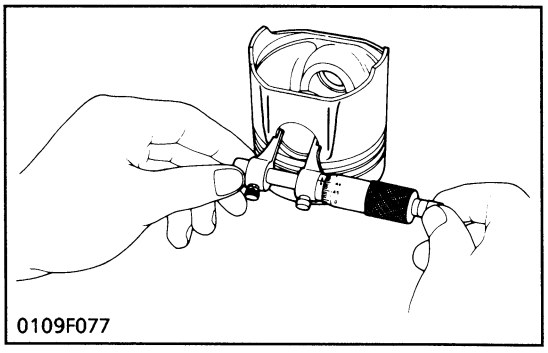
Oil clearance	Factory specification	0.02 to 0.054 mm 0.00079 to 0.00212 in.
	Allowable limit	0.10 mm 0.0039 in.


0107F066

Replacing Idle Gear Bushings

1. Press the used bushings out using a idle gear bushing replacing tool.
2. Press fit new bushings.

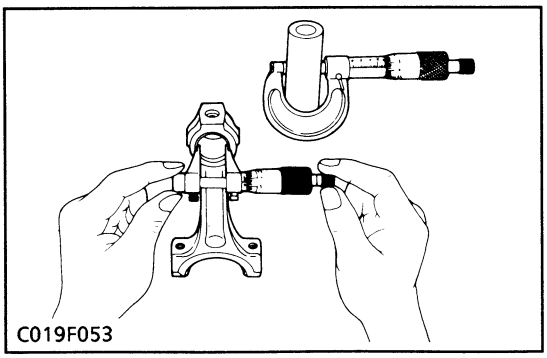
[3] PISTON AND CONNECTING ROD


0109F077

Piston Pin-Bore I.D.

1. Measure the I.D. of the piston pin-bore in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

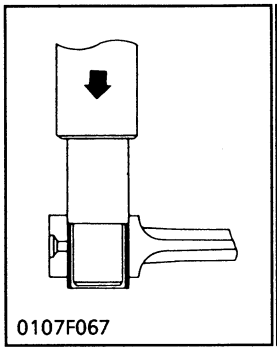
Piston pin-hole I.D.	Factory specification	18.000 to 18.011 mm 0.70866 to 0.70910 in.
	Allowable limit	18.05 mm 0.7106 in.

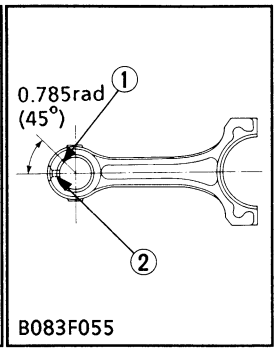

C019F053

Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the piston pin bushing at the connecting rod small end with a cylinder gauge. Calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory specification	0.02 to 0.04 mm 0.0008 to 0.0016 in.
	Allowable limit	0.10 mm 0.0039 in.


0107F067



B083F055

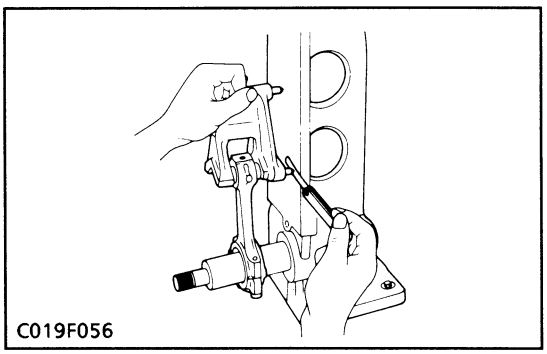
(1) Seam (2) Oil Hole

Replacing Connecting Rod Small End Bushing

(When removing)
1. Press out the small end bushing with a connecting rod small end bushing replacing tool. (See page S-23)

(When installing)
1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Insert a new bushing onto the tool and press-fit it with a press so that the seam of bushing positions as shown in the figure, until it is flash with the connecting rod.
3. Drill a hole to the bushing with aligning the oil hole (2) of connecting rod using 3.5 mm dia. (0.138 in. dia.) drill.

■ NOTE
- **Be sure to chamfer the oil hole circumference with an oil stone.**

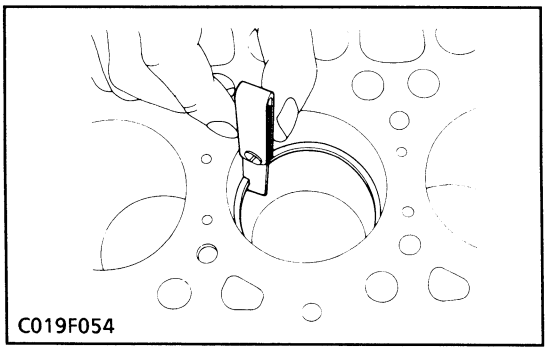

C019F056

Connecting Rod Alignment

■ NOTE
- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.**

1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the connecting rod alignment tool (Code No: 07909-31661).
3. Put a gauge over the piston pin and move it against the face plate.
4. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
5. If the measurement exceeds the allowable limit, replace the connecting rod.

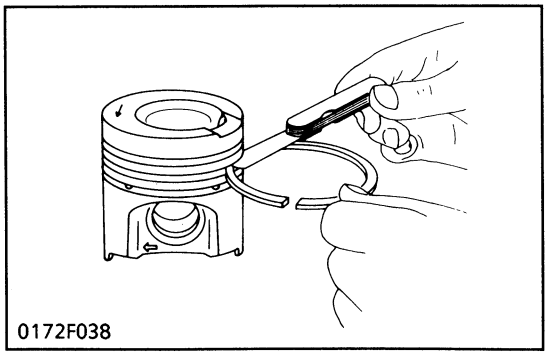
Space between pin and face plate	Allowable limit	0.05 mm 0.0020 in. (gauge pin span at 100 mm (3.94 in.)


C019F054

Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the ring.

Piston ring gap	Compression ring	Factory spec.	0.25 to 0.40 mm 0.0098 to 0.0157 in.
		Allowable limit	1.25 mm 0.0492 in.
	Oil ring	Factory spec.	0.20 to 0.40 mm 0.0079 to 0.0157 in.
		Allowable limit	1.25 mm 0.0492 in.

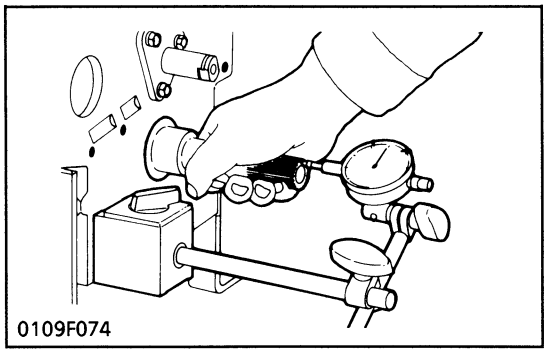

0172F038

Clearance between Piston Ring and Groove

1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge.
3. If the clearance exceeds allowable limit, replace the ring .
4. If the clearance still exceeds the allowable limit after replacing the ring, replace the piston.

Piston ring clearance	Compression ring	Factory spec.	0.02 to0.06 mm 0.0008 to 0.0024 in.
		Allowable limit	0.15 mm 0.0059 in.
	Oil ring	Factory spec.	0.02 to0.06 mm 0.0008 to 0.0024 in.
		Allowable limit	0.15 mm 0.0059 in.

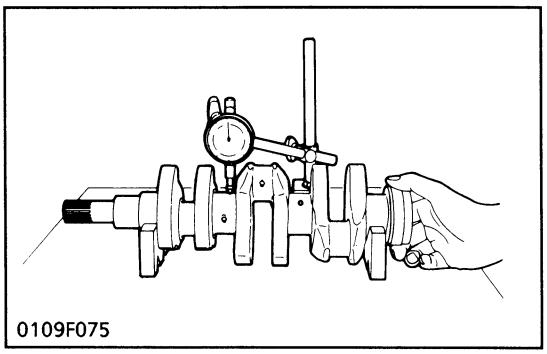
[4] CRANKSHAFT


0109F074

End Play of Crankshaft

1. Move the crankshaft to the flywheel side.
2. Set a dial indicator to the crankshaft.
3. Measure the end play by pulling the crankshaft toward the crank gear.
4. If the measurement exceeds the allowable limit, replace the thrust bearings.

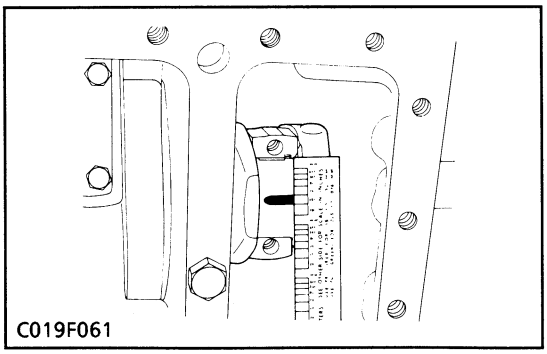
End play	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.5 mm 0.020 in.

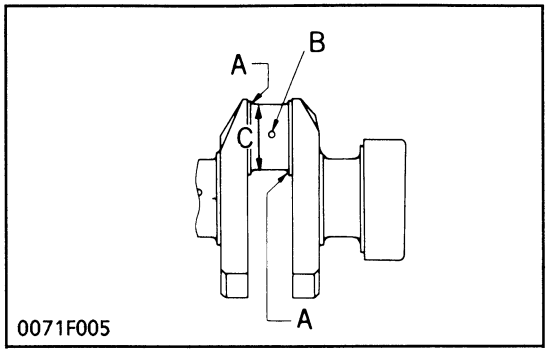

0109F075

Crankshaft Alignment

1. Support the crankshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V-blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Eccentricity	Factory specification	0.02 mm 0.0008 in.
	Allowable limit	0.04 mm 0.0016 in.


C019F061



0071F005

Oil Clearance between Crank Pin and Pin Bearing

1. Clean the crank pin and crank pin bearing.
2. Put a strip of press gauge (Code No: 07909-30241) on the center of the crank pin in each direction as shown in the figure.

■ IMPORTANT

- **Never insert the press gauge into the crank pin oil hole.**

3. Install the connecting rod cap and tighten the screws to the specified torque, and remove the cap again.

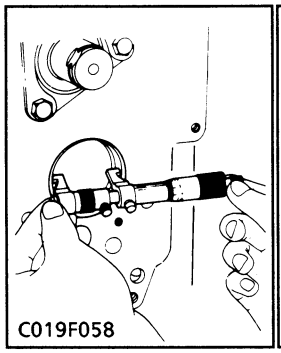
■ NOTE

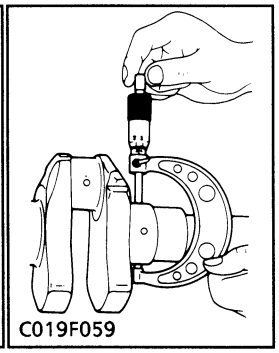
- **Fasten the crankshaft so that it does not turn.**

4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the bearing (See page S-6).

(Reference)

- When the oil clearance is to be measured by removing the crankshaft, tighten the connecting rod cap with the specified torque, then measure the crank pin bearing I.D. with a cylinder gauge or an inside micrometer. And measure the crank pin O.D. with an outside micrometer. Calculate the oil clearance.

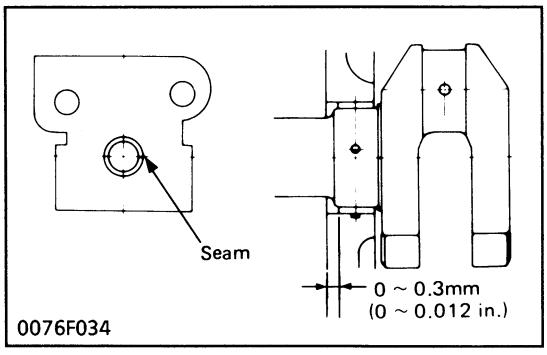

C019F058


C019F059

Oil Clearance between Crankshaft Journal and Bearing 1

1. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer.
2. Measure the O.D. of the crankshaft front journal with an outside micrometer.
3. If the oil clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and the figure.

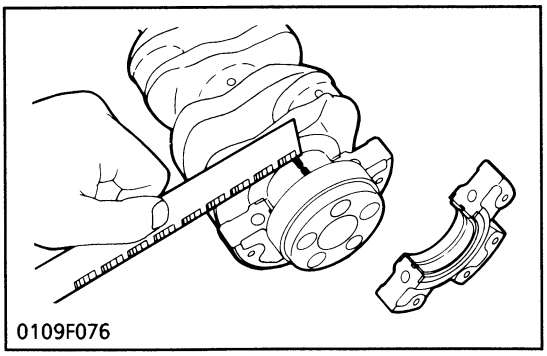
Oil clearance	Factory spec.	0.034 to 0.106 mm 0.00134 to 0.00417 in.
	Allowable limit	0.20 mm 0.0079 in.

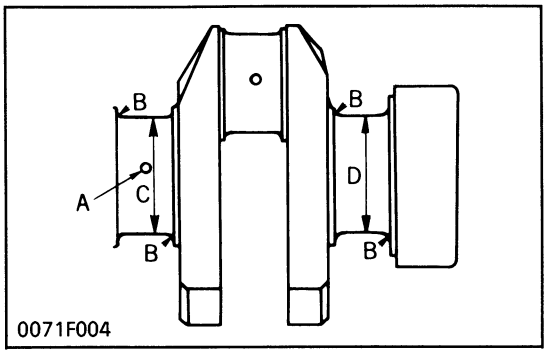


0076F034

■ IMPORTANT

- **Install the bearing using a replacing tool (see page S-23), so that its seam directs toward the exhaust side in the crankcase (See figure).**


0109F076



0071F004

Oil Clearance between Crankshaft Journal and Bearing 2 and 3

1. Put a strip of press gauge in the center of the journal.
2. Install the bearing cap and tighten the screws to the specified torque, and remove the bearing cap.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the oil clearance exceeds the allowable limit, replace the crankshaft bearing.
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and the figure.

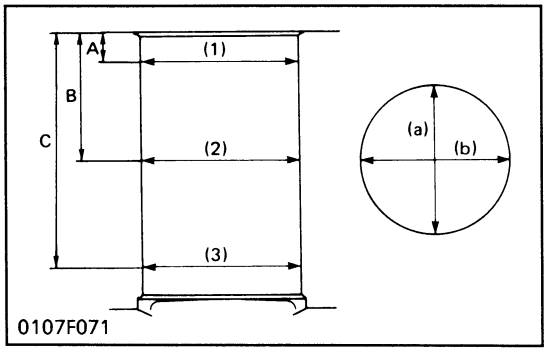
Tightening torque	Bearing cap screw	11.8 to 14.7 N·m 1.3 to 1.6 kgf·m 8.7 to 10.8 ft-lbs
Oil clearance	Factory specification	0.034 to 0.092 mm 0.00134 to 0.00417 in.
	Allowable limit	0.20 mm 0.0079 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	3 mm dia. 0.12 in. dia.	3 mm dia. 0.12 in. dia.
B	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius
C	39.734 to 39.750 mm 1.56433 to 1.56496 in.	39.534 to 39.550 mm 1.55646 to 1.55709 in.
D	43.734 to 43.750 mm 1.72181 to 1.72244 in.	43.534 to 43.550 mm 1.71394 to 1.71457 in.
The crank pin must be fine-finished to higher than ∇∇∇∇ (0.4 S)		

[5] CYLINDER LINER



0107F071

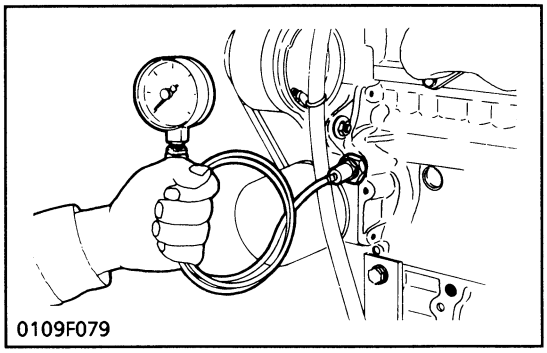
A : Approx. 11mm (0.433 in.)
B : Approx. 45 mm (1.771 in.)
C : Approx. 95 mm (3.740 in.)

Cylinder I.D. (Maximum Wear)

1. Measure the six points shown in the figure with a cylinder gauge to find out the maximum wear. Generally, position (1) in the (a, b) direction (at about 11 mm (0.433 in.) from the top) shows the maximum wear. Since position (3) at the lower part of the cylinderwall will show the minimum wear, find this difference.

Cylinder I.D.	Factory spec.	68.00 to 68.019 mm 2.6772 to 2.6779 in.
Maximum wear	Allowable limit	0.15 mm 0.0059 in.

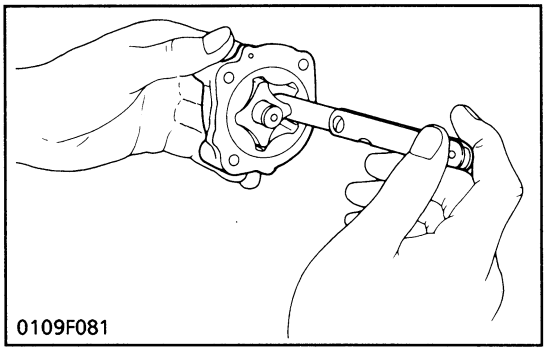
2 LUBRICATING SYSTEM


0109F079

Engine Oil Pressure

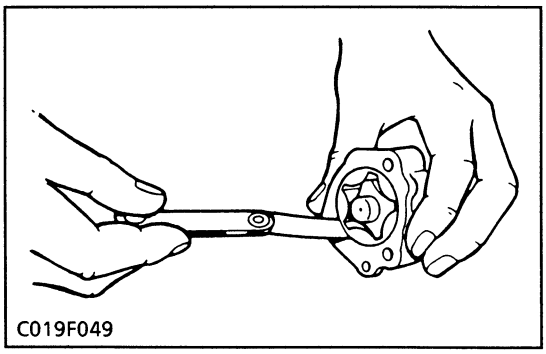
1. Remove the oil switch and set a pressure tester (Code No: 07916-32032).
2. Start the engine. After warming up, measure the oil pressure both at idling and rated speed.
3. If the oil pressure is less than the allowable limit, check and repair referring to the causes below.
   - ●Engine oil insufficient
   - ●Oil filter clogged
   - ●Dirt in relief valve
   - ●Oil gallery clogged
   - ●Excessive oil clearance
   - ●Oil pump defective

Engine oil pressure	At idle speed	Factory specification	more than 69 kPa 0.7 kgf/cm² 10 psi
	At rated speed	Factory specification	196 to 441 kPa 2.0 to 4.5 kgf/cm 28 to 64 psi
		Allowable limit	186 kPa 1.9 kgf/cm 27 psi


0109F081

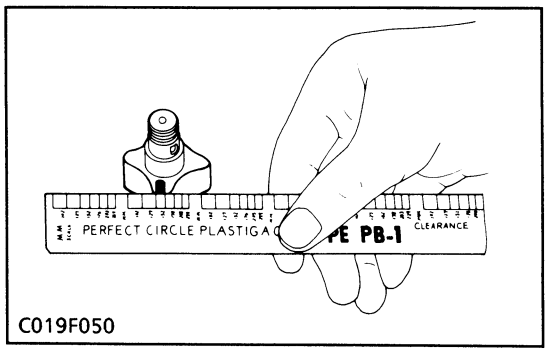
Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.


C019F049

Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.



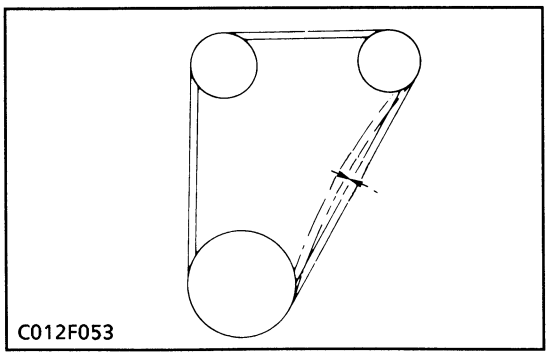
C019F050

Clearance between Rotor and Cover

1. Put a strip of press gauge (Code No: 07909-30241) onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the allowable limit, replace oil pump rotor assembly.

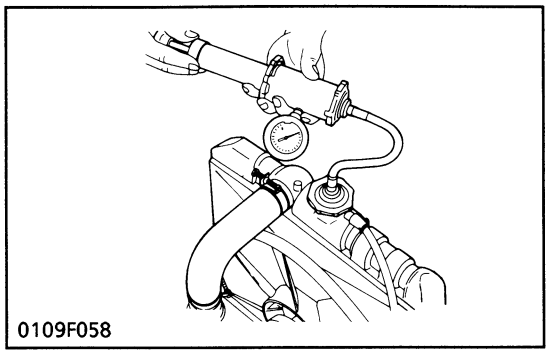
3 COOLING SYSTEM

CHECKING


C012F053

Fan Belt Tension

1. Press the fan belt between fan pulley and pulley with your finger at force of 10 kgf (98N, 22 lbs).
   Check if the fan belt deflection is 7 to 9 mm (0.28 to 0.35 in.)
2. If the deflection is not within the factory specifications, adjust with the tension pulley adjusting nut.

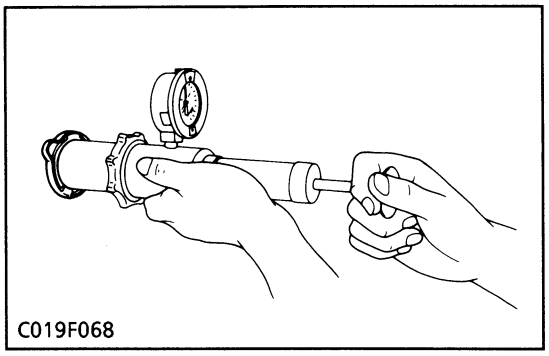

0109F058

Radiator Water Tighteness

1. Fill the radiator with water to the specified amount and warm up the engine.
2. Set a radiator tester and raise the water pressure to the 13.7 kPa (1.4 kgf/cm^2, 20 psi.)
3. Check the radiator for water leaks.
4. For water leak from the pinhole, repair with the radiator cement, and for other leaks, replace the radiator.

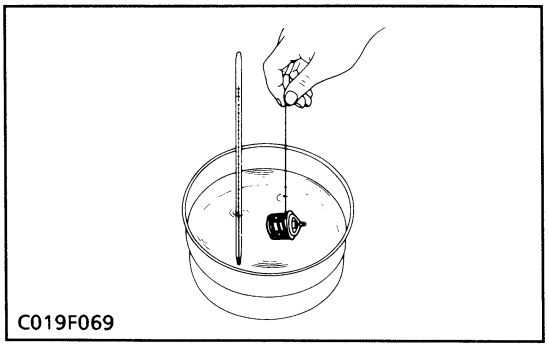
⚠ CAUTION

- **When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.**


C019F068

Radiator Cap Opening Pressure

1. Set a radiator tester on the radiator cap.
2. Apply the pressure of 88 kPa (0.9 kgf/cm^2, 13 psi) and measure the time for the pressure to fall to 59 kPa 0.6 kgf/cm^2, 9 psi)
3. If the measurement is less than the specified valve, replace the radiator cap.


C019F069

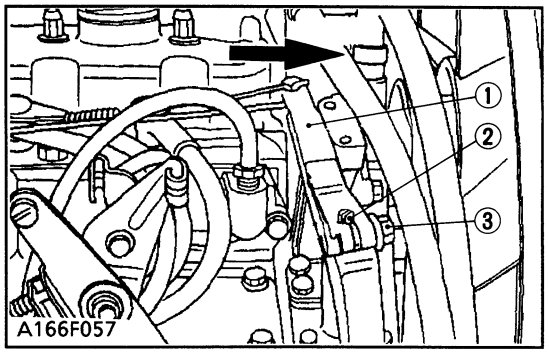
Thermostat's Valve Opening Temperature

1. Push down the thermostat valve and insert a string between the valve and the valve seat.
2. Place the thermostat and a thermometer in a container with water and gradually heat the water.
3. Hold the string to suspend the thermostat in the water. When the water temperature rises, the thermostat valve will open, allowing it to fall down from the string.
   Read the temperature at this moment on the thermometer.
4. Continue heating the water and read the temperature when the valve has risen by about 6 mm (0.236 in.).
5. If the measurement is not acceptable , replace the thermostat.

4 FUEL SYSTEM

CHECKING AND ADJUSTING

[1] GOVERNOR



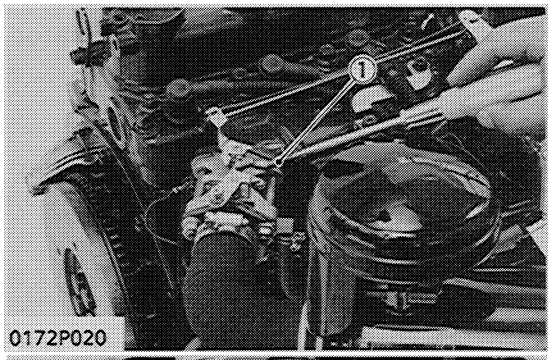
Adjusting Governor

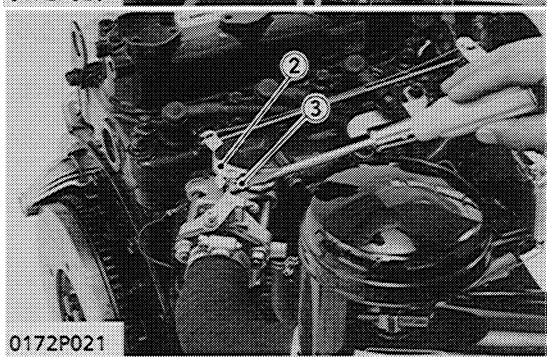
1. Loosen the governor lever nut (3).
2. Set the throttle valve to the fully "open" position with the governor lever (1), turn the groove on the governor lever shaft (2) fully clockwise with a screwdriver (to open the governor completely), and then tighten the nut (3) in this position.

Tightening torque	Governor lever nut	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.2 ft-lbs

(1) Governor Lever
(2) Governor Lever Shaft
(3) Governor Lever Nut

[2] ENGINE SPEED





Adjusting Engine Speed (for WG750)

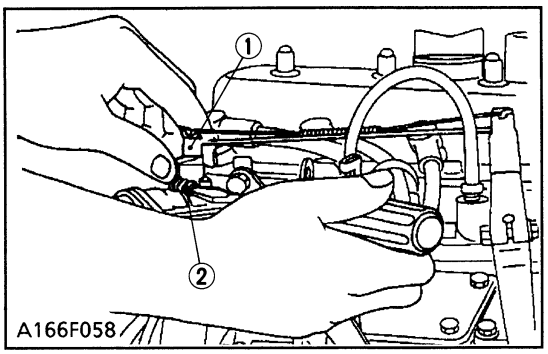
1. Warm up the engine at a medium speed for 10 to 15 minutes, and then stop the engine.
2. Tighten the pilot screw (1) of the carburetor completely, and then loosen it by 1 to 1.5 turns.

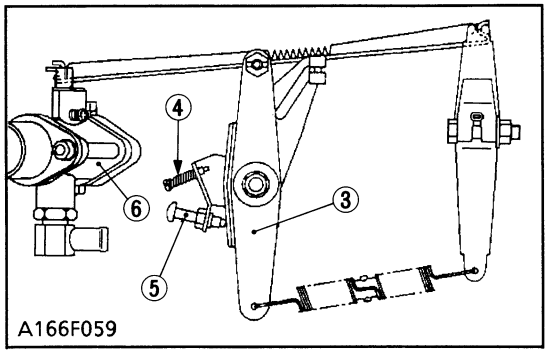
■ **NOTE**

- **Do not tighten the pilot screw (1) too much. The taper may become stepped.**

3. Start the engine, set the speed control lever to the lowest speed position, and then adjust the engine speed with the throttle stopper adjusting screw (3) of the carburetor in such a way the engine maintains a lowest speed. (Adjust the engine to the lowest speed but fast enough to keep it running.).
4. Tighten or loosen the pilot screw (1) to adjust the engine to the highest speed. (The speed drops when the screw is turned too much in either direction.).
5. Screw in the throttle stopper adjusting screw (3) with the screw tip touching the throttle valve (2); until the speed reaches approximately 1200 r.p.m.

(1) Pilot Screw
(2) Throttle Valve
(3) Throttle Stopper Adjusting Screw





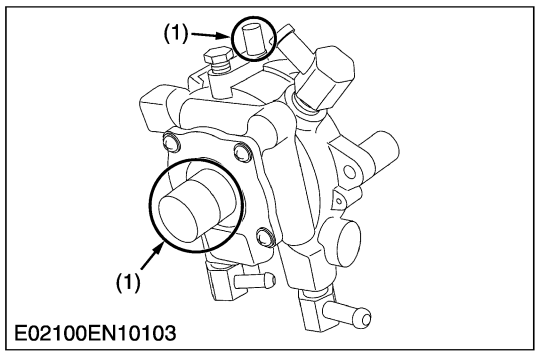
Adjusting Engine Speed (for DG750, DF750)

1. Warm up the engine at a medium speed for 10 to 15 minutes.
2. Engine speed is adjusted to approx. 1500 rpm by the speed control lever (3).
3. Throttle valve (1) is closed by hand and the rpm of the engine is adjusted with the throttle adjust screw (2) to 1200 rpm (1100 to 1300 rpm).
4. Adjust the low-idling speed adjust screw (4) until the engine rpm reaches 1500 rpm (1400 to 1600 rpm) with the speed control lever (3) in the minimum speed position.
5. Adjust the high-idling speed adjust screw (5) until the engine speed reaches 3850 rpm (3850 to 3950 rpm) with the speed control lever (3) in the maximum speed position.

(1) Throttle Valve
(2) Throttle Adjust Screw
(3) Speed Control Lever
(4) Low-idling Adjust Screw
(5) High-idling Adjust Screw
(6) Mixer (DG750) or D.F. Carburetor (DF750)

SERVICING

[1] VAPORIZER [LPG Model]

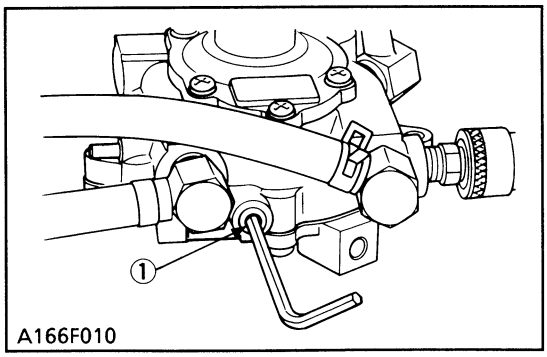


Tamper Resistance

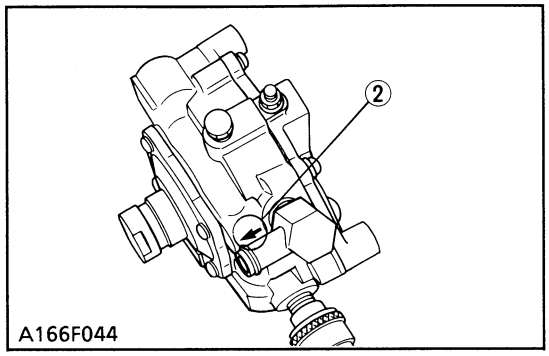
KUBOTA Corporation is to provide safeguards for the parts where never to be adjusted, and is approved by EPA/CARB for the purpose of this engine to be in compliance with EPA/CARB Emission Regulations through its useful life. Intentional removable and adjustment of such tamper resistance are subject to the penalty.

(1) Tamper Resistance

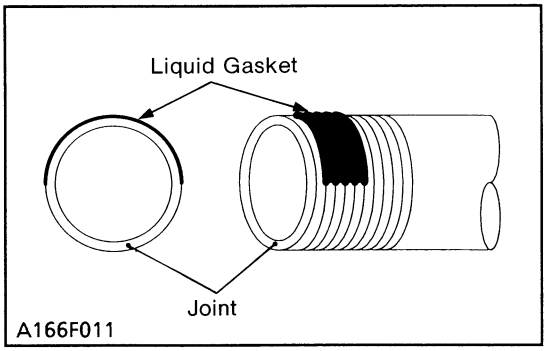
W1139105



A166F010



A166F044



A166F011

Joints (Fittings)

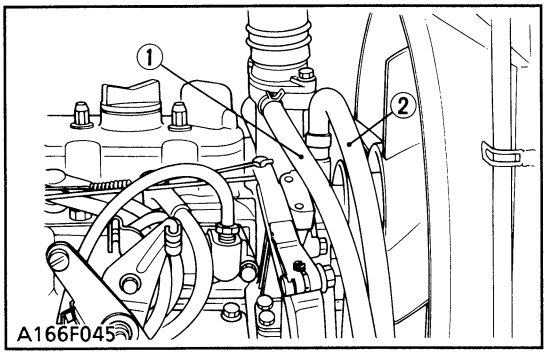
1. The direction of the joint for vapor hose is decided upon and a mark (2) is made.
2. The direction of the joint for water hose is decided upon and a mark is made.

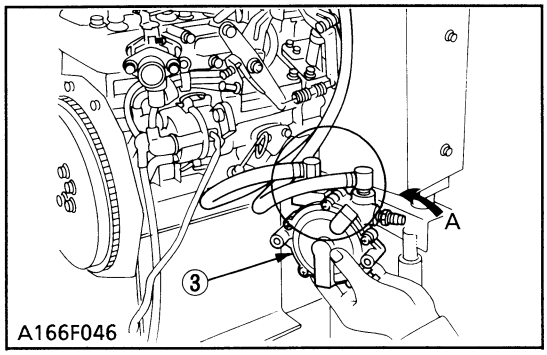
■ NOTE

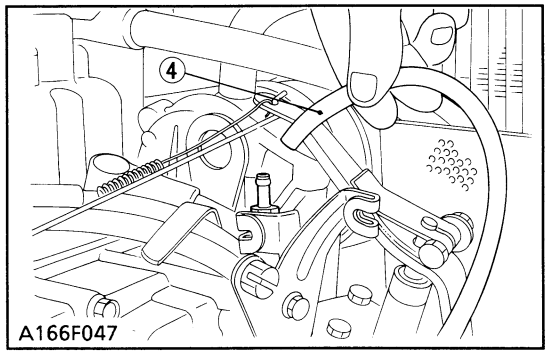
- **Vaporizer must be installed in an upright position (water hoses at bottom).**
- **The joints (fitting) can be adjusted to any position. The joint must be tight in that position.**
- **Apply an approved for GAS or LPG use liquid gasket (Three Bond #1104 or its equivalent) to thread (see fig.) and tighten it.**
- **Drain plug (1) must not be obstructed ; so that it can be removed during maintenance.**
- **Apply liquid gasket to the thread of each joint and tighten them.**
- **After selecting the joint (fitting) positions, insure that there are no leaks.**

Tightening torque	Joint for LPG hose (local arrangement)	19.6 to 32.9 N·m 2.0 to 4.0 kgf·m
	Joint for vapor hose	29.4 to 58.8 N·m 3.0 to 6.0 kgf·m
	Joint for water hose	

(1) Drain Plug (2) Mark







Piping

1. Connect the water hose (1) and (2) through the vaporizer.
2. The water joint part of vaporizer is adjusted to the upper side (see fig A.) and cooling water is replenished through radiator, to air bleed the vaporizer.
3. Vaporizer (3) is returned to former position.
4. Connect the vapor hose (5).
5. Connect the vacuum lock hose (4).
6. Tighten the vaporizer (3).
7. Connect the LPG hose (6).

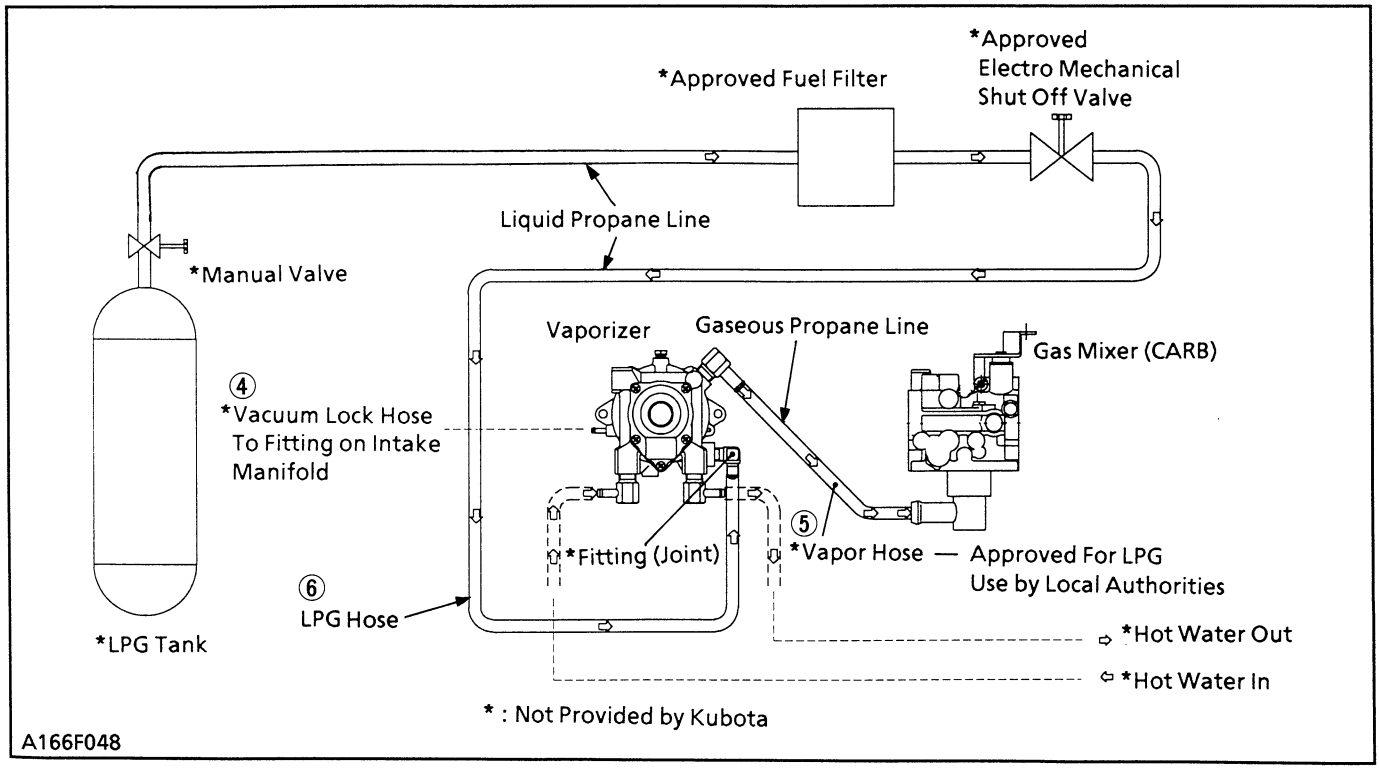
- O.D. of joint for vapor hose : ϕ 12.7 mm, ϕ 0.5 in.
- O.D. of joint for water hose : ϕ 9.0 mm, ϕ 0.35 in.

⚠ CAUTION

- **All fuel connections added to this engine must be installed by qualified personnel and utilizing recognized procedures and standards.**
- **These non-Kubota installed parts, such as hoses, fittings, piping, should be approved for LPG use and conform to UL, CSA, NFPA, and all other recognized standards.**
- **An approved, listed fuel filter and electromechanical positive shutoff must be installed between the LPG tank and Kubota vaporizer. (Not Kubota Provided)**

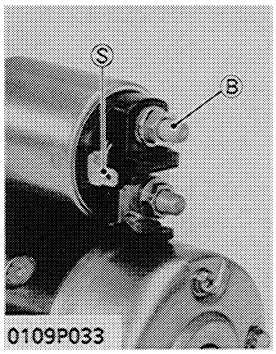
■ NOTE

- **The LPG liquid in joint (fitting) to the vaporizer / regulator is not provided in the KIT by Kubota, due to the many different connection requirements by the OEM. The female thread into the vaporizer / regulator is a PT 1/4 METRIC thread. To insure good sealing the correct fitting must be used.**
- **Vapor hose between the vaporizer and mixer must be of 300 mm ± 20 mm (11.81 in. ± 0.79 in.) in length. To assure correct emissions and proper operation.**
- **Perform air bleeding of the vaporizer (water passage).**
- **Each hose must be tightened with a hose clamp.**

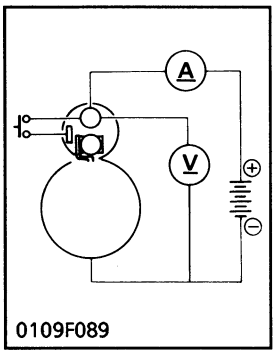


5 ELECTRICAL SYSTEM

[1] STARTER CHECKING



0109P033



0109F089

No-load Test

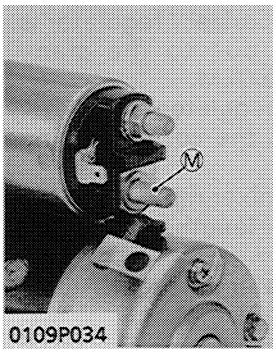
1. Connect a cable from the negative terminal of the battery to the body of the starter.
2. Connect a voltmeter across "B" terminal and the body of the starter, and an ammeter across the positive terminal of the battery and "B" terminal of the starter.
3. Connect a switch between "B" and "S" terminals of the starter, and run the starter.
4. The starter should run at the specified rate (See table).

(Reference)

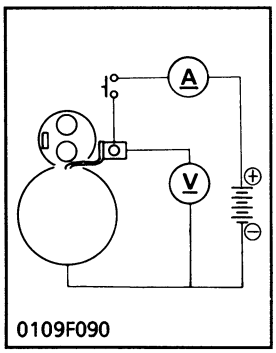
Supply Voltage	11.5V
Current	Less than 53A
Speed	More than 7,000 rpm

■ NOTE

- **Test with a cable and an ammeter for large current, and a fully charged battery.**



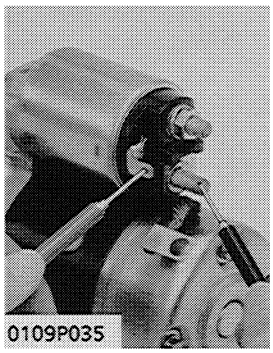
0109P034

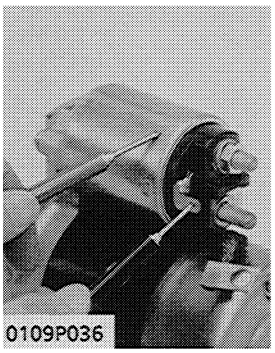


0109F090

Motor Test

1. Disconnect the connecting lead to "M" terminal and connect a voltmeter across the lead and the body of the starter.
2. Connect a cable between the negative terminal of the battery and the starter body.
3. Connect an ammeter and a switch in series between the positive terminal of the battery and the connecting lead, and run the starter.
4. The starter should run at the specified rate (See "No-load test").

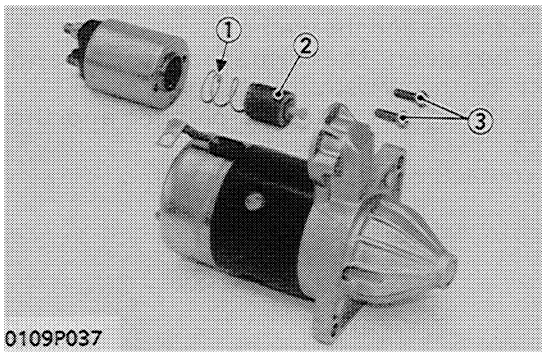

0109P035


0109P036

Solenoid Switch

1. Check the continuity across "S" and "M" terminals, and across "S" terminal and the body with an ohmmeter.
2. If not continuous, replace.

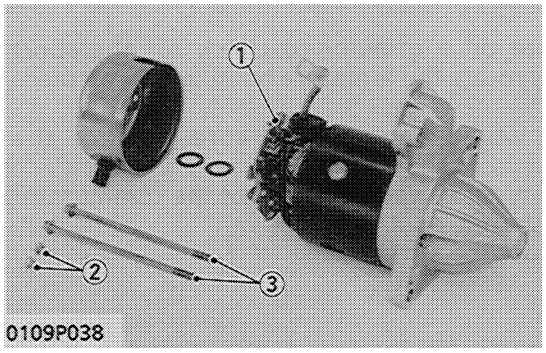
DISASSEMBLING AND ASSEMBLING



Solenoid Switch

1. Remove the screws (3) to separate the solenoid switch.
2. Pull out the plunger (2) and the spring (1).

(1) Spring
(2) Plunger
(3) Screw

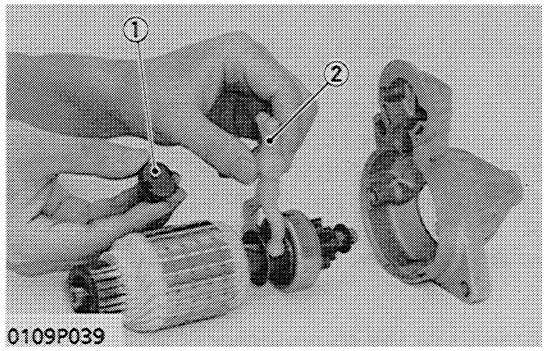


End Frame

1. Remove the through bolts (3) and the screw (2).
2. Remove the rear end frame.
3. Lift the brush and remove the brush holder (1).
4. Remove the yoke assembly.

■ **NOTE**
- **Do not miss the thrust washers behind the commutator.**

(1) Brush Holder
(2) Screw
(3) Through Bolt



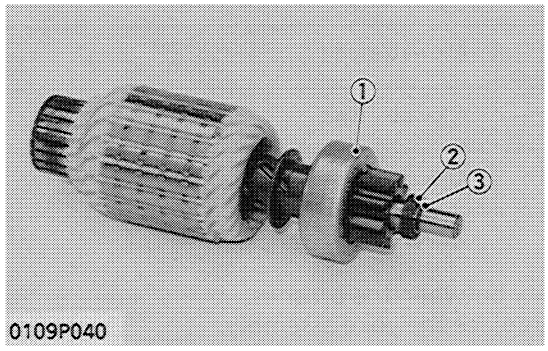
Armature

1. Pull out the armature.
2. Remove the plate (1) and the lever (2).

(When reassembling)
- Install the lever, noting its direction (See photo).

■ **NOTE**
- **Do not miss the thrust washers on the front of the armature shaft.**

(1) Plate
(2) Lever

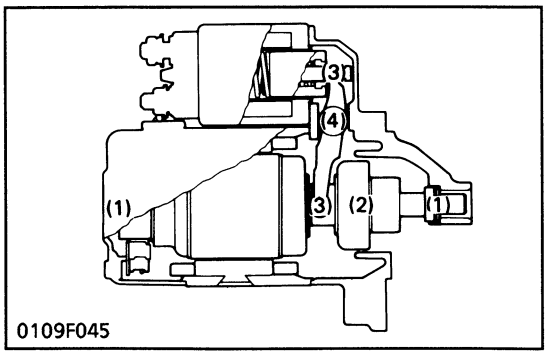


Overrunning Clutch

1. Tap in the stop ring (3).
2. Remove the retainer ring (2).
3. Remove the stop ring (3) and the overrunning clutch (1).

(When reassembling)
- Install the stop ring first, then the retainer ring, and then pull up the stop ring with a puller.

(1) Overrunning Clutch
(2) Retainer Ring
(3) Stop Ring

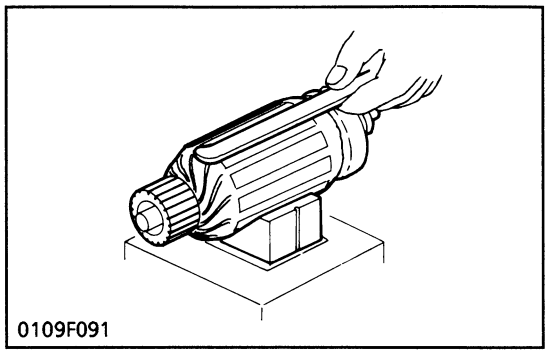


0109F045

Lubrication

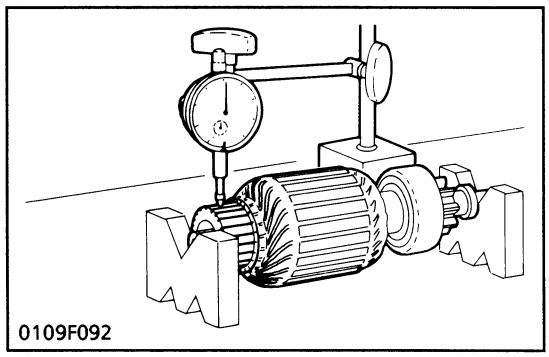
Before reassembling, lubricate the following.
(1) Bearings in the end frames and the washers.
(2) Sliding surface between the armature shaft and overrunning clutch. (with low viscosity oil).
(3) Shift lever where it engages with the plunger and the overrunning clutch.
(4) Plunger where it contacts with solenoid housing.

SERVICING


0109F091

Armature Coil

1. Place the armature on a growler to check for the short circuits, and slowly rotate the armature holding an iron piece above the core.
2. If the iron piece vibrates against the core, replace the armature.
3. Check the continuity across each segment of the commutator and the armature shaft.
4. If continuous, replace the armature.


0109F092

Commutator

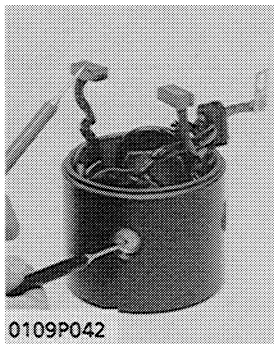
1. Rotate the armature in V blocks to check out-of-roundness and run-out, setting a dial indicator with its tip on the commutator.
2. If the variance among the readings is more than the allowable limit, turn the armature in the lathe.
3. If the depth of undercut is less than the allowable limit, undercut with a hacksaw blade or an undercutter.
4. Sand off all burrs with sandpaper.

■ **NOTE**

- **When the smallest radius of the commutator is less than the allowable limit, replace the armature shaft.**

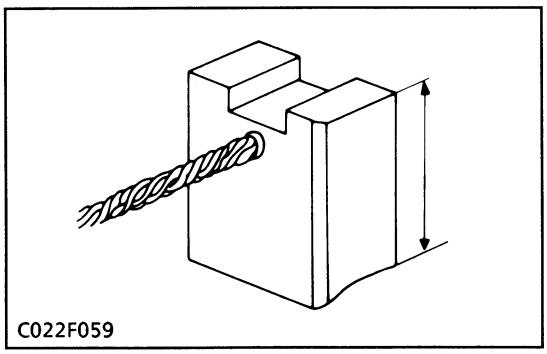
Variance on commutator O.D.	Allowable limit	0.05 mm 0.0020 in.
Commutator O.D.	Allowable limit	31 mm 1.22 in.
Commutator undercut	Allowable limit	0.2 mm 0.008 in.


0109P041


0109P042

Field Coil

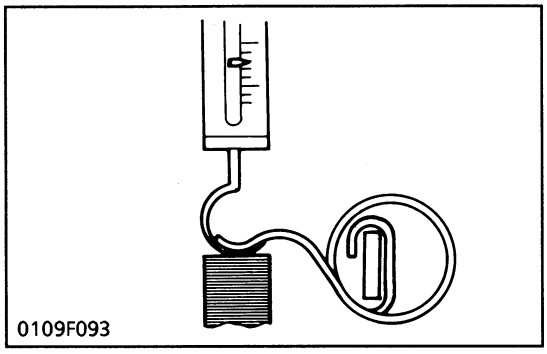
1. Check the continuity between the brushes.
2. If not continuous, replace the yoke assembly.
3. Check the continuity across the yoke and the brush or the connecting lead.
4. If continuous, check for the breakage of the insulation.
5. If not repairable, replace the yoke assembly.
6. Check that the pole and windings are not loose.


C022F059

Brush

1. Clean off the brush and check for the wear.
2. If unevenly worn, correct.
3. If worn to less than the allowable limit, replace.
4. Check that the brushes move freely in the brush holder.

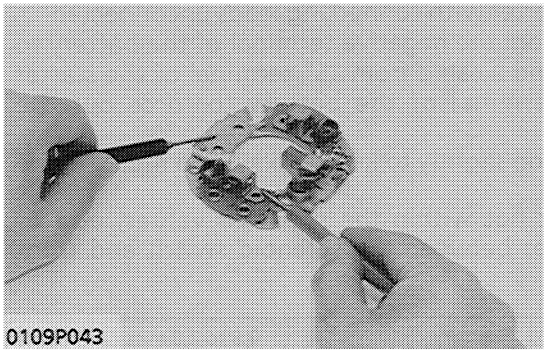
Brush length	Factory specification	17 mm 0.67 in.
	Allowable limit	11.5 mm 0.453 in.


0109F093

Brush Spring

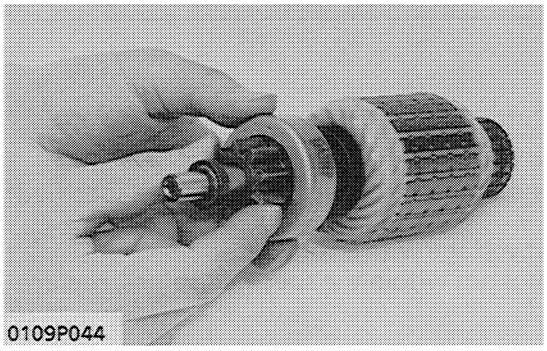
1. Pull the brush in the brush holder with a spring scale.
2. Measure the brush spring tension required to raise the spring from contact position with the commutator.
3. If the tension is less than the allowable limit, replace the spring.

Brush length	Factory specification	13.7 to 25.5 N 1.4 to 2.6 kgf 3.1 to 5.7 lbs
	Allowable limit	13.7 to 25.5 N 1.4 to 2.6 kgf 3.1 to 5.7 lbs


0109P043

Brush Holder

1. Check the continuity across the insulated brush holder and the brush holder support.
2. If continuous, replace the brush holder assembly.

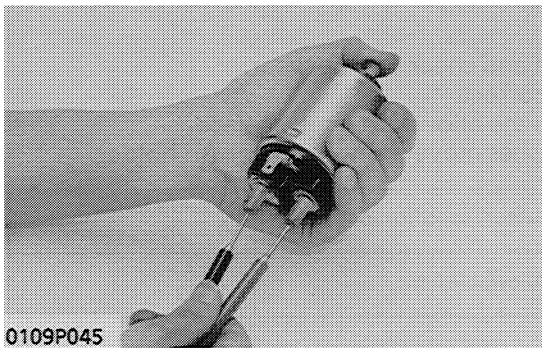

0109P044

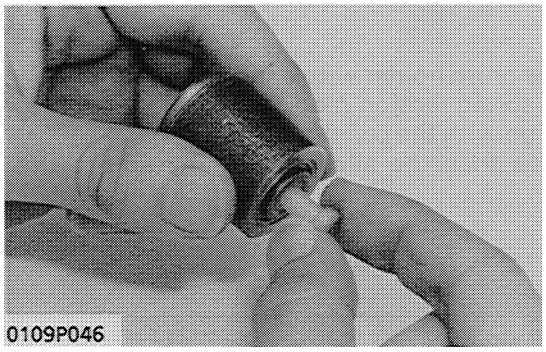
Overrunning Clutch

1. Check the pinion and if worn or damaged, replace the clutch assembly.
2. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
3. If the pinion slip or does not turn in both directions, replace the overrunning clutch assembly.

■ NOTE

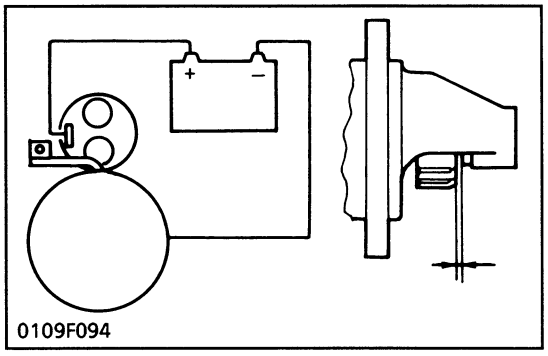
- **Do not wash off the grease in the overrunning clutch with the chemicals or oils.**


0109P045


0109P046

Solenoid Switch

1. Check the continuity across "B" and "M" terminals with an ohmmeter, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the solenoid switch.
3. Pull the pull-rod to check the spring built in the plunger.



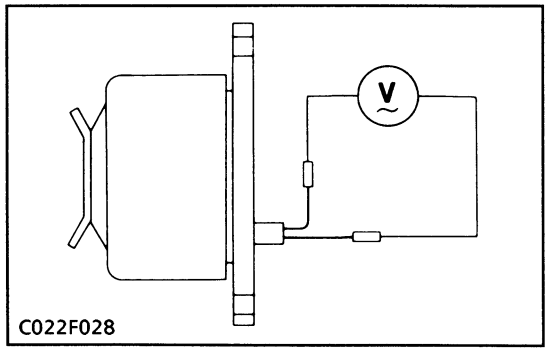
0109F094

Pinion Clearance

1. Reassemble the starter with connecting leads unconnected.
2. Connect a cable from the negative terminal of the battery to the starter body and a cable from "S" terminal of the starter to the positive terminal of the battery to force out the pinion.
3. Push back the pinion slightly to kill the play, and measure the pinion clearance.
4. If the clearance is not within the specified values, add or remove the washer between the solenoid switch and front end frame.

Pinion clearance	Factory specification	0.5 to 2.0 mm 0.020 to 0.079 in.

[2] ALTERNATOR AND REGULATOR CHECKING

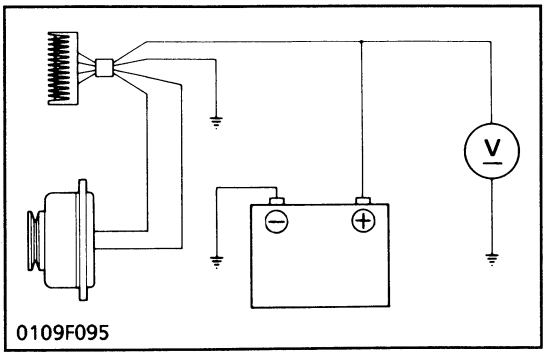


C022F028

No-Load Alternator Output

1. Disconnect the lead wires from the alternator.
2. Start the engine and operate the alternator at the specified speed.
3. Measure the output voltage with a volt meter.
   If the measurement is not within the specified values, replace the alternator.

No-load output	Factory specification	AC 20V or more at 5200 rpm

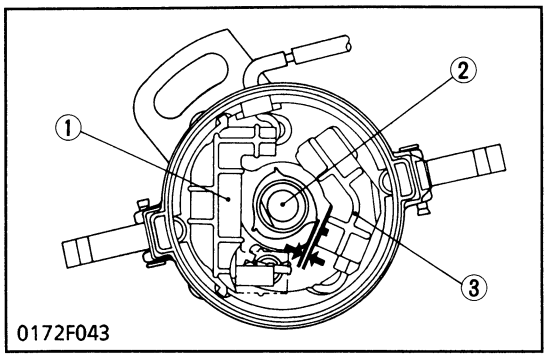


Regulating Voltage

1. Complete the charging circuit with a fully charged battery and operate the alternator at the specified speed.
2. Measure the battery voltage with a volt meter.
3. If the measurement is not within the specified values, replace the regulator.

Regulating voltage	Factory specification	14 to 15V at 5200 rpm

[3] DISTRIBUTOR CHECKING



Inspect Air Gap

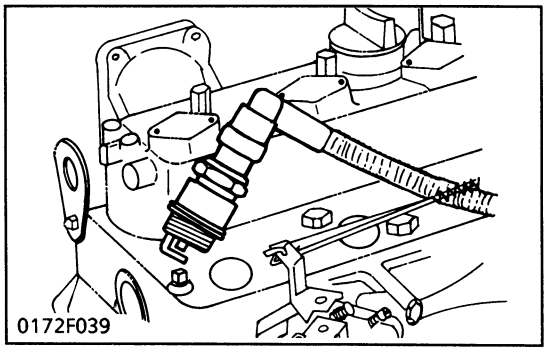
1. Using a feeler gauge, measure the gap between the signal rotor and the pickup coil projection.

Air gap	Factory specification	0.2 to 0.4 mm 0.008 to 0.016 in.

⚠ CAUTION

- **Since the ignition part of the distributor has been completely mold-shielded, it is rather difficult to check even if the following instructions are followed. Replacement of the entire assembly is best if a malfunction is suspected.**

[4] SPARK PLUG AND IGNITION COIL CHECKING

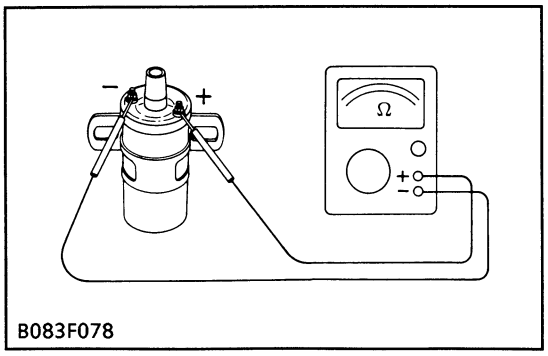


Spark Test

1. Remove the spark plug, put it inside the high voltage cord cap firmly, and then ground the threaded section to the engine body (not to painted or resin parts).
2. Rotate the starter with the key switch and check that the plug sparks.

⚠ CAUTION

- **This test is hazardous of electric shocks. Never use hand or screwdriver to press the plug to ground it to the engine body.**
- **Keep inflammables away from the engine.**

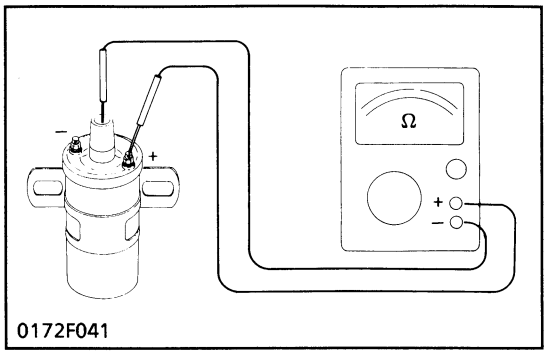


B083F078

Inspect Primary Coil Resistance

1. Disconnect high-tension cord.
2. Disconnect distributor wire connector.
3. Using an ohmmeter, measure the resistance between the positive (+) and negative (–) terminals.

Resistance	Factory specification	1.3 to 1.6Ω

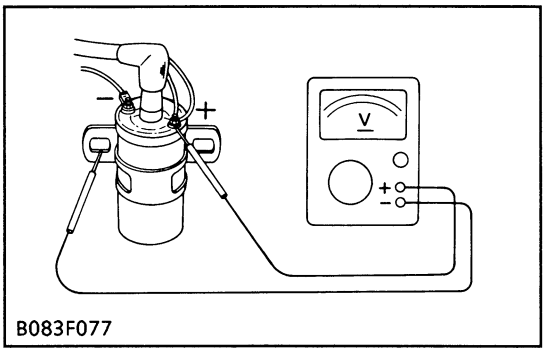


0172F041

Inspect Secondary Coil Resistance

1. Using an ohmmeter, measure the resistance between the positive (+) terminal and high-tension terminal.

Resistance	Factory specification	10.7 to 14.5Ω



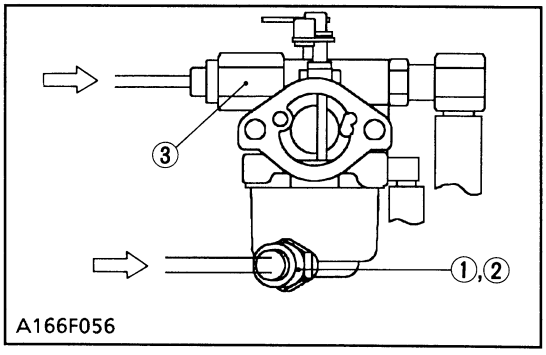
B083F077

Check Power Source Line

1. With the key switch at ON and using a voltmeter, connect the positive (+) probe to the ignition coil (+) terminal and the negative (–) probe to the body ground.
2. If a problem is found, check the ignition switch and wire harness.

Voltage	Factory specification	Approx. 12V

[5] SOLENOID CHECKING



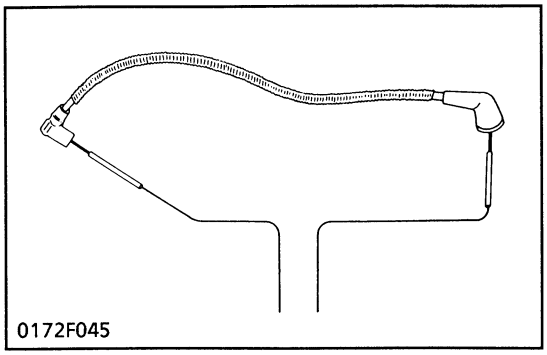
A166F056

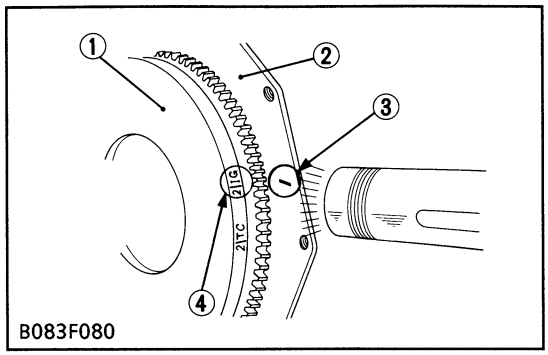
Fuel Cut Off Solenoid (WG750, DF750)

1. Disconnect the conector.
2. Measure the resistance with an ohmmeter between the connector terminals.
3. If the factory specification is not indicated the solenoid is faulty.

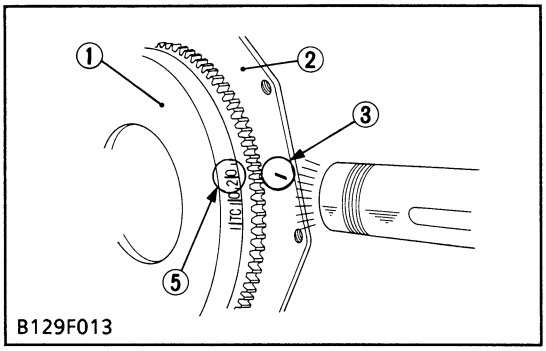
WG750 ; for Gasoline	Factory spec.	Approx. 38 Ω
DF750 ; for Gasoline		Approx. 38 Ω
DF750 ; for LPG		Approx. 28 Ω

[6] HIGH TENSION CORD CHECKING

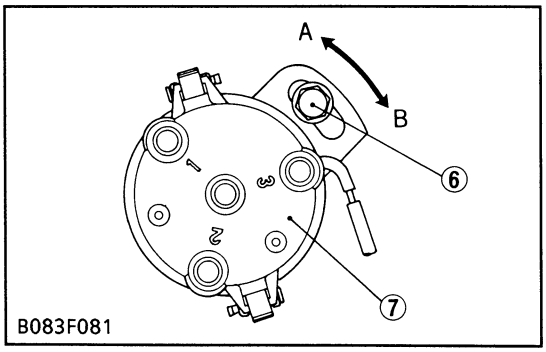

0172F045



B083F080



B129F013



B083F081

High Tension Cord

1. Using an ohmmeter, check that the resistance does not exceed the maximum.
2. If more than maximum, check the terminals, and replace the high-tension cord and/or distributor cap as required.

Center Cord	Factory spec.	3.1 to 5.2 kΩ
High Tension Cord 1		2.5 to 4.2 kΩ
High Tension Cord 2		3.0 to 5.1 kΩ
High Tension Cord 3		3.1 to 5.4 kΩ

Ignition Timing

1. Using a timing light, check that the **IG** mark (4) on the flywheel (1) is aligned with the mark (3) on the rear end plate (2).
2. If the timing is wrong, loosen the distributor mounting screw (6) and turn the distributor (7) so taht the **IG** mark on the flywheel is aligned with the mark on the rear end palte.

Ignition Timing [Engine serial number: 238547 and beyond]

1. Using a timing light, check that the ignition timing (stamps on the flywheel) (5) is aligned with the mark (3) on the rear end plate (2).
2. If the timing is wrong, loosen the distributor mounting screw (6) and turn the distributor (7) so that the ignition timing (stamps on the flywheel) is aligned with the mark on the rear end plate.

Ignition timing	Factory spec.	0.315 rad. (18°) before T.D.C.

(A) To retard
(B) To advance

(1) Flywheel
(2) Rear End Plate
(3) Mark
(4) **IG** Mark
(5) Ignition Timing
(6) Distributor Mounting Screw
(7) Distributor

EDITOR:
KUBOTA FARM & INDUSTRIAL MACHINERY SERVICE, LTD.
64, ISHIZU-KITAMACHI, SAKAI-KU, SAKAI-CITY, OSAKA, 590-0823, JAPAN
PHONE : (81)72-241-1129
FAX : (81)72-245-2484
E-mail : ks_g.ksos-pub@kubota.com

KUBOTA Corporation

Printed in Japan 2005. 10, S, AK, EI, engusa Code No.9Y011-00643
1988. 09, S, AK, AK, engusa