



**FD680V
FD731V**



4-stroke liquid-cooled v-twin gasoline engine
Service Manual

Quick Reference Guide

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This quick reference guide will assist you in locating a desired topic or procedure.

- Bend the pages back to match the black tab of the desired chapter number with the black tab on the edge at each table of contents page.
- Refer to the sectional table of contents for the exact pages to locate the specific topic required.



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Service Manual

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All information contained in this publication is based on the latest product information available at the time of publication. Illustrations and photographs in this publication are intended for reference use only and may not depict actual model component parts.

LIST OF ABBREVIATIONS

A	ampere(s)	lb	pound(s)
ABDC	after bottom dead center	m	meter(s)
AC	alternating current	min	minute(s)
ATDC	after top dead center	N	newton(s)
BBDC	before bottom dead center	Pa	pascal(s)
BDC	bottom dead center	PS	horsepower
BTDC	before top dead center	psi	pound(s) per square inch
°C	degree(s) Celsius	r	revolution
DC	direct current	rpm	revolution(s) per minute
F	farad(s)	TDC	top dead center
°F	degree(s) Fahrenheit	TIR	total indicator reading
ft	foot, feet	V	volt(s)
g	gram(s)	W	watt(s)
h	hour(s)	Ω	ohm(s)
L	liter(s)		

Read OWNER'S MANUAL before operating.

EMISSION CONTROL INFORMATION

To protect the environment in which we live, Kawasaki has incorporated crankcase emission (1) and exhaust emission (2) control systems in compliance with applicable regulations of the United States Environmental Protection Agency and the California Air Resources Board.

1. **Crankcase Emission Control System**

A sealed-type crankcase emission control system is used to eliminate blow-by gasses. The blow-by gasses are led to a breather chamber through the crankcase and from there to the air cleaner.

Oil is separated from the gasses while passing through the inside of the breather chamber from the crankcase, and then returned to the bottom of the crankcase.

2. **Exhaust Emission Control System**

The exhaust emission control system applied to this engine consists of a carburetor and an ignition system having optimum ignition timing characteristics.

The carburetor has been calibrated to provide lean air/fuel mixture characteristics and optimum fuel economy with a suitable air cleaner and exhaust system.

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

Federal law and California State law prohibits the following acts or the causing thereof: (1) the removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new engine for the purpose of emission control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the engine after such device or element of design has been removed or rendered inoperative by any person.

Among those acts presumed to constitute tampering are the acts listed below:
Do not tamper with the original emission related part.

- Carburetor and internal parts
- Spark plugs
- Magneto or electronic ignition system
- Fuel filter element
- Air cleaner elements
- Crankcase
- Cylinder heads
- Breather chamber and internal parts
- Inlet pipe and tube

Foreword

This manual is designed primarily for use by trained mechanics in a properly equipped shop. However, it contains enough detail and basic information to make it useful to the owner who desires to perform his own basic maintenance and repair work. A basic knowledge of mechanics, the proper use of tools, and workshop procedures must be understood in order to carry out maintenance and repair satisfactorily. Whenever the owner has insufficient experience or doubts as to his ability to do the work, all adjustments, maintenance, and repair should be carried out only by qualified mechanics.

In order to perform the work efficiently and to avoid costly mistakes, read the text, thoroughly familiarize yourself with the procedures before starting work, and then do the work carefully in a clean area. Whenever special tools or equipment are specified, do not use makeshift tools or equipment. Precision measurements can only be made if the proper instruments are used, and the use of substitute tools may adversely affect safe operation.

To get the longest life out of your engine:

- Follow the Periodic Maintenance Chart in the Service Manual.
- Be alert for problems and non-scheduled maintenance.
- Use proper tools and genuine Kawasaki engine parts. Genuine parts provided as spare parts are listed in the Parts Catalog.
- Follow the procedures in this manual carefully. Don't take shortcuts.
- Remember to keep complete records of maintenance and repair with dates and any new parts installed.

How to Use This Manual

In this manual, the product is divided into its major systems and these systems make up the manual's chapters. The Quick Reference Guide shows you all of the product's system and assists in locating their chapters. Each chapter in turn has its own comprehensive Table of Contents.

For example, if you want ignition coil information, use the Quick Reference Guide to locate

the Electrical System chapter. Then, use the Table of Contents on the first page of the chapter to find the Ignition coil section.

Whenever you see these WARNING and CAUTION symbols, heed their instructions! Always follow safe operating and maintenance practices.

WARNING

This warning symbol identifies special instructions or procedures which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION

This caution symbol identifies special instructions or procedures which, if not strictly observed, could result in damage to or destruction of equipment.

This manual contains four more symbols (in addition to WARNING and CAUTION) which will help you distinguish different types of information.

NOTE

○ *This note symbol indicates points of particular interest for more efficient and convenient operation.*

- Indicates a procedural step or work to be done.
- Indicates a procedural sub-step or how to do the work of the procedural step it follows. It also precedes the text of a WARNING, CAUTION, or NOTE.
- ★ Indicates a conditional step or what action to take based on the results of the test or inspection in the procedural step or sub-step it follows.

In most chapters an exploded view illustration of the system components follows the Table of Contents. In these illustrations you will find the instructions indicating which parts require specified tightening torque, oil, grease or a locking agent during assembly.

General Information

1

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1-2 GENERAL INFORMATION

Before Servicing

Before starting to service the engine, carefully read the applicable section to eliminate unnecessary work. Photographs, diagrams, notes, cautions, warnings, and detailed descriptions have been included wherever necessary. Nevertheless, even a detailed account has limitations, a certain amount of basic knowledge is required for successful work.

Especially note the following:

(1) Dirt

Before removal and disassembly, clean the engine. Any dirt entering the engine, carburetor, or other parts, will work as an abrasive and shorten the life of engine. For the same reason, before installing a new part, clean off any dust or metal filings.

(2) Battery Ground

Remove the ground (–) lead from the battery before performing any disassembly operations on the equipment. This prevents:

- (a) the possibility of accidentally turning the engine over while partially disassembled.
- (b) sparks at electrical connections which will occur when they are disconnected.
- (c) damage to electrical parts.

(3) Tightening Sequence

Generally, when installing a part with several bolts, nuts, or screws, start them all in their holes and tighten them to a snug fit. Then tighten them evenly, in a staggered sequence. This is to avoid distortion of the part and/or causing gas or oil leakage. Conversely, when loosening the bolts, nuts, or screws, first loosen all of them by about a quarter of a turn and then remove them. Where there is a tightening sequence indication in this Service Manual, the bolts, nuts, or screws must be tightened in the order and method indicated.

(4) Torque

When torque values are given in this Service Manual, use them. Either too little or too much torque may lead to serious damage. Use a good quality, reliable torque wrench.

(5) Force

Common sense should dictate how much force is necessary in assembly and disassembly. If a part seems especially difficult to remove or install, stop and examine what may be causing the problem. Whenever tapping is necessary, tap lightly using a wooden or plastic-faced mallet. Use an impact driver for screws (particularly for the removal of screws held by a locking agent) in order to avoid damaging the heads.

(6) Edges

Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.

(7) High-Flash Point Solvent

A high-flash point solvent is recommended to reduce fire danger. A commercial solvent commonly available in North America is Standard solvent (generic name). Always follow manufacturer and container directions regarding the use of any solvent.

(8) Gasket, O-Ring

Do not reuse a gasket or O-ring once it has been in service. The mating surfaces around the gasket should be free of foreign matter and perfectly smooth to avoid oil or compression leaks.

(9) Liquid Gasket, Non-Permanent Locking Agent

Follow manufacturer's directions for cleaning and preparing surfaces where these compounds will be used. Apply sparingly. Excessive amounts may block engine oil passages and cause serious damage. An example of a non-permanent locking agent commonly available in North America is Loctite Lock'n Seal (Blue).

(10) Press

A part installed using a press or driver, such as a journal, should first be coated with oil on its outer or inner circumference so that it will go into place smoothly.

(11) Ball Bearing

When installing a ball bearing, the bearing race which is affected by friction should be pushed by a suitable driver. This prevents severe stress on the balls and races, and prevents races and balls from being dented. Press a ball bearing until it stops at the stop in the hole or on the shaft.

(12) Oil Seal and Grease Seal

Replace any oil or grease seals that were removed with new ones, as removal generally damages seals.

Before Servicing

When pressing in a seal which has manufacturer's marks, press it in with the marks facing out. Seals should be pressed into place using a suitable driver, which contacts evenly with the side of seal, until the face of the seal is even with the end of the hole.

(13) Seal Guide

A seal guide is required for certain oil or grease seals during installation to avoid damage to the seal lips. Before a shaft passes through a seal, apply a little oil, preferably high temperature grease on the lips to reduce rubber to metal friction.

(14) Circlip, Retaining Ring and Cotter Pin

When installing circlips and retaining rings, take care to compress or expand them only enough to install them and no more. Install the circlip with its chamfered side facing load side as well.

Replace any circlips, retaining rings, and cotter pins that were removed with new ones, as removal weakens and deforms them. If old ones are reused, they could become detached while running, leading to a problem.

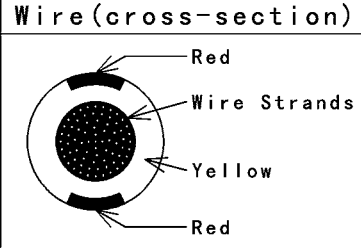

(15) Lubrication

Engine wear is generally at its maximum while the engine is warming up and before all the rubbing surfaces have an adequate lubricative film. During assembly, oil or grease (whichever is more suitable) should be applied to any rubbing surface which has lost its lubricative film. Old grease and dirty oil should be cleaned off. Deteriorated grease has lost its lubricative quality and may contain abrasive foreign particles.

Don't use just any oil or grease. Some oils and greases in particular should be used only in certain applications and may be harmful if used in an application for which they are not intended. This manual makes reference to molybdenum disulfide grease (MoS₂) in the assembly of certain engine parts. Always check manufacturer recommendations before using such special lubricants.

(16) Electrical Wires

All the electrical wires are either single-color or two-color and, with only a few exceptions, must be connected to wires of the same color. On any of the two-color wires there is a greater amount of one color and a lesser amount of a second color, so a two-color wire is identified by first the primary color and then the secondary color. For example, a yellow wire with thin red stripes is referred to as a "yellow/red" wire; it would be a "red/yellow" wire if the colors were reversed to make red the main color.

Wire (cross-section)	Color Indicated on the Wire	Color Indicated on the Wiring Diagram
	Yellow/Red	

GB020601W1 C

(17) Replacement Parts

When there is a replacement instruction, replace these parts with new ones every time they are removed. Their replacement parts will be damaged or lose their original function once removed.

(18) Inspection

When parts have been disassembled, visually inspect these parts for the following conditions or other damage. If there is any doubt as to the condition of them, replace them with new ones.

Abrasion	Crack	Hardening	Warp
Bent	Dent	Scratch	Wear
Color change	Deterioration	Seizure	

(19) Specifications

Specification terms are defined as follows:

"Standards" show dimensions or performances which brand-new parts or systems have.

"Service Limits" indicate the usable limits. If the measurement shows excessive wear or deteriorated performance, replace the damaged parts.

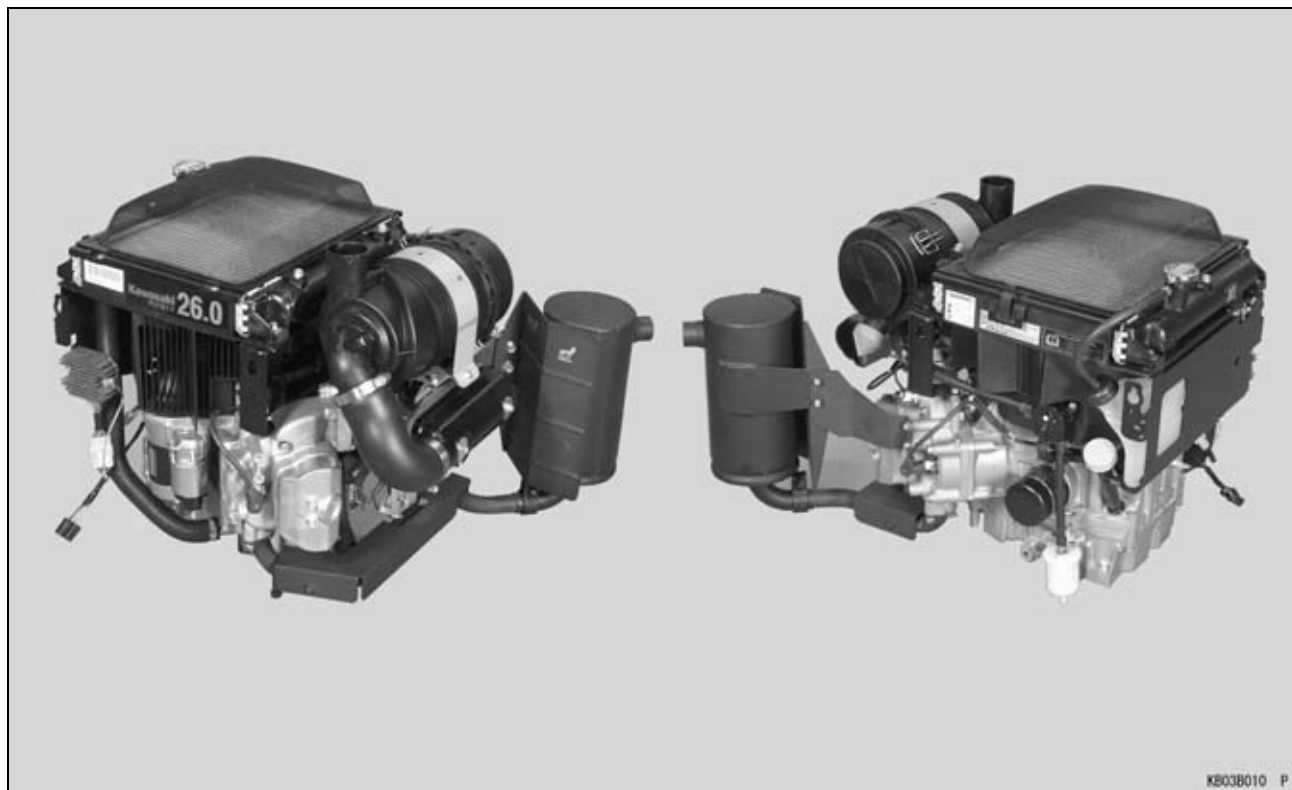
1-4 GENERAL INFORMATION

Model Identification

FD680V



FD731V



Cylinder Number Designation

No.1 Cyl. is on the electric starter side.

No.2 Cyl. is on the oil filter side.

General Specifications

Items	FD680V, FD731V
Type of engine	Liquid-cooled, Vertical shaft, OHV, 4-stroke, 90°V-twin, Gasoline engine.
Bore × Stroke	75.2 mm × 76 mm (2.96 in. × 2.99 in.)
Piston displacement	675 mL (41.2 cu in.)
Direction of rotation	Counterclockwise facing the PTO shaft
Low idle speed	1 550 r/min (rpm)
High idle speed	3 600 r/min (rpm)
Ignition system	Solid-state ignition
RFI	Per Canada and U.S.A. requirements
Starting system	Shift type electric starter
Charging system	12 V - 20 A with regulator
Carburetor	Float type, fixed main jet
Fuel pump	Diaphragm type pulse pump
Air cleaner	Dual stage element, dry type
Governor	All speed mechanical fly weights
Lubrication system	Pressure feed by positive displacement pump
Oil filter	Cartridge type full flow filter
Oil pressure switch	ON-OFF switch (When oil filter is removed.)
Oil capacity	2.0 L (2.1 US qt)
Cooling system	Pressurized forced circulation type
Radiator	2-rows with louverless corrugated fin (aluminum)
Dimensions (H × W × L)	555 mm × 434.5 mm × 431.5 mm (21.9 in. × 17.1 in. × 17.0 in.)
Dry weight	45 kg (99 lb)

Specifications subject to change without notice.

Periodic Maintenance

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Periodic Maintenance Chart

Some adjustments require the use of special tools or other equipment. An electronic tachometer will facilitate setting idle and running speeds.

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PERIODIC MAINTENANCE 2-3

Periodic Maintenance Chart

OPERATION	INTERVAL								
	Daily	First 8 hr.	Every 25 hr.	Every 100 hr.	Every 200 hr.	Every 250 hr.	Every 300 hr.	Every 400 hr.	Every 500 hr.
★ Clean and lap valve seating surface							•		
★ Inspect radiator and hoses					•				
★ Change coolant								•	

(1): Service more frequently under dusty conditions.

★: These items must be performed with the proper tools. See your authorized Kawasaki Engine Dealer for service, unless you have the proper equipment and mechanical proficiency.

2-4 PERIODIC MAINTENANCE

Torque and Locking Agent

The following tables list the tightening torque for the major fasteners, and the parts requiring use of a non-permanent locking agent or liquid gasket.

Letters used in the "Remarks" column mean:

L: Apply a non-permanent locking agent to the threads.

Lh: Left-hand threads.

O: Apply engine oil.

S: Tighten the fasteners following the specified sequence.

SS: Apply silicone sealant.

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Fuel System				
Carburetor and Inlet Pipe Mounting Bolts and Nuts (Standard Air Cleaner Model)	12	1.2	104 in·lb	S
Carburetor and Inlet Pipe Mounting Bolts and Nuts (Heavy Duty Air Cleaner Model)	12	1.2	104 in·lb	
Inlet Manifold Mounting Bolts	6	0.6	53 in·lb	
Pilot Jets	1.7	0.17	15 in·lb	
Main Jets	0.7	0.07	6 in·lb	
Float Chamber Mounting Screws	2.0	0.20	17 in·lb	
Fuel Shut-Off Solenoid Valve	7.0	0.71	61 in·lb	
Drain Screw	1.3	0.13	11 in·lb	
Air Cleaner Wing Nuts	2	0.2	17 in·lb	
Air Cleaner Tube Clamps	2	0.2	17 in·lb	
Governor Arm Clamp Nut	8	0.8	69 in·lb	
Cooling System				
Radiator Hose Clamp Bolts	1.3	0.13	12 in·lb	S Lh SS
Water Pump Cover Mounting Bolts (M6)	10	1.0	87 in·lb	
Water Pump Cover Mounting Bolts (M8)	22	2.2	17	
Impeller Bolt	10	1.0	87 in·lb	
Thermo Switch	28	2.9	21	
Thermostat Cover Bolts	6	0.6	53 in·lb	
Radiator Mounting Bolts	6	0.6	53 in·lb	
Coolant Drain Plug	15	1.5	11	
Engine Top End				
Rocker Arm Bracket Mounting Bolts	22	2.2	17	O S S
Valve Clearance Adjusting Nuts	11	1.1	96 in·lb	
Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	
Exhaust Pipe Flange Nuts	20	2.0	15	
Cylinder Head Bolts (New)	32	3.3	24	
Cylinder Head Bolts (Reuse)	25	2.5	18	
Muffler Bracket Bolts	20	2.0	15	
Lubrication System				
Oil Drain Plugs	6.9	0.70	61 in·lb	SS
Oil Pressure Switch	9.8	1.0	87 in·lb	
Camshaft/Crankshaft				
Crankcase Cover Bolts (M8)	22	2.2	17	S

Torque and Locking Agent

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	O
Electrical System				
Flywheel Bolt	56	5.7	41	
Stator Coil Screws	3.4	0.35	30 in·lb	
Ignition Coil Mounting Bolts	3.4	0.35	30 in·lb	S
Spark Plugs	25	2.5	18	
Thermo Switch	28	2.8	21	SS
Oil Pressure Switch	10	1.0	87 in·lb	SS
Starter Motor Mounting Bolts	15	1.5	11	
Regulator Bolts	6	0.6	53 in·lb	

The table below, relating tightening torque to thread diameter, lists the basic torque for the bolts and nuts. Use this table for only the bolts and nuts which do not require a specific torque value. All of the values are for use with dry solvent-cleaned threads.

Basic Torque for General Fasteners

Threads Diameter (mm)	Torque		
	N·m	kgf·m	ft·lb
4	2.0	0.20	17 in·lb
5	3.4	0.35	30 in·lb
6	5.9	0.60	52 in·lb
8	15	1.5	11

2-6 PERIODIC MAINTENANCE

Specifications

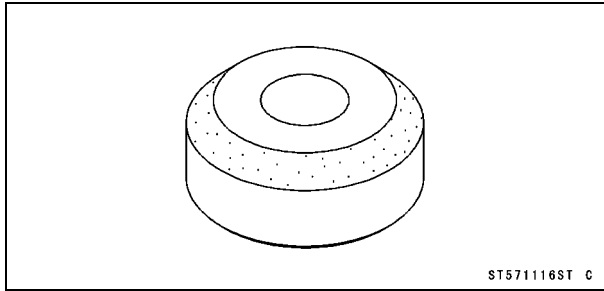
Item	Standard	
	FD680V	FD731V
Fuel System Idle Speed: (1) Low Idle Speed High Idle Speed Air Cleaner: Type Pre-Cleaner Two-Stage Cleaner	1 550 r/min (rpm) 3 600 r/min (rpm) Dual stage filtration system Foam element Paper element	← ← Heavy duty air cleaner type Primary element Secondary element
Cooling System Coolant: Type Color Mixed Ratio Freezing Point Total Amount	Permanent type of antifreeze for aluminum engine and radiator Green 50% -35°C (-31°F) 2.7 L (2.9 US qt)	
Engine Top End Valve Clearance: Inlet, Exhaust Valve Seating Surface Angle: Inlet, Exhaust Valve Seating Surface Width: Inlet Exhaust	0.15 mm (0.006 in.) 45° 0.8 ~ 1.4 mm (0.031 ~ 0.055 in.) 1.1 ~ 1.6 mm (0.043 ~ 0.063 in.)	
Lubrication System Engine Oil: Type Viscosity Capacity Level	SF, SG, SH or SJ class SAE 40, SAE 30, SAE 10W-30/SAE 10W-40, or SAE 5W-20 2.0 L (2.1 US qt) (When filter is not removed) 2.3 L (2.4 US qt) (When filter is removed) Between "ADD" and "FULL" marks	
Electrical System Spark Plug Gap	0.75 mm (0.30 in.)	

(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

Special Tools and Sealant

Valve Seat Cutter, 45° - ϕ 35:

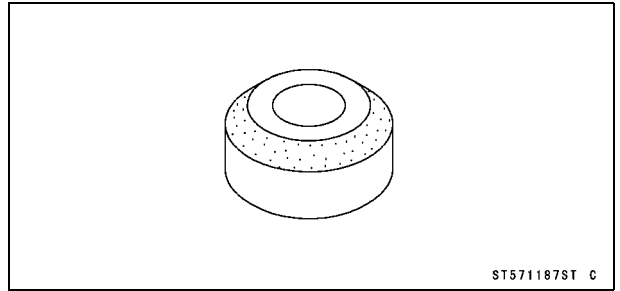
57001-1116



ST571116ST C

Valve Seat Cutter, 45° - ϕ 30:

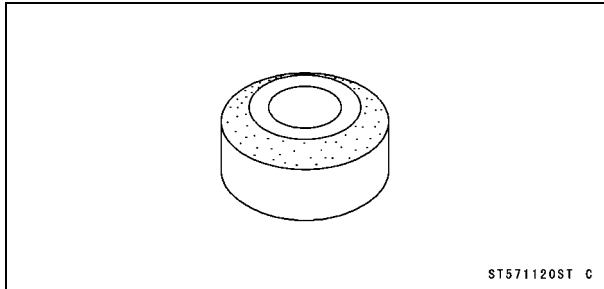
57001-1187



ST571187ST C

Valve Seat Cutter, 32° - ϕ 30:

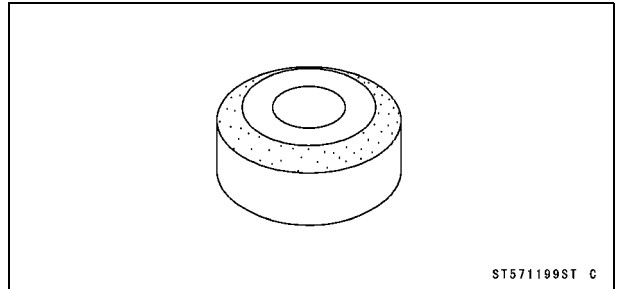
57001-1120



ST571120ST C

Valve Seat Cutter, 32° - ϕ 33:

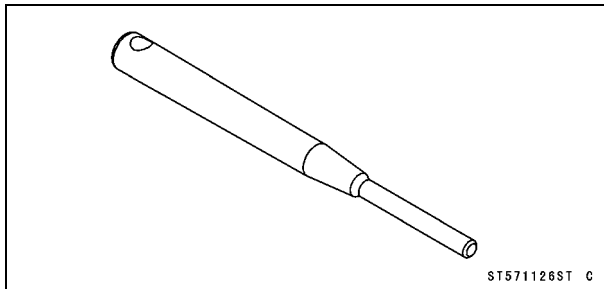
57001-1199



ST571199ST C

Valve Seat Cutter Holder, ϕ 7:

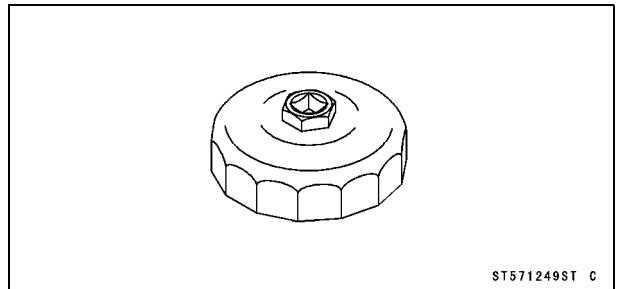
57001-1126



ST571126ST C

Oil Filter Wrench:

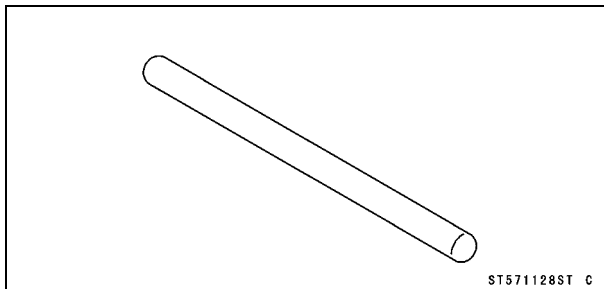
57001-1249



ST571249ST C

Valve Seat Cutter Holder Bar:

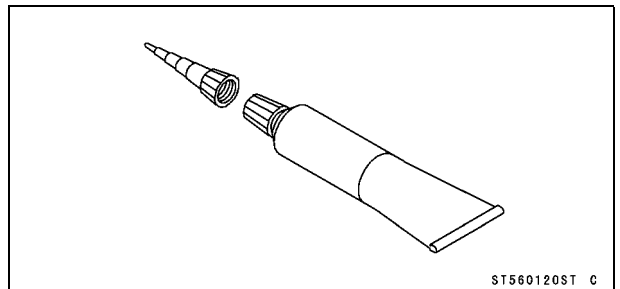
57001-1128



ST571128ST C

Kawasaki Bond (Silicone Sealant):

56019-120



ST560120ST C

2-8 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Fuel System

NOTE

○High and low idle speeds may vary depending on the equipment on which the engine is used. Refer to the equipment specification.

High Idle Speed Adjustment

NOTE

○High idle speed adjustment should be made after the idle speed adjustment is performed.

CAUTION

Do not adjust high idle speed with the air cleaner removed.

- Start and warm up the engine thoroughly.

⚠ WARNING

Always keep your hands clear of the moving parts.

- Move the throttle lever on dash in the high idle position and leave it there.
- Loosen the M6 control panel mounting bolts [A] enough to move the control panel assembly [B].
- Carefully move the control panel assembly up or down to obtain the specified high idle speed.

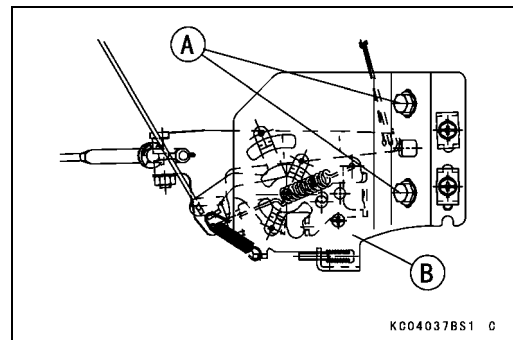
High Idle Speed

3 600 rpm (r/min)

- Tighten the M6 mounting bolts.

CAUTION

Be sure to make the idle and fast idle speeds respectively correspond to those of the equipment.



Periodic Maintenance Procedures

Low Idle Speed Adjustment

- Disconnect all possible external loads from the engine.
- Start the engine and warm it up thoroughly.

⚠ WARNING

Always keep your hands clear of the moving parts.

- Move the throttle lever on dash to the idle position.
- Hold the throttle lever [A] on the carburetor in closed position (turn the governor arm [B] clockwise all the way), and adjust the low idle speed screw [C] until the engine idles at specified speed.

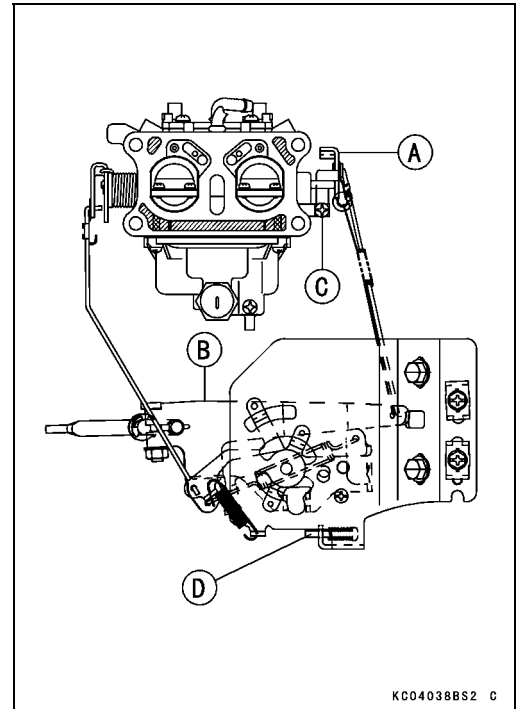
Idle Speed (Carburetor idle rpm)

1 450 rpm (r/min)

- Release the throttle lever and adjust the low idle speed set screw [D] on the control plate to obtain the specified governed low idle speed.

Low Idle Speed (Governed idle rpm)

1 550 rpm (r/min)

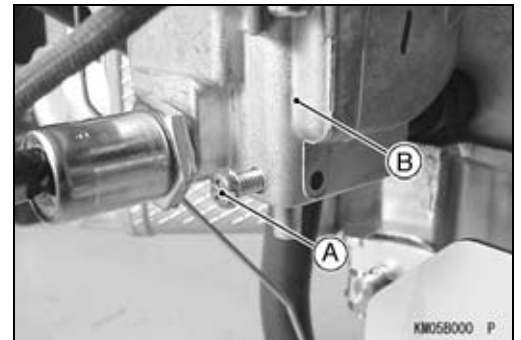


Fuel System Cleanliness Inspection

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Place a suitable pan under the drain screw [A] on the carburetor [B].
- Turn out the drain screw a few turns to drain the carburetor and check to see if water or dirt has accumulated in the carburetor.
- Tighten the drain screw.
- ★ If any water or dirt come out, clean the carburetor (see Carburetor Cleaning), and fuel tank, and check the fuel filter.



Element Cleaning and Inspection Standard Type

NOTE

○ In dusty areas, the elements should be cleaned more frequently than the recommended intervals.

2-10 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

⚠ WARNING

Because of the danger of highly flammable liquids, do not use gasoline or a low flash-point solvent to clean the element.

- Remove the foam element [A] and the paper element [B].
- Clean the foam element in detergent and water, and dry it thoroughly.
- Clean the paper element [B] by tapping it gently on a flat surface to remove dust. If the element is very dirty, replace it with a new one or wash the element in a detergent and water.
- Rinse the element until a water is clear. Let the element air-dry thoroughly before install it.

CAUTION

Do not use compressed air to clean the paper element. Do not oil the paper and foam element. Do not use pressurized air to clean or dry paper element.

Heavy Duty Type

This air cleaner elements are not recommended to be cleaned, and each air cleaner element should be replaced with the new one at the maintenance time as shown in the maintenance chart.

NOTE

○ *Operating in dusty condition may require more frequent maintenance than above.*

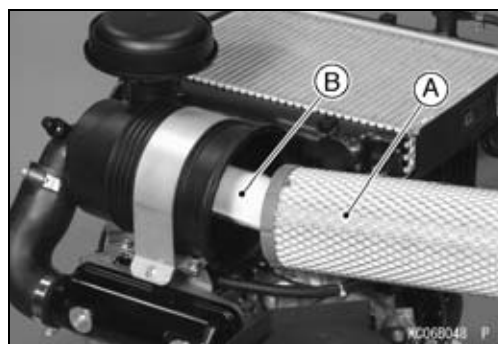
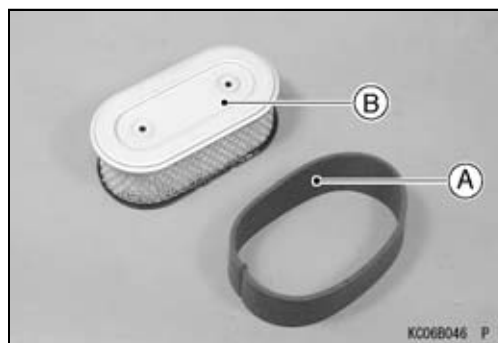
- Replace the primary element [A] every 250 hrs.
- Replace the secondary element [B] with the new one if dirty when primary element is checked.
- Replace the secondary element every 500 hrs.

CAUTION

Do not wash air cleaner elements. Do not oil air cleaner elements. Do not use pressurized air to clean air cleaner elements.

Housing (Case and Body) Inspection

- Clean the housing with detergent and water and dry thoroughly.
- Check the housing for deformation or other damage. The housing must seal well and permit only filtered air to reach the carburetor.
- ★ If the housing is damaged, it must be replaced.
- Check that no foreign material is obstructing the air passage.



Periodic Maintenance Procedures

Cooling System

Coolant Filling

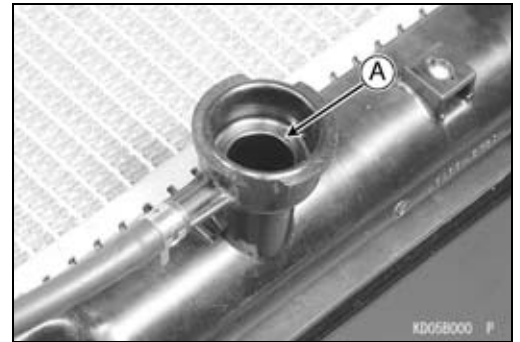
- Install the drain plug. Always replace the gaskets with a new ones.
- Tighten the drain plug to the specification.

Torque - Coolant Drain Plug: 15 N·m (1.5 kgf·m, 11 ft·lb)

- Fill the radiator up to bottom of the radiator filler neck [A] with coolant, and install the cap turning it clockwise.

NOTE

- Pour in the coolant slowly so that it can expel the air from the engine and radiator.
- To install the radiator cap, push down it and then turn the cap clockwise to the rest of the way.



CAUTION

Soft or distilled water must be used with the antifreeze in the cooling system. If hard water is used in the system, it causes scales accumulation in the water passages, and considerably reduces the efficiency of the cooling system.

NOTE

- Choose a suitable mixture ratio by referring to the coolant manufacturer's instructions.

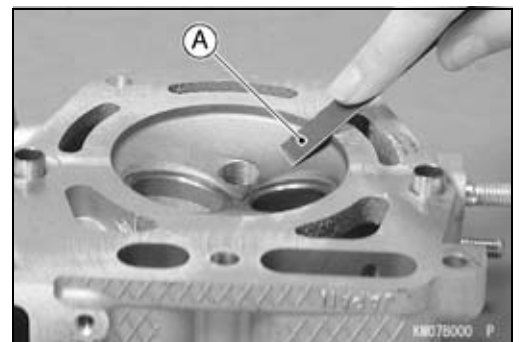
Original Coolant

Type:	Permanent type antifreeze for aluminum engine and radiator
Color:	Green
Mixed ratio:	50% solution of ethylene glycol
Freezing Point:	-35°C (-31°F)
Total amount:	2.7 L (2.9 US qt)

Engine Top End

Cylinder Head Cleaning

- Scrape the carbon deposits from the head and exhaust port with a suitable tool [A].
- To avoid gouging, use scrapers that are made of a material that will not cause damage.
- Clean the head in a bath of high-flash point solvent and dry it with compressed air.



⚠ WARNING

Clean the cylinder head in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean the cylinder head. A fire or explosion could result.

2-12 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Valve Clearance Inspection

NOTE

○ Valve clearance must be checked when the engine is cold (at room temperature).

- Remove the rocker case (see Cylinder Head Assembly Removal in the Engine Top End chapter).
- Place the piston at top dead center (TDC) of the compression stroke turning the crankshaft clockwise facing the flywheel.

No.1 Cylinder:

- Align the flywheel magnet [A] with No.1 ignition coil [B].
- Check the inlet and exhaust valves are closed completely, if it is not at T.D.C, turn the flywheel clockwise one turn (360°).

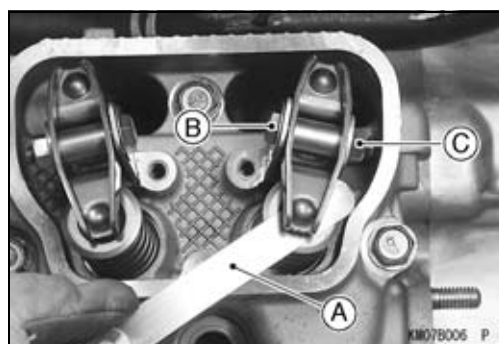
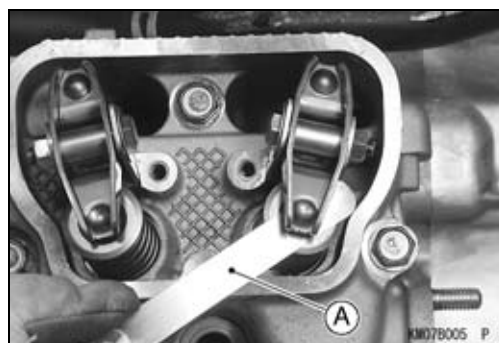
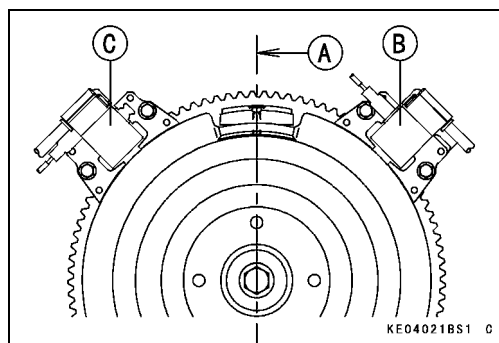
No.2 Cylinder:

- Align the flywheel magnet [A] with No.2 ignition coil [C]. Follow No.1 Cylinder alignment.

- Then check the clearance.
- Using a thickness gauge [A], measure the valve clearance between the rocker arm and the valve stem end.
- ★ If the valve clearance is incorrect, adjust it (see Valve Clearance Adjustment in this chapter).

Valve Clearance (when cold)

Inlet, Exhaust: 0.15 mm (0.006 in.)



Valve Clearance Adjustment

- Since the valve repairs change the valve clearance, adjust the valve clearance to the specification.
- Assemble the cylinder head and install the cylinder head assembly on the block (see Cylinder Head Assembly Installation in the Engine Top End chapter).
- Turn the crankshaft proper direction until the piston is at TDC of the compression stroke (described above).
- Loosen the nut [C] and valve clearance adjusting bolts [B].
- Insert a 0.15 mm (0.006 in.) thickness gauge [A] between the rocker arm and valve stem, and turn the adjusting bolt until the thickness gauge begin to bind between the rocker arm and valve stem end. Use a sweeping motion with the thickness gauge while making this adjustment.
- Holding the adjusting bolt with a spanner, tighten the nut to the specified torque.

Torque - Valve Clearance Adjusting Nuts: 11 N·m (1.1 kgf·m, 96 in·lb)

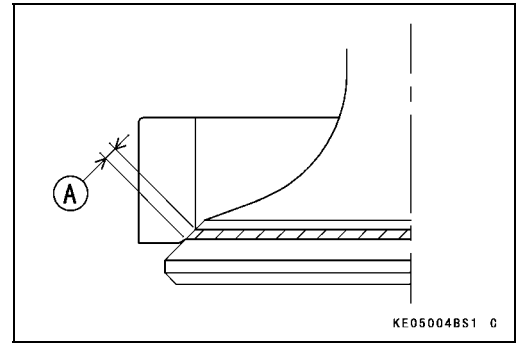
CAUTION

Do not overtighten.

Periodic Maintenance Procedures

Valve Seat Inspection

- Remove the valve (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
- Inspect the valve seats for damage.
- ★ If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
- Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapper.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.



NOTE

○ The valve stem and guide must be in good condition or this check will not be valid.

Good [A]

Too Wide [B]

Too Narrow [C]

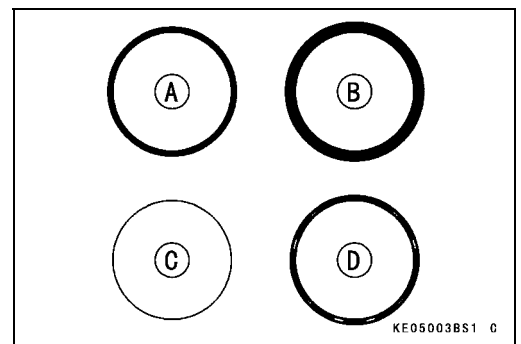
Uneven [D]

- ★ If the valve seating pattern is not correct, repair the seat.

Valve Seating Surface Width (STD)

Inlet 0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)

Exhaust 1.1 ~ 1.6 mm (0.043 ~ 0.063 in.)



Valve Seat Repair

- Follow the manufacturer's instructions for use of valve seat cutters (special tools).

Special Tools - Valve Seat Cutter Holder, ϕ 7: 57001-1126

Valve Seat Cutter Holder Bar: 57001-1128

Inlet Valve

Valve Seat Cutter, 45° - ϕ 35: 57001-1116

Valve Seat Cutter, 32° - ϕ 33: 57001-1199

Exhaust Valve

Valve Seat Cutter, 45° - ϕ 30: 57001-1187

Valve Seat Cutter, 32° - ϕ 30: 57001-1120

- ★ If the manufacturer's instructions are not available, use the following procedure.

2-14 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Seat Cutter Operating Cares

1. This valve seat cutter is designed only for valve seat repair. Therefore the cutter must not be used for other purposes.
2. Do not drop or hit the valve seat cutter, or the diamond particles may fall off.
3. Do not fail to apply engine oil to the valve seat cutter before grinding the seat surface. Also wash off ground particles sticking to the cutter with washing oil.

NOTE

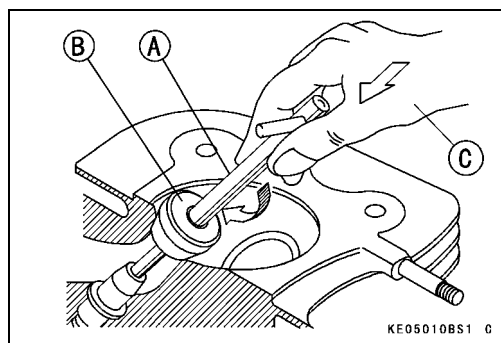
○Do not use a wire brush to remove the metal particles from the cutter. It will take off the diamond particles.

4. Setting the valve seat cutter holder [A] in position, operate the cutter [B] with one hand [C]. Do not apply too much force to the diamond portion.

NOTE

○Prior to grinding, apply oil to the cutter, and during the operation wash off any ground particles sticking to the cutter with washing oil.

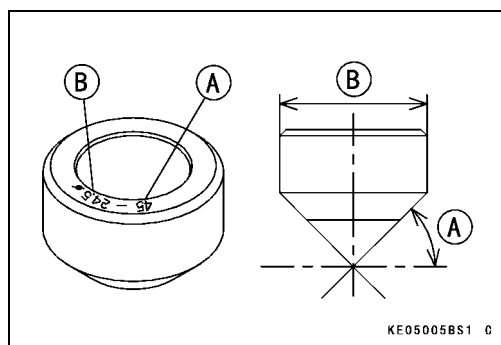
5. After use wash the cutter with washing oil and apply a thin layer of engine oil before storing.



Marks Stamped on the Cutter

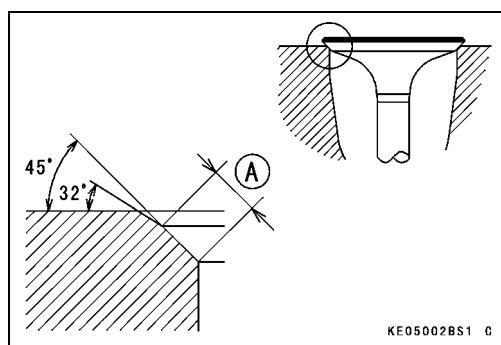
The marks stamped on the back of the cutter represent the following.

45°	Cutter angle [A]
φ24.5	Cutter diameter of cutter [B]



Operating Procedures

- Clean the seat area carefully.
- Recondition the valve seats with the valve seat cutters (45°, 32°) and lap the valves.
- Check the seats for good contact all the way around with machinist's dye.
- Measure the seat width [A]. If it is more than the STD width, the seating surface should be refaced.
- ★ If the valve seating pattern is not correct, repair the seat.



Periodic Maintenance Procedures

- Coat the seat with machinist's dye.
- Fit a 45° cutter [A] to the holder and slide it into the valve guide.
- Resurface the valve seat with a 45° cutter, removing only enough material to produce a smooth and concentric seat.

CAUTION

Do not grind the seat too much. Overgrinding will reduce valve clearance by sinking the valve into the head. If the valve sinks too far into the head, it will be impossible to adjust the clearance, and the cylinder head must be replaced. Do not turn the cutter counterclockwise or drop it against the seat, or it will be dulled.

- Use a 32° seat cutter [A] to narrow the seat width to the STD width.
- Turn the seat cutter one turn at a time while pressing down very lightly. Check the seat width after each turn.

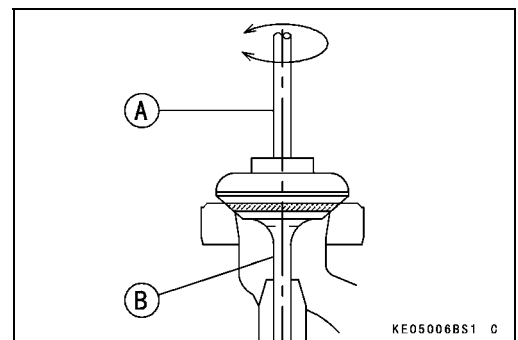
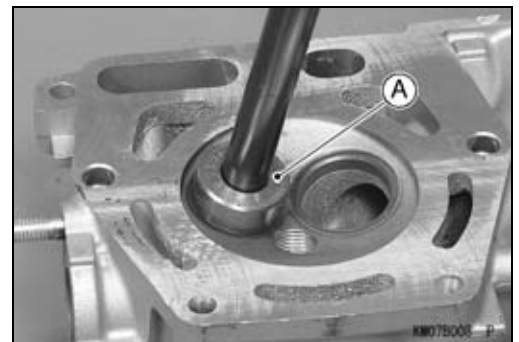
CAUTION

The 32° cutter removes material very quickly. Check the seat width frequently to prevent over grinding.

NOTE

○ *Keep the seat width as close as possible to the STD width.*

- Make a light pass with the 45° cutter to remove any possible burrs at the edge of the seat.
- After resurfacing the seat, inspect for even valve seating.
- Apply a machinist's dye to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.
- ★ If the seat does not make proper contact, lap the valve into seat with a lapper.
- Coat the face of valve sparingly with a fine lapping compound.
- Use the lapper [A], to grip top of the valve [B]. Rotate the valve in a circular motion to lap the valve to the seat.
- Lift the valve slightly from the seat every 8 to 10 strokes, continue lapping operation until a uniform ring appears around entire surface of the valve face.



2-16 PERIODIC MAINTENANCE

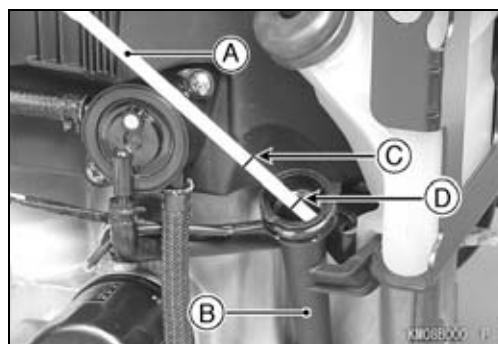
Periodic Maintenance Procedures

- When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
- Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the valve face.
- When the engine is assembled, be sure to adjust the valve clearances (see Valve Clearance Adjustment in this chapter).

Lubrication System

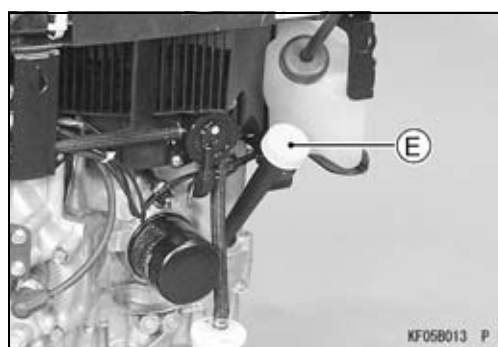
Oil Level Inspection

- Place the engine on a level surface.
- Clean area around the oil gauge [A] before removing it.
- Remove the oil gauge and wipe it with a clean cloth.
- Insert the oil gauge into tube [B] following the tube bend and let its plug firmly fit into the tube, then check the oil level.
- The oil level should be between the “ADD” [D] and “FULL” [C] marks on the oil gauge.
- ★ If the oil level is near or below the “ADD” mark, remove the oil filler cap [E] and add enough engine oil to bring oil level to the “FULL” mark.



CAUTION

Do not fill above the “FULL” mark. Excess oil will cause a smoking condition, and may cause the engine to overheat.



- ★ If the oil level is too high, remove the excess oil by loosening the drain plug [A].

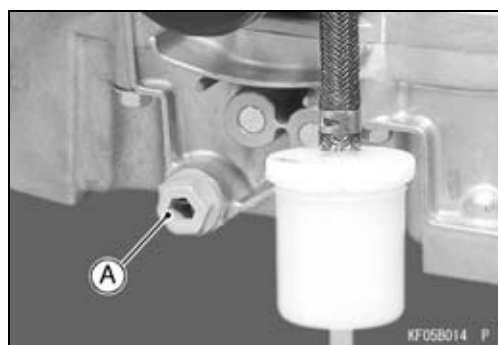
CAUTION

Before starting the engine for the first time, add oil: The engine is shipped dry. Preoil the engine to force all air from the internal oil passages and the oil filter.

- Fill fresh engine oil to the specified level.
- Run the engine at slow speed 2 minutes.
- Stop the engine and check the oil level.
- Add oil only to the “FULL” mark on the oil gauge. Use the same type and make of oil that is already in the engine.

NOTE

○ If the engine oil type and make are unknown, use any brand of the specified oil to top up the level in preference to running the engine with the oil level low. Then at your earliest convenience, change the oil completely.



Periodic Maintenance Procedures

Oil Change

- Change oil after first 8 hours of operation. Thereafter change oil every 100 hours.
- Start and warm up the engine so the oil will drain easily. Stop the engine.
- Place the engine on a level surface.
- Place a suitable container under the engine.
- Remove the drain plug [A] and drain the oil.

⚠ WARNING

Be careful with not oil being drained. If may be hot enough to burn you severely.

- Check the gasket [B] at the drain plug for damage. Replace the gasket with a new one.
- Install the drain plug with the gasket and tighten it.

Torque - Oil Drain Plugs: 6.9 N·m (0.70 kgf·m, 61 in·lb)

- Remove the oil filler cap and pour in the specified type and amount of oil.

Engine Oil :

- Grade:** API Service Classification;
SF, SG, SH, or SJ Class
- Viscosity:** SAE40, SAE30, SAE10W-30/SAE10W-40,
or SAE5W-20
- Capacity:** 2.0 L (2.1 US qt)
(When filter is not removed)
2.3 L (2.4 US qt)
(When filter is removed)
- Level:** Between ADD and FULL level lines.

NOTE

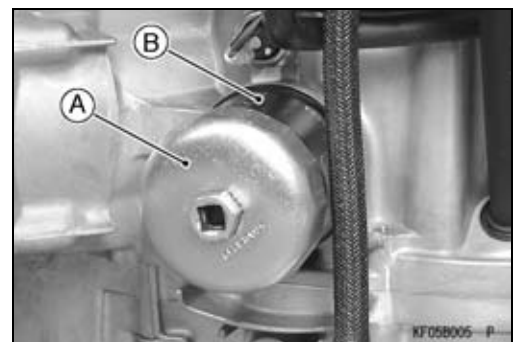
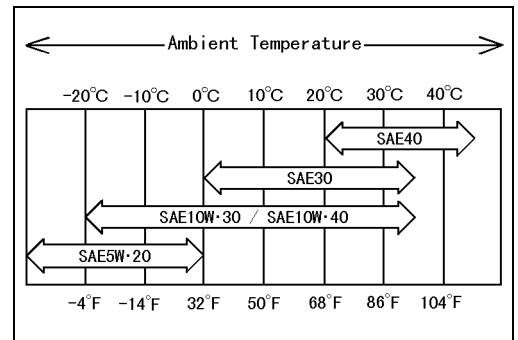
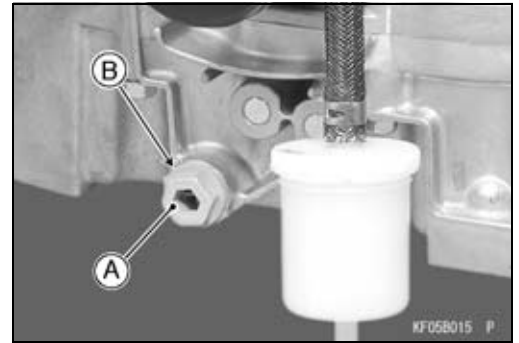
- Some increase in oil consumption may be expected when a multi grade engine oil (10W-30/10W-40, 5W-20) is used. Check the oil level frequently.

Oil Filter Replacement

- Using a strap wrench or oil filter wrench [A], remove the oil filter [B].

Special Tool - Oil Filter Wrench: 57001-1249

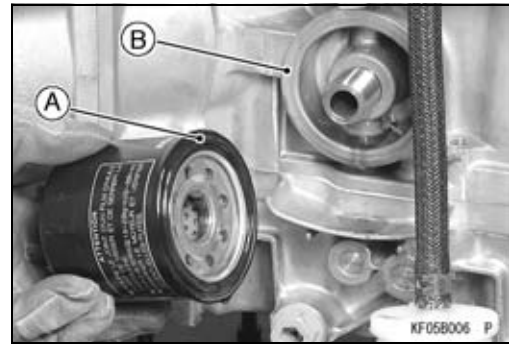
- When unscrewing the oil filter, place a suitable container beneath the oil filter to receive oil from the oil filter and oil passages in the engine. Turn the filter counterclockwise to remove it.



2-18 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

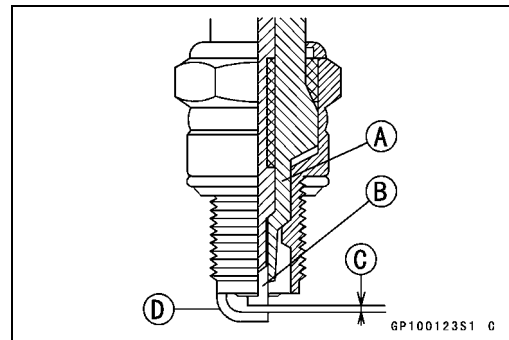
- Apply a thin coat of grease to the seal [A].
- Install a new filter.
- Turn the filter until the seal contacts mounting surface [B] of the engine. Then turn the filter BY HAND(S) 3/4 turn more.
- Run the engine at slow idle speed 2 minutes. Check for leaks around the engine.
- Stop the engine. Check the oil level (see Oil Level Inspection in this chapter).



Electrical System

Spark Plug Cleaning and Gap Inspection

- Remove the spark plug (see Spark Plug Removal in the Electrical System chapter).
 - ★ If the plug is oily or has carbon build up on it, clean the plug using a high-flash point solvent and a wire brush or other suitable tool.
 - ★ If the spark plug electrodes are corroded or damaged, or if the insulator is cracked, replace the plug. Use the standard spark plug or its equivalent.
- Insulator [A]
Center Electrode [B]
Plug Gap [C]
Side Electrode [D]
- Measure the gap with a wire-type thickness gauge.
 - ★ If the gap is incorrect, carefully bend the side electrode with a suitable tool to obtain the correct gap.



Spark Plug Gap

Standard: 0.75 mm (0.30 in.)

Fuel System

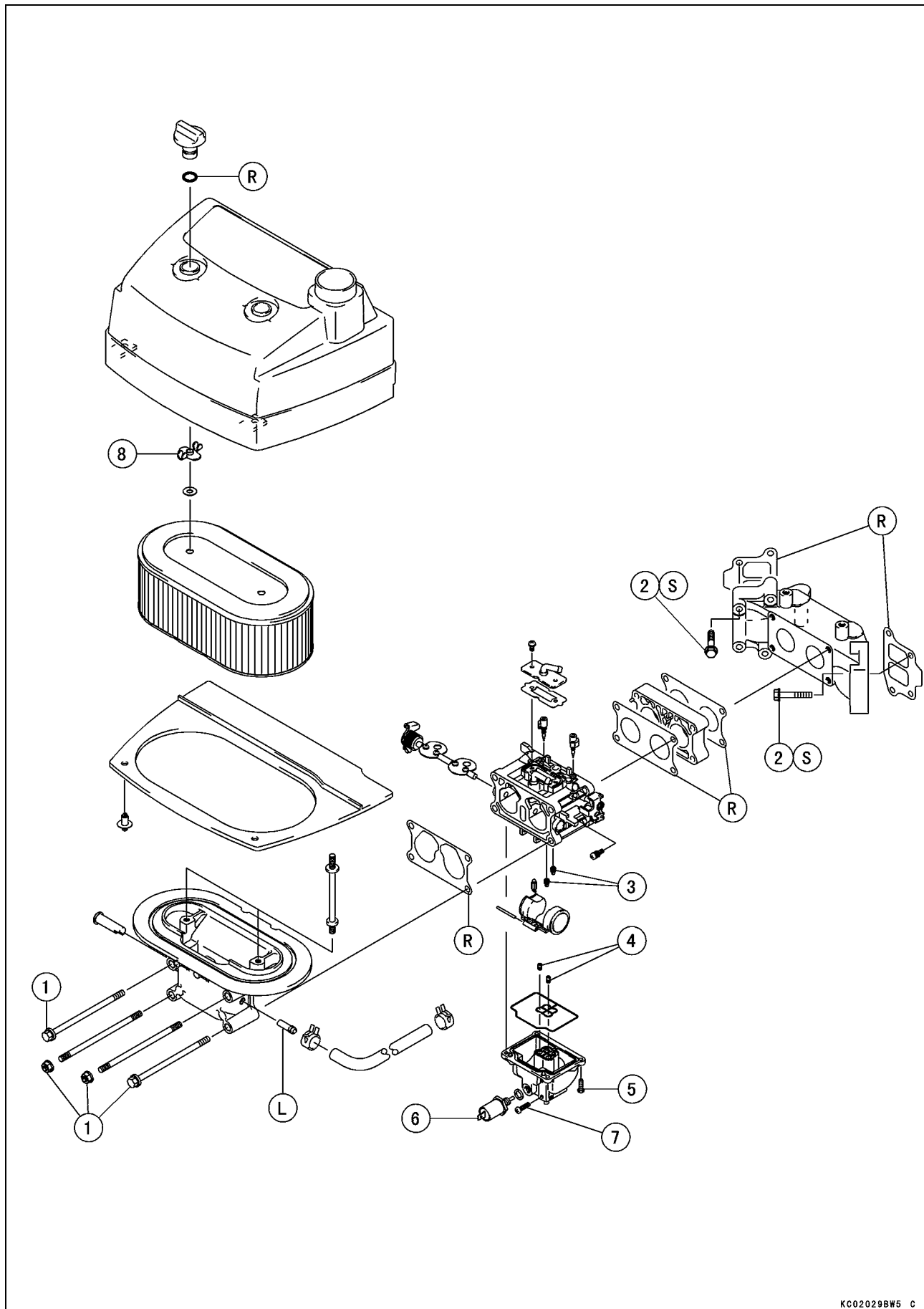
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3-2 FUEL SYSTEM

Exploded View

Standard Air Cleaner Model



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Carburetor and Inlet Pipe Mounting Bolts and Nuts	12	1.2	104 in·lb	
2	Inlet Manifold Mounting Bolts	6	0.6	53 in·lb	S
3	Pilot Jets	1.7	0.17	15 in·lb	
4	Main Jets	0.7	0.07	6 in·lb	
5	Float Chamber Mounting Screws	2.0	0.20	17 in·lb	
6	Fuel Shut-Off Solenoid Valve	7.0	0.71	61 in·lb	
7	Drain Screw	1.3	0.13	11 in·lb	
8	Air Cleaner Wing Nuts	2	0.2	17 in·lb	

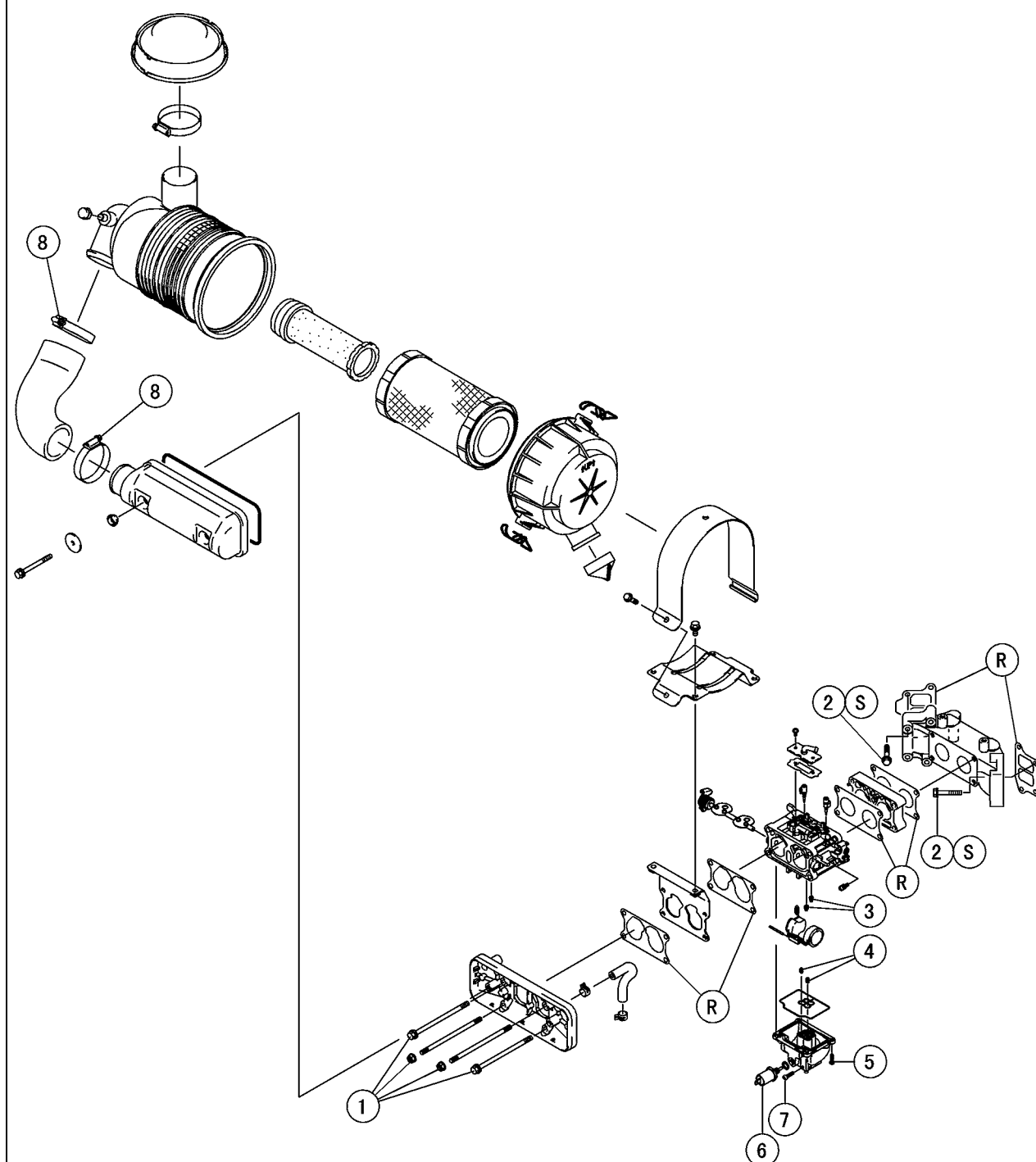
L: Apply a non-permanent locking agent.

R: Replacement Parts

S: Follow the specific tightening sequence.

Exploded View

Heavy Duty Air Cleaner Model



Exploded View

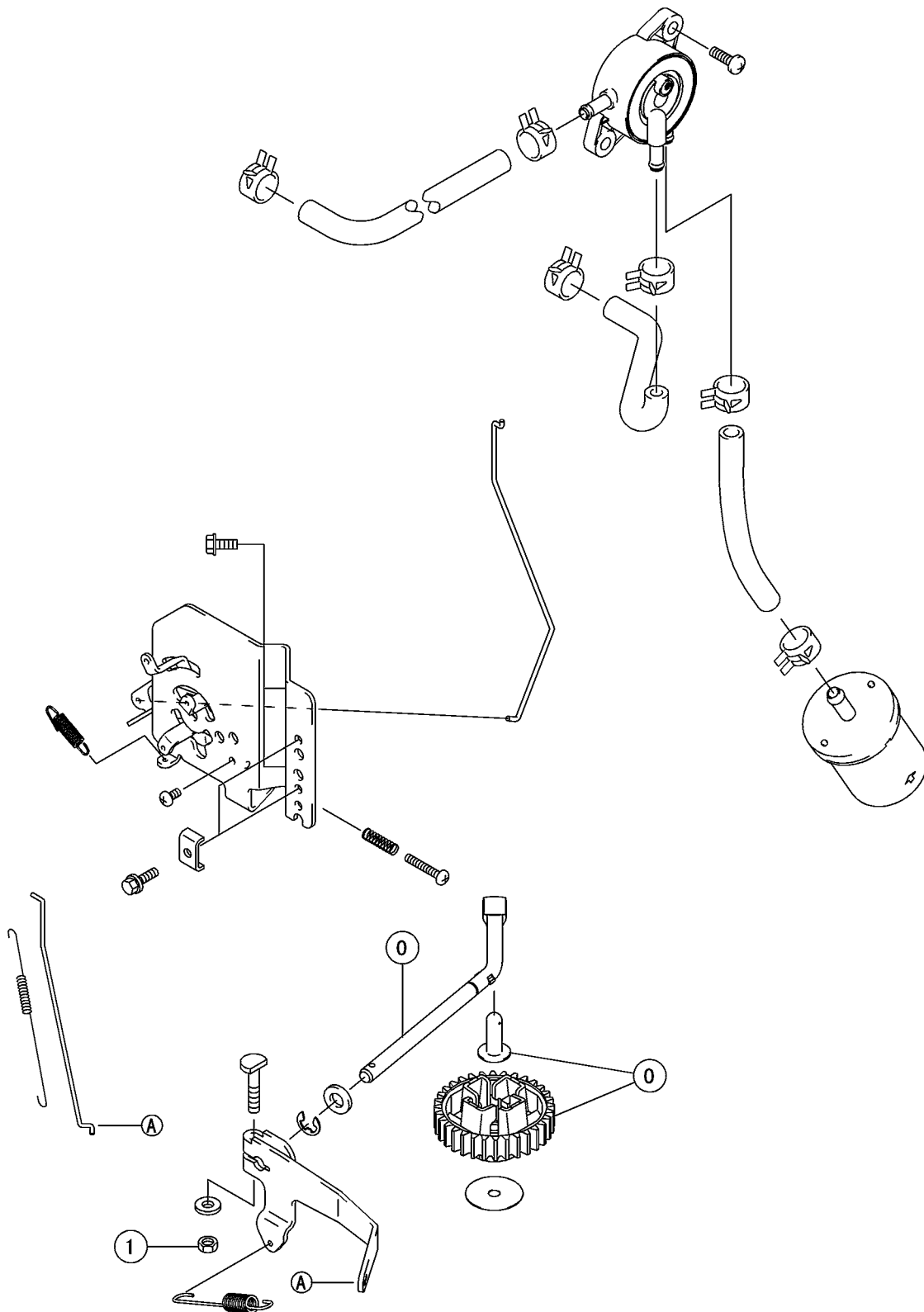
No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Carburetor and Inlet Pipe Mounting Bolts and Nuts	12	1.2	104 in·lb	
2	Inlet Manifold Mounting Bolts	6	0.6	53 in·lb	S
3	Pilot Jets	1.7	0.17	15 in·lb	
4	Main Jets	0.7	0.07	6 in·lb	
5	Float Chamber Mounting Screws	2.0	0.20	17 in·lb	
6	Fuel Shut-Off Solenoid Valve	7.0	0.71	61 in·lb	
7	Drain Screw	1.3	0.13	11 in·lb	
8	Air Cleaner Tube Clamps	2	0.2	17 in·lb	

R: Replacement Parts

S: Follow the specific tightening sequence.

3-6 FUEL SYSTEM

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Governor Arm Clamp Nut	8	0.8	69 in·lb	

O: Apply engine oil.

3-8 FUEL SYSTEM

Specifications

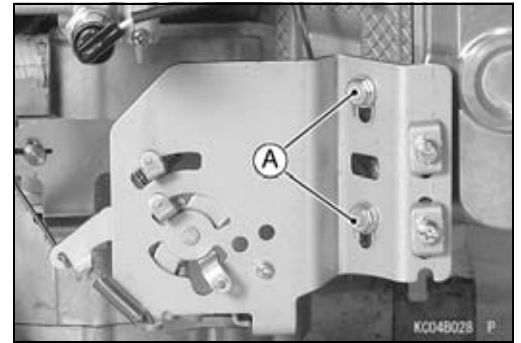
Item	Standard	
	FD680V	FD731V
Carburetors Specifications		
Make/type	MIKUNI BW26	←
Throttle Bore Diameter	26 mm (1.02 in.)	←
Venturi Diameter	21 mm (0.83 in.)	←
Main Jet (MJ)	[R]: #130, [L]: #128.8	[R]: #120, [L]: #115
Pilot Jet (PJ)	[R]: #50, [L]: #46.3	←
Main Air Jet (MAJ)	φ1.7	←
Pilot Air Jet (PAJ)	φ1.2	←
Pilot Air Screw Turns Out (PS) (Idle Mixture Screw Turns Out)	[R]: 2-3/4, [L]: 3-5/8	[R]: 2-7/8, [L]: 3-11/16
Float Level	Float parallel to carburetor body	
Idle Speed (1)		
Low Idle Speed	1 550 r/min (rpm)	
High Idle Speed	3 600 r/min (rpm)	
Air Cleaner		
Standard Model:		
Type	Dual stage filtration system	
Pre-Cleaner	Foam element	
Two-Stage cleaner	Paper element	
Heavy Duty Model:		
Type	Heavy duty type	
Pre-Cleaner	Primary element	
Two-Stage Cleaner	Secondary element	
Fuel		
Fuel Requirement	Unleaded regular grade gasoline	
Fuel Pump		
Type	Pulse-diaphragm pump	
Governor		
Type	Flyweight all speed governor	

(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

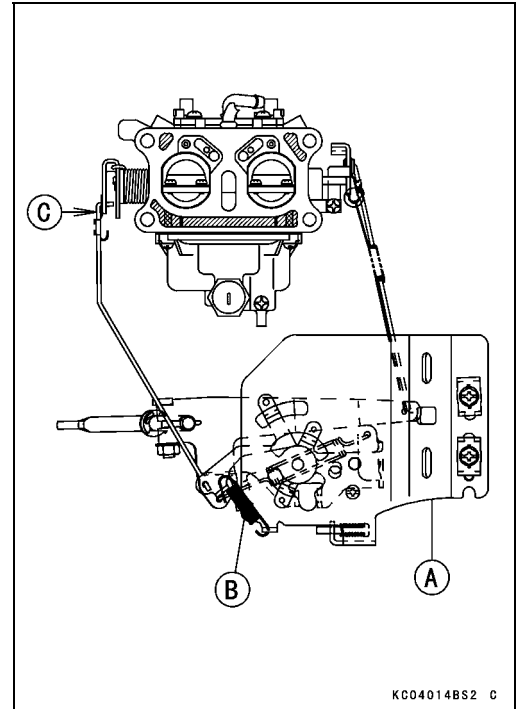
Governor Link Mechanism

Control Panel Assembly Removal

- Remove:
Muffler (see Muffler/Exhaust Pipe Removal in the Engine Top End chapter)
Control Panel Mounting Bolts [A]

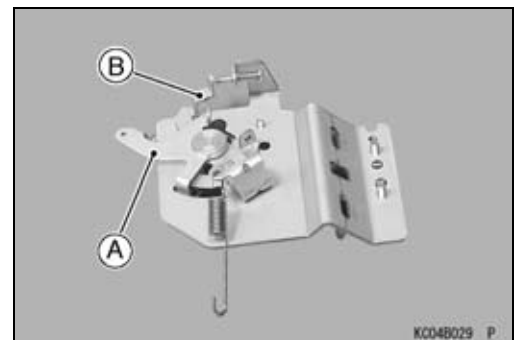


- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the governor arm.
- First, clear the choke link rod end [C] from the carburetor, and then remove the choke link from the choke lever.



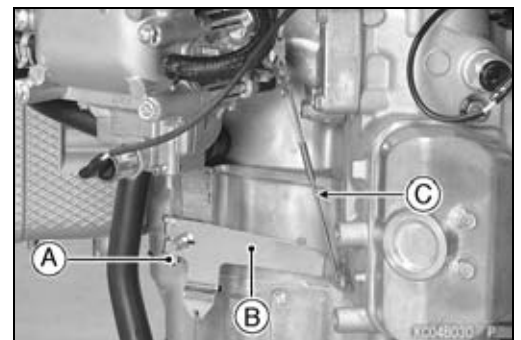
Control Panel Assembly Installation

- Before installing the control panel assembly, check to see that the choke lever [A] and engine speed control lever [B] move smoothly in all directions.
- ★ If any part is worn or damaged, replace the control panel assembly.
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low Idle Speed and High Idle Speed Adjustment in the Periodic Maintenance chapter).



Governor Arm Removal

- Remove:
Control Panel Assembly
- Loosen the clamp nut [A] and take off the governor arm [B].
- Clear the throttle link rod [C] from the governor arm and choke lever.

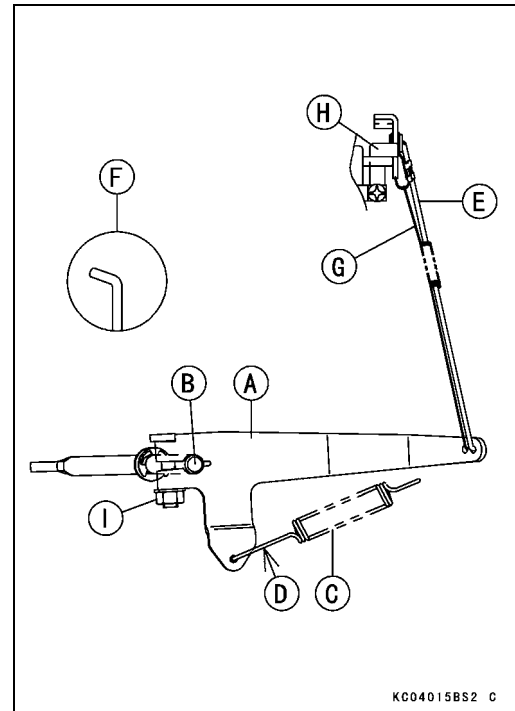


3-10 FUEL SYSTEM

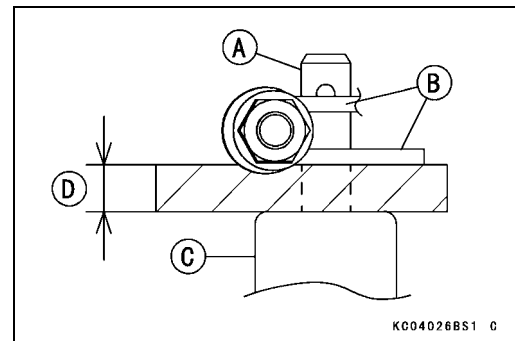
Governor Link Mechanism

- Install the governor arm [A] onto the governor shaft [B] temporarily.
- Install the control panel assembly, and connect the governor arm with the governor spring [C] as shown.
Longer Side [D]
- Install the throttle link rod [E] as shown.
Carburetor Side of the Link Rod [F]
- Be sure the link spring [G] around the throttle link rod [E] is in place as shown and that it pulls the governor arm and throttle lever [H] each other.
- Loosen the clamp nut [I] on the governor arm enough to move the governor shaft.
- Turn top end of the governor arm counterclockwise to fully open the carburetor throttle valve and tighten the clamp nut to the specified torque.

Torque - Governor Arm Clamp Nut: 8 N·m (0.8 kgf·m, 69 in·lb)



- Be sure the governor arm [B] is installed as shown.
Governor Shaft [A]
Crankcase [C]
Approx. 8.5 mm (0.33 in.) [D]

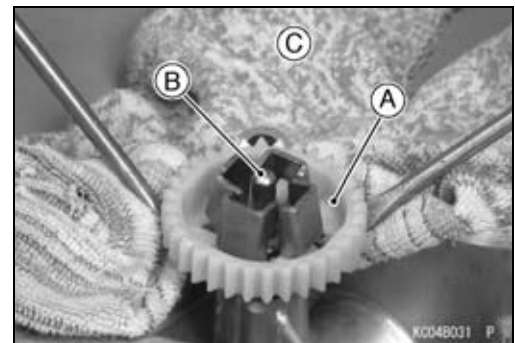


Governor Assembly Removal

- Remove:
Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter)
- Remove the governor assembly [A] with the sleeve [B] by prying the gear with two proper size screw drivers.

NOTE

○To avoid damage to the surface of crankcase cover, use a suitable soft mats [C] as shown.



CAUTION

Do not remove the governor assembly unless it is necessary. Once it has been removed, it must be replaced.

- Remove the thrust washer.

Governor Link Mechanism

Governor Assembly Installation

- Fit the sleeve into the governor assembly, and install them as a set.

NOTE

- *The sleeve and the governor assembly cannot be installed separately. Push the set onto the shaft until inner flange snaps into the groove securely.*

Sleeve [A]

Governor Assembly [B]

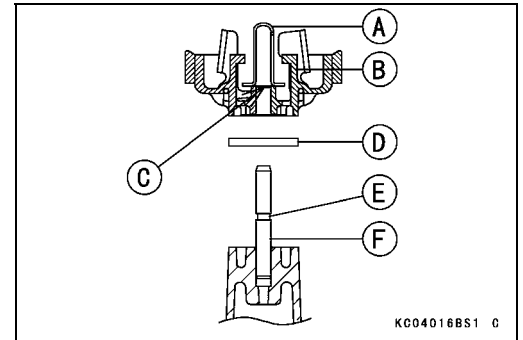
Inner Flange [C]

Thrust Washer [D]

Groove [E]

Shaft [F]

- Spin the governor assembly by hand and check that the flyweights operate freely and the center sleeve moves outward.



Governor Assembly Inspection

- Visually check the assembly for wear and damage.
- ★ If any parts is worn or damaged, replace the assembly.

Governor Shaft Removal

- Remove:
 - Camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter)
- Unscrew the governor arm clamp nut, and remove the governor arm.
- Remove the circlip [B] on the governor shaft [C], and remove the governor shaft and washer [A].

NOTE

- *It is not necessary to remove the governor shaft unless it is being replaced.*

- Replace the oil seal only if the lip shows signs of leakage or it has been damaged.

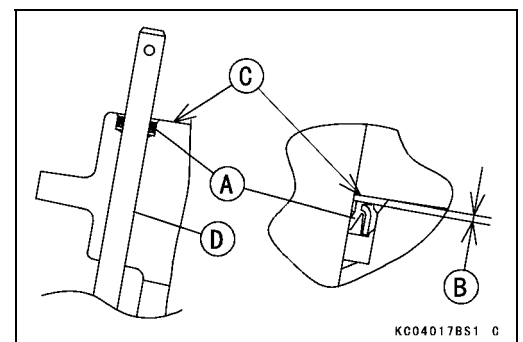
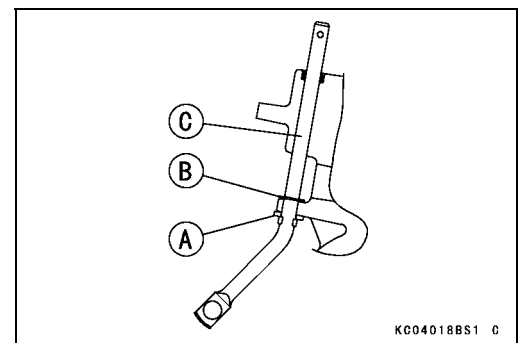
- The oil seal [A] must be assembled with seal lip towards inside of the engine.

- Press in the oil seal as shown.

0 ~ 5 mm (0 ~ 0.04 in.) [B]

Crankcase Surface [C]

Governor Shaft [D]



3-12 FUEL SYSTEM

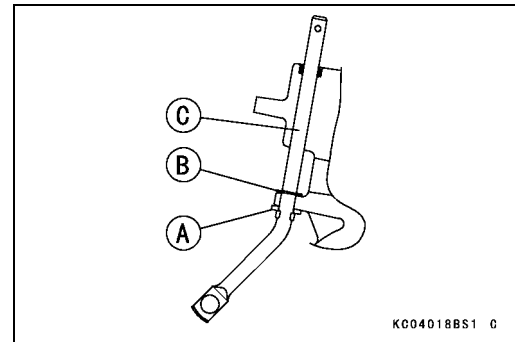
Governor Link Mechanism

Governor Shaft Installation

- Apply engine oil to the governor shaft.
- Insert the governor shaft into the crankcase and washer [A].
- Fit the circlip [B] securely into the groove of governor shaft [C] as shown.
- Check that the governor shaft moves freely in its operating range.

NOTE

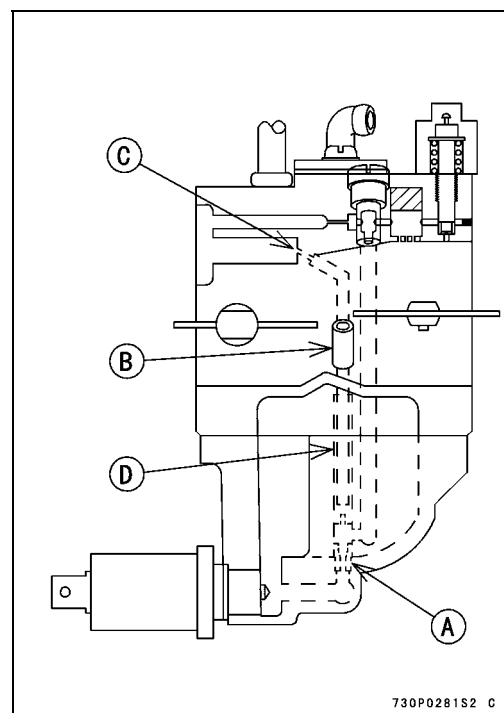
○If the oil seal is removed, reinstall it after the shaft is installed.



Carburetor

Fuel and Air Flow

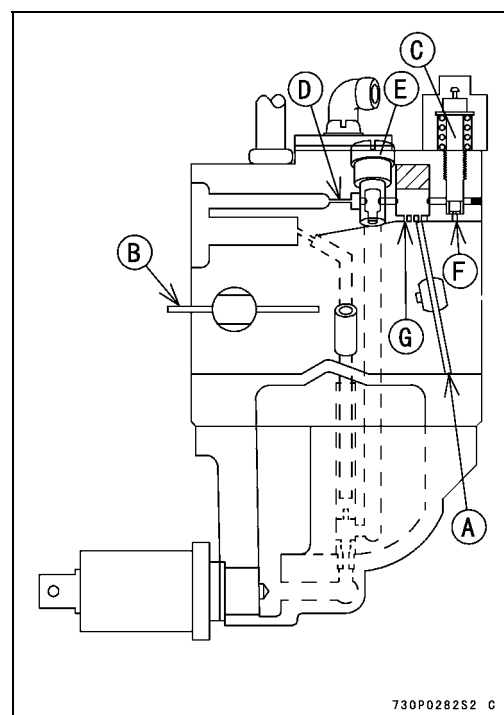
The main system of the carburetor consists of the main jet [A], main nozzle [B], and the main air passage (main air jet) [C]. The main system meters fuel to the engine during moderate to heavy load conditions. Fuel flows through the main jet and into the bleed pipe [D], where it is joined by air from the main air passage (main air jet). The resulting mixture flows out the end of the main nozzle into the carburetor bore, where it is atomized by the high speed air flow, and carried into the engine.



The pilot system includes the pilot jet [E], pilot screw (idle mixture screw) [C], pilot air jet [D], pilot outlet [F], and the bypass holes [G]. The pilot system meters the fuel/air mixture while the engine is idling and running under a light load. Under these conditions there is very little air flow through the carburetor bore; so little that it is not enough to draw fuel through the main system of the carburetor and atomize it. Instead, the fuel is drawn through the pilot system, since the nearly closed throttle valve [A] causes high speed air flow past the pilot outlet and bypass holes (even at low engine speed).

Choke Valve [B]

Fuel flow in the pilot system is metered by the pilot jet. Air for better atomization is admitted via the pilot air jet in the mid-way of the carburetor. The fuel/air mixture passes into the bore of the carburetor downstream of the throttle valve through the bypass holes and pilot outlet. While the throttle valve is almost closed, it covers the small bypass holes opening into the bore from the pilot system. As the throttle valve begins to open, it uncovers the bypass holes, allowing more fuel/air mixture to flow. The extra flow is needed because the engine starts to run faster as the throttle is opened. The pilot screw controls the amount of fuel/air mixture allowed through the pilot outlet, but does not meter the bypass holes. A moderate amount of air comes in around the throttle valve at an idle, so adjusting the pilot screw changes the fuel/air ratio. Turning the pilot screw (idle mixture screw) out (counterclockwise) enriches the mixture; turning it in (clockwise) leans the mixture.



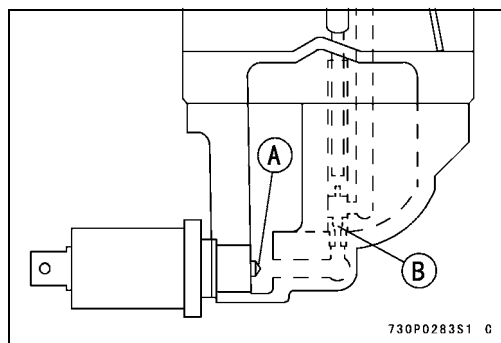
3-14 FUEL SYSTEM

Carburetor

Fuel Shut Off Solenoid Valve

To avoid after firing when stopping the engine, a solenoid actuated fuel shut off solenoid valve [A] is installed in the carburetor bowl. The valve shuts off the fuel supply to the main jet [B] simultaneously when the switch key turned to the “OFF” position.

The valve opens automatically when the switch key is turned to the “Run” position.



Low Idle Speed Adjustment

- Refer to the Low Idle Speed Adjustment in the Periodic Maintenance chapter.

High Idle Speed Adjustment

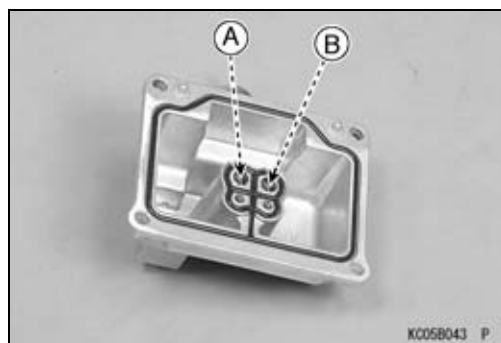
- Refer to the High Idle Speed Adjustment in the Periodic Maintenance chapter.

High Altitude Operation

At high altitude, the standard carburetor air-fuel mixture will be excessively rich. Performance will decrease, and fuel consumption will increase. High altitude performance can be improved by installing a smaller diameter main-jet in the carburetor and correct idle speed.

Main-jet [R] [A]

Main-jet [L] [B]



NOTE

- The main jet high altitude kits are available if the equipment is to be used in the high altitudes. The main jet numbers are stamped on ends of the main jets.

High Altitude Main Jet

Altitude	Main Jet No.	
	FD680V	FD731V
0 ~ 1 000 m (0 ~ 3 000 ft)	R: #130 L: #128.8	R: #120 L: #115
1 000 ~ 2 000 m (3 000 ~ 6 000 ft)	R: #127.5 L: #126.3	R: #117.5 L: #112.5
2 000 m (6 000 ft) and higher	R: #125 L: #123.8	R: #115 L: #110

Carburetor

Main Jet Replacement

- Place the engine (equipment) on a level surface.
- Close the fuel shut off valve in the equipment.
- Drain the fuel in the carburetor completely by unscrewing the drain screw [A] at the bottom of the float chamber.
- Remove the carburetor (see Carburetor Removal in this chapter).
- Unscrew the float chamber screws and take off the float chamber [B].
- Using a proper blade screw driver, carefully replace the main jet [C] with a new one for altitude expected.
- Tighten the main jet to the specification (see Carburetor Disassembly/Assembly in this chapter).

Torque - Main Jets: 0.7 N·m (0.07 kgf·m, 6 in·lb)

- Install the gasket and float chamber.

Torque - Float Chamber Mounting Screws: 2.0 N·m (0.20 kgf·m, 17 in·lb)

Fuel System Cleanliness Inspection

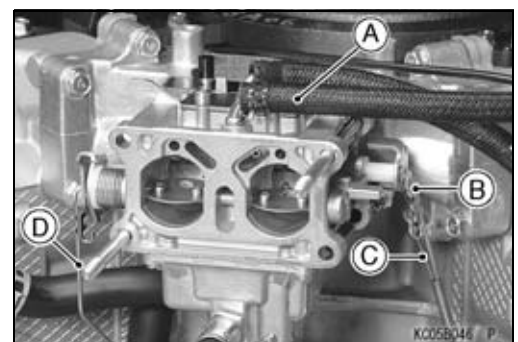
- Refer to the Fuel System Cleanliness Inspection in the Periodic Maintenance chapter.

Carburetor Removal

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Remove:
 - Air Cleaner and Related Parts (see Element Removal and Cleaner Body Removal in this chapter)
- Turn the fuel shut off valve to the OFF position.
- Drain the carburetor.
- Disconnect the fuel tube [A] at the fuel inlet joint of the carburetor.
- Unhook the throttle rod [B] and spring [C] and choke link rod [D] at the ends of their arms while pull off the carburetor.



Carburetor Installation

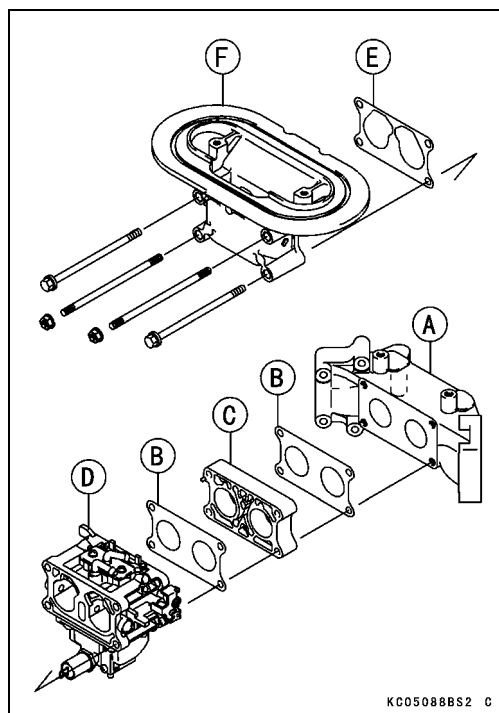
- Refer to the illustration shown for installation. Install the carburetor with the following procedures.
 - Clean the mating surfaces of the carburetor, insulator and inlet manifold, and fit new gaskets.
 - Take care not to bend the throttle and choke link rods during installation. Make sure the link spring around the throttle link rod is in place and that it pulls the governor arm and carburetor throttle shaft lever toward each other.

3-16 FUEL SYSTEM

Carburetor

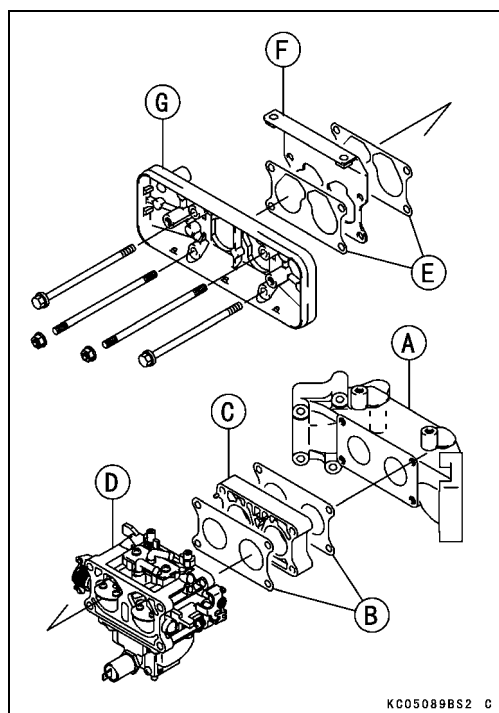
Standard Type Air Cleaner

Inlet Manifold [A]
Gaskets [B]
Insulator [C]
Carburetor [D]
Gasket [E]
Inlet Pipe [F]



Heavy Duty Type Air Cleaner

Inlet Manifold [A]
Gaskets [B]
Insulator [C]
Carburetor [D]
Gaskets [E]
Bracket [F]
Cover [G]



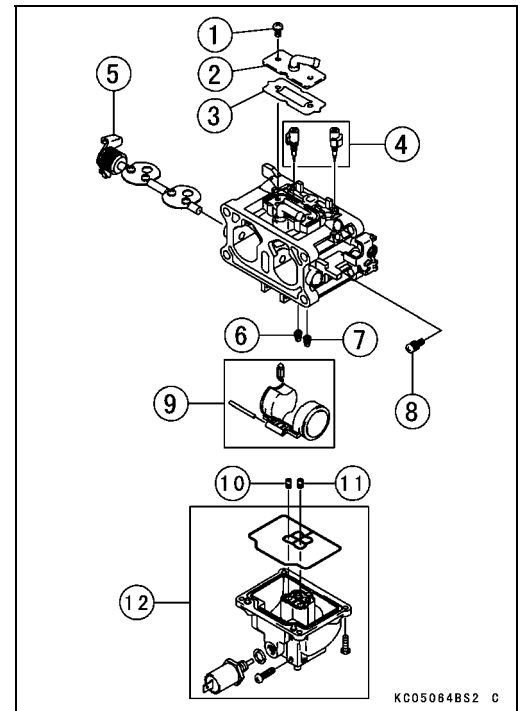
- Connect the solenoid valve lead terminal.
- Adjust:
 - Carburetor Pilot Screw
 - Idle Speed (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter)
- Install the removed parts.

Carburetor

Carburetor Disassembly/Assembly

- Refer to the illustration shown for disassembly and assembly.
- There are several passage plugs (ball plugs) in the carburetor body. Do not remove.
- Before disassembly, mark the out side of choke valve for assembling it.

1. Screw
2. Cover
3. Gasket
4. Pilot Screw Assy
5. Choke Valve Assy
6. Pilot Jet
7. Pilot Jet
8. Screw
9. Float Assy
10. Main Jet (L)
11. Main Jet (R)
12. Float Chamber Assy



- Replace the pilot screw in accordance with the following procedure if necessary.
 - Carefully mark the position of the pilot screw limiter on the carburetor body so that it can be installed and set to its original position later.
 - Remove the limiter. Be careful not to turn pilot screw at this point.
 - Turn the pilot screw clockwise and count the number of turns until screw is gently seated in the pilot passage. Record the number of turns needed to closed the screw.
 - Turn out the pilot screw to replace it with a new one.
 - Install the new pilot screw until the screw is gently seated. Then open the screw the same number of turns as recorded prior to removal.
 - Align the limiter with the mark on the carburetor body to install, taking care not to turn the pilot screw.
- Install the choke valve on the shaft as the out side mark of it facing out side.
- Drive in the float pin so that the pin extends the same distance on both side of the float hinge bracket.
- The fuel inlet valve seat is pressed into the carburetor body and is not replaceable.
- When assembling the carburetor parts which are attached to the carburetor with the recommended tightening torque of a bolts and screws (see Exploded View).

3-18 FUEL SYSTEM

Carburetor

Carburetor Cleaning

WARNING

Clean the carburetor in a well-ventilated area, and take care that there is no spark or flame anywhere near the working area; this include any appliance with a pilot light. Because of the danger of highly flammable liquids, do not use gasoline or low-flash point solvents to clean the carburetors.

CAUTION

Do not use compressed air on an assembled carburetor, the float may be crushed by the pressure. Remove as many rubber or plastic parts from the carburetor as possible before cleaning the carburetor with a cleaning solution. This will prevent damage or deterioration of the parts. The carburetor body has plastic parts that cannot be removed. Do not use a strong carburetor cleaning solution which could attack these parts; instead, use a mild high flash-point cleaning solution safe for plastic parts. Do not use wire or any other hard instrument to clean carburetor parts, especially jets, as they may be damaged.

- Disassemble the carburetor.
- Immerse all the carburetor metal parts in a carburetor cleaning solution and clean them.
- Rinse the carburetor parts in water and dry them with compressed air.
- Do not use rags or paper to dry parts. Lint may plug the holes or passages.
- Blow air through the holes and fuel passages with the compressed air. All holes must be open.
- Assemble the carburetor.

Carburetor

Carburetor Inspection

⚠ WARNING

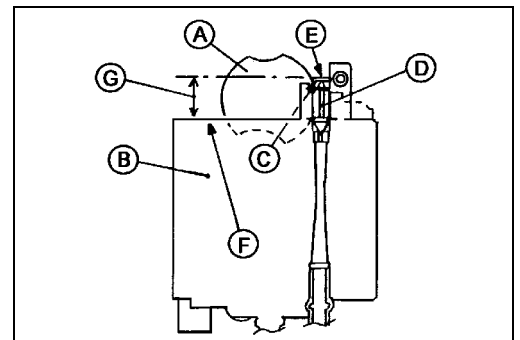
Gasoline is extremely flammable and can be explosive under certain. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burrs and nicks. Replace the gasket if necessary.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.
- ★ If the valves do not move smoothly, replace the carburetor body and/or throttle shaft and choke shaft assembly.
- Check that the gasket on the float chamber.
- ★ If the gasket is not in good condition, replace it.
- Check the other parts of the carburetor for wear or damage. Replace the part if necessary.
- Clean and check the float level as follows.

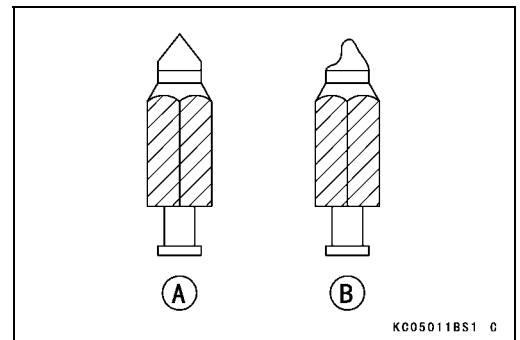
CAUTION

Do not push down on the float during float level checking.

- With the float [A] assembly installed onto the carburetor body [B], hold the carburetor upside down at an eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab [C] just touches the float valve [D]. The float arm surface [E] should be parallel [G] with the carburetor body mating surfaces [F].
- ★ If the float position is not correct, bend the tab as required for correct adjustment.



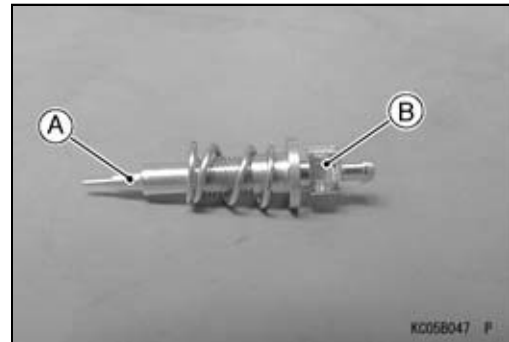
- Inspect the float valve for excessive wear or damage. The tip should be smooth, without any grooves, scratches, or tears. The rod at the other end of the needle should move smoothly when push in and released.
- ★ If either the valve or the seat is worn or damaged, replace the float assembly and carburetor body as a set.



3-20 FUEL SYSTEM

Carburetor

- Inspect the tapered portion [A] of the pilot screw [B] for wear or damage.
- ★ If the pilot screw is worn or damaged on the taper portion, replace it.
- Check the spring for weakened condition, replace it, if necessary.



Fuel Shut-Off Solenoid Valve Test

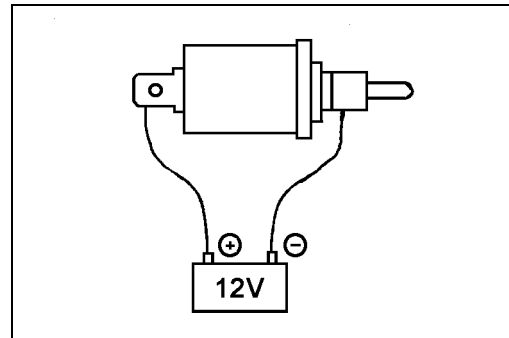
- Unscrew the fuel shut off valve and remove the valve.
- Connect a 12 VDC source to the solenoid as shown.
- ★ If the actuate solenoid plunger (needle valve) does not pop in when the test voltage is applied, replace it.

NOTE

○ If may be necessary to push the plunger slightly for the plunger to withdraw.

- Install the gasket and the valve.

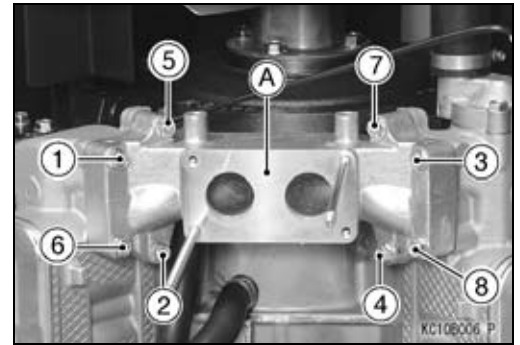
Torque - Fuel Shut-Off Solenoid Valve: 7.0 N·m (0.71 kgf·m, 61 in·lb)



Inlet Manifold

Inlet Manifold Removal

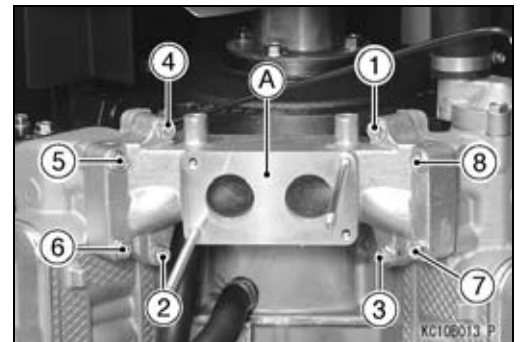
- Remove:
 - Air Cleaner and Related Parts (see Element Removal and Cleaner Body Removal in this chapter)
 - Carburetor (see Carburetor Removal in this chapter)
 - Control Panel Assembly
- Drain the coolant in the engine (see Coolant Draining in the Cooling System chapter).
- Unscrew the manifold mounting bolts in numerical sequence, 1/4 turn at a time, until all bolts are loose.
- ★ If the mounting bolts removal sequence is not followed, manifold mating surfaces may be warped.
- Remove the manifold [A] and gaskets.



Inlet Manifold Installation

- Before assembling the manifold [A], install the cylinder heads on each cylinder and tighten the head bolts (see Cylinder Head Assembly Installation in the Engine Top End chapter).
- Place a new gaskets on each mating surface, and install the manifold.
- Tighten the mounting bolts following the tightening sequence.

Torque - Inlet Manifold Mounting Bolts: 6 N·m (0.6 kgf·m, 53 in·lb)



Inlet Manifold Inspection

- Visually inspect the coolant passage in the manifold for deposits or corrosion in layers inside the passage, clean the passage if necessary.
- An improperly installed gaskets can cause coolant leakage and air drawn into the induction passage. Check the gaskets for correct installation.

NOTE

○ *Small coolant leaks appear only as a rust, corrosion or stain.*

- Inspect the inlet manifold for cracks or porous casting.
- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25% kerosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a crack is present, the coating will become discolored at the defective area.
- ★ If a crack is present in the inlet manifold, replace it.
- Inspect the gasket surfaces for burrs and nicks.

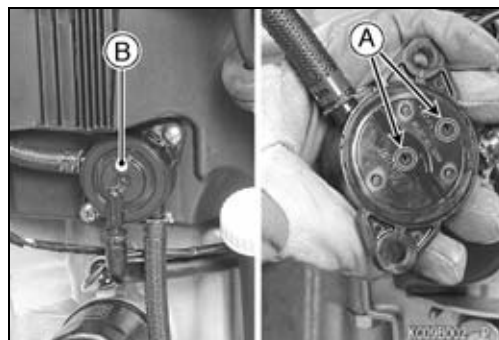
3-22 FUEL SYSTEM

Fuel Pump

The fuel pump cannot be disassembled, if any damage for the pump is noticed replace it with a new one.

Fuel Pump Inspection

- Check the vent holes [A] and filter [B] for plugging or clogging.
- ★ If vent hole and filter are plugged or clogged, remove the foreign matter from them.

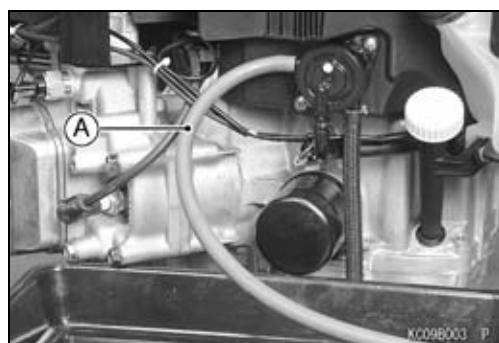


Fuel Flow Test

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well-ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

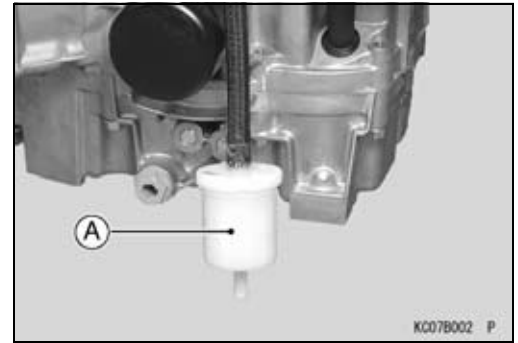
- Disconnect the fuel pump outlet nozzle from the tube.
- Connect a suitable hose [A] to the outlet nozzle.
- Run the lower end of the hose into a container.
- Start the engine, check the fuel flow.
- ★ If fuel flow is none or little, replace the fuel pump.
- ★ Check for clogged or damaged tubes and fuel filter. Replace the faulty parts.



Fuel Filter

Fuel Filter Inspection

- Visually inspect the fuel filter [A].
- ★ If the filter is clear with no signs of dirt or other contamination, it is OK and need not be replaced.
- ★ If the filter is dark or looks dirty, replace with a new one. Also check the rest of the fuel system for contamination.



3-24 FUEL SYSTEM

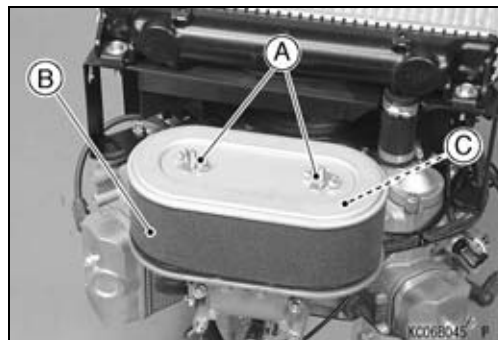
Air Cleaner (Standard Type)

Element Removal

- Remove:
 - Air Cleaner Case Nuts [A]
 - Upper-case [B]



- Remove:
 - Wing Nuts [A]
 - Foam Element [B]
 - Paper Element [C]



Element Installation

- Install the element correctly on the air cleaner body.
- Be sure the paper element is in-place in the air cleaner body.
- Be sure the foam element is in-place on the paper element body.
- Tighten the air cleaner wing nuts to the specified torque.

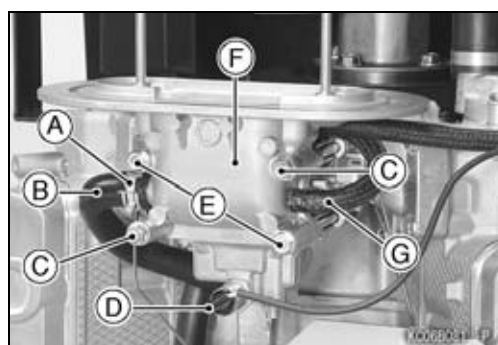
Torque - Air Cleaner Wing Nuts: 2 N·m (0.2 kgf·m, 17 in·lb)

Element Cleaning and Inspection

- Refer to the Element Cleaning and Inspection in the Periodic Maintenance chapter.

Cleaner Body Removal

- Remove the elements (see Element Removal in this chapter).
- Remove the clamp [A], and take off the breather tube [B] and vent hose [G].
- Loosen the nuts [C] and remove the solenoid valve lead terminal [D].
- Unscrew the bolts [E] and remove the inlet pipe [F].



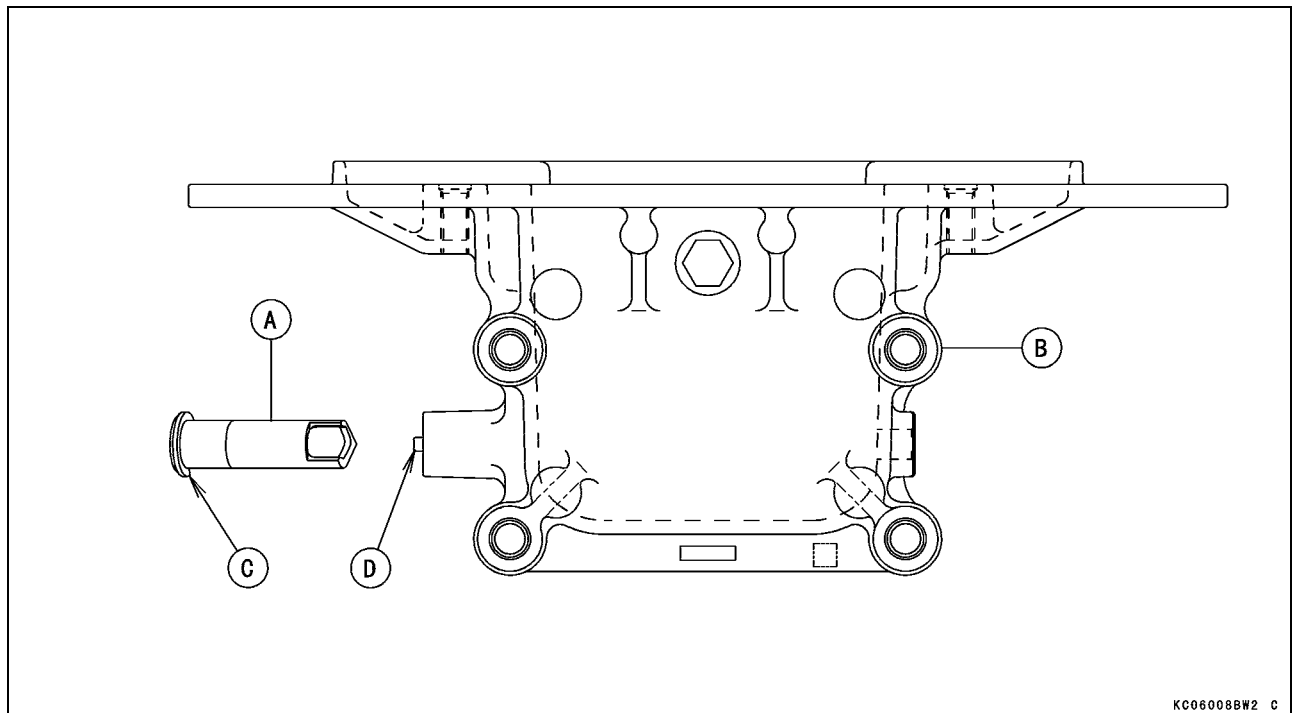
Air Cleaner (Standard Type)

Cleaner Body Installation

- Replace the inlet pipe gasket with new ones.
- Clean the mating surfaces of the carburetor and inlet pipe.
- Install the inlet pipe and connect the solenoid valve lead terminal.
- Tighten the mounting bolts and nuts.

Torque - Carburetor and Inlet Pipe Mounting Bolts and Nuts: 12 N·m (1.2 kgf·m, 104 in·lb)

- Install the sleeve on the inlet pipe.
- Press-in the sleeve [A] to the inlet pipe [B] fixing the groove [C] to the projection [D] as following.
- Connect the breather tube to the pipe at the inlet pipe and clip it with a clamp.



KC06008BW2 C

Housing Inspection

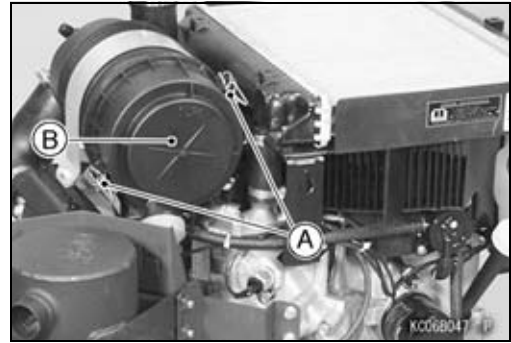
- Refer to the Housing Inspection in the Periodic Maintenance chapter.

3-26 FUEL SYSTEM

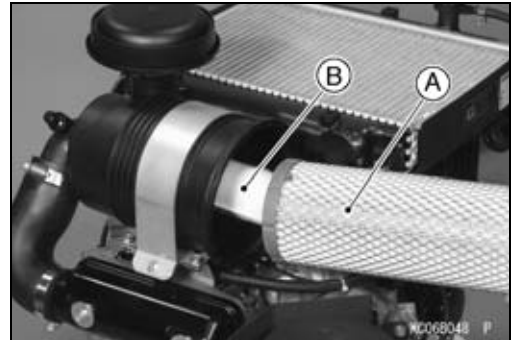
Air Cleaner (Heavy Duty Type)

Element Removal

- Unhook the two clips [A] and remove the cap [B] from the air cleaner housing.



- Remove:
 - Primary Element [A]
 - Secondary Element [B]



Element Installation

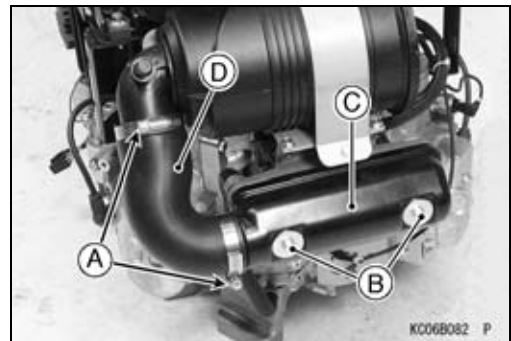
- Slide the secondary element and primary element into place in the air cleaner body.
- Install the cap and fasten the two clips.

Element Cleaning and Inspection

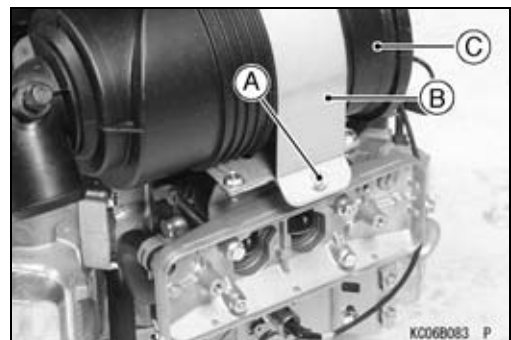
- Refer to the Element Cleaning and Inspection in the Periodic Maintenance chapter.

Cleaner Body Removal

- Remove the elements (see Element Removal in this chapter).
- Loosen the hose clamps [A], and remove the hose [D].
- Remove:
 - Bolts and Washers [B]
 - Inlet Pipe Cover [C]

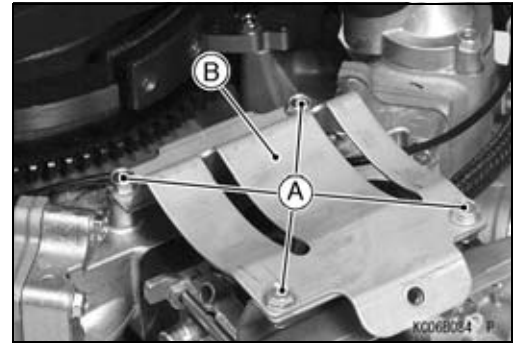


- Loosen the bolt [A], and remove the bracket [B] and air cleaner body [C].

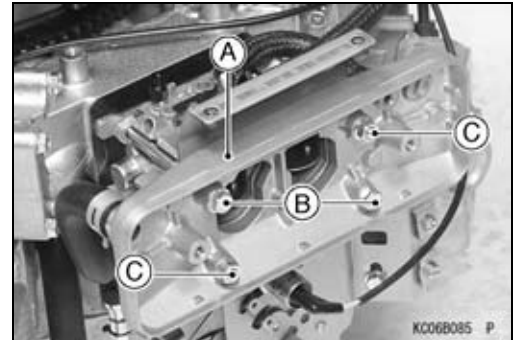


Air Cleaner (Heavy Duty Type)

- Loosen the bolts [A], and remove the bracket [B].



- Loosen the bolts [B] and nuts [C], and remove the inlet pipe [A].



Cleaner Body Installation

- Replace the inlet pipe gasket with new ones.
- Clean the mating surfaces of the carburetor and inlet pipe.
- Install the inlet pipe and connect the solenoid valve lead terminal.
- Tighten the mounting bolts and nuts.

Torque - Carburetor and Inlet Pipe Mounting Bolts and Nuts: 12 N·m (1.2 kgf·m, 104 in·lb)

- Install the removed parts.

NOTE

○Set the air cleaner body onto the bracket so that the air inlet duct is facing upward.

- Tighten the air cleaner tube clamps.

Torque - Air Cleaner Tube Clamps: 2 N·m (0.2 kgf·m, 17 in·lb)

Housing Inspection

- Refer to the Housing Inspection in the Periodic Maintenance chapter.

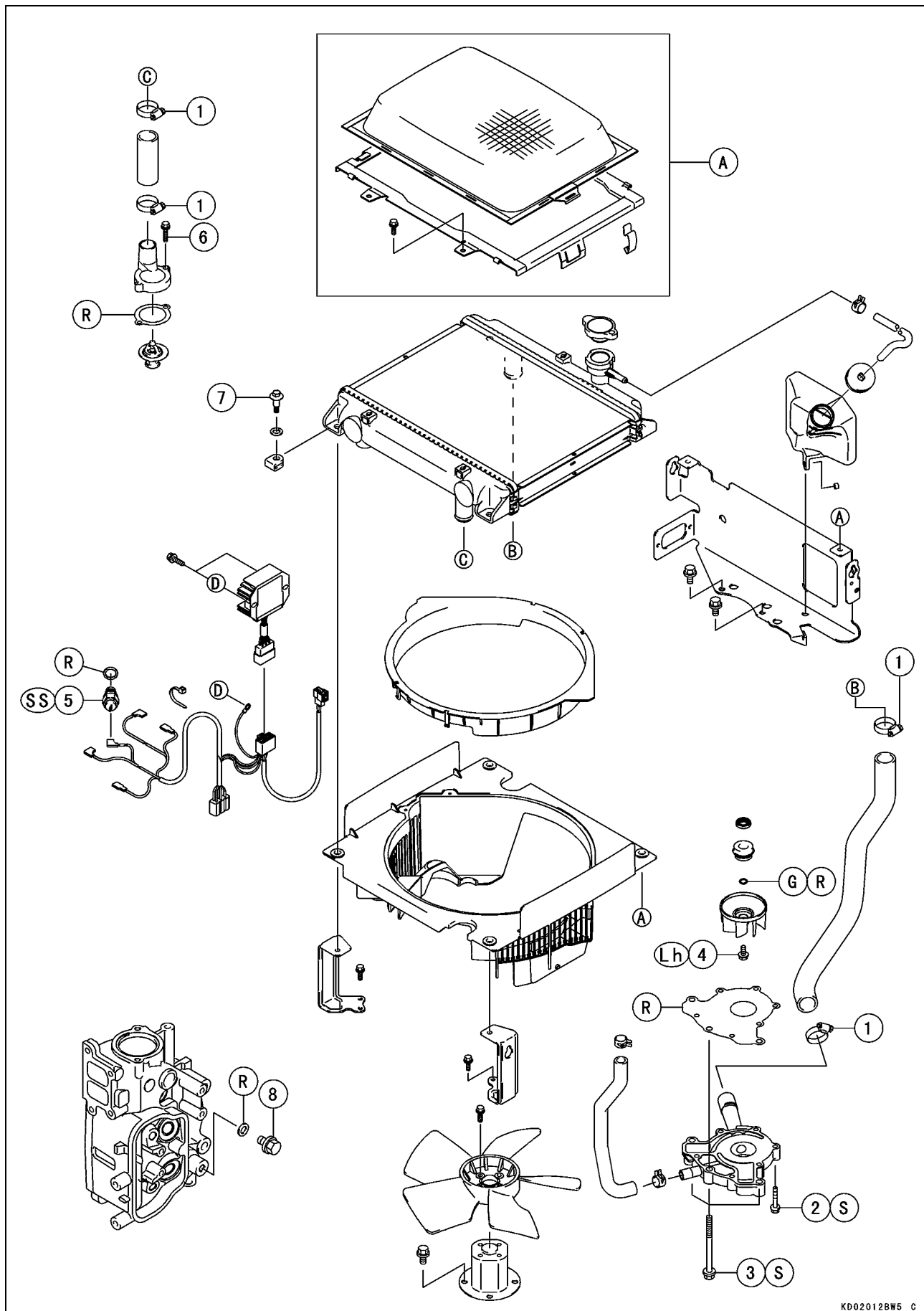
Cooling System

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4-2 COOLING SYSTEM

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Radiator Hose Clamp Bolts	1.3	0.13	12 in·lb	
2	Water Pump Cover Mounting Bolts (M6)	10	1.0	87 in·lb	S
3	Water Pump Cover Mounting Bolts (M8)	22	2.2	16	S
4	Impeller Bolt	10	1.0	87 in·lb	Lh
5	Thermo Switch	28	2.9	21	SS
6	Thermostat Cover Bolts	6	0.6	53 in·lb	
7	Radiator Mounting Bolts	6	0.6	53 in·lb	
8	Coolant Drain Plug	15	1.5	11	

G: Apply grease.

Lh: Left-hand threads

R: Replacement Parts

S: Follow the specific tightening sequence.

SS: Apply silicone sealant.

A: Optional Parts

4-4 COOLING SYSTEM

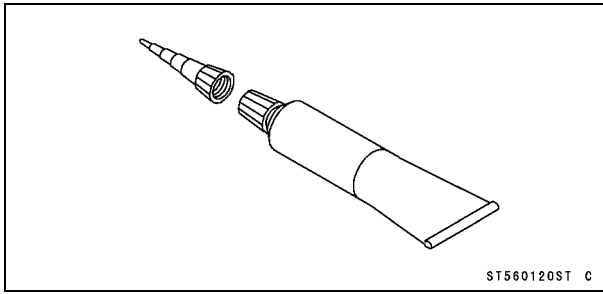
Specifications

Item	Standard
*Coolant	
Type	Permanent type of antifreeze for aluminum engine and radiator
Color	Green
Mixed Ratio	50% solution of ethylene glycol
Freezing Point	−35°C (−31°F)
Total Amount	2.7 L (2.9 US qt)
Radiator Cap Relief Pressure	
Pressure Valve (Positive)	73.3 ~ 102.7 kPa (0.75 ~ 1.05 kgf/cm ² , 10.6 ~ 14.9 psi)
Vacuum Valve (Negative)	4.90 kPa (0.050 kgf/cm ² , 0.71 psi)
Thermostat	
Valve Opening Temperature	80 ~ 84°C (176 ~ 183°F)
Valve Full Opening Lift	not less than 7 mm (0.28 in.) at 95°C (203°F)
Thermo Switch	
Detect Temperature	108 ~ 114°C (226 ~ 237°F)

*A permanent type of antifreeze is not installed in the cooling system when shipped.

Sealant

Kawasaki Bond (Silicone Sealant):
56019-120



4-6 COOLING SYSTEM

Cooling System

This engine is equipped with a highly efficient pressurized cooling system using a thermostat to maintain an optimum operating temperature. Coolant bypasses the closed thermostat when cold until operating temperature is attained, causing the engine to warm up more quickly. If the coolant temperature becomes too high, a thermo switch on the engine activates the coolant warning lamp to alert the operator or cooling problem.

Reserve Tank [A]

Radiator [B]

Cooling Fan [C]

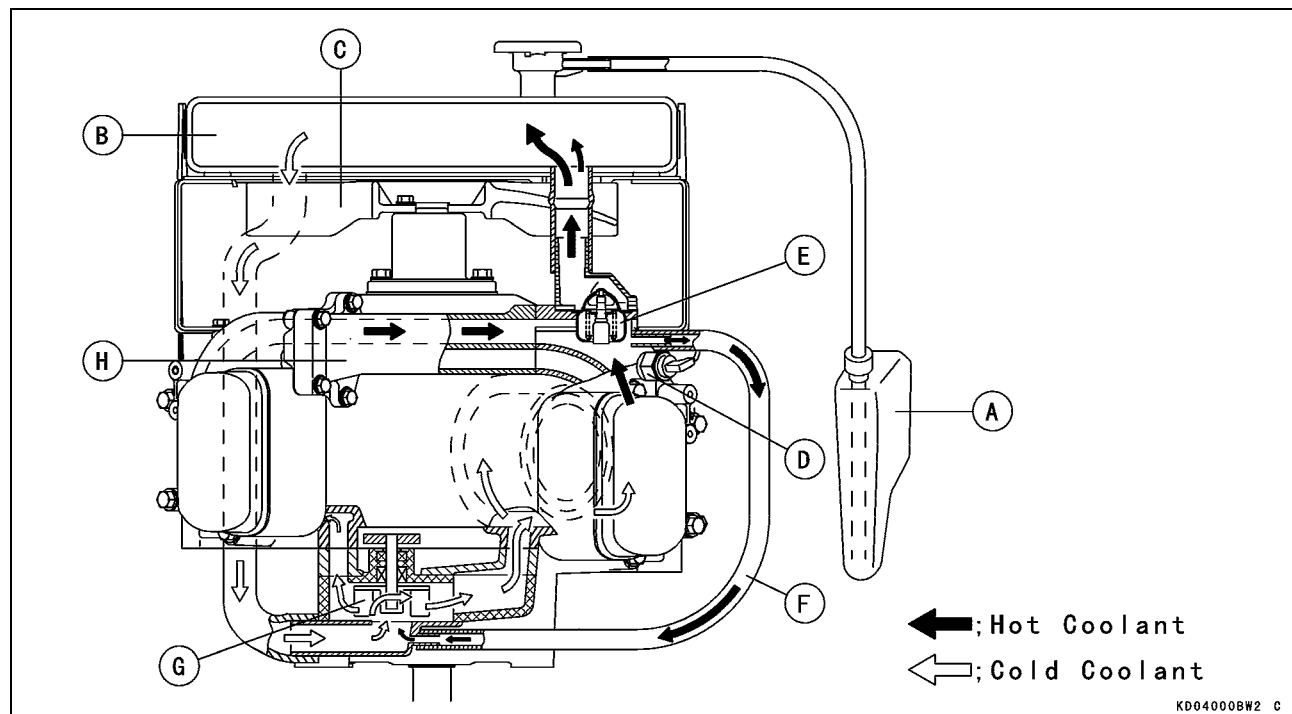
Thermo Switch [D]

Thermostat [E]

Bypass Tube [F]

Water Pump (Impeller) [G]

Inlet Manifold [H]



⚠ WARNING

Prior to disassembly of cooling system parts (radiator, pump, sensor, etc), wait until the coolant cools down, and then drain the coolant.

CAUTION

After assembling and filling the system with a coolant, purge any air from the system.

Coolant

Coolant Deterioration

- Visually inspect the coolant in the radiator.
- If whitish cotton-like wafts are observed, aluminum parts in the cooling system are corroded. If the coolant is brown, iron or steel parts are rusting. In either case, flush the cooling system.
- If the coolant gives off an abnormal smell when changing, check for a cooling system leak. It may be caused by exhaust gas leaking in to the cooling system.

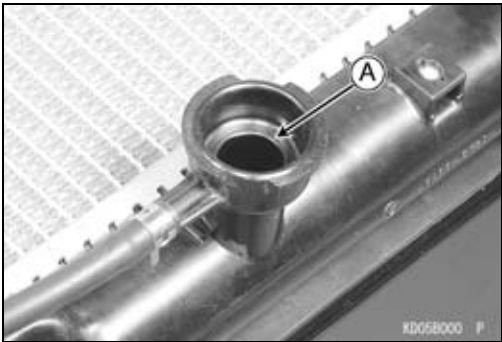
Coolant Level Inspection

- Put the engine on a level surface.
- Remove the radiator cap turning it counterclockwise and check the coolant level in the radiator.

⚠ WARNING

Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.

- Coolant level must be maintained a level of the filler neck bottom [A].
- ★ If the amount of the coolant is insufficient, fill the radiator up to the bottom of the radiator filler neck [A] with the coolant, and install the cap turning it clockwise.



CAUTION

For refilling, add the specified mixture of coolant and soft water. Adding water alone dilutes the coolant and degrades its anticorrosion properties. The diluted coolant can attack the aluminum engine parts. In an emergency, soft water can be added. But the diluted coolant must be returned to the correct mixture ratio within a few days. If coolant must be added often, there is probably leakage in the cooling system. Check the system for leaks (see Visual Leak Inspection, and Pressure Testing).

Coolant Draining

The coolant should be changed periodically to ensure long engine life.

CAUTION

Use coolant containing corrosion inhibitors made specifically for aluminum engines and radiators in accordance with the instructions of the manufacturers (see Coolant Filling Section).

4-8 COOLING SYSTEM

Coolant

⚠ WARNING

To avoid burns do not remove the radiator cap or try to change the coolant when the engine is still hot. Wait until it cools down. Since coolant is harmful to the human body, do not use for drinking.

- Remove the radiator cap [A] as follows.
 - First turn the cap counterclockwise to the first stop and wait there for a few seconds.
 - Push down the cap, then turn the cap counterclockwise to the next stop.
 - Lift off the cap.
- Place a suitable container under the drain plug [B] (black head). Turn the drain plug counterclockwise to drain the coolant in the radiator and water jacket.
- Inspect the old coolant for color and smell (see Coolant Deterioration in this chapter).

Coolant Filling

- Refer to the Coolant Filling in the Periodic Maintenance chapter.

Air Bleeding

Before putting the engine into operation, any air trapped in the cooling system must be removed as follows.

- Remove the radiator cap.
- Fill the radiator up to the radiator filler neck with coolant.
- Check the cooling system for leaks.
- Install the radiator cap.
- Start the engine, warm it up thoroughly, and then stop it.
- Check the coolant level in the radiator after the engine cools down.
- ★ If the coolant level is low, add coolant up to the filler neck bottom [A].
- Install the cap.

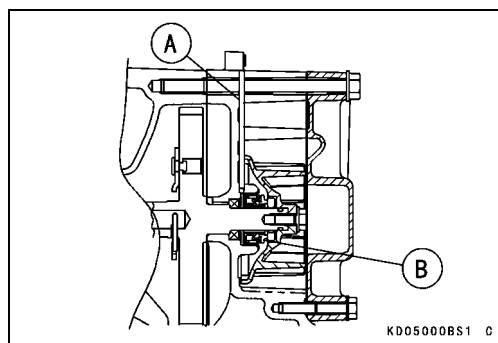
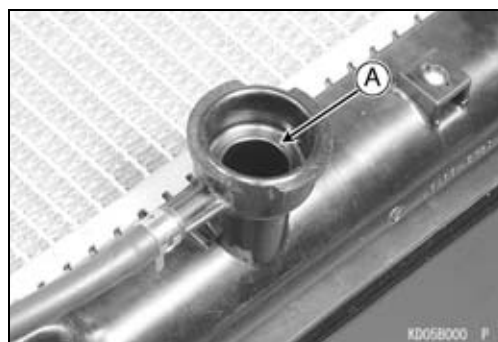
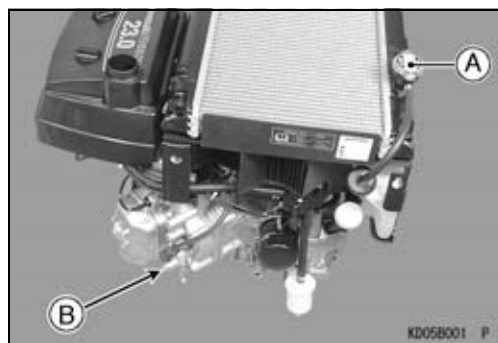
Visual Leak Inspection

Any time the system slowly loses water, inspect for leaks. Small leaks may appear only as a rust, corrosion or stain due to evaporation. Watch for these trouble spots.

- Check the water pump housing drainage outlet passage [A] for coolant leaks.
- ★ If the mechanical seal is damaged, the coolant leaks through the seal and drain through the passage. Replace the mechanical seal [B].
- ★ If there are no apparent leaks, pressure test the system.

Cooling System Pressure Testing

An air pressure leakage tester can help locate external leaks but they cannot be depended upon to locate small combustion leaks.



CAUTION

During pressure testing, do not exceed the pressure for which the system is designed. The maximum pressure is 102.7 kPa (1.05 kgf/cm², 14.9 psi).

Coolant

- Remove the radiator cap, and install a cooling system pressure tester [A] on the radiator filler neck.
- Wet the cap sealing surfaces with water or coolant to prevent pressure leaks.
- Build up pressure in the system carefully until the pressure reaches 60 kPa (0.61 kgf/cm², 8.7 psi).
- Watch the pressure gauge for at least 6 seconds. If the pressure holds steady, the system is all right.
- Remove the pressure tester, replenish the coolant, and install the cap.
- ★ If the pressure drops and no external source is found, check for internal leaks. Droplets in the engine oil indicate internal leakage. Check the cylinder head gaskets.



Flushing

Over a period of time, the cooling system accumulates rust, scale, and lime in the water jacket and radiator. When this accumulation is suspected or observed, flush the cooling system. If this accumulation is not removed, it will clog up the water passage and considerably reduce the efficiency of the cooling system.

⚠ WARNING

Prior to disassembly of cooling system parts (radiator, pump, sensor, etc), wait until the coolant cools down, and then drain the coolant.

CAUTION

After assembling and filling the system with a coolant, purge any air from the system.

- Drain the cooling system.
- Fill the cooling system with fresh water mixed with a flushing compound.

CAUTION

Avoid the use of a flushing compound which is harmful to the aluminum engine and radiator. Carefully follow the instructions supplied by the manufacturer of the cleaning product.

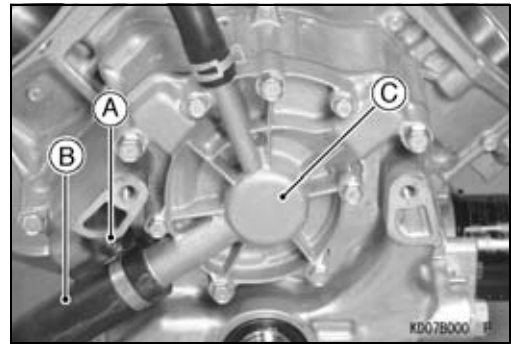
- Warm up the engine, and run it at normal operating temperature for about ten minutes.
- Stop the engine, and drain the cooling system.
- Fill the system with fresh water.
- Warm up the engine and drain the system.
- Repeat the previous two steps once more.
- Fill the system with a permanent type coolant, and bleed the air from the system.

4-10 COOLING SYSTEM

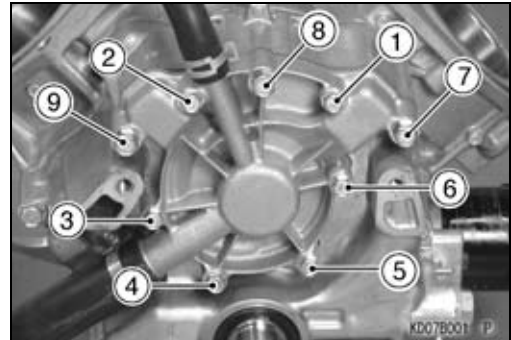
Water Pump

Water Pump Removal

- Loosen the tube clamp [A], and pull off the coolant by-pass tube [B].
Water Pump Cover [C]



- Unscrew the water pump mounting bolts in the order shown, and remove the water pump cover and gasket.



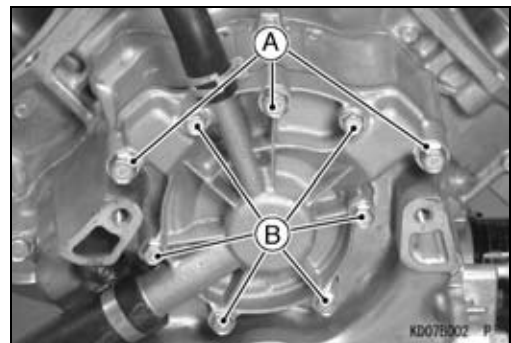
NOTE

- Note the position of different length of bolts so they can be installed in their original positions.

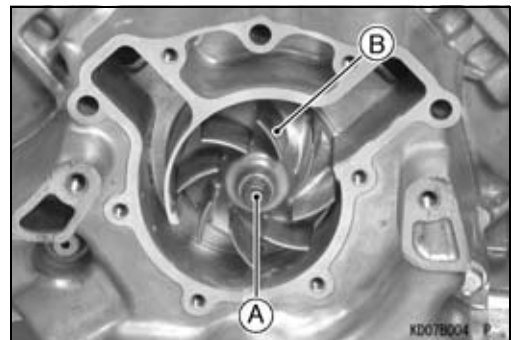
Bolt Dimensions

Bolts (M8), L = 100 mm (3.9 in.) [A]

Bolts (M8), L = 35 mm (1.4 in.) [B]



- Unscrew the impeller bolt [A] and remove the impeller [B].
○ The impeller bolt has left-hand threads.



Water Pump Installation

- Chip the old gasket off the mating surfaces of the crankcase cover and pump cover.
- Put a new gasket on the pump cover.
- Install the impeller and tighten the impeller bolt to the specified torque.
- The impeller bolt has left-hand threads.

Torque - Impeller Bolt: 10 N·m (1.0 kgf·m, 87 in·lb)

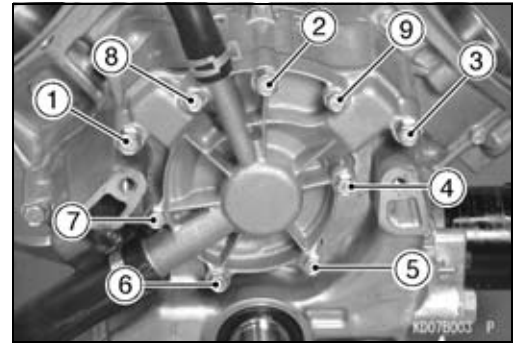
Water Pump

- Install the mounting bolts and tighten them in the order shown.

**Torque - Water Pump Cover Mounting Bolts (M6): 10 N·m
(1.0 kgf·m, 87 in·lb)**

**Water Pump Cover Mounting Bolts (M8): 22 N·m
(2.2 kgf·m, 16 ft·lb)**

- Note the position of different length of bolts.



Pumps Parts Inspection

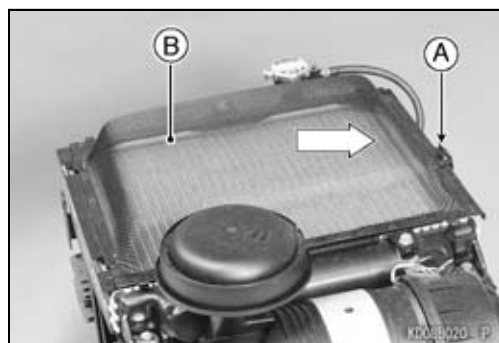
- Clean all parts except plastic and rubber parts in a bath of high flash-point solvent and dry them compressed air. Clean non-metal parts with detergent and water, and dry them.
- Inspect the pump cover for damage. Mating surfaces should be smooth and free of burrs and nicks.
- Check the other parts for wear or damage, replace the parts if necessary.
- ★ If the mechanical seal is damaged, the coolant leaks through the seal, and drain through the drainage outlet passage.
- ★ If the oil seal is damaged, the engine oil drain through the drainage passage.
- ★ If the mechanical seal parts are damaged, replace the seal as a set.
- Visually check the impeller.
- ★ If the surface is corroded, or if the blades are damaged, replace all internal pump parts.

4-12 COOLING SYSTEM

Radiator

Radiator Removal

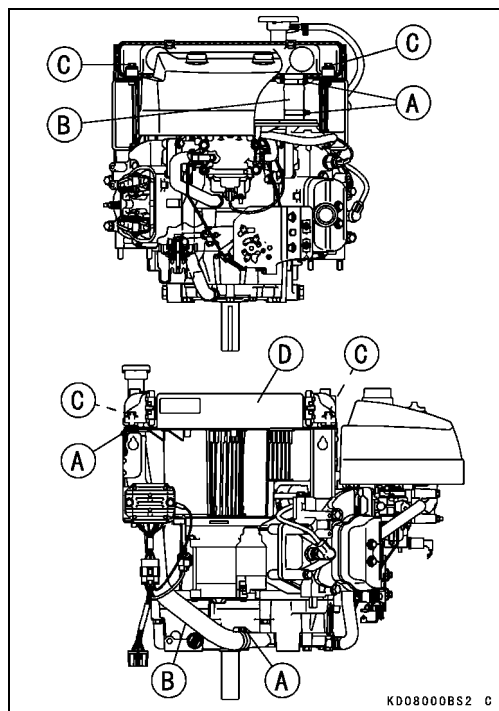
- For FD731D Model note the following.
- Clear the hook [A].
- Remove the radiator cover [B] by sliding the cover as shown.



⚠ WARNING

Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.

- Remove the radiator cap and drain the coolant in the radiator (see Coolant Draining in this chapter).
- Loosen the hose clamps [A], and disconnect the radiator hoses [B].
- Unscrew the radiator mounting bolts [C].
- Remove the radiator [D] pulling toward you and up.

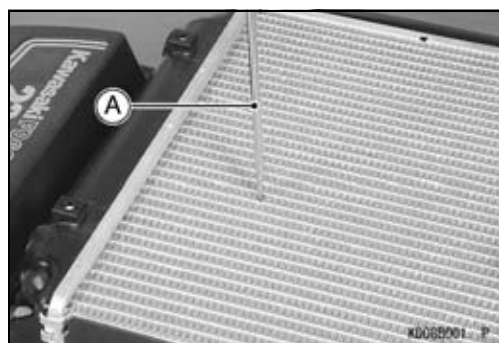


Radiator Installation

- Installation is the reverse of removal.
- Torque - Radiator Mounting Bolts: 6 N·m (0.6 kgf·m, 53 in·lb)**

Radiator Inspection

- Check the radiator core.
- ★ If the corrugated fins are deformed, carefully straighten them with the blade of thin screw driver [A].
- Inspect the inlet and outlet tubes for cracks, kinks, dents, and fractured seams. Repair or replace the radiator, if necessary.
- Check for dirt and insects that may be lodged in the radiator. Clean them out by using compressed air or a low-pressure washer.

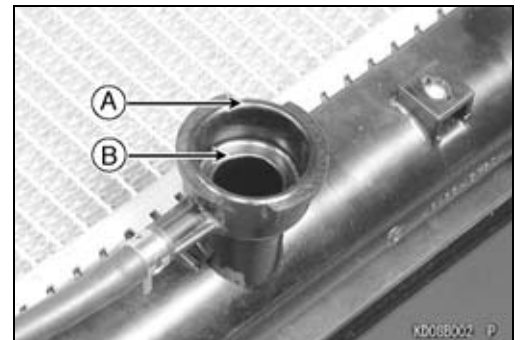
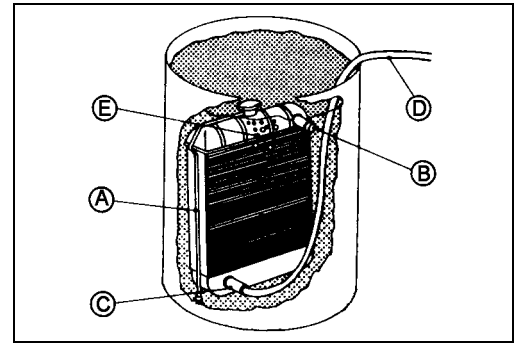


CAUTION

Using high-pressure water, as from a car wash facility, could damage the radiator fins and impair the radiator's effectiveness.

Radiator

- If the air passages of the radiator core are blocked more than 30% by unremovable obstructions or irreparably deformed fins, replace the radiator with a new one.
- ★ If a radiator leak is detected, but cannot be spotted visually, test it as follows:
 1. Install the radiator cap, and plug the overflow tube [A] and inlet pipe [B]. Attach an air hose [D] to the outlet connection [C].
 2. Pressurize the inside of the radiator with compressed air to about 50 to 70 kPa (7 to 10 psi).
 3. Submerge the radiator in water and look for bubbles [E] which indicate the location of the leak.
 4. Repair any leaks or replace it with a new one.
- Check the radiator filler neck for signs of damage.
- Check the condition of the top [A] and bottom [B] sealing seats in the filler neck. They must be smooth and clean for the radiator cap to function properly.



Radiator Cap Inspection

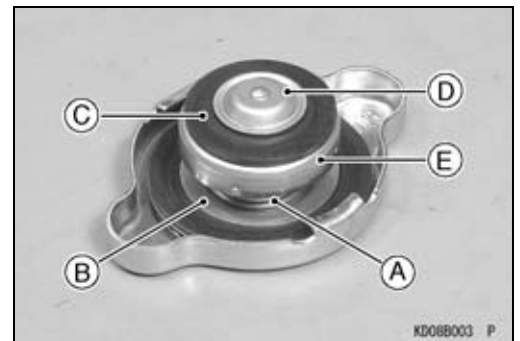
The radiator cap has two functions:

1. Allow atmospheric pressure to enter the cooling system.
2. Prevents coolant escape at normal operating pressure.

A pressure valve [E] in the cap permits the escape of coolant or steam when the pressure in the system rises above the relief pressure.

A vacuum valve [D] in the cap opens when needed to prevent a vacuum in the cooling system.

- Check the condition of the valve spring [A], and the top [B] and bottom [C] valve seats of the radiator cap.
- ★ If any one of them shows visible damage, replace the cap.



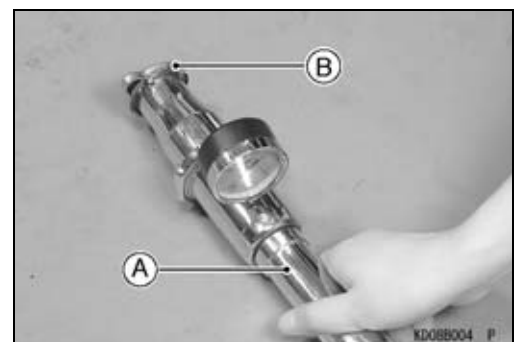
- Wet the radiator cap [B] seating surfaces with water or coolant to prevent pressure leaks.
- Install the cap on a cooling system pressure tester [A].
- Watching the pressure gauge, pump the pressure tester to build up the pressure. The cap must retain the pressure at least 6 seconds. Also the cap must open at the pressure shown in the table.

Radiator Cap Relief Pressure

Pressure Valve: 73.3 ~ 102.7 kPa (0.75 ~ 1.05 kgf/cm², 10.6 ~ 14.9 psi)

Vacuum Valve: 4.90 kPa (0.050 kgf/cm², 0.71 psi)

- ★ If the cap cannot hold the specified pressure, or if it holds too much pressure, replace it with a new one.



4-14 COOLING SYSTEM

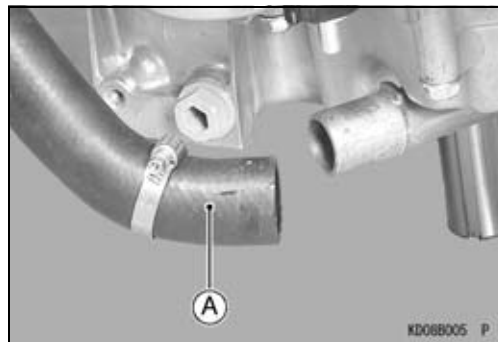
Radiator

Radiator Hose Inspection

- In accordance with the Periodic Maintenance Chart, visually inspect the hoses [A] for signs of deterioration. Squeeze the hose. A hose should not be hard and brittle, nor should it be soft or swollen.
- Replace any damaged hose.

NOTE

○Hoses can deteriorated on the inside and still appear to be in good condition on the outside.



Radiator Hose Installation Notes

- Install the radiator hoses being careful to follow bending direction (see in the figures). Avoid sharp bending, kinking, flattening, or twisting.

Upper Hose Clamp [A]

Radiator Hose (Thermostat Side) [B]

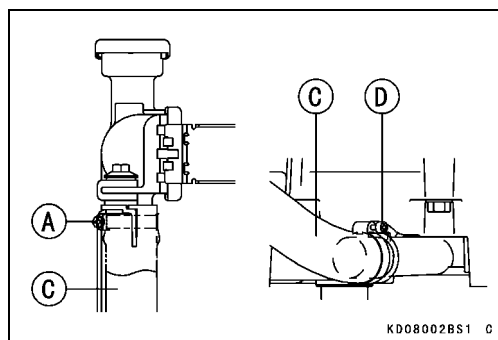
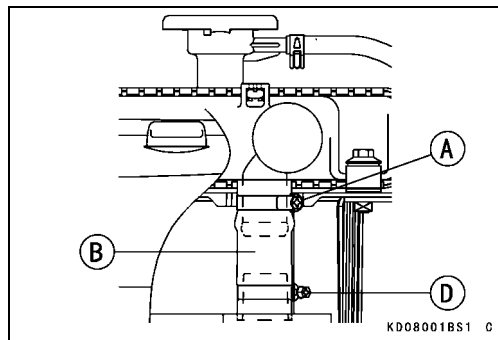
Radiator Hose (Starter Motor Side) [C]

Lower Hose Clamp [D]

NOTE

○Locate the hose clamps properly over the connections.
A pressurized cooling system will blow a hose that is not installed properly. Tighten the hose clamps securely.

Torque - Radiator Hose Clamp Bolts: 1.3 N·m (0.13 kgf·m, 12 in·lb)

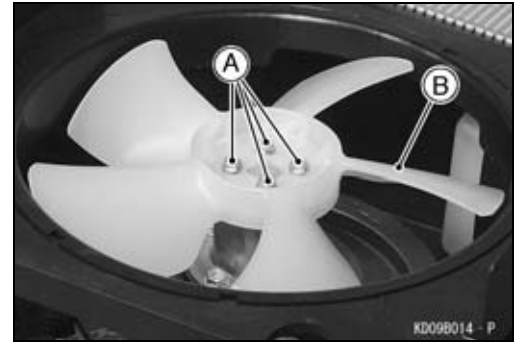


Cooling Fan

The only service on the cooling fan is to be sure the fan blades are not deformed, and the blade tips are far enough from the air duct to not strike the duct.

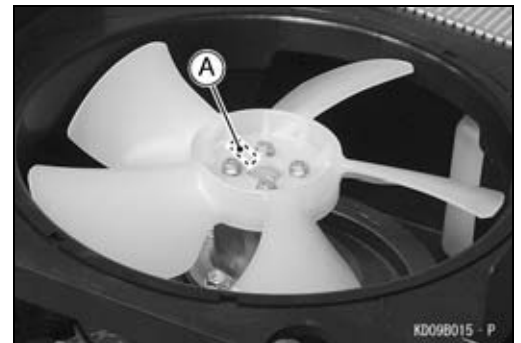
Cooling Fan Removal

- Remove:
Radiator (see Radiator Removal in this chapter)
- Unscrew the mounting bolts [A] and remove the cooling fan [B].



Cooling Fan Installation

- Install the cooling fan as “AISHIN” raised lettering [A] on the fan boss facing toward the radiator.



Cooling Fan Inspection

- Be sure the fan blades are straight. Deformed blades reduce the cooling system efficiency and throw the fan out of balance.

4-16 COOLING SYSTEM

Thermostat

Thermostat Removal and Installation

- Remove the radiator (see Radiator Removal in this chapter).
- Remove the cooling fan (see Cooling Fan Removal in this chapter).
- Unscrew the thermostat cover bolts [A], and remove the cover [B].
- Take off the thermostat [C].

NOTE

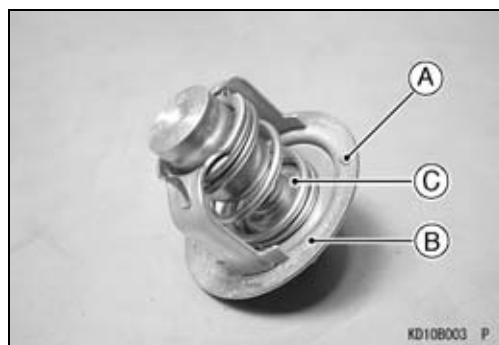
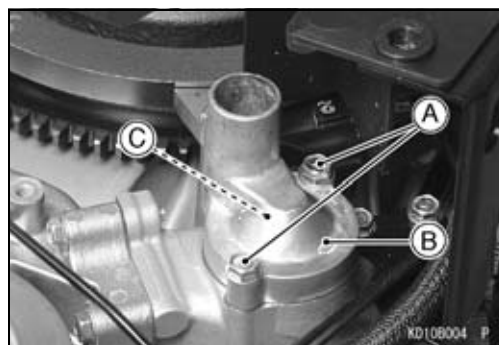
○With the thermostat installed, the jiggle valve may be positioned up-side of the thermostat when installing.

- Installation is reversed of removal.
- Replace the gasket with a new one.
- Tighten the bolts to the specified torque.

Torque - Thermostat Cover Bolts: 6 N·m (0.6 kgf·m, 53 in·lb)

Thermostat Inspection

- Remove the thermostat, and check the jiggle valve [A] for sticking or binding on the flange [B] due to accumulation of a rust, scale or lime. Clean up the valve to ensure free movement of the valve [C], if necessary.



- Inspect the thermostat valve [A] at room temperature.
- ★If the valve is open, replace the valve with a new one.
- To check valve opening temperature, suspend the thermostat and an accurate thermometer [B] in a container filled with a water.
- Place the container over a source of heat and gradually raise the temperature of the water while stirring the water gently.
- Watch the valve. The valve should begin to open at the temperature specified.
- It should be fully opened to 7 mm (0.28 in.) or more at the temperature specified.

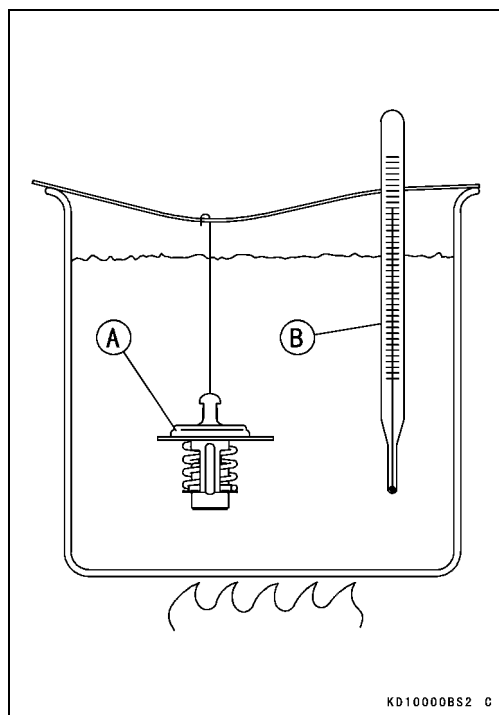
Thermostat Valve Specification

Begin Opening 80 ~ 84°C (176 ~ 183°F)

Full Open 95°C (203°F)

The thermostat and thermometer must not touch the container sides.

- ★If the thermostat fails any of these check, replace it.



Thermo Switch

When coolant temperature rises above 111°C (232°F), the thermo switch detects this and turns on a warning light on dash. Whenever you start the engine, make sure the warning light is not on in started engine.

If the warning light comes on, stop the engine immediately, and check the cooling system for over heating. Over heating can caused by:

- Lack of coolant
- Clogging of cooling system
- Malfunction water pump or thermostat

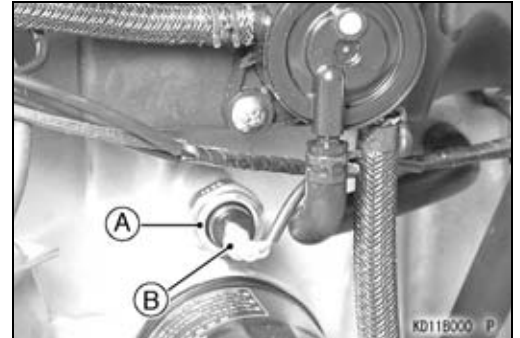
Check the coolant level and temperature frequently.

Thermo Switch Removal and Installation

- Drain the coolant (see Coolant Draining in this chapter).
- Disconnect the switch lead terminal [B].
- Unscrew the thermo switch [A] and remove it.
- When installing the thermo switch, apply silicone sealant to the threads and tighten the switch.

Torque - Thermo Switch: 28 N·m (2.9 kgf·m, 21 ft·lb)

Sealant - Kawasaki Bond (Silicone Sealant): 56019-120



Thermo Switch Inspection

- Using a ohmmeter, check to see that only the connections in the table have continuity.
- ★ If the switch has an open or short, repair it or replaced it with a new one.

Thermo Switch Connections

- **Rising temperature:**
From Off to On at 108 ~ 114°C (226 ~ 237°F)
- **Falling temperature:**
From On to Off at 101 ~ 107°C (214 ~ 225°F)
ON: Continuity
OFF: Infinit

4-18 COOLING SYSTEM

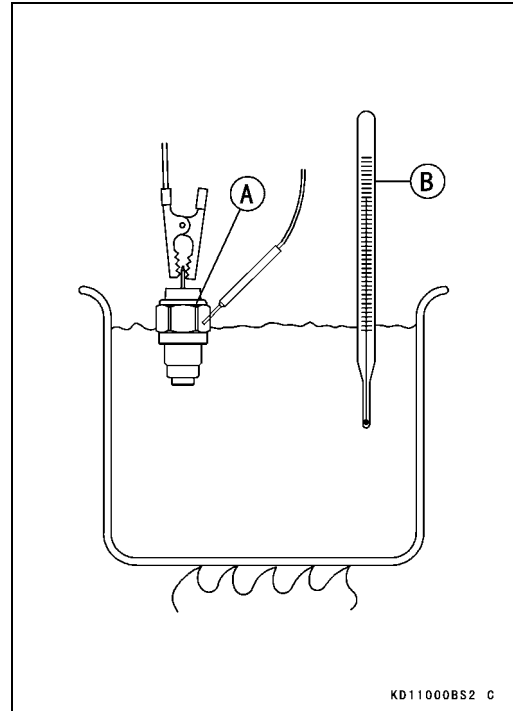
Thermo Switch

- Suspend the switch [A] in a container of coolant so that the temperature sensing projection and threaded portion are submerged.
- Suspend an accurate thermometer [B] in the coolant.

NOTE

○ *The switch and thermometer must not touch the container sides or bottom.*

- Place the container over a source of heat and gradually raise the temperature of the coolant while stirring the coolant gently.

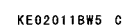


Engine Top End

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Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Rocker Arm Bracket Mounting Bolts	22	2.2	17	
2	Valve Clearance Adjusting Nuts	11	1.1	96 in·lb	
3	Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	O

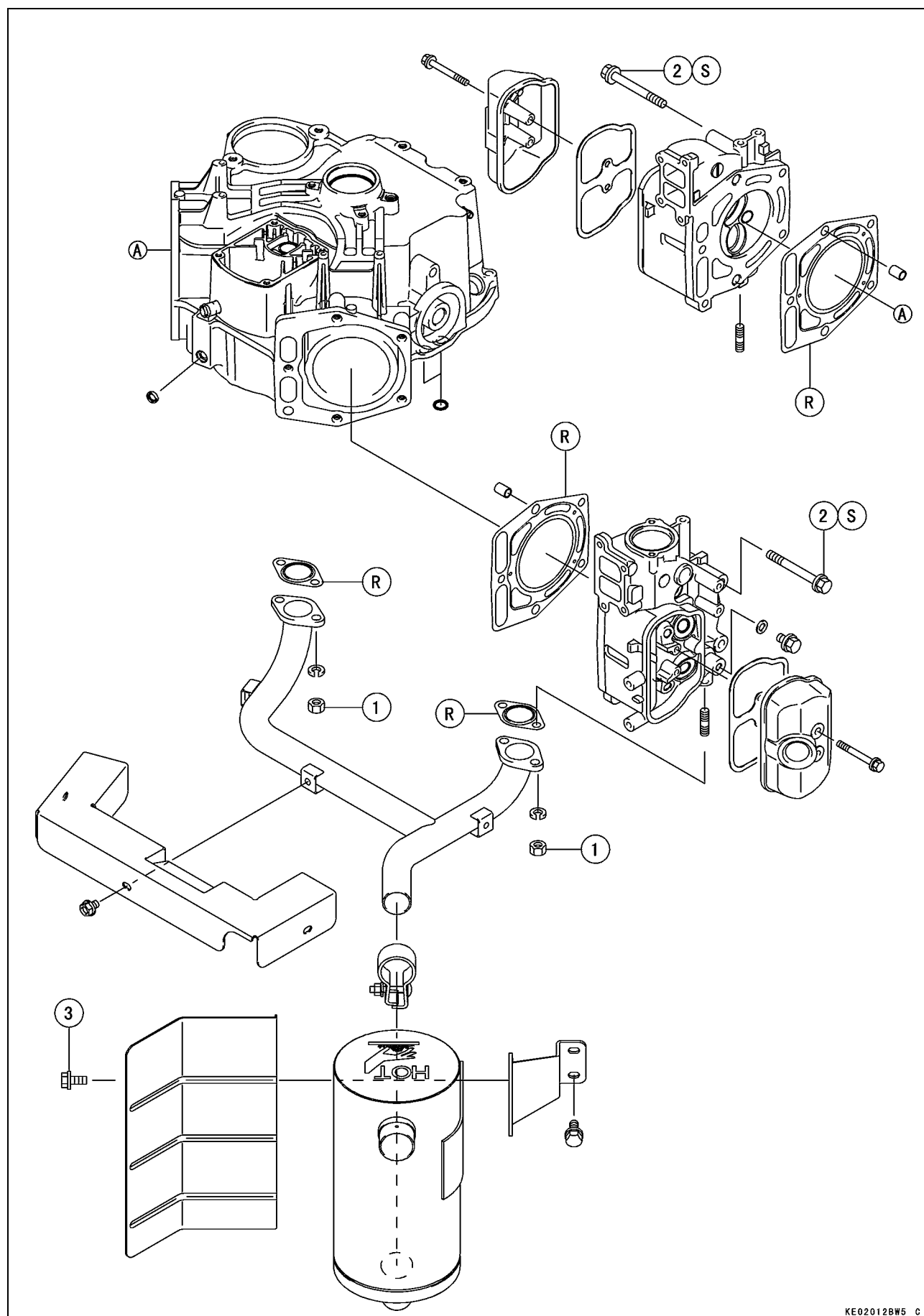
M: Apply molybdenum disulfide grease.

O: Apply engine oil.

R: Replacement Parts

5-4 ENGINE TOP END

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Exhaust Pipe Flange Nuts	20	2.0	15	
2	Cylinder Head Bolts (New)	32	3.3	24	S
	Cylinder Head Bolts (Reuse)	25	2.5	18	S
3	Muffler Bracket Bolts	20	2.0	15	

R: Replacement Parts

S: Follow the specific tightening sequence.

5-6 ENGINE TOP END

Specifications

Item	Service Limit
Cylinder Head	
Cylinder compression (MIN)	682 kPa (99 psi) (MIN)
Cylinder head warp	0.03 mm (0.001 in.)
Valves	
Valve head thickness:	
Inlet, Exhaust	0.35 mm (0.014 in.)
Valve stem bend:	
Inlet, Exhaust	0.05 mm (0.002 in.)
Valve stem diameter:	
Inlet, Exhaust	6.94 mm (0.2730 in.)
Valve guide inside diameter:	
Inlet, Exhaust	7.08 mm (0.279 in.)
Valve spring free length:	
Inlet, Exhaust	32.9 mm (1.30 in.)
Rocker arm push rod runout:	
Inlet, Exhaust	0.5 mm (0.02 in.)
Rocker arm collar outside diameter:	
Inlet, Exhaust	10.914 mm (0.4297 in.)
Rocker arm bearing inside diameter:	
Inlet, Exhaust	11.132 mm (0.4382 in.)
Cylinder, Piston	
Piston ring/groove clearance:	
Top	0.16 mm (0.0063 in.)
Second	0.15 mm (0.0059 in.)
Piston ring thickness:	
Top, Second	1.40 mm (0.055 in.)
Piston ring end gap:	
Top, Second	0.7 mm (0.03 in.)
Oil	1.0 mm (0.04 in.)
Piston pin outside diameter	15.96 mm (0.628 in.)
Piston pin hole inside diameter	16.09 mm (0.6335 in.)
Connecting rod small end inside diameter	16.06 mm (0.6323 in.)
Cylinder inside diameter:	75.30 mm (2.965 in.)
Piston outside diameter	74.98 mm (2.952 in.)
Cylinder bore out round	0.056 mm (0.0022 in.)

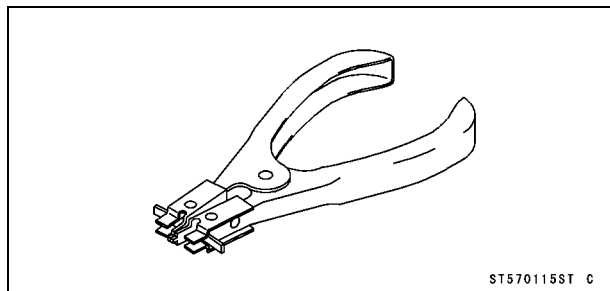
Specifications

Item	Standard
Valve clearance: Inlet, Exhaust	0.15 mm (0.006 in.)
Valve seating surface angle: Inlet, Exhaust	45°
Valve seating surface width: Inlet	0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)
Exhaust	1.1 ~ 1.6 mm (0.43 ~ 0.063 in.)
Valves guide inside diameter: Inlet, Exhaust	7.000 ~ 7.015 mm (0.2756 ~ 0.2762 in.)
Cylinder bore diameter: Standard cylinder	75.18 ~ 75.2 mm (2.598 ~ 2.9606 in.)

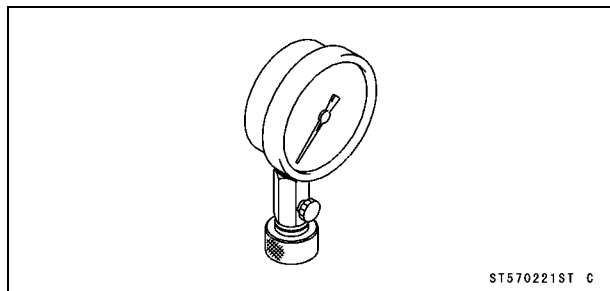
5-8 ENGINE TOP END

Special Tools

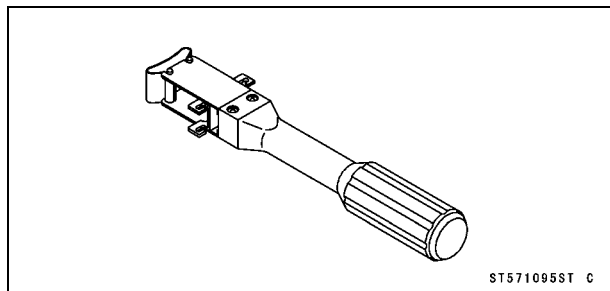
Piston Ring Pliers:
57001-115



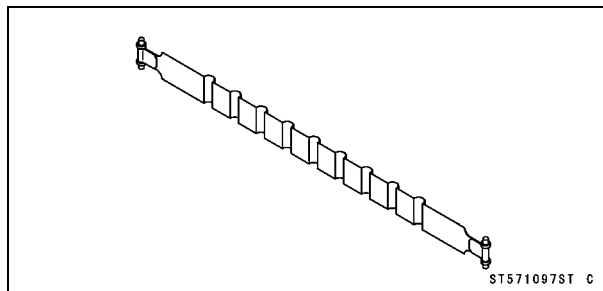
Compression Gauge, 20 kgf/cm²:
57001-221



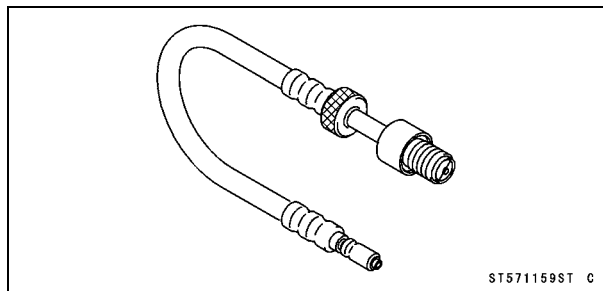
Piston Ring Compressor Grip:
57001-1095



Piston Ring Compressor Belt, $\phi 67 \sim \phi 79$:
57001-1097



Compression Gauge Adapter, M14 \times 1.25:
57001-1159



Cylinder Head

Compression Measurement

- Before measuring compression, do the following.
 - Be sure the battery is fully charged.
 - Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help seal compression as it does during normal running.
 - Stop the engine.
- Disconnect the spark plug caps of each cylinder and remove the spark plugs.
- Attach the compression gauge assembly firmly into one plug hole.

Special Tools - Compression Gauge, 20 kgf/cm²: 57001-221 [A]

Compression Gauge Adapter, M14 × 1.25: 57001-1159 [B]

- Ground the spark plugs to the engine.

⚠ WARNING

To avoid fire, do not ground the spark plugs in closed positions to the plug holes. Keep the plugs as far away as possible from the plug holes.

- Using the starter motor, turn the engine over with the throttle fully open until the compression gauge stops rising; the compression reading obtainable.
- Repeat the measurement to the other cylinder.

Measurement Condition: Valve Clearance

Inlet, Exhaust: 0.15 mm (0.006 in.)

Carburetor with full open throttle valve

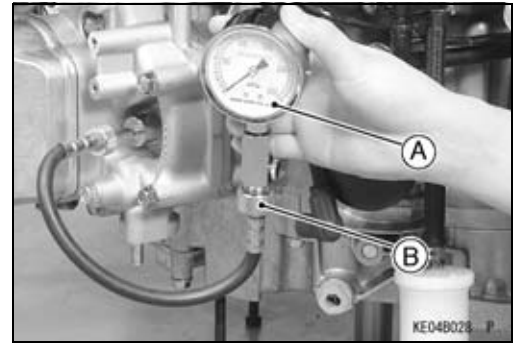
Engine Oil Temperature

50 ~ 60°C (122 ~140°F)

Cranking rpm at time

480 rpm /5 seconds

Cylinder Compression (MIN): 682 kPa (99 psi)



5-10 ENGINE TOP END

Cylinder Head

★ If the compression is higher than the specified value, the piston rings, cylinder and valves are probably in good condition.

If the compression is too high, check the following.

1. Carbon build-up on the piston head and cylinder head - clean off any carbon on the piston head and cylinder head.
2. Cylinder head gasket - use only the proper gasket. The use of a gasket of incorrect thickness will change the compression.
3. Valve guides and piston rings - rapid carbon accumulation in the combustion chamber may be caused worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.

★ If cylinder compression is lower than the (MIN), check the following:

1. Gas leakage around the cylinder head - replace the damaged gasket and check the cylinder head warp.
2. Condition of the valve seating.
3. Valve clearance.
4. Piston/cylinder wear, piston seizure.
5. Piston ring, piston ring groove.

Cylinder Head Assembly Removal

● Remove:

Radiator (see Cooling System chapter)
Air Cleaner and Carburetor (see Fuel System chapter)
Control Panel (see Fuel System chapter)
Muffler and Exhaust Pipe (see Engine Top End chapter)
Inlet Manifold (see Fuel System chapter)
Spark Plugs (see Electrical System chapter)
Thermo Switch Terminal

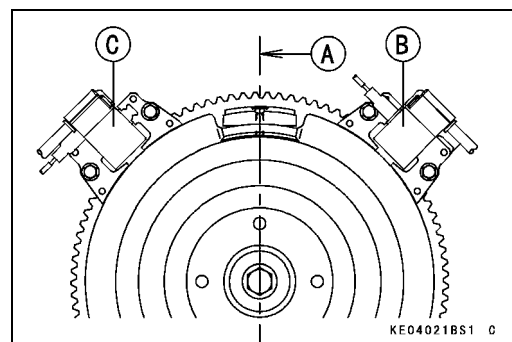
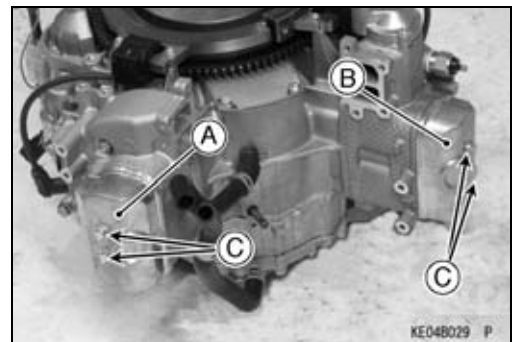
- Unscrew the rocker cover mounting bolts [C], and remove the covers and gaskets.

[A] Rocker Cover (No. 1 Cylinder)
[B] Rocker Cover (No. 2 Cylinder)
[C] Mounting Bolts (4 Bolts)

- When removing the cylinder head, set the flywheel at top dead center (T.D.C) of power stroke each cylinder.

○ When setting the flywheel at T.D.C of #1 cylinder, align the center of the flywheel magnet [A] with No.1 ignition coil [B]. If it is not at T.D.C, turn the flywheel clockwise one turn (360°).

○ When setting the flywheel at T.D.C of #2 cylinder, turn the flywheel-magnet clockwise from position at T.D.C of #1 cylinder to at No.2 ignition coil [C]. If it is not at T.D.C, turn the flywheel clockwise with one turn (360°).



Cylinder Head

- Loosen the cylinder head bolts 1/4 turn in the sequence shown.

CAUTION

If the above procedure is not followed, the cylinder head may be warped during removal.

- Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.

NOTE

○Mark the push-rods so they can be installed in their original position during assembly.

Cylinder Head Assembly Installation

- When installing the cylinder head, set the flywheel at T.D.C of power stroke each cylinder.
- When setting the flywheel at T.D.C of #1 cylinder, align the center of the flywheel magnet [A] with No.1 ignition coil [B]. If it is not at T.D.C, turn the flywheel clockwise one turn (360°).
- When setting the flywheel at T.D.C of #2 cylinder, turn the flywheel-magnet [A] clockwise from position at T.D.C of #1 cylinder to at No. 2 ignition coil [C]. If it is not at T.D.C, turn the flywheel clockwise with one turn (360°).
- Clean the mating surfaces of the cylinder heads and cylinder.
- Install the knock pins on the cylinder.
- Put a new gaskets [A] with its fire ring facing to the crankcase side and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms (see Valve Mechanism Removal/Installation, Push Rod Installation).

NOTE

○As the head gaskets are coated with sealing agents, be careful not to injure the surfaces of them.

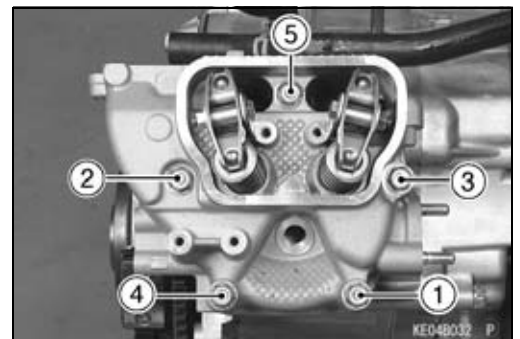
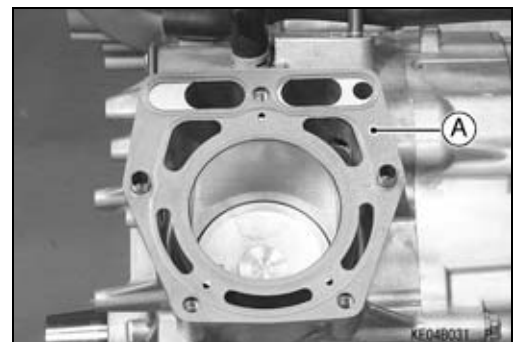
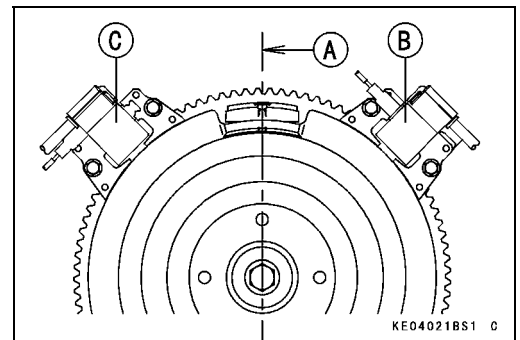
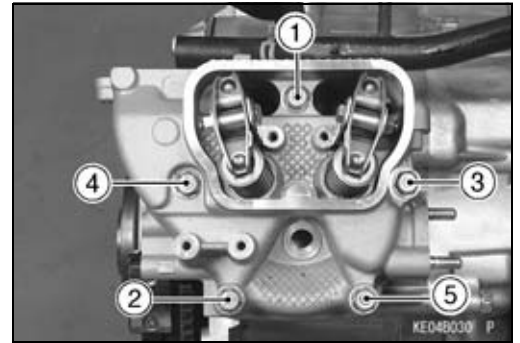
- Install the head bolts.
- Tighten the head bolts following the tightening sequence as shown.

Torque - Cylinder Head Bolts (New): 32 N·m (3.3 kgf·m, 24 ft·lb)

Cylinder Head Bolt (Reuse): 25 N·m (2.5 kgf·m, 18 ft·lb)

CAUTION

A torque wrench must be used to prevent loose or overtight the head bolts which may result in warping of the cylinder head.

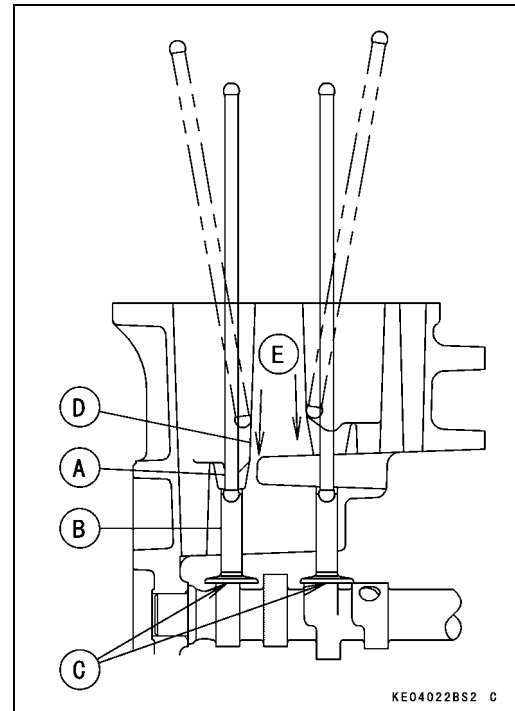


5-12 ENGINE TOP END

Cylinder Head

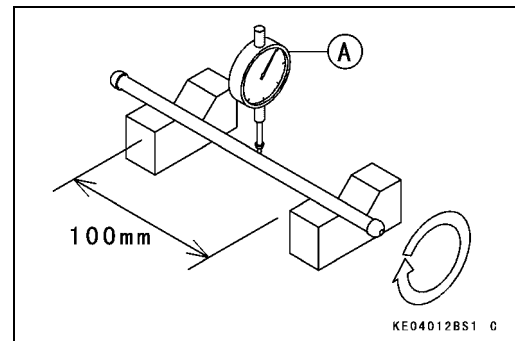
Push Rod Installation

- When installing the push rod, set the flywheel at T.D.C of power stroke each cylinder. (see Cylinder head Assembly Installation)
- Install the push rods in their original positions on each cylinder.
- To install the push rod in a correct position on the tappet, insert the push rod so end of the push rod is sliding down along inside wall of the crankcase and position the push rod end on the tappet.
- Check both intake and exhaust push rods on each cylinder are lowest position on the cam lobes, if not turn the flywheel clockwise one turn (360°).
- Be sure the end of the push rods are correctly seated on the tappets.
 - [A] Push Rods
 - [B] Tappets
 - [C] Lowest Cam Lobes
 - [D] Inside Walls
 - [E] Sliding Down



Push Rod Inspection

- Place the rocker arm push rod in V blocks that are as far apart as possible, and set a dial gauge [A] on the rod at a point halfway between the blocks. Turn the rod to measure the runout. The difference between highest and the lowest dial readings is the amount of runout.
- ★ If the runout exceeds the service limit, replace the rod.



Rocker Arm Push Rod Runout

Service Limit (Inlet, Exhaust): 0.5 mm (0.02 in.)

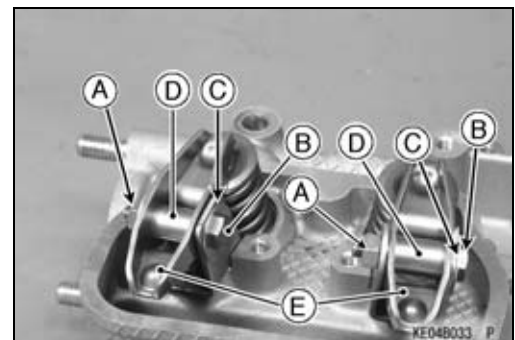
Valve Mechanism Removal/Installation

- Remove the cylinder head assembly (see Cylinder Head Assembly Removal).

NOTE

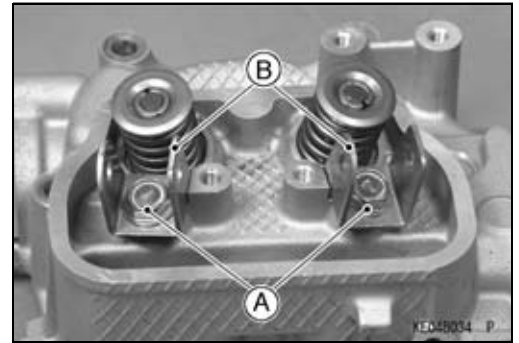
○ When removing the valve mechanism parts, note their position so that they may be reinstalled in their original position during assembly.

- Remove:
 - Nuts [A]
 - Bolts [B]
 - Washers [C]
 - Collars [D]
 - Rocker Arms [E]

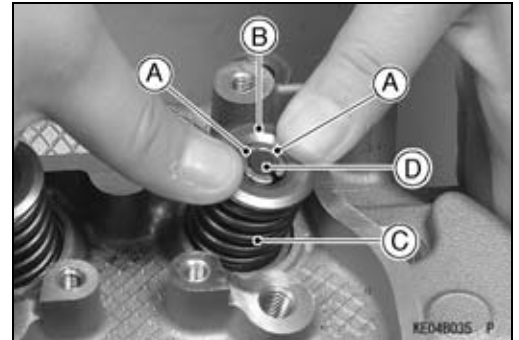


Cylinder Head

- Remove:
Bolts [A]
Brackets [B]



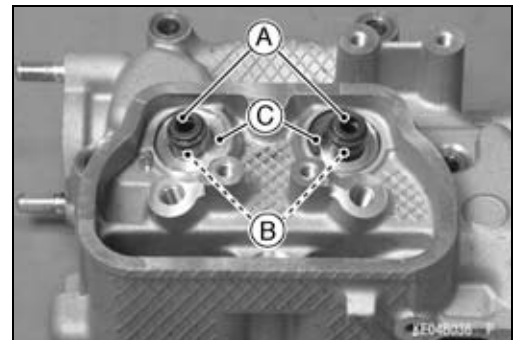
- Support the valve head in the combustion chamber with a suitable block.
- To remove the collets [A], push down the valve retainer [B] with thumbs and remove the collets.
- Remove the spring [C] and valve [D] .



- Remove the stem seals [A].

NOTE

- It is not necessary to remove the stem seal unless it is being replaced.
- Bottom spring retainer [C] can only be removed with stem seal.
- Valve guide [B] is not replaceable, do not remove it.



- Install the valve according to the following procedures.
 - Apply molybdenum disulfide grease to the valve stem to avoid damaging the stem seal.
 - Check to see that the valve moves smoothly up and down in the guide.
 - Check to see that the valve seats properly in the valve seat. If it does not, repair the valve seat.
- Valve installation is the reverse of removal.
- Install the cylinder head assembly. (see Cylinder Head Assembly Installation)
- Install the rocker arm according to the following procedures.
 - Set the flywheel at T.D.C of power stroke each cylinder. (see Cylinder Head Assembly Installation)

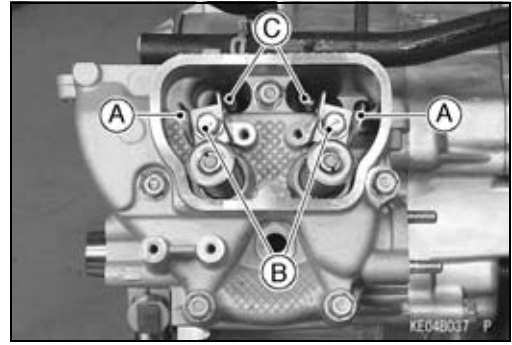
5-14 ENGINE TOP END

Cylinder Head

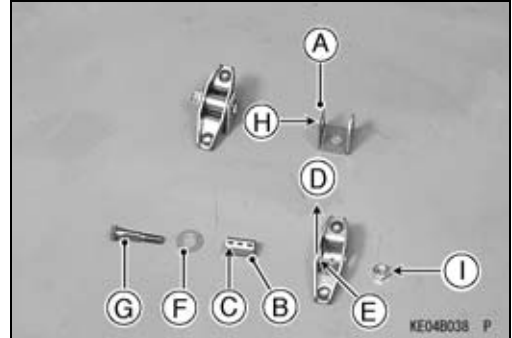
- Install the brackets [A] on the cylinder head with two bolts [B] and tighten them.

Torque - Rocker Arm Bracket Mounting Bolts: 22 N·m (2.2 kgf·m, 17 ft·lb)

- Install the push rods (see Push Rod Installation).



- Insert the collar [B] into the rocker arm hole [E] so that the groove [C] of the collar face toward upside [D], then set them on the brackets [A].
- Insert the washer [F] onto bolt [G], and insert the bolt [G] into the hole at the rightside [H] of the bracket [A] and through the collar installed with rocker arm.
- Install the nut [I] onto the bolt [G], and tighten the nut temporarily.
- Position the push rod end on to rocker arm dent.



Cylinder Head Cleaning

- Refer to the Cylinder Head Cleaning in the Periodic Maintenance chapter.

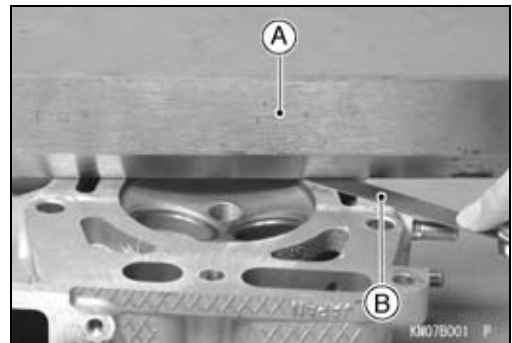
Cylinder Head Inspection

- Lay a straightedge [A] across the mating surface of the head at several different points, and measure warp by inserting a thickness gauge [B] between the straightedge and head.
- ★ If warp exceeds the service limit, repair the mating surface. Replace the cylinder head if the mating surface is badly damaged.

Cylinder Head Warp

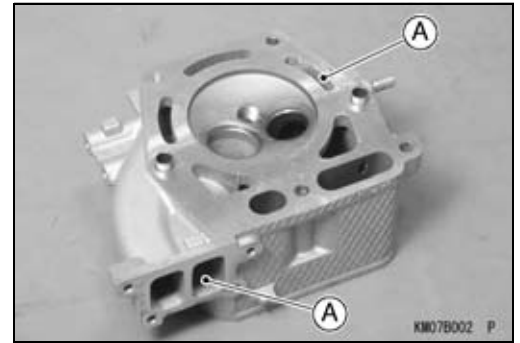
Service Limit: 0.03 mm (0.001 in.)

- Check the cylinder head for cracks or other damage.
- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25% kerosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a cracks is present, the coating will become discolored at the defective area.
- If a cracks is present in the cylinder head, replace it.
- Inspect the mating surface for burrs and nicks.



Cylinder Head

- Inspect the cylinder head for accumulation of rust, scale and lime in the water jacket [A].
- ★ If this accumulation is observed, flush the cooling system (see Cooling System chapter).



- Measure the diameter [A] of the rocker arm collar with a micrometer at several points of bearing the rocker arm.
- ★ If the outside diameter is less than the service limit, replace the rocker arm collar.

Rocker Arm Collar Outside Diameter

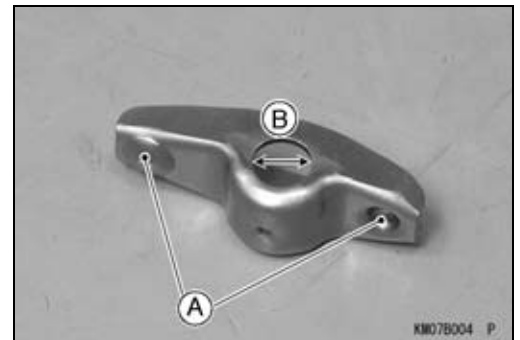
Service Limit (Inlet, Exhaust): 10.914 mm (0.4297 in.)



- Clean and inspect the rocker arm where it touches the push rod and valve stem.
- ★ If the contact points [A] are worn or damaged, replace the rocker arm.
- Measure the inside diameter of the rocker arm bearing [B] at several points using a dial bore gauge or inside micrometer.
- ★ If the inside diameter is more than the service limit, replace the rocker arm.

Rocker Arm Bearing Inside Diameter

Service Limit (Inlet, Exhaust): 11.132 mm (0.4382 in.)



5-16 ENGINE TOP END

Valves

Valve Clearance Inspection

- Refer to the Valve Clearance Inspection in the Periodic Maintenance chapter.

Valve Clearance Adjustment

- Refer to the Valve Clearance Adjustment in the Periodic Maintenance chapter.

Valve Seat Inspection

- Refer to the Valve Seat Inspection in the Periodic Maintenance chapter.

Valve Seat Repair

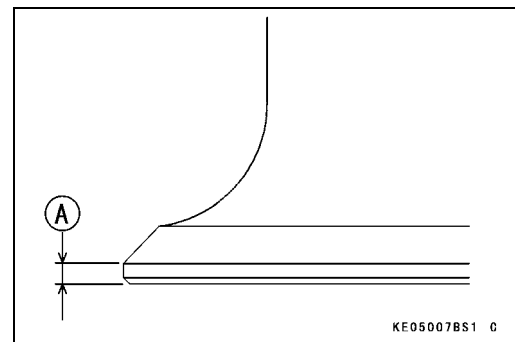
- Refer to the Valve Seat Repair in the Periodic Maintenance chapter.

Valve Head Thickness

- Remove the valve (see Valve Mechanism Removal/Installation).
- Measure the thickness of the valve head.
- ★ If the valve head thickness (valve margin) [A] is less than the service limit, replace the valve.

Valve Head Thickness

Service Limit (Inlet, Exhaust): 0.35 mm (0.014 in.)

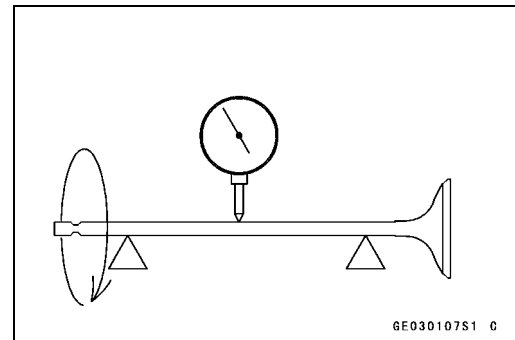


Valve Stem Runout

- Support the valve in V blocks at each end of the stem.
- Position a dial gauge perpendicular to the stem.
- Turn the valve and read the variation on the dial gauge.
- ★ If the stem runout is greater than service limit, replace the valve.

Valve Stem Bend

Service Limit (Inlet, Exhaust): 0.05 mm (0.002 in.)

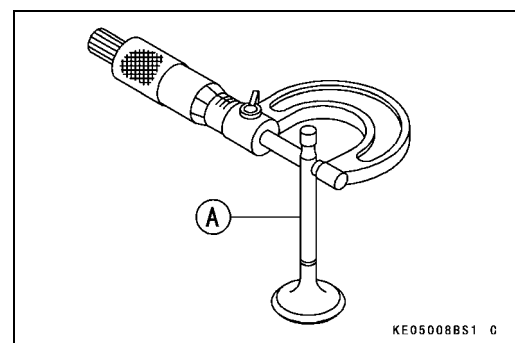


Valve Stem Diameter

- Measure the diameter of the valve stem [A] in two directions at right angles, at four different positions on the stem.
- ★ If any single measurement is less than the service limit, replace the valve.

Valve Stem Diameter

Service Limit (Inlet, Exhaust): 6.94 mm (0.2730 in.)



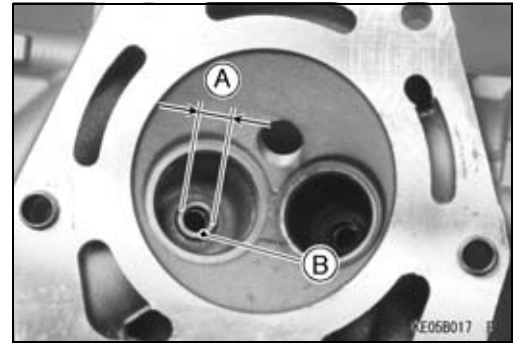
Valves

Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter [A] of the valve guide a three places down the length of the guide.
- ★ If the measurement is more than the service limit, replace the cylinder head with a new one.

Valve Guide Inside Diameter

Service Limit (Inlet, Exhaust): 7.08 mm (0.279 in.)

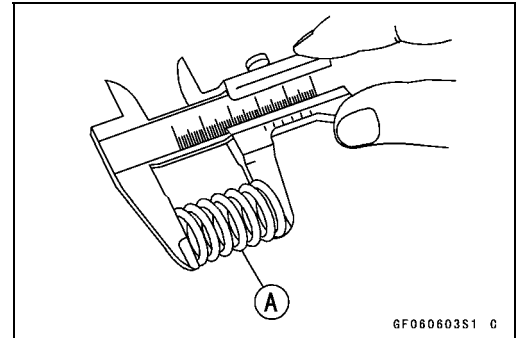


Valve Spring Inspection

- Inspect the valve spring for pitting, cracks, rusting, and burrs. Replace the spring if necessary.
- Measure the free length [A] of the spring.
- ★ If the measurement is less than the service limit, replace the spring.

Valve Spring Free Length

Service Limit (Inlet, Exhaust): 32.9 mm (1.30 in.)



5-18 ENGINE TOP END

Cylinder, Piston

Piston Removal

- Split the crankcase (see Camshaft/Crankshaft chapter).
- Remove the camshaft (see Camshaft/Crankshaft chapter).
- Turn the crankshaft to expose the connecting rod cap bolts [A].
- Remove the bolts and take off the connecting rod caps [B].

NOTE

○Note the position of the connecting rod caps for re-installing the caps.

- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.

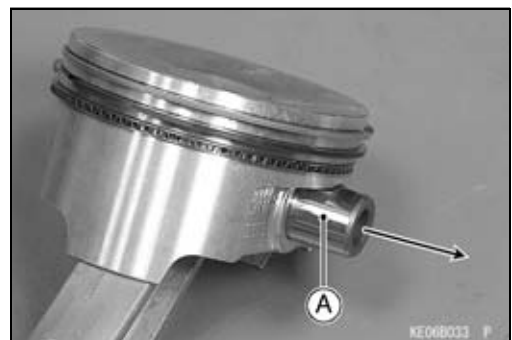
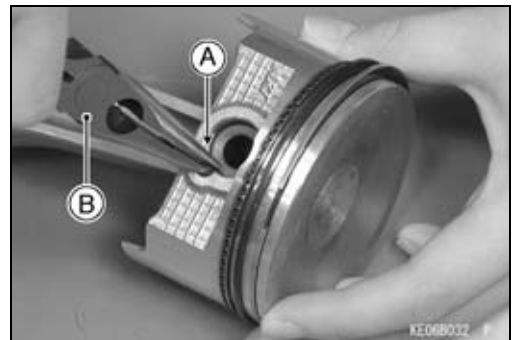
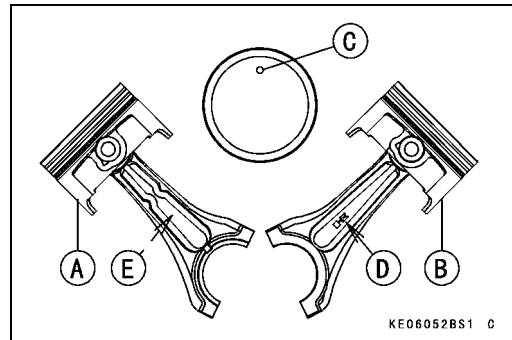
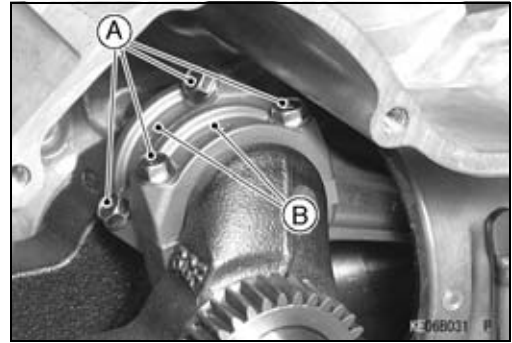
CAUTION

Note a location of the circle mark on the piston head in relation to "K" mark on the connecting rod. No.1 cyl. piston is opposite of No.2 cyl. piston. Keep parts together as a set.

- [A] No.1 Cyl. Piston
- [B] No.2 Cyl. Piston
- [C] Circle marks
- [D] "K" Mark
- [E] Opposite "K" Mark

- Remove one of the piston pin snap rings [A] with needle nose plier [B].

- Remove the piston by pushing the piston pin [A] out the side from which the snap ring was removed.

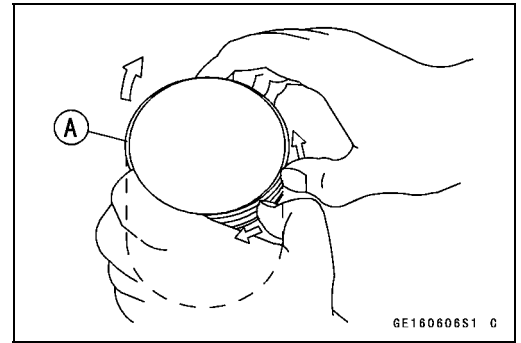


Cylinder, Piston

- Remove the top and second rings with piston ring pliers.

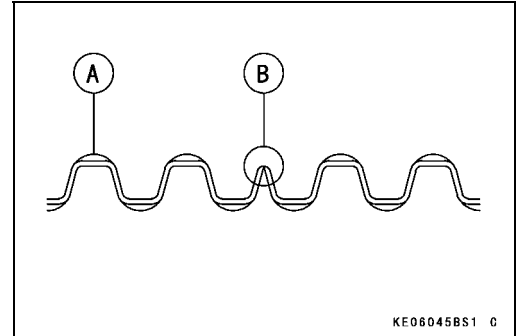
Special Tool - Piston Ring Pliers: 57001-115

- ★ If the special too is not available, carefully spread the ring opening with your thumbs and then push up on the opposite side of the ring [A] to remove it.
- ★ Remove the 3-piece oil ring with your thumbs in the same manner.



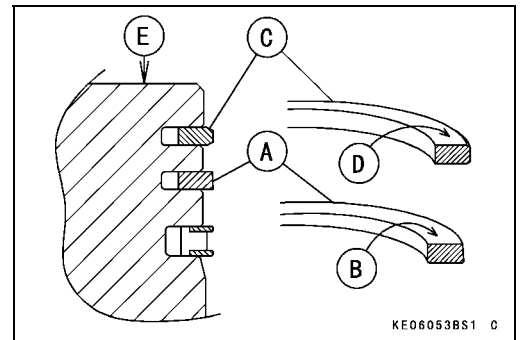
Piston Installation

- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



- Do not mix up the top and second rings.
- Install the second ring [A] so that the "R" mark [B] face up.
- Install the top ring [C] so that the "R" mark [D] face up.
- The rings should turn freely in the grooves.

Piston Head [E]



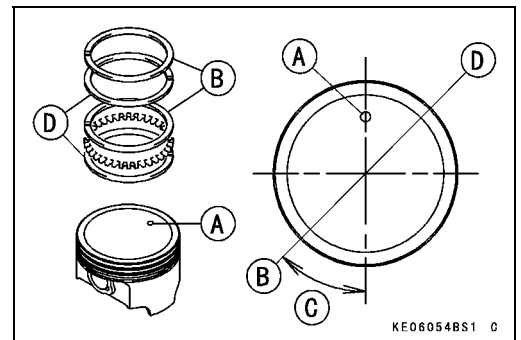
- Align the piston and rings with the piston ring end gap as shown.

Circle Marks [A]

Top Ring End Gap, Upper Steel Rail End Gap [B]

30° ~ 45° [C]

Second Ring End Gap, Lower Steel Rail End Gap [D]



- Apply engine oil to the piston pins.
- Assemble the pistons onto the connecting rods as follow:
No.1 Cyl. piston, align the circle mark on the piston head with the raised letters ("K" Mark) on the connecting rod.
No.2 Cyl. piston, align the circle mark on the piston head with opposite "K" mark on the connecting rod.

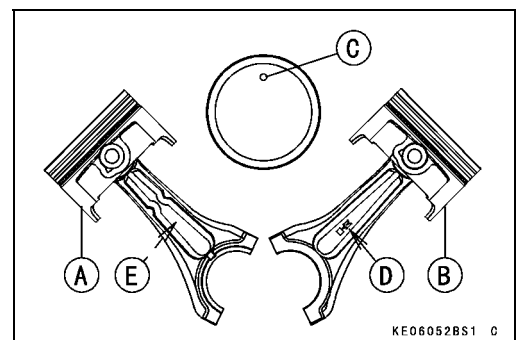
[A] No.1 Cyl. Piston

[B] No.2 Cyl. Piston

[C] Circle Marks

[D] "K" Mark

[E] Opposite "K" Mark



5-20 ENGINE TOP END

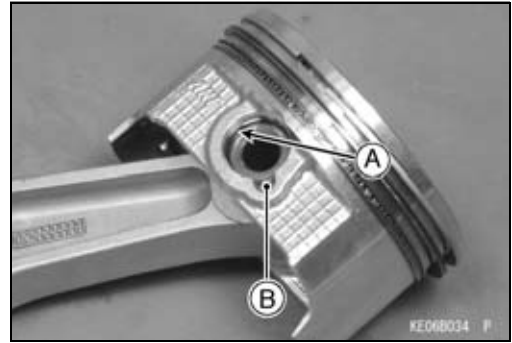
Cylinder, Piston

- When installing a piston pin snap ring, compress it only enough to install it and no more.
- Fit a new piston pin snap ring into the side of the piston so that the ring opening [A] does not coincide with the notch [B] in the edge of the piston pin hole.

CAUTION

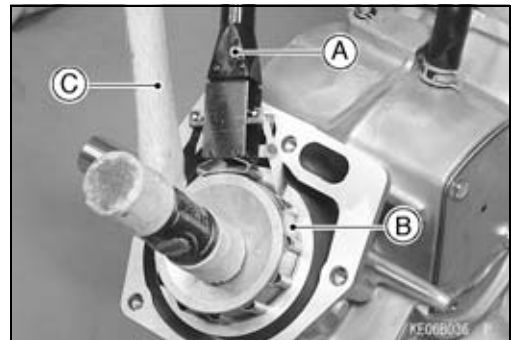
Do not reuse the snap rings, as removal weakens and deforms them. They could fall out and score the cylinder wall.

- Install the piston and connecting rod so that the circle mark [A] on the top of the piston facing the flywheel side [B].
- ★ Apply engine oil to the piston skirt and the cylinder bore.



- Using the piston ring compressor grip [A] and the belt [B], insert the piston and connecting rod into the cylinder.
- Lightly tap the top of the piston with a plastic mallet [C] to insert the piston and connecting rod into the cylinder.

Special Tools - Piston Ring Compressor Grip: 57001-1095
Piston Ring Compressor Belt, $\phi 67 \sim \phi 79$: 57001-1097



Cylinder, Piston

CAUTION

The connecting rod and the connecting rod big end cap are machined at the factory in the assembled state, so they must be replaced together as a set.

- Apply engine oil to the inner surface [A] of the connecting rod big end [B] and caps [C].
- Install the connecting rod big end caps on their original position on each connecting rod big ends.
- Apply a small amount of engine oil to the thread [D] and seating surface [E] of the cap bolts.
- Tighten the cap bolts temporarily.

NOTE

○ *Before tightening the cap bolts to the specified torque, make sure that the sliding surface between the connecting rods moves freely.*

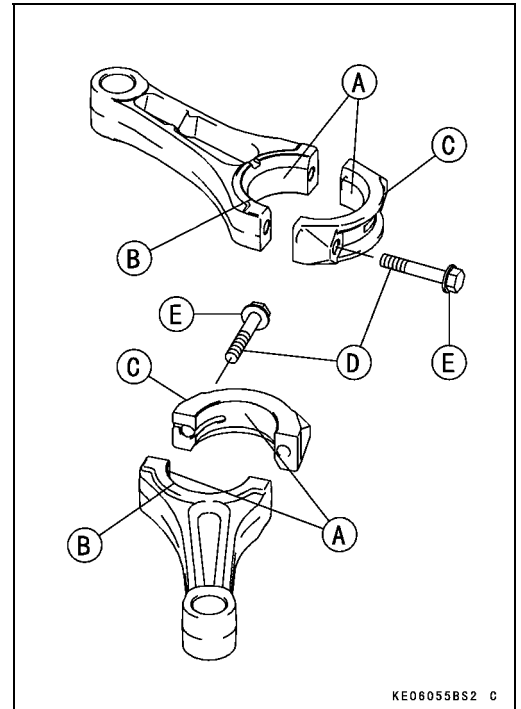
- Tighten the cap bolts to the specified torque.

Torque - Connecting Rod Big End Cap Bolts: 9.8 N·m (1.0 kgf·m, 87 in·lb)

- Check the connecting rods move freely after tightening the bolts.
- ★ If the connecting rods do not operate freely, remove the bolts and adjust them.
- Install:
 - Camshaft (see Camshaft/Crankshaft chapter)
 - Crankcase Cover (see Camshaft/Crankshaft chapter)
- Install the other removed parts.

Piston/Cylinder Seizure

- In case of seizure, remove the piston.
- Visually inspect the cylinder and piston damage.
- ★ If there is only light damage, smooth the position with #400 emery cloth. Remove the small aluminum deposits from the cylinder with #400 emery cloth or light honing.
- ★ If the damage is severe, replace the cylinder and pistons.



KE06055BS2 C

5-22 ENGINE TOP END

Cylinder, Piston

Piston Cleaning

- Remove the piston and piston rings (see Piston Removal).

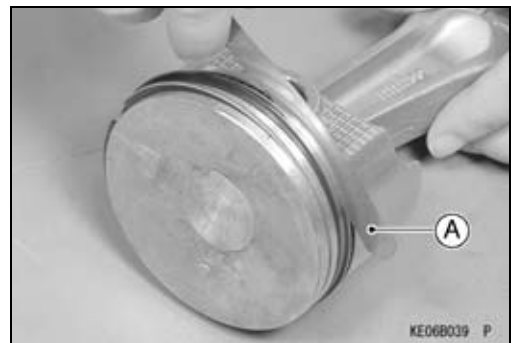
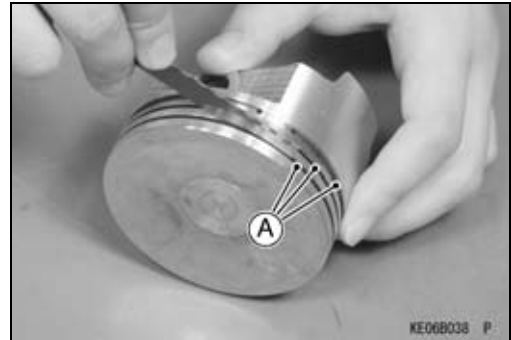
CAUTION

Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.

- Scrape the carbon off [A] the piston head.
- Use the scraping tools carefully. Do not gouge the piston head. To avoid gouging, use scrapers that are made of a material that will not cause damage.
- Clean the piston ring grooves [A] with a broken piston ring or other suitable tools.

CAUTION

Be careful not to widen the ring grooves. Damaged ring grooves will require piston replacement.



Piston Ring and Ring Groove Wear

- Clean the piston (see Piston Cleaning).
 - Visually inspect the piston rings and ring grooves.
 - ★ If the piston rings are worn unevenly or damaged, replace them.
 - ★ If the ring grooves are worn unevenly or damaged, replace both the piston and piston rings.
 - Check ring grooves for wear by inserting a new ring in the proper groove at several points around the piston.
 - Measure the clearance between the top and second rings and their grooves using a thickness gauge [A].
- ★ If the piston ring/groove clearance is greater than the specified value, replace the piston.

Piston Ring/Groove Clearance

Service Limit:

Top	0.16 mm (0.0063 in.)
Second	0.15 mm (0.0059 in.)

NOTE

- The oil ring is a three piece assembled ring. Difficult to measure the ring groove clearance and thickness, visually inspect only.

Cylinder, Piston

- Measure the piston ring thickness [A].
- Use a micrometer to measure at several points around the rings.
- ★ If any of the measurement are less than the service limit, replace the entire set of rings.

Piston Ring Thickness

Service Limit (Top Second): 1.40 mm (0.055 in.)

NOTE

○ When using new rings in a used piston, check for uneven groove wear. The rings should fit perfectly parallel to the groove sides. If not, replace the piston.

Piston Ring End Gap

- Remove the piston rings.
- Push each ring (one at a time) in the cylinder bore to a point close to the bottom of the cylinder bore.
- Use the piston to push it in to be sure it is square.
- Measure the gap [B] between the ends of the ring [A] with a thickness gauge.
- ★ If the end gap of any ring is greater than the service limit, replace the entire set of rings.

Piston Ring End Gap

Service Limit:

Top, Second 0.7 mm (0.03 in.)

Oil 1.0 mm (0.04 in.)

Piston Pin, Piston Pin Hole, and Connecting Rod Wear

- Remove the piston pin.
- Measure the diameter of the piston pin with a micrometer at several points.
- ★ If the outside diameter is less than service limit, replace the piston pin.

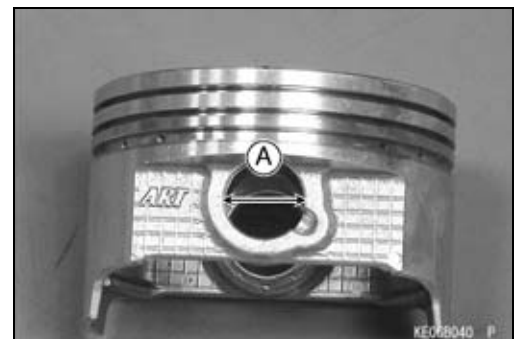
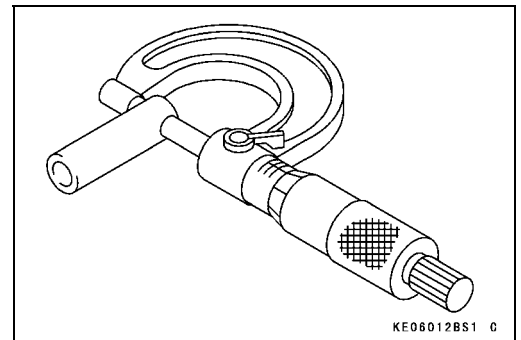
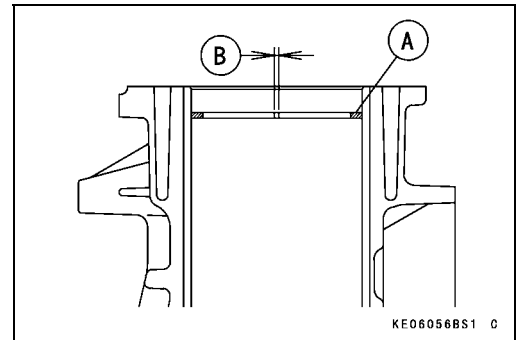
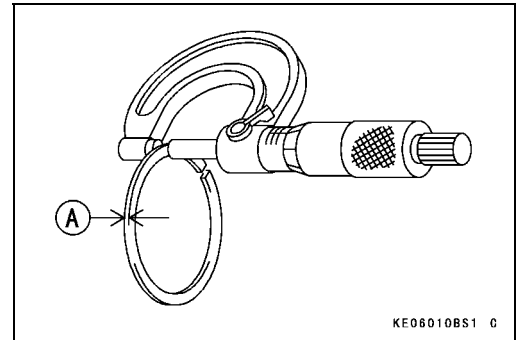
Piston Pin Outside Diameter

Service Limit: 15.96 mm (0.628 in.)

- Measure the inside diameter [A] of the piston pin hole at several points on both side. Use a dial bore gauge.
- ★ If the inside diameter is more than the service limit, replace the piston.

Piston Pin Hole Inside Diameter

Service Limit: 16.09 mm (0.6335 in.)



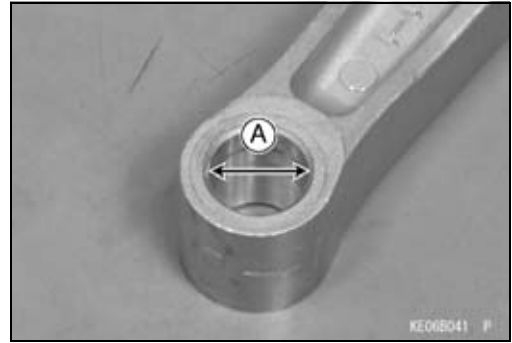
5-24 ENGINE TOP END

Cylinder, Piston

- Measure the inside diameter [A] of the small end of the connecting rod at several points. Use a dial bore gauge.
- ★ If the inside diameter is more than the service limit, replace the connecting rod.

Connecting Rod Small End Inside Diameter

Service Limit: 16.06 mm (0.6323 in.)

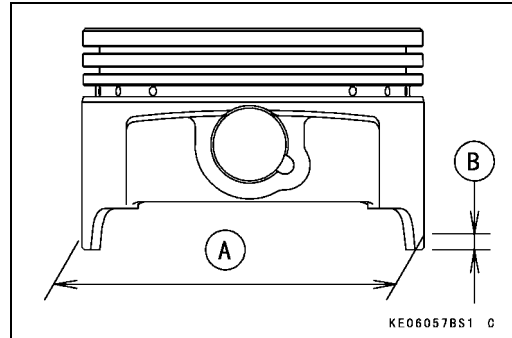


Piston Diameter

- Measure the outside diameter [A] of the piston 3.5 mm (0.14 in.) [B] up from the bottom of the piston at a right angle to the direction of the piston pin hole.
- ★ If the measurement is less than the service limit, replace the piston.

Piston Outside Diameter

Service Limit: 74.98 mm (2.952 in.)



Cylinder Inside Diameter

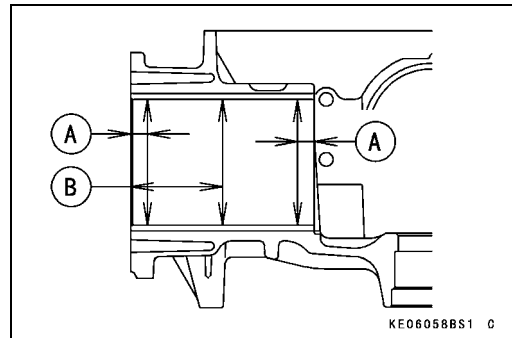
- Clean and measure the cylinder inside diameter.
- Use a dial bore gauge to measure front-to-back and side-to-side at the points shown below.
- ★ If any of the cylinder bore measurements is greater than the service limit, replace the cylinder with a new one.
 - 10 mm (0.39 in.) [A]
 - 55 mm (2.17 in.) [B]

Cylinder Inside Diameter

Cylinder Inside Diameter:

Standard: 75.18 ~ 75.20 mm (2.960 ~ 2.961 in.)

Service Limit: 75.30 mm (2.965 in.)



Cylinder Bore Out-of-Round

Service Limit: 0.056 mm (0.0022 in.)

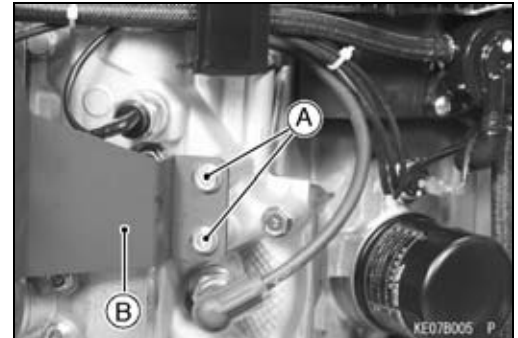
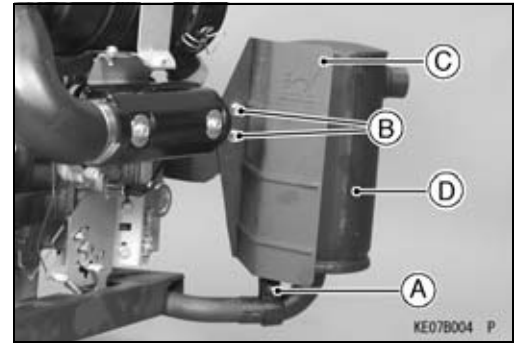
Muffler/Exhaust Pipe

Muffler/Exhaust Pipe Removal

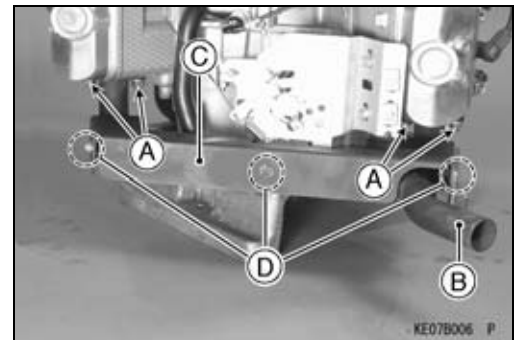
⚠ WARNING

Do not touch the muffler when the muffler is still hot. Wait until it cools down.

- Loosen the clamp nut [A].
- Remove the bolts [B] on the muffler cover [C] and take off the muffler cover and the muffler [D].
- Remove the bolts [A] on the muffler bracket [B] and take off the bracket.



- Unscrew the exhaust pipe flange nuts [A], and remove the exhaust pipe [B] with pipe cover [C]. Use a penetrating oil if necessary to break threads loose.
- Remove the gaskets.
- Unscrew the nuts [D], separate the exhaust pipe and pipe cover.
- Do not use unnecessary force on the exhaust pipes when removing the muffler assembly, or they could become damaged or destroyed.



Muffler/Exhaust Pipe Installation

- Clean the exhaust pipe flanges to the exhaust port gasket surfaces and install a new gaskets each time the muffler installed.
- Install the gasket.
- To prevent mis-threading, finger tight the flange nuts first. Next tighten the nuts.
- Tighten the exhaust pipe flange nuts.

Torque - Exhaust Pipe Flange Nuts: 20 N·m (2.0 kgf·m, 15 ft·lb)

- Install the muffler.
- After installation, thoroughly warm up the engine, wait until the engine cools down and retighten the bolts and nuts.

Inspection

- Inspect the exhaust pipe or muffler for dents, cracks, rust and holes.
- ★ If the exhaust pipe or muffler is damaged, it should be replaced for best performance and least noise.
- Check the muffler for distortion and/or loose internal components. Loss of power could develop if the muffler loose the internal components restricting the exhaust flow.
- Check for breaks in the seams and check weld at the junction of the exhaust pipes and muffler.
- Tap the muffler with a plastic hammer to decarbonize.

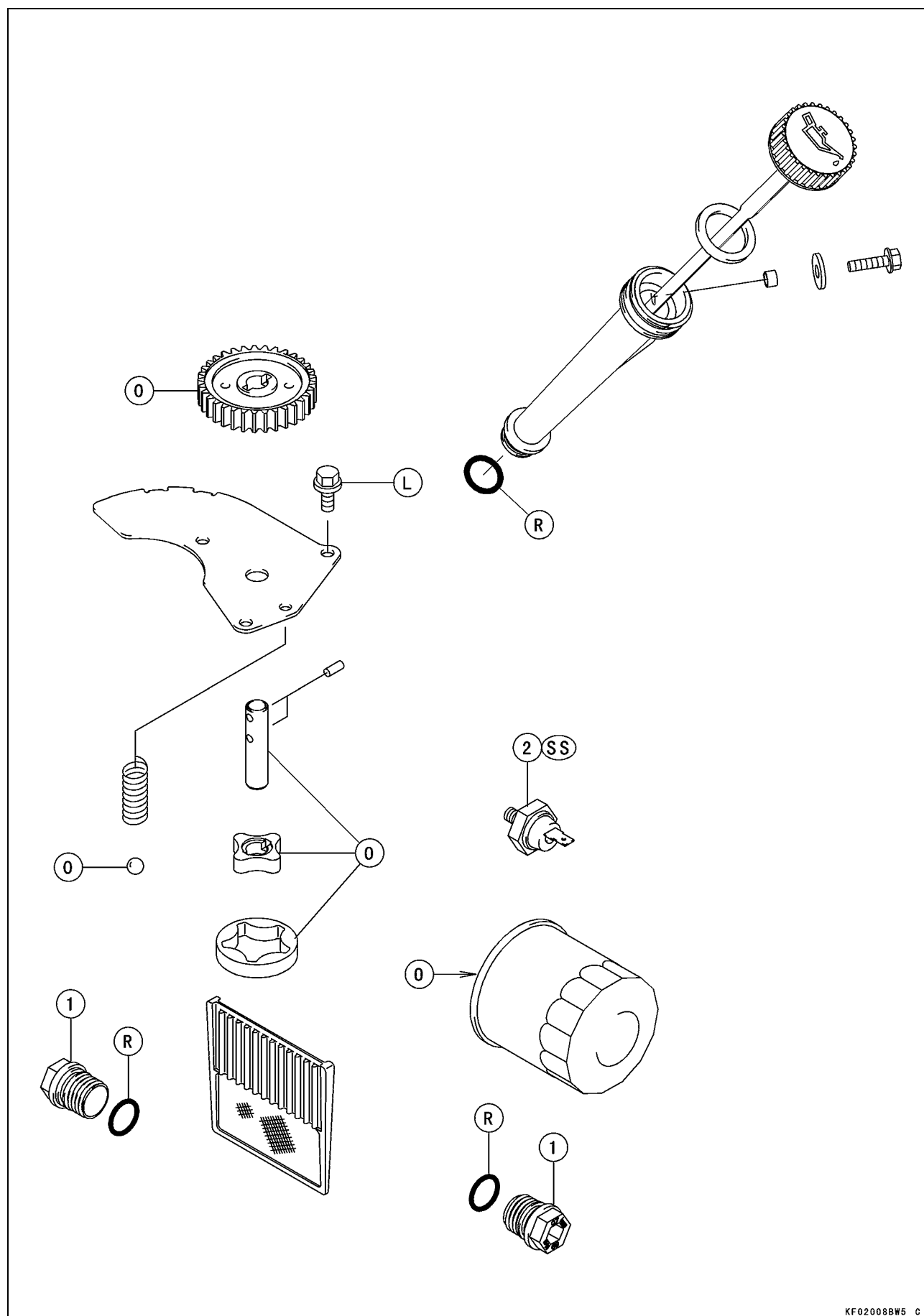
Lubrication System

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6-2 LUBRICATION SYSTEM

Exploded View



LUBRICATION SYSTEM 6-3

Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Oil Drain Plugs	6.9	0.70	61 in·lb	
2	Oil Pressure Switch	9.8	1.0	87 in·lb	SS

L: Apply a non-permanent locking agent.

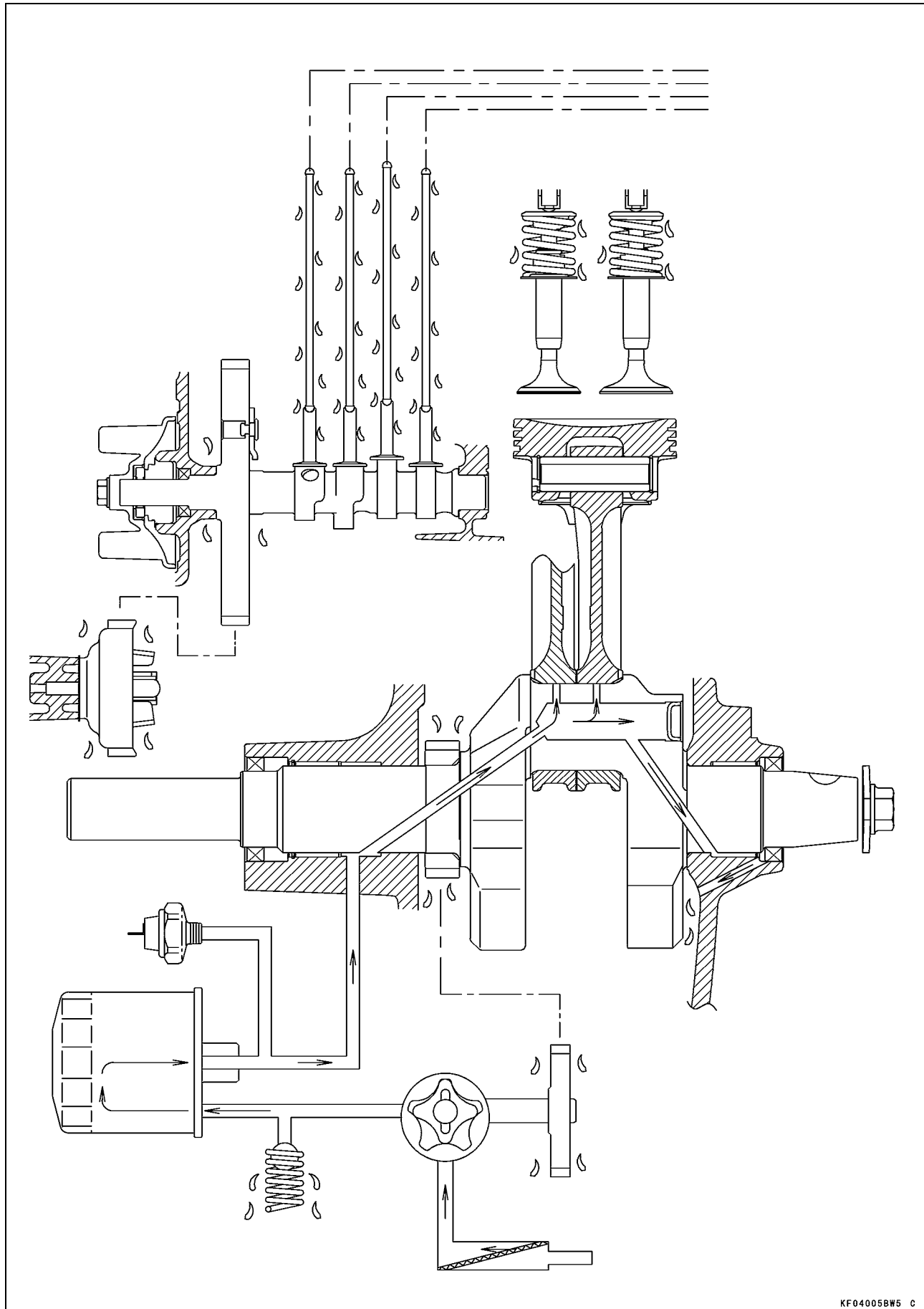
O: Apply engine oil.

R: Replacement Parts

SS: Apply Silicone Sealant (Kawasaki Bond: 56019-120).

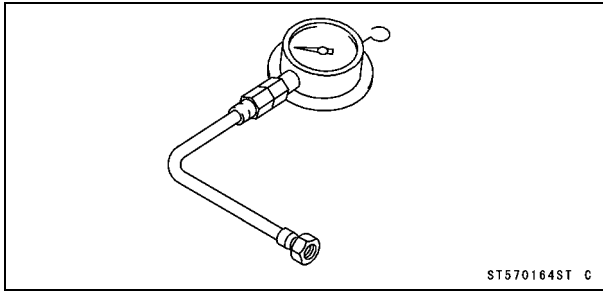
6-4 LUBRICATION SYSTEM

Engine Oil Flow Chart

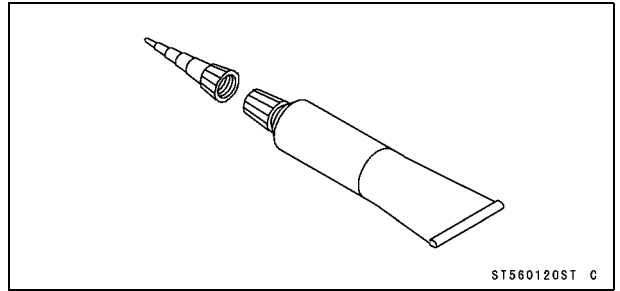


Special Tools and Sealant

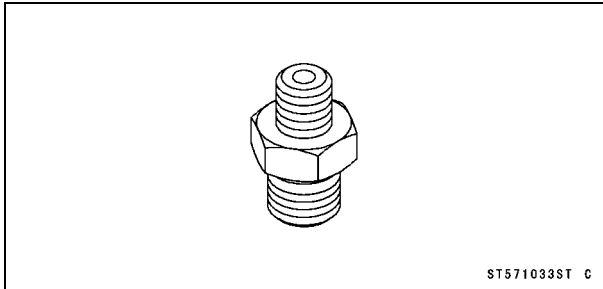
Oil Pressure Gauge, 10 kgf/cm²:
57001-164



Kawasaki Bond (Silicone Sealant):
56019-120



Oil Pressure Gauge Adapter, PT 1/8:
57001-1033



6-6 LUBRICATION SYSTEM

Specifications

Item	Standard
Engine Oil	
Grade	API service classification; SF, SG, SH, or SJ class
Viscosity	SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20
Capacity	2.0 L (2.1 US qt) [When filter is not removed] 2.3 L (2.4 US qt) [When filter is removed]
Level	Between “ADD” and “FULL” marks
Oil Pressure	294 ~ 686 Kpa (42.6 ~ 99.5 psi): Engine oil temperature 50 ~ 60°C
Oil Pressure Switch	
Detect Pressure	98 kPa (14.2 psi)
Screw	PT 1/8 pipe thread
Oil Filter By-pass Valve Opening	
Pressure	69 ~ 127 kPa (10 ~ 18.4 psi)

Item	Service Limit
Oil Pump	
Inner and Outer Rotor Clearance	0.21 mm (0.0083 in.)
Outer Rotor Outside Diameter	40.470 mm (1.5933 in.)
Outer Rotor Thickness	9.94 mm (0.391 in.)
Pump Housing Inside Diameter	40.801 mm (1.6063 in.)
Pump Housing Depth	10.230 mm (0.4028 in.)
Pump Shaft Outside Diameter	10.923 mm (0.4300 in.)
Relief Valve Spring Free Length	19.50 mm (0.7677 in.)
Pump Shaft Bearing Inside Diameter	11.079 mm (0.43618 in.)

Engine Oil and Oil Filter

CAUTION

Engine operation with insufficient, deteriorated, or contaminated engine oil will cause accelerated wear and may result in engine seizure and accident.

Oil Level Inspection

- Refer to the Engine Oil Level Inspection in the Periodic Maintenance chapter.

Oil Change

- Refer to the Engine Oil Change in the Periodic Maintenance chapter.

Oil Filter Removal

- Refer to the Oil Filter Replacement in the Periodic Maintenance chapter.

Oil Filter Installation

- Refer to the Oil Filter Replacement in the Periodic Maintenance chapter.

6-8 LUBRICATION SYSTEM

Pressurized Lubrication System

The engine lubrication circuit is a pressurized system consisting of a positive displacement pump which picks up oil through a filter screen from the crankcase. The oil is pumped to a replaceable oil filter cartridge, through the engine's oil passages to lubricate internal components, and return to the crankcase. A bypass valve is incorporated in the oil filter to allow oil to circulate if the filter becomes clogged. A pressure relief valve is used between the oil pump and oil filter to relieve excessive oil pressure by returning excess oil to the crankcase (see Oil Flow Chart).

Oil Pressure Measurement

- Remove the oil pressure switch [A] from the crankcase.
- Install the oil pressure gauge adapter [B] and oil pressure gauge [C].

Special Tools - Oil Pressure Gauge, 10 kgf/cm²: 57001-164
Oil Pressure Gauge Adapter, PT 1/8: 57001-1033

- Run the engine and allow warm up completely.
- Run the engine at fast idle speed and read the oil pressure gauge.
- Stop the engine.
- Remove the oil pressure gauge and adapter.
- Apply silicone sealant to the taper threads of the pressure switch and install the switch.

Sealant - Kawasaki Bond (Silicone Sealant): 56019-120

Torque - Oil Pressure Switch: 9.8 N·m (1.0 kgf·m, 87 in·lb)

- ★ If the oil pressure is below the specification, inspect the oil pump and relief valve.
- ★ If the oil pump and relief valve are not at fault, inspect the rest of the lubrication system.

Oil Pressure

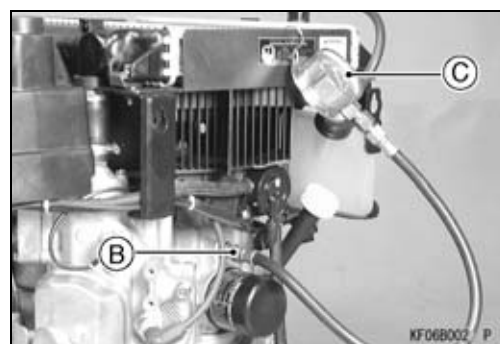
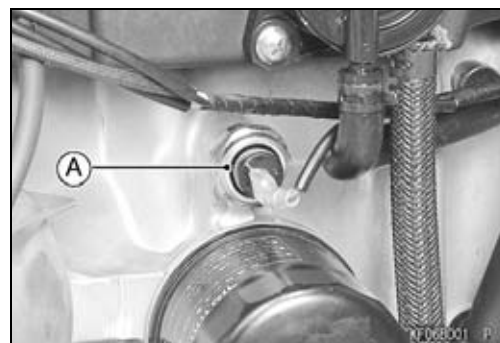
294 ~ 686 kPa (3.0 ~ 7.0 kgf/cm², 42.6 ~ 99.5 psi)

Measurement Condition

Engine Oil Temperature: 50 ~ 60°C

Oil Pressure Switch

Screw PT 1/8 pipe thread



Pressurized Lubrication System

Oil Pressure Switch Inspection

When the oil pressure falls below 98 kPa (14.2 psi), the oil pressure switch activates the oil warning light to alert the operator of a lubricating problem.

- To check the oil warning system, insert the switch key into the "OFF" position of the engine switch, then turn it to the "RUN" position. The warning light must be illuminated.
- Whenever start the engine, make sure the warning light is not on in started engine.
- ★ If the warning light comes on, stop the engine immediately and check the oil level.
- When starting the engine, note the warning light on dash carefully.
- ★ If the warning light is on in the started engine in spite of adequate oil level, check the lead from the pressure switch to the warning light for short circuit and/or check the pressure switch and replace damaged part.
- ★ If the light is not on at the moment of the engine switch operation, check all leads of the warning light circuit or bulb and replace damaged parts.

6-10 LUBRICATION SYSTEM

Oil Pump and Relief Valve

Oil Pump/Relief Valve Removal

- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter).
- Unscrew the mounting bolts and remove the oil pump parts assembly (pump gear, pump cover plate, pump shaft, pins and rotors).
- Take off the relief valve spring and ball.
- Disassemble the pump parts assembly.

Pin [A]

Pump Gear [B]

Mounting Bolts [C]

Outer Rotor [D]

Inner Rotor [E]

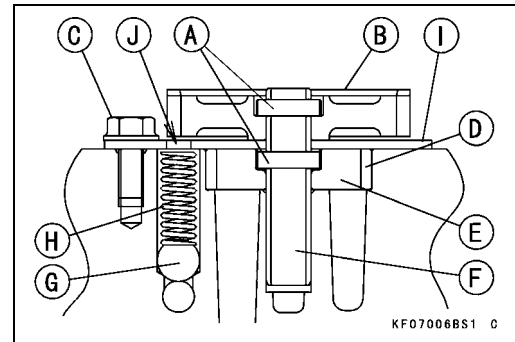
Pump Shaft [F]

Relief Valve Ball [G]

Spring [H]

Pump Cover Plate [I]

6 mm DIA Hole [J]



Oil Pump/Relief Valve Installation

- Fill the rotor housing with engine oil for initial lubrication.
- Install the relief valve ball and spring in position, then install the pump parts assembly in the crankcase cover.

NOTE

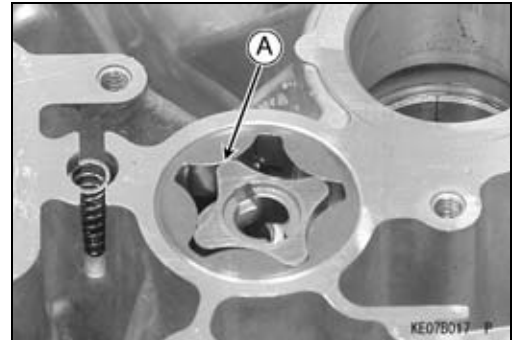
○When installing the pump parts assembly, align the 6 mm DIA hole [A] on the cover plate with center of the relief valve.

- Apply a non-permanent locking agent to the threads of the mounting bolts and tighten them.



Oil Pump/Relief Valve Inspection

- Remove the oil pump (see Oil Pump, Relief Valve Removal in this chapter).
- Visually inspect the pump gear, outer and inner rotor, and cover plate.
- ★ If there is any damage or uneven wear, replace them.
- Check the clearance [A] between the inner and outer rotor with a feeler gauge. Measure the clearance between the high point of the inner rotor and the high point of the outer rotor.
- ★ If the measurement exceed the service limit, replace the rotors as a set.



Inner and Outer Rotor Clearance

Service Limit: 0.21 mm (0.0083 in.)

Oil Pump and Relief Valve

- Measure the outside diameter [A] of the outer rotor with a micrometer at several points.
- ★ If the rotor diameter is less than the service limit, replace both the inner and outer rotor.

Outer Rotor Outside Diameter

Service Limit: 40.470 mm (1.5933 in.)

- Measure the thickness [B] of the outer rotor with a micrometer at several points
- ★ If the rotor thickness is less than the service limit, replace both the inner and outer rotor.

Outer Rotor Thickness

Service Limit: 9.94 mm (0.391 in.)

- Measure the inside diameter [A] of the pump housing with a inside micrometer at several points.
- ★ If the inside diameter is more than the service limit, replace the crankcase cover.

Pump Housing Inside Diameter

Service Limit: 40.801 mm (1.6063 in.)

- Measure the depth [B] of the pump housing with a depth micrometer at several points.
- ★ If any of measurement is more than the service limit, replace the crankcase cover.

Pump Housing Depth

Service Limit: 10.230 mm (0.4028 in.)

- Measure the outside [A] diameter of the pump shaft with a micrometer at several points.
- ★ If the diameter is less than the service limit, replace the pump shaft.

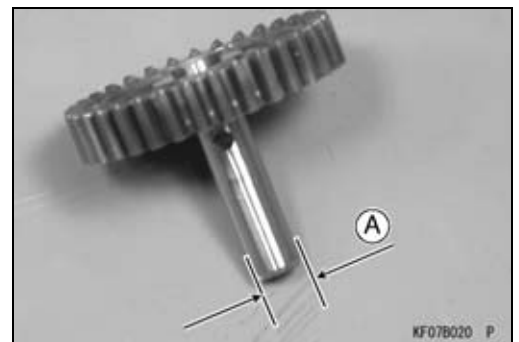
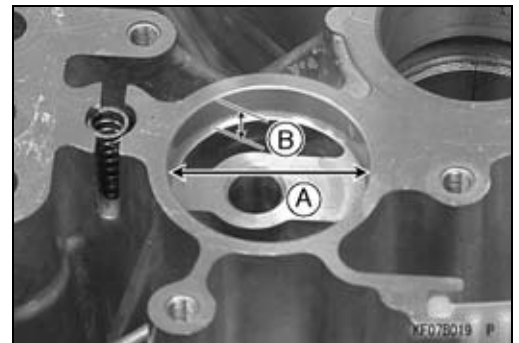
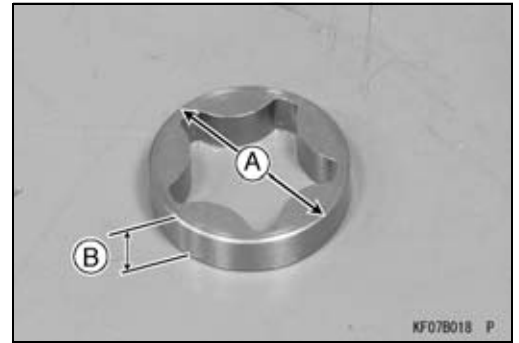
Pump Shaft Outside Diameter

Service Limit: 10.923 mm (0.4300 in.)

- Measure the inside diameter [A] of the pump shaft bearing in the crankcase cover with a inside micrometer at several points.
- ★ If the inside diameter is more than the service limit replace the crankcase cover.

Pump Shaft Bearing Inside Diameter

Service Limit: 11.079 mm (0.43618 in.)



6-12 LUBRICATION SYSTEM

Oil Pump and Relief Valve

- Visually inspect the relief valve spring, steel ball and valve seat in the crankcase cover.
- ★ If any rough spots are found during above inspection, wash the valve clean with a high flash-point solvent and blow out any foreign particles that may be in the valve with compressed air.

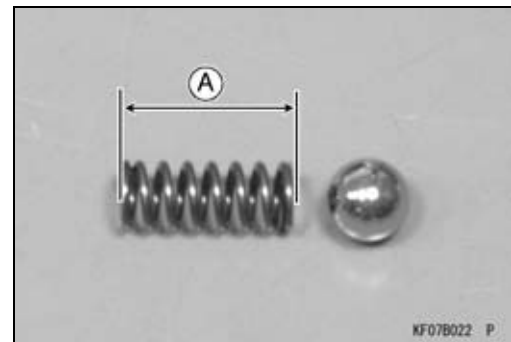
⚠ WARNING

Clean the parts in a well ventilated area, and take care that there is no spark or flame anywhere near the working areas. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents.

- ★ If cleaning does not solve the problem, replace the relief valve parts.
- ★ If necessary, put the ball in position and lightly tap the ball with a suitable tools to form a perfect seat.
- Measure free length [A] of the spring with a vernier caliper.
- ★ If the free length of the spring is less than the service limit, replace the spring.

Relief Valve Spring Free Length

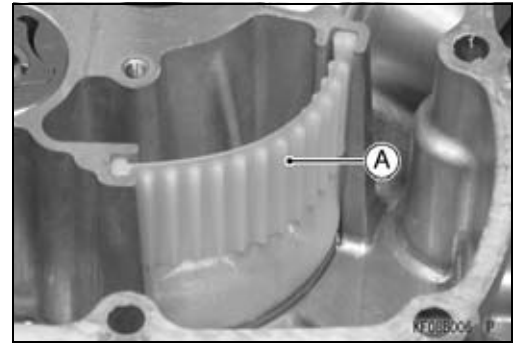
Service Limit: 19.50 mm (0.7677 in.)



Oil Screen Filter

Oil Screen Filter Removal

- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankcase chapter).
- Remove the oil pump parts assembly (see Oil Pump/Relief Valve Removal in this chapter).
- Remove the oil screen filter [A].

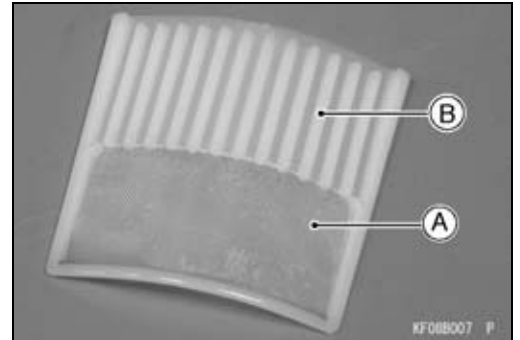


Oil Screen Filter Cleaning and Inspection

- Clean the oil screen [A] with high flash-point solvent and remove any particles stuck to it.

⚠ WARNING

Clean the screen in a well-ventilated area, and take care that there is no spark or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents.



NOTE

○ *While cleaning the screen, check for any metal particles that might indicate internal engine damage.*

- Check the screen carefully for any damage: holes and broken wire.
- ★ If the screen is damaged, replace the oil screen filter [B].

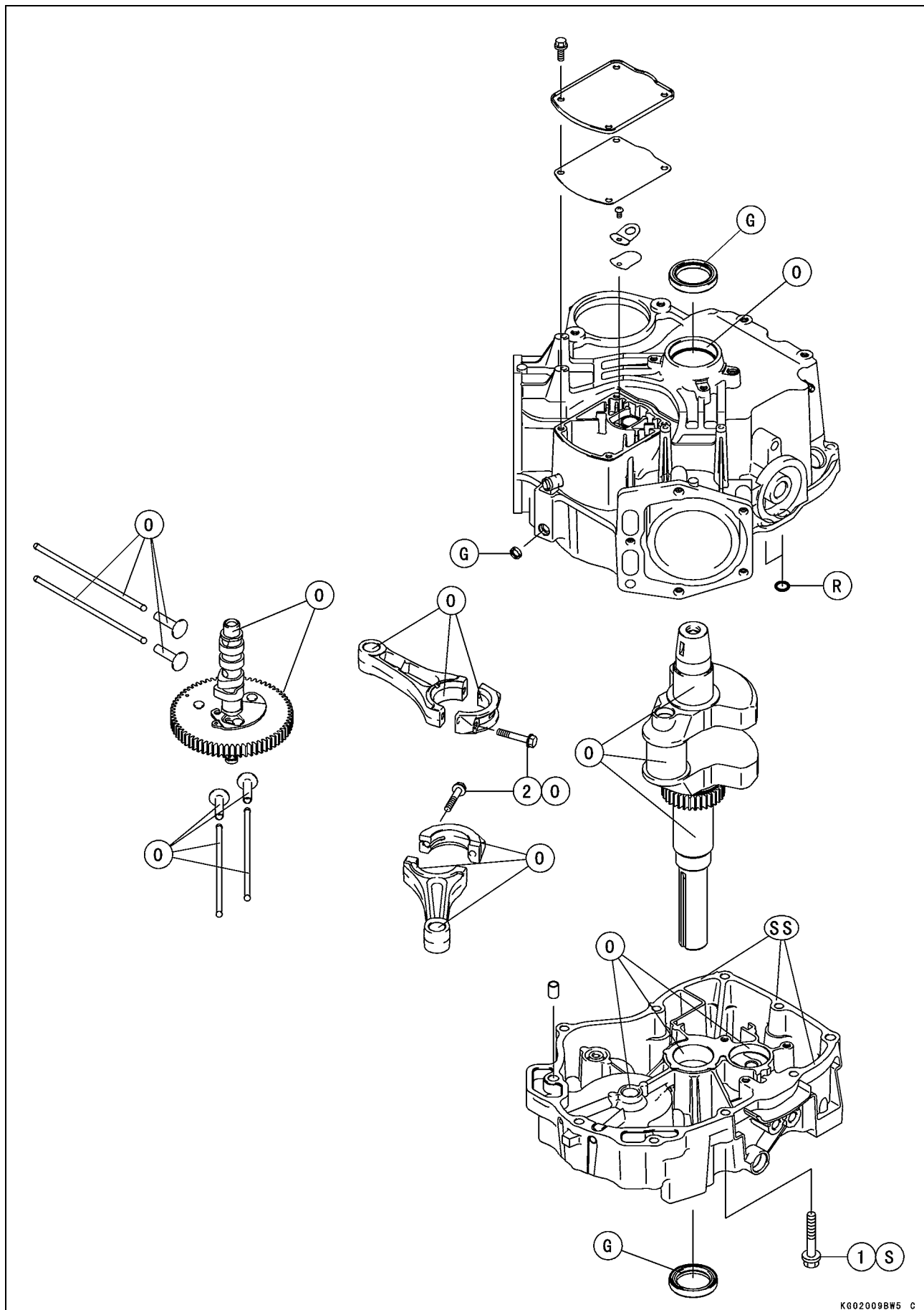
Camshaft/Crankshaft

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7-2 CAMSHAFT/CRANKSHAFT

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Crankcase Cover Bolts (M8)	22	2.2	17	S
2	Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	O

G: Apply grease.

O: Apply engine oil.

R: Replacement Parts

S: Follow the specific tightening sequence.

SS: Apply silicone sealant.

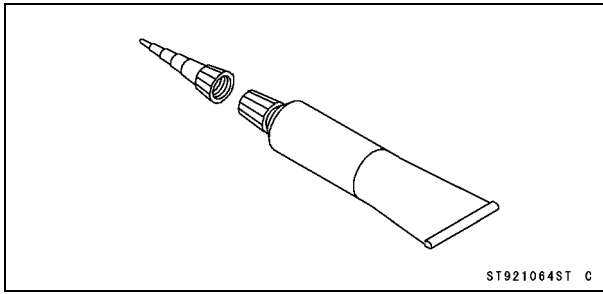
7-4 CAMSHAFT/CRANKSHAFT

Specifications

Item	Service Limit
Camshaft, Tappet Cam Lobe Height: Inlet, Exhaust Camshaft Journal Diameter: PTO Side Flywheel Side Camshaft Bearing Inside Diameter: Crankcase Crankcase Cover	 41.45 mm (1.6319 in.) 15.99 mm (0.6295 in.) 15.99 mm (0.6295 in.) 16.08 mm (0.6331 in.) 16.08 mm (0.6331 in.)
Crankshaft, Connecting Rod Connecting Rod Bend Connecting Rod Twist Connecting Rod Big End Width Crankpin Width Connecting Rod Big End Inside Diameter Crankpin Outside Diameter Crankshaft Runout Crankshaft Journal Diameter: PTO Side Flywheel Side	 0.2/100 mm (0.008/3.94 in.) 0.2/100 mm (0.008/3.94 in.) 20.2 mm (0.795 in.) 45.0 mm (1.772 in.) 40.05 mm (1.577 in.) 39.95 mm (1.573 in.) TIR 0.05 mm (0.002 in.) 39.90 mm (1.571 in.) 39.90 mm (1.571 in.)
Crankcase PTO Shaft Bearing Inside Diameter: Crankcase Cover Crankshaft Journal Bearing Inside Diameter: Crankcase	 40.04 mm (1.576 in.) 40.01 mm (1.575 in.)

Sealant

Kawasaki Bond:
92104-1064

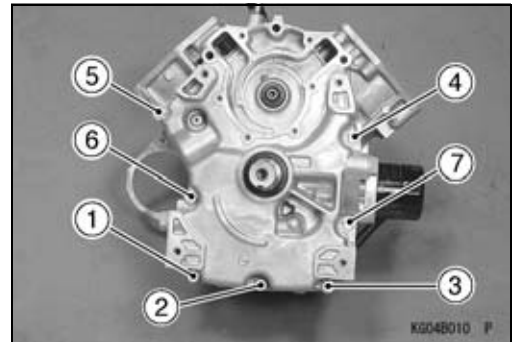


7-6 CAMSHAFT/CRANKSHAFT

Crankcase

Crankcase Cover Removal

- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Oil Change in the Periodic Maintenance chapter).
- Remove:
 - Muffler Assembly (see Muffler/Exhaust Pipe Removal in the Engine Top End chapter)
 - Air Cleaner and Related Parts (see Element Removal and Cleaner Body Removal in the Fuel System chapter)
 - Carburetor Assembly (see Carburetor Removal in the Fuel System chapter)
 - Control Panel (see Control Panel Assembly Removal in the Fuel System chapter)
 - Radiator (see Radiator Removal in the Cooling System chapter)
 - Radiator Hoses and Bypass Tube
 - Water Pump (see Water Pump Removal in the Cooling System chapter)
 - Cooling Fan and Brackets (see Cooling Fan Removal in the Cooling System chapter)
 - Cylinder Head Assemblies (see Cylinder Head Assembly Removal in the Engine Top End chapter)
 - Inlet Manifold (see Inlet Manifold Removal in the Fuel System chapter)
 - Flywheel (see Flywheel, Stator Coil Removal in the Electrical System chapter)
 - Stator Coil (see Flywheel, Stator Coil Removal in the Electrical System chapter)
 - Ignition Coils (see Ignition Coil Removal in the Electrical System chapter)
 - Starter Motor (see Starter Motor Removal in the Electrical System chapter)
- Unscrew the mounting bolts in the order shown [1 ~ 7] and pull the crankcase cover from the crankcase.
- There are two knock pins on the crankcase mating surface. A wooden or plastic mallet may be used to gently tap loose the crankcase cover.



Crankcase Cover Installation

- Before fitting the cover onto the crankcase, note the following.
- Chip off the old gasket from the mating surfaces of the crankcase and cover.
- Using compressed air, blow out the oil passage in the crankcase cover.
- With a high-flash point solvent, clean off the mating surfaces of the crankcase and cover, and wipe dry.

Crankcase

⚠ WARNING

Clean the crankcase and cover in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean parts. A fire or explosion could result.

- Be sure to replace any oil seal removed with a new one.
- Install the oil seal so that the marks [A] face out.
- Pack some amount of a high temperature grease [B] into the space between the seal lip [C] and dust lip [D]. Press in the new oil seal 0 ~ 0.5 mm (0 ~ 0.02 in.) [E] below the crankcase cover surface [F] using a press or suitable tools until it is flush with flange surface. Do not damage the seal lips.

(Crankcase installation)

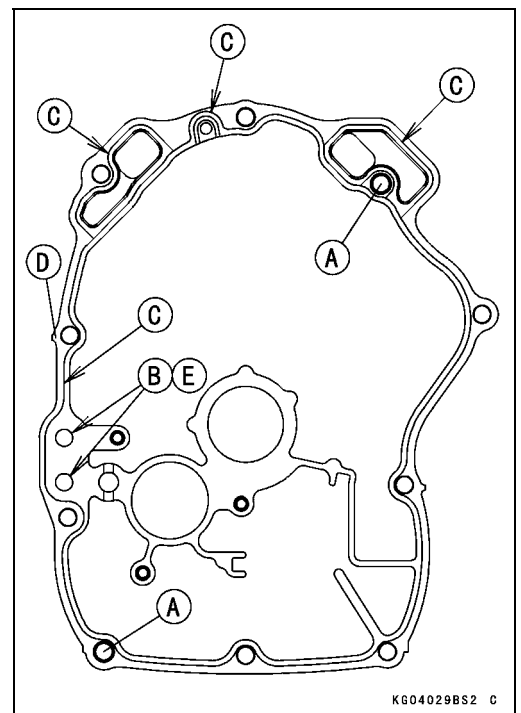
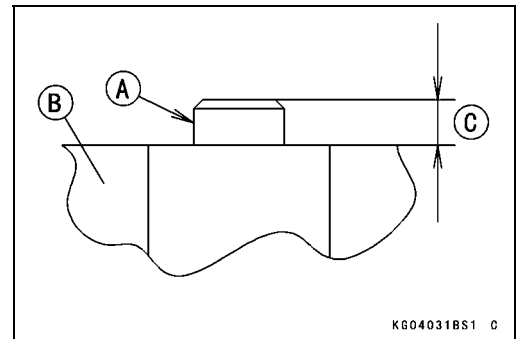
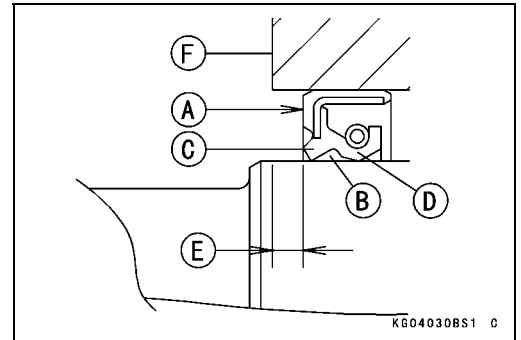
- Check to see that the crankcase dowel pins [A] are in place on the crankcase cover as shown in the figure.
- Press in the dowel pins [A] into the crankcase cover [B]. 5 mm (0.20 in.) [C]

- Check to see that the O-rings [B] are in place on the crankcase as shown in the figure.
- Apply sealant bead [C] (wide 1 ~ 2 mm) to the mating surface [D] of the crankcase cover as shown in the figure.

Sealant - Kawasaki Bond: 92104-1064

CAUTION

Do not get the sealant into the oil line hole [E] on the crankcase or crankcase cover.



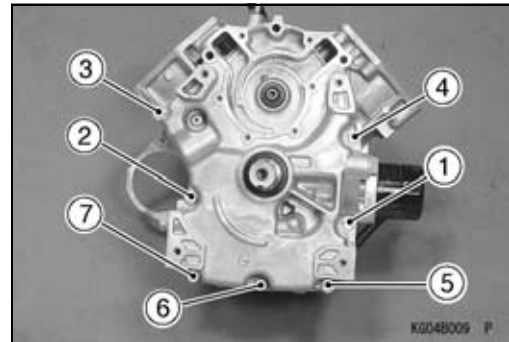
7-8 CAMSHAFT/CRANKSHAFT

Crankcase

- Install the crankcase cover and tighten the crankcase cover bolts following the tightening sequence shown.

Torque - Crankcase Cover Bolts: 22 N·m (2.2 kgf·m, 17 ft·lb)

- Note the position of different length of the bolts.
- Do not turn one screw down completely before the others, as it may cause the crankcase cover to warp.

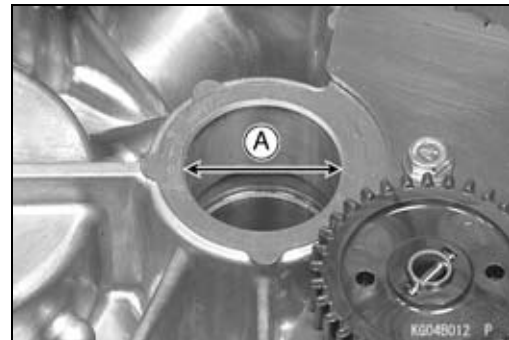


Inspection

- Measure the inside diameter [A] of the PTO shaft bearing on the crankcase cover at several points. This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

PTO Shaft Bearing Inside Diameter

Service Limit: 40.04 mm (1.576 in.)



- Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase at several points. This bearing is not replaceable. Replace the journal bushing if the inside diameter is more than the service limit.

Crankshaft Journal Bearing Inside Diameter

Service Limit: 40.01 mm (1.575 in.)



Breather

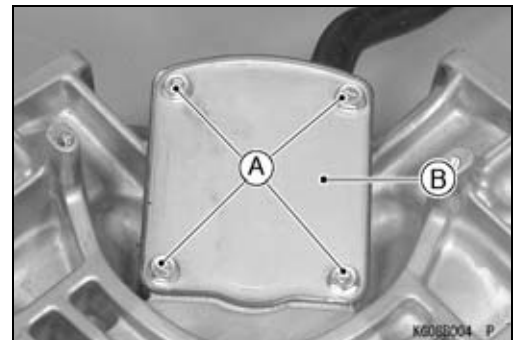
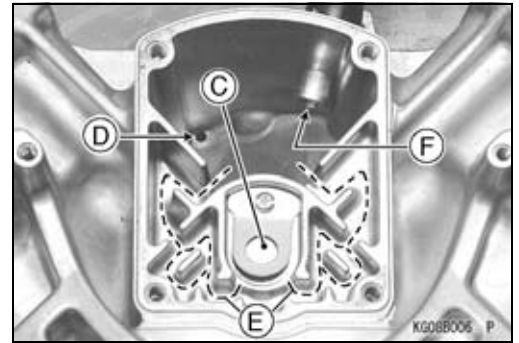
The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve [C], which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one way reed valve blocks return flow. It thus maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expand into the breather chamber. Here most oil separates from the air and drains back to the crankcase. The air passes through a maze [E] and vents to the air cleaner [F].

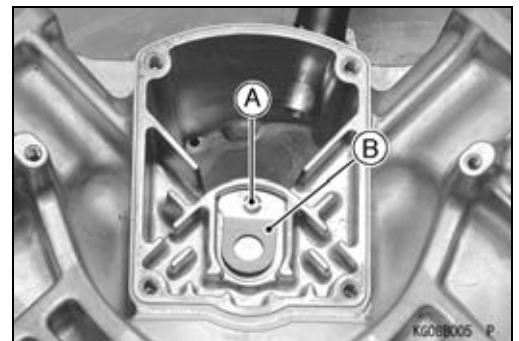
Drain Hole [D]

Breather Valve Removal

- Remove the bolts [A] and breather chamber cover [B].



- Unscrew the mounting screw [A], and remove the back plate [B] and reed valve.



Breather Valve Installation

- Be sure the drain hole does not accumulate with slugs before installing the breather valve.
- Align center of the valve seat with center of the reed valve and back plate, then tighten the mounting screw.

Breather Valve Inspection

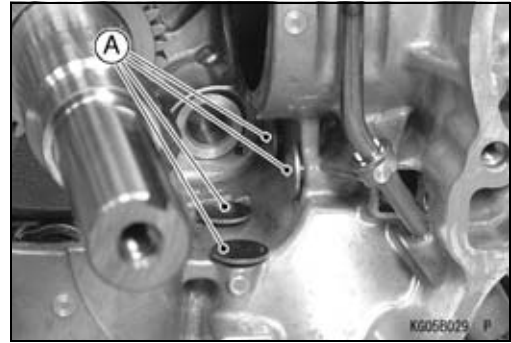
- Inspect the reed valve for breakage, hair cracks or distortion, replace it if necessary.
- Inspect the back plate for damage or rough contact surface, replace it if necessary.
- Inspect the valve seating surface. The surface should be free of nicks or burrs.

7-10 CAMSHAFT/CRANKSHAFT

Camshaft, Tappet

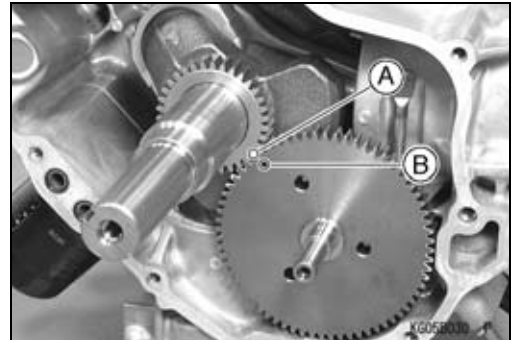
Camshaft, Tappet Removal

- Remove the crankcase cover (see Crankcase Cover Removal).
- Turn the crankcase up side down so that the tappets will fall away from the cam lobes.
- Pull the camshaft out of the crankcase.
- Remove the tappets [A] and mark them so they can be installed in their original positions during assembly.



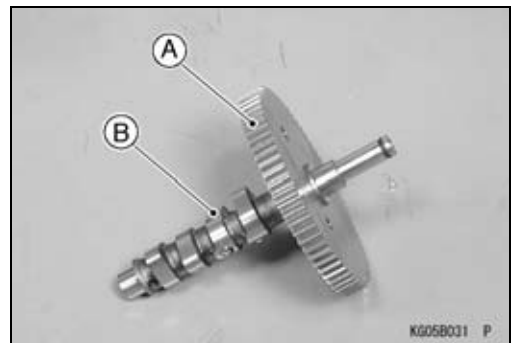
Camshaft, Tappet Installation

- Apply engine oil to the following:
 - Tappet Journal
 - Camshaft Journal
 - Cam Lobe Surface
 - Camshaft Gear
- Align the punch mark [A] on the crankshaft gear with punch mark [B] on the camgear.



Camshaft Inspection

- Check the camshaft gear [A] for pitting, fatigue cracks, burrs or an evidence of improper tooth contact.
- ★ Replace the shaft if necessary.
- Check the top of the cam lobes [B] for wear, burrs or uneven contact.
- ★ Replace the shaft if necessary.



Camshaft Bearing/Journal Wear

- Measure the height of each cam lobe.
- ★ If the cam height is less than the service limit for either lobe, replace the camshaft.

Cam Lobe Height

Service Limit (Inlet, Exhaust): 41.45 mm (1.6319 in.)



- Measure both camshaft journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the camshaft.

PTO Side Camshaft Journal Diameter

Service Limit: 15.99 mm (0.6295 in.)

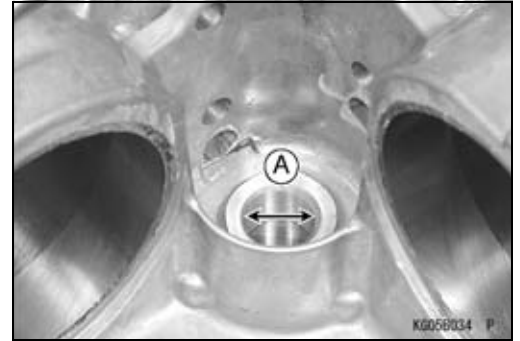
Flywheel Side Camshaft Journal Diameter

Service Limit: 15.99 mm (0.6295 in.)



Camshaft, Tappet

- Measure the inside diameter [A] of the camshaft bearing on the crankcase at several points. This bearing is not replaceable.
- ★ Replace the crankcase if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase)**Service Limit: 16.08 mm (0.6331 in.)**

- Measure the inside diameter [A] of the camshaft bearing on the crankcase cover at several points. This bearing is not replaceable.
- ★ Replace the crankcase cover if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase Cover)**Service Limit: 16.08 mm (0.6331 in.)**

7-12 CAMSHAFT/CRANKSHAFT

Crankshaft, Connecting Rod

Connecting Rod Removal

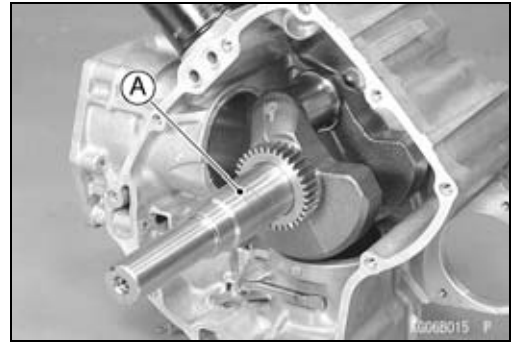
- Remove:
Piston (see Engine Top End Chapter)

Connecting Rod Installation

- Install:
Piston (see Engine Top End chapter)

Crankshaft Removal

- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Lubrication System chapter).
- Remove:
Flywheel (see Electrical System chapter)
Camshaft (see Camshaft, Tappet Removal)
Connecting Rod and Piston Assembly (see Engine Top End chapter)
- Pull the crankshaft [A] out of the crankcase. Tap gently with a wooden or plastic mallet if necessary to loosen the crankshaft.



Crankshaft Installation

- Clean up the crankshaft and crankcase thoroughly, especially at the bearing contact surfaces.
- Pack some amount of high temperature grease into the oil seal on the crankcase.
- Apply engine oil to the journal and bearing.
- Carefully insert the crankshaft flywheel end into the main bearing and oil seal in the crankcase.

Cleaning/Inspection

- After removing, clean the crankshaft and connecting rods with a high-flash point solvent and dry them with compressed air.
- Inspect the teeth of the crankshaft gear for pitting, fatigue cracks, burrs and evidence of improper tooth contact.
- ★ Replace the gear if necessary.
- Inspect the crankshaft and connecting rods especially at the bearing surfaces for wear, scratches, evidence of improper contact or other damages.
- ★ Replace them if necessary.

Crankshaft, Connecting Rod

Connecting Rod Bend/Twist

- Measure the connecting rod bend.
- Select an arbor of the same diameter as the connecting rod big end, and insert the arbor through the connecting rod big end.
- Select an arbor of the same diameter as the piston pin and at least 100 mm (3.94 in.) long, and insert the arbor through the connecting rod small end.
- On a surface plate, set the big-end arbor on V blocks.
- With the connecting rod held vertically, use a height gauge to measure the difference in the height of the small end arbor above the surface plate over a 100 mm length to determine the amount of connecting rod bend.
- ★ If connecting rod bend exceeds the service limit, the connecting rod must be replaced.

Connecting Rod Bend

Service Limit: 0.2/100 mm (0.008/3.94 in.)

- Measure connection rod twist.
- With the big-end arbor still on the V blocks, hold the connection rod horizontally and measure the amount that the small end arbor varies from being parallel with the surface plate over a 100 mm (3.94 in.) length of the arbor to determine the amount of connecting rod twist.
- ★ If connecting rod twist exceeds the service limit, the connecting rod must be replaced.

Connecting Rod Twist

Service Limit: 0.2/100 mm (0.008/3.94 in.)

Connecting Rod Big End/Crankpin Width Wear

- Measure the connecting rod big end width [A] with a micrometer or dial caliper.
- ★ If the measurement is less than the service limit, replace the connecting rod.

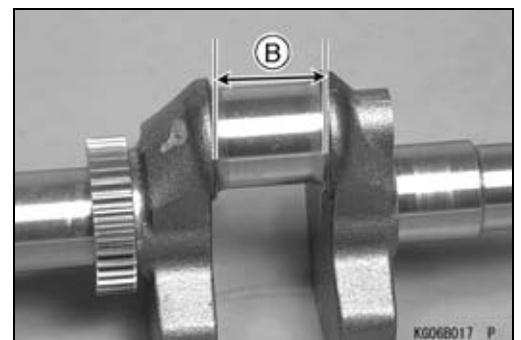
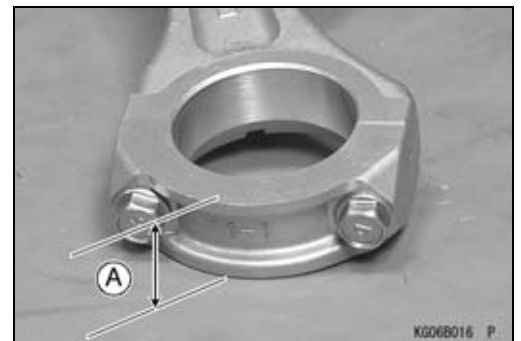
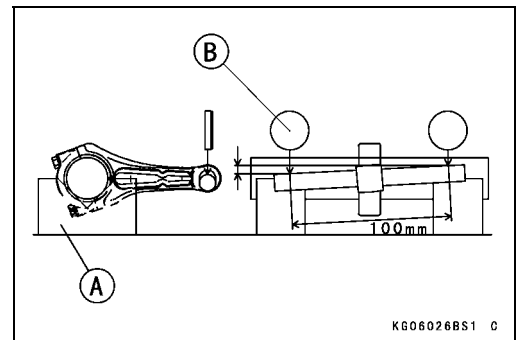
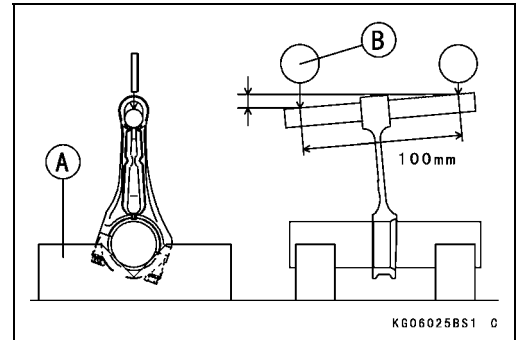
Connecting Rod Big End Width

Service Limit: 20.2 mm (0.795 in.)

- Measure the crankpin width [B] with a dial caliper.
- ★ If the crankpin width is more than the service limit, replace the crankshaft.

Crankpin Width

Service Limit: 45.0 mm (1.772 in.)



7-14 CAMSHAFT/CRANKSHAFT

Crankshaft, Connecting Rod

Connecting Rod Big End Bearing/Crankpin Wear

- Apply a light film of oil on the thread of the cap bolts.
- Install the cap bolts and tighten the bolts to the specified torque (see Piston Installation in the Engine Top End chapter).
- Measure the inside diameter [A] of both big ends with a inside micrometer.
- ★ If the inside diameter is more than the service limit, replace the connecting rod with a new one.

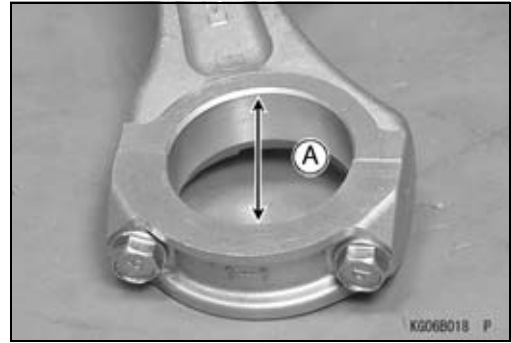
Connecting Rod Big End Inside Diameter

Service Limit: 40.05 mm (1.577 in.)

- Measure the crankpin outside diameter [A].
- Use a micrometer to measure several points around the crankpin circumference.
- ★ If the crankpin diameter is less than the service limit, replace the crankshaft with a new one.

Crankpin Outside Diameter

Service Limit: 39.95 mm (1.573 in.)

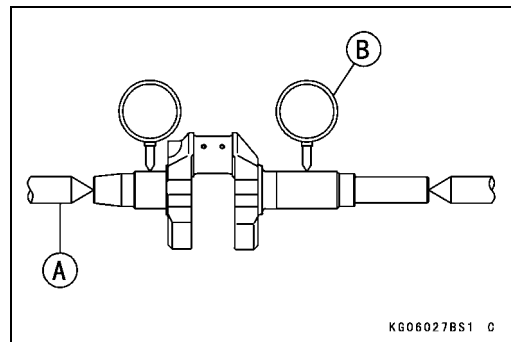


Crankshaft Runout

- Measure the crankshaft runout.
- Set the crankshaft in a flywheel alignment jig [A] or on V blocks gauge.
- Set a dial gauge [B] against both bearing journals.
- Turn the crankshaft slowly to measure the runout. The difference between the highest and lowest dial gauge readings (TIR) is the amount of runout.
- ★ If the measurement exceeds the service limit, replace the crankshaft.

Crankshaft Runout

Service Limit: TIR 0.05 mm (0.002 in.)



Crankshaft Main Journal/Wear

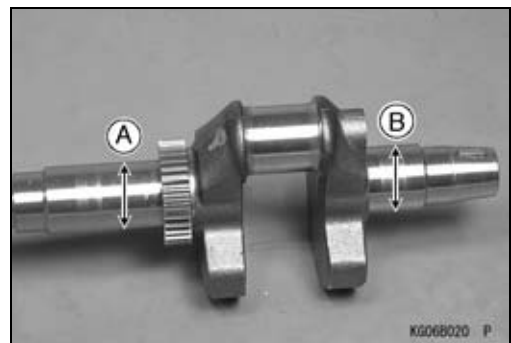
- Measure both main journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the crankshaft with a new one.

PTO Side Crankshaft Journal Diameter [A]

Service Limit: 39.90 mm (1.571 in.)

Flywheel Side Crankshaft Journal Diameter [B]

Service Limit: 39.90 mm (1.571 in.)



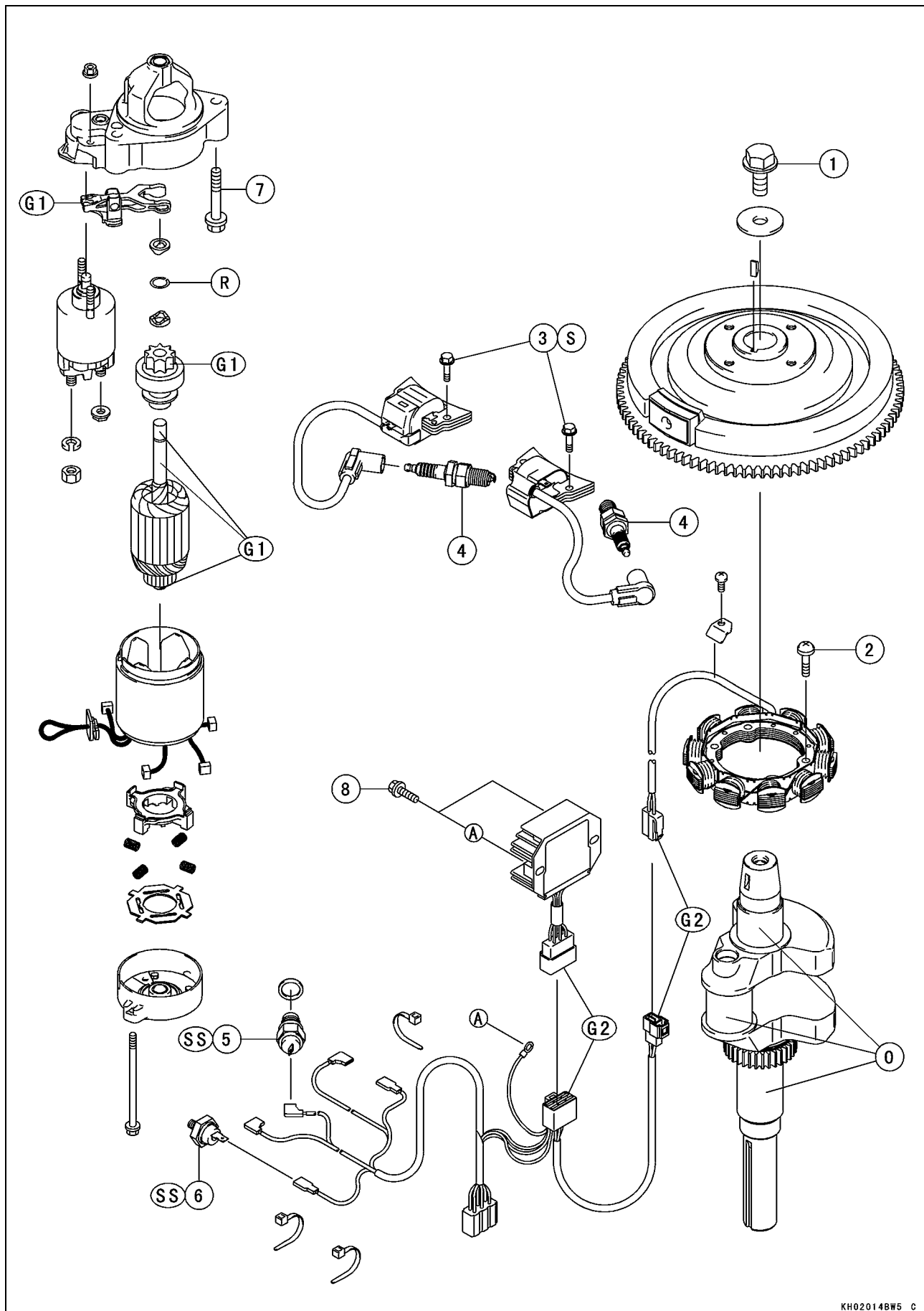
Electrical System

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8-2 ELECTRICAL SYSTEM

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Flywheel Bolt	56	5.7	41	
2	Stator Coil Screws	3.4	0.35	30 in·lb	
3	Ignition Coil Mounting Bolts	3.4	0.35	30 in·lb	S
4	Spark Plugs	25	2.5	18	
5	Thermo Switch	28	2.8	21	SS
6	Oil Pressure Switch	10	1.0	87 in·lb	SS
7	Starter Motor Mounting Bolts	15	1.5	11	
8	Regulator Bolts	6	0.6	53 in·lb	

G1: Apply grease.

G2: Apply grease [Three Bond: TB2585G or Grease No. Rykon premium grease EP#2 general purpose (Green)].

O: Apply engine oil.

R: Replacement Parts

S: Follow the specific tightening sequence.

SS: Apply silicone sealant.

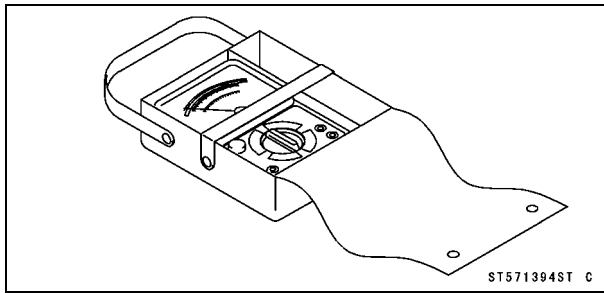
8-4 ELECTRICAL SYSTEM

Specifications

Item	Standard	Service Limit
Charging System		
Regulated Output Voltage	Battery voltage to 15 V DC	— — —
Alternator Stator Coil Resistance	0 ~ 2 Ω	— — —
Unregulated Stator Output	— — —	26 V AC/3 000 rpm
Regulator Resistance	See charging system	
Ignition System		
Ignition Coil:		
Primary Winding Resistance	16 ~ 24 Ω	— — —
Secondary Winding Resistance	17 ~ 25 k Ω	— — —
Spark Plug:	NGK BPR2ES	— — —
Plug Gap	0.75 mm (0.030 in.)	— — —
Electric Starter System		
Starter Motor:		
Carbon Brush Length	10 mm (0.394 in.)	6.0 mm (0.24 in.)
Commutator Groove Depth	0.5 ~ 0.8 mm (0.020 ~ 0.031 in.)	0.2 mm (0.008 in.)
Commutator Diameter	28 mm (1.102 in.)	27 mm (1.06 in.)
Commutator Runout	— — —	0.4 mm (0.016 in.)

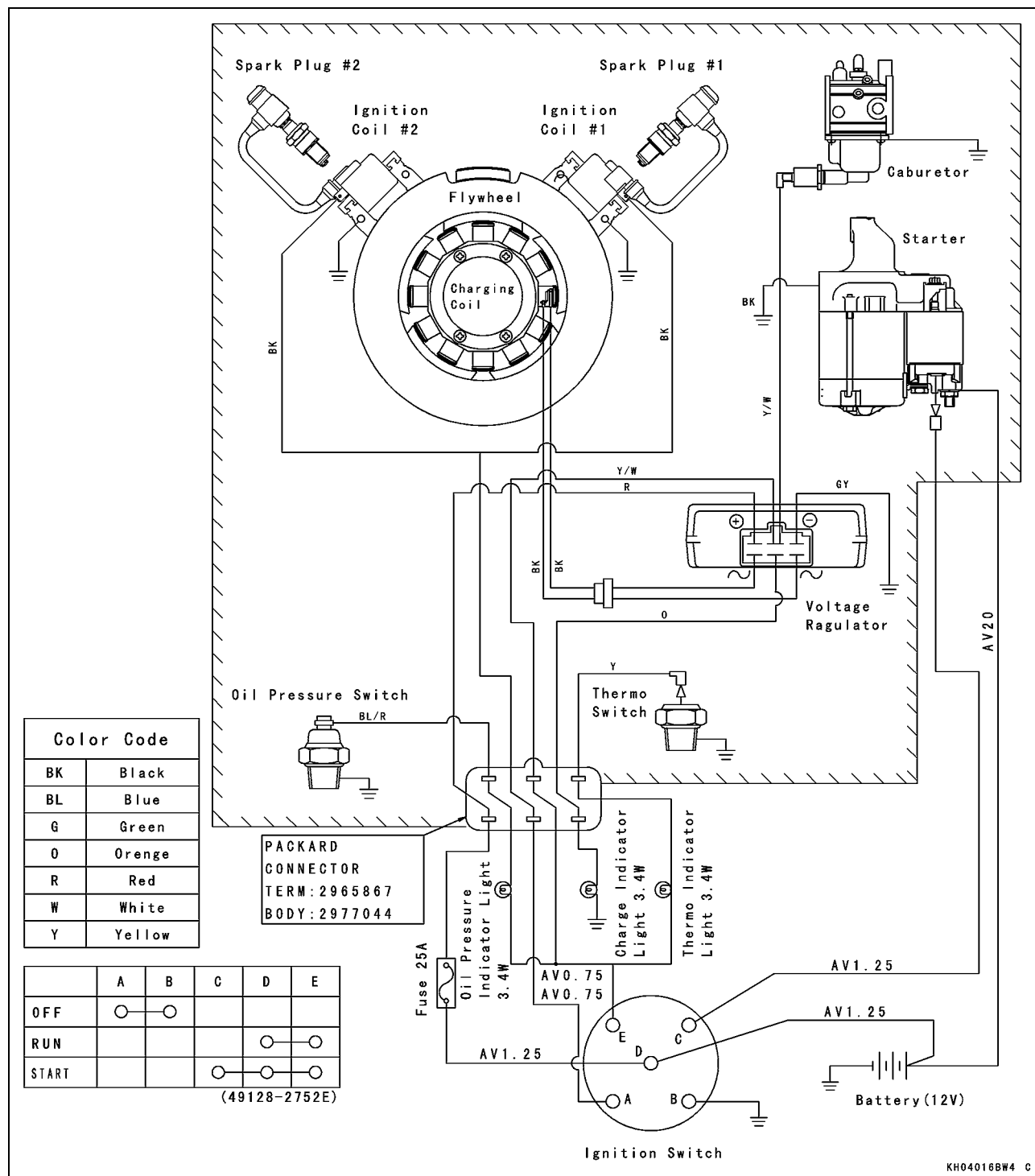
Special Tool

Hand Tester:
57001-1394



8-6 ELECTRICAL SYSTEM

Wiring Diagram



KH04016BW4 C

NOTE

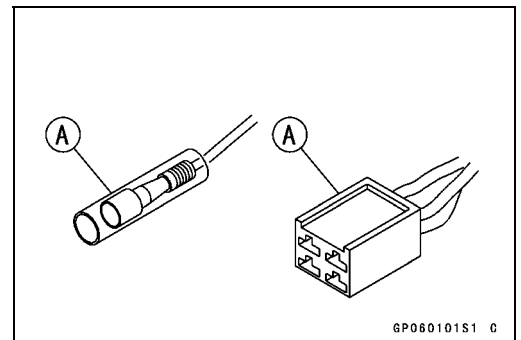
○Portion surrounded by shows KHI procurement parts.

Precautions

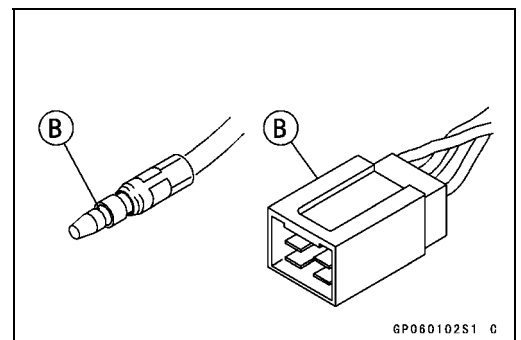
There are a number of important precautions that are musts when servicing electrical systems. Learn and observe all the rules below.

- Do not reverse the battery lead connections. This will burn out the diodes in the electrical parts.
- Always check battery condition before condemning other parts of an electrical system. A fully charged battery is a must for conducting accurate electrical system tests.
- The electrical parts should never be struck sharply, as with a hammer, or allowed to fall on a hard surface. Such a shock to the parts can damage them.
- To prevent damage to electrical parts, do not disconnect the battery leads or any other electrical connections when the engine switch is on, or while the engine is running.
- Because of the large amount of current, never keep the engine switch turned to the start position when the starter motor will not turn over, or the current may burn out the starter motor windings.
- Take care not to short the leads that the directly connected to the battery positive (+) terminal to the chassis ground.
- Troubles may involve one or in some cases all items. Never replace a defective part without determining what CAUSED the failure. If the failure was brought on by some other item or items, they too must be repaired or replaced, or the replacement part will soon fail again.
- Make sure all connectors in the circuit are clean and tight, and examine wires for signs of burning, fraying, etc. Poor wires and bad connections will affect electrical system operation.
- Measure coil and winding resistance when the part is cold (at room temperature).
- Electrical Connectors:

Female Connectors [A]



Male Connectors [B]



8-8 ELECTRICAL SYSTEM

Charging System

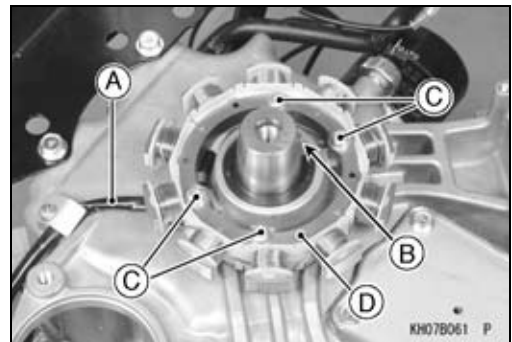
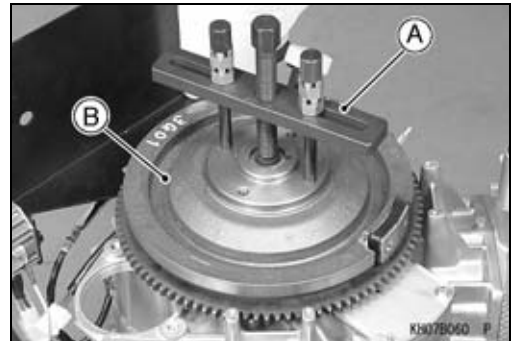
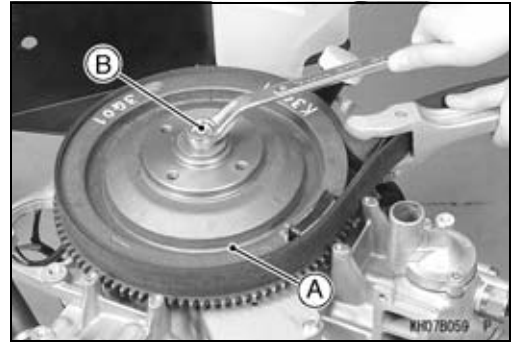
Flywheel, Stator Coil Removal

- Remove:
 - Radiator (see Radiator Removal in the Cooling System chapter)
 - Cooling Fan (see Cooling Fan Removal in the Cooling System chapter)
 - Starter Motor (see Starter Motor Removal in this chapter)
 - Ignition Coils (see Ignition Coil Removal in this chapter)
 - Cooling Fan Extension
- Hold the flywheel [A] with a suitable tools, remove the flywheel bolt [B].
- Using a suitable flywheel puller [A], remove the flywheel [B].

NOTE

○If a flywheel puller is not available, screw the flywheel bolt and tap sharply and squarely on the bolt end to break the flywheel loose. Flywheel will loose.

- Note the stator coil output leads [A] position for reinstalling the stator coil.
- Remove:
 - Woodruff Key [B]
 - Stator Coil Screws [C]
 - Stator Coil [D]



Flywheel, Stator Coil Installation

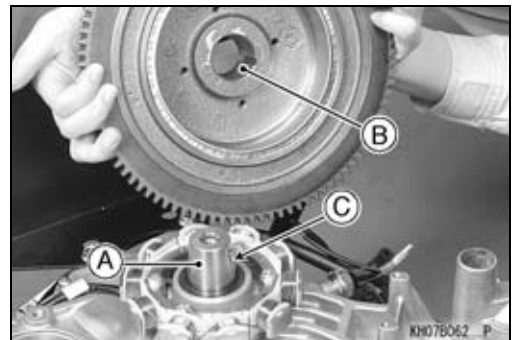
- Apply grease to the female and male starter coil connectors, and connect it.

Grease - Three Bond: TB2585G or Grease No. Rykon premium grease EP#2 general purpose (Green)

Install the stator coil and tighten the screws.

Torque - Stator Coil Screws: 3.4 N·m (0.35 kgf·m, 30 in·lb)

- Using a cleaning fluid, clean off any oil or dirt on the following portions and dry them with a clean cloth.
 - Crankshaft Tapered Portion [A]
 - Flywheel Tapered Portion [B]
- Fit the woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.



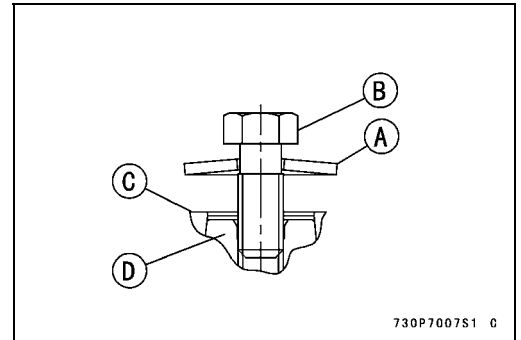
Charging System

- Install the flywheel onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.
- Put the (coned disc spring) washer [A] in the direction as shown and tighten the flywheel bolt [B].

Flywheel [C]

Crankshaft [D]

Torque - Flywheel Bolt: 56 N·m (5.7 kgf·m, 41 ft·lb)



Charging System Operational Inspection

- Check battery condition.

NOTE

○Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.

- Warm up the engine to bring the components up to their normal operating temperatures.
- Measure regulated output voltage at various engine speeds.
- Connect a voltmeter across the battery terminals.
- ★The readings should show nearly battery voltage when the engine speed is low, and as the engine speed rises, the readings should also rise. But they must stay within the specified range.
- ★If the output voltage is much higher than the specification, the regulator is defective, or the regulator leads are loose or open.
- ★If the output voltage does not rise as the engine speed increase, the regulator is defective or the alternator output is insufficient for the loads.

Regulated Output Voltage

Battery Voltage to 15 V DC

Stator Coil Resistance

- Disconnect the stator coil connector.
- Measure the stator coil resistance.
- Connect an ohmmeter between stator pins [C].

Stator Coil Resistance

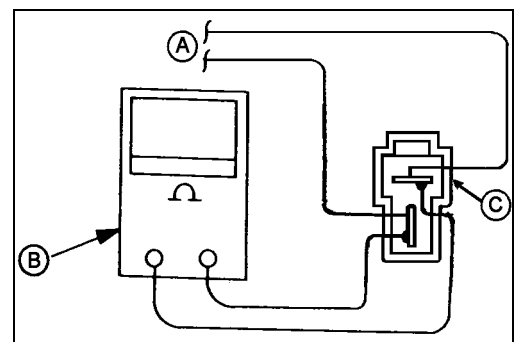
0 ~ 2 Ω

- ★If the meter does not read as specified, replace the alternator stator.
- ★If the coil has normal resistance, but the voltage inspect showed the alternator to be defective; the rotor magnets have probably weakened, and the rotor must be replaced.

To Stator [A]

Ohm Meter [B]

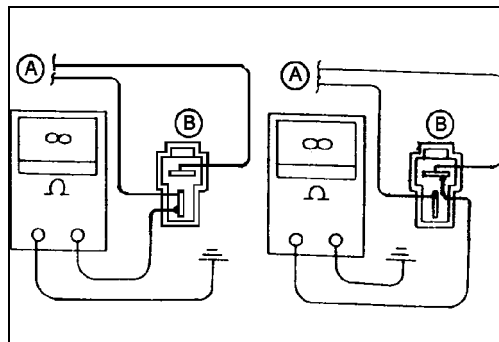
Stator Coil Connector [C]



8-10 ELECTRICAL SYSTEM

Charging System

- Check for continuity between each stator pin and ground. There should be no continuity (infinite ohm).
- ★ If the stator coil fails any of these tests, replace the coil with a new one.
 - To Stator [A]
 - Stator Coil Connector [B]



Unregulated Stator Output

- Disconnect the stator coil connector.
- Connect AC voltmeter to the stator pins.
- Start the engine. Run the engine at the 3 000 rpm speed.
- Voltage reading should be minimum 26 V AC/3 000 rpm.
- ★ If the AC voltage reading is less than the specification replace the stator.

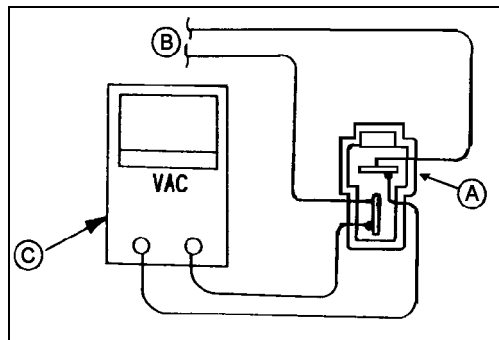
Unregulated Stator Output

26 V AC/3 000 rpm

Stator Coil Connector [A]

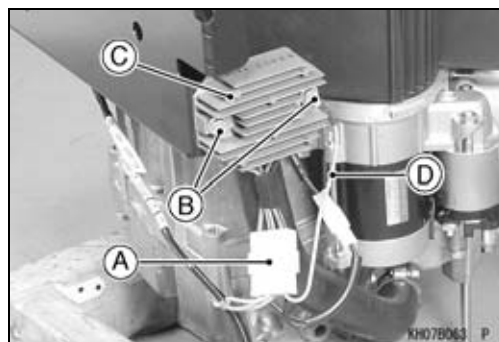
To Stator [B]

AC Voltmeter [C]



Regulator Removal

- Remove:
 - Starter Coil Lead Connector [A]
 - Regulator Bolts [B]
 - Regulator [C]
 - Harness Lead [D]

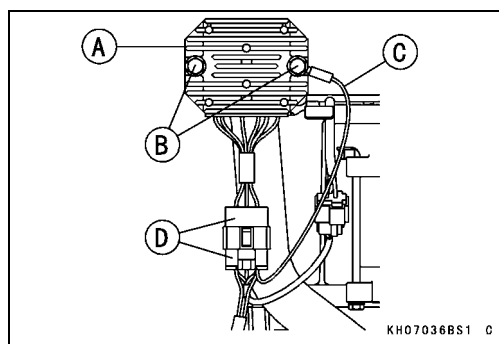


Regulator Installation

- Install the regulator [A] and tighten the bolts [B].
- Harness lead [C] is tighten with the bolt.
- Apply grease to the female and male connectors [D], and connect it.

Torque - Regulator Bolts: 6 N·m (0.6 kgf·m, 53 in·lb)

Grease - Three Bond: TB2585G or Grease No. Rykon premium grease EP#2 general purpose (Green)



Charging System

Regulator Resistance

- Set the hand tester selector switch to the $R \times 100 \Omega$ position.
- **Special Tool - Hand Tester: 57001-1394**
- Connect the test leads to the points shown on the chart and read the resistance.
- ★ If the resistance is not as specified replace the regulator.

NOTE

○ This voltage regulator is an open type one.

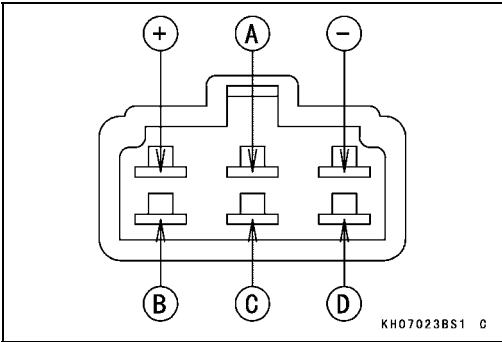
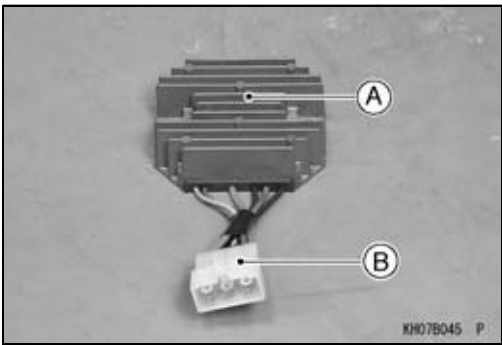
Regulator [A]
6P Connector [B]

Range: $R \times 100 \Omega$

	-	+	A	-	B	C	D
+							
+	-		12 k Ω ~ 36 k Ω	∞	0.47 k Ω ~ 1.43 k Ω	∞	
A	∞	-		∞	∞	∞	0.45 k Ω ~ 1.37 k Ω
-		∞	3.5 k Ω ~ 10.5 k Ω	-	∞	∞	∞
B	∞		9.5 k Ω ~ 28.5 k Ω	∞	-	∞	∞
C	∞	∞	∞	∞	∞	-	∞
D	∞			∞	∞	∞	-

NOTE

○ Resistance value may vary with an individual meter.



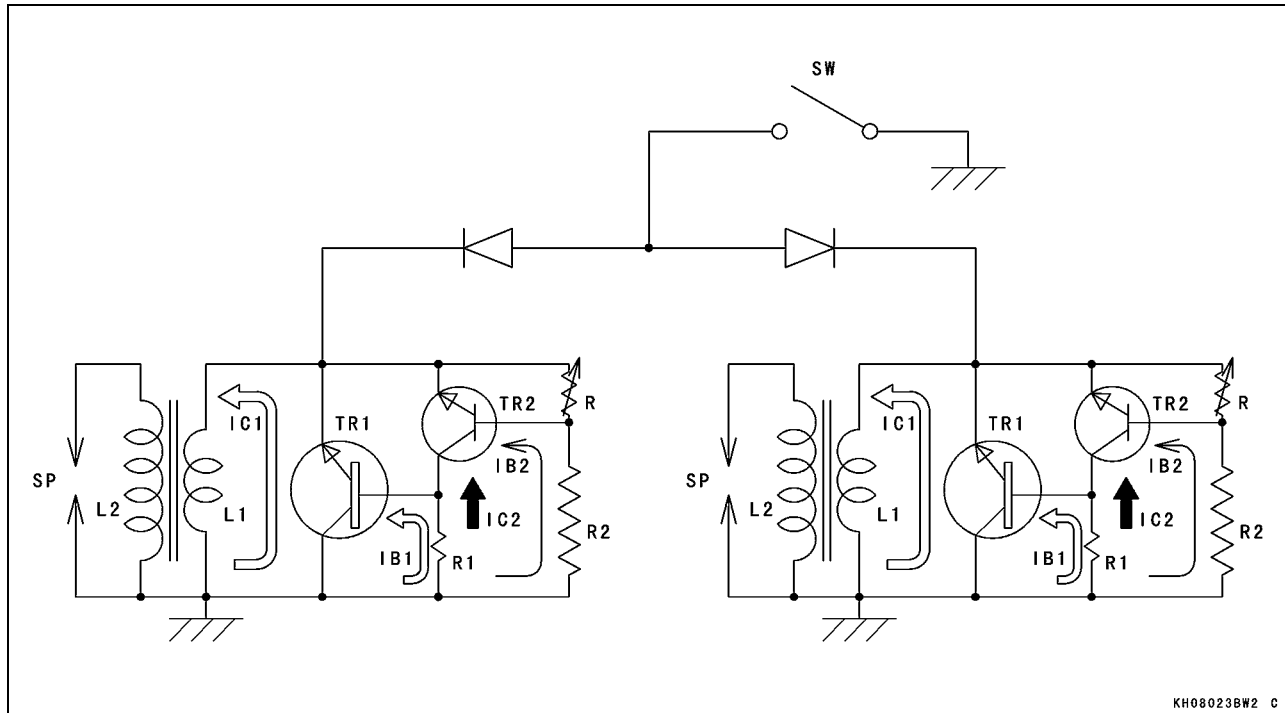
8-12 ELECTRICAL SYSTEM

Ignition System

The ignition system is the voltage-interruption method which interrupts the primary current conducted by turning the flywheel and generates the high secondary voltage, and therefore this system is basically the same as the traditional system of mechanical contact parts.

As compared with the traditional mechanical parts and condenser, a transistor in the igniter serves as an interrupter of the current. This system is called TIC (Transistor Ignition Control).

Electrical Circuit



L1: Ignition Coil (Primary)

L2: Ignition Coil (Secondary)

R1: Resistance to regulate the base current of TR1

R2: Resistance to regulate the base current of TR2

SP: Spark Plug

SW: Stop Switch

TR1: Power Transistor

TR2: Drive Transistor

Ignition Theory of Operation

1. The revolution of the flywheel generates a voltage in the L1, causing a base current IB1 to flow from TR1. Then, current IC1 that is amplified by TR1 flows to form the primary circuit.
2. The flywheel revolves further and the voltage that is generated in the L1 increases. When the flywheel reaches the position of the ignition timing, the generated voltage overcomes the resistance R2, causing a base current IB2 to flow to transistor TR2. At that instant, the current changes into collector current IC2, which is amplified by transistor TR2.
3. In the meantime, because the internal resistance of TR2 is considerably lower than TR1, IB1 that was flowing through TR1 until then will turn into IC2, thus changing its direction to flow via TR2.
4. In this manner, base current IB1 of TR1 will not momentarily flow, thus causing large current IC1 that was flowing in the L1 until then to stop suddenly.
5. Due to the sudden change in the current in the primary circuit, a high voltage is generated in secondary side L2, causing spark plug to spark.

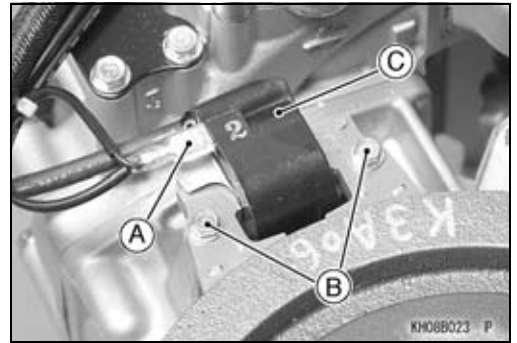
Handling and Maintenance Care

1. Do not bring the Igniter near fire.
2. Ignition timing is fixed and no necessary for adjusting.
3. In case of spark test, pull the recoil starter grip with all your strength to obtain a required speed of the flywheel for sparking.

Ignition System

Ignition Coil Removal

- Remove:
 - Radiator (see Radiator Removal in the Cooling System chapter)
 - Cooling Fan (see Cooling Fan Removal in the Cooling System chapter)
 - Spark Plug Caps
 - Stop Switch Lead Connector [A]
 - Bolts [B]
 - Ignition Coil [C]



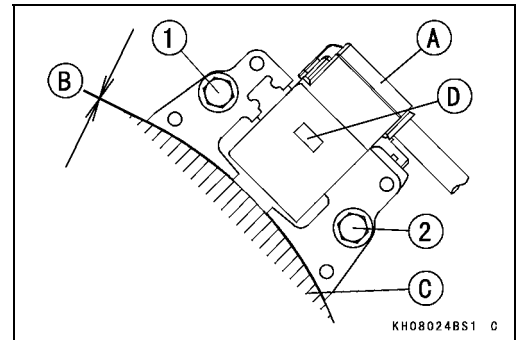
Ignition Coil Installation

- Install ignition coil on crankcase, and tighten bolt (1) first, then tightening bolt (2). While tightening bolts, adjust the air gap [B] between the legs of ignition coil and the fly-wheel [C] to the specified gap value as shown.

NOTE

- The ignition coils are not identical. The ignition coil for #1 cylinder (electric starter side) is identified by "1" on its surface and the other by "2". Install the ignition coils on the cylinders so that the each identical number matches the cylinder number.

Identical Number [D]



Ignition Coil Air Gap

Standard: 0.25 ~ 0.40 mm (0.010 ~ 0.016 in.)

Torque - Ignition Coil Mounting Bolts: 3.4 N·m (0.35 kgf·m, 30 in·lb)

NOTE

- Above procedure must be used to insure proper coil air gap is not too large.

8-14 ELECTRICAL SYSTEM

Ignition System

Ignition Coil Inspection

- Remove the ignition coils (see Ignition Coil Removal in this chapter).
- Measure the primary winding resistance as follows:
 - Set the hand tester to the $R \times 1 \Omega$ range.

Special Tool - Hand Tester: 57001-1394

- Make the measurements shown in the table.

Ignition Coil Primary Winding Resistance

–	+	A	B
A		–	16 ~ 24 Ω
B		∞	–

CAUTION

Use only Tester 57001-1394 with new battery at room temperature for this test. A tester other than the Kawasaki Hand Tester should show different readings.

If a megger or a meter with a large-capacity battery is used, the ignition coil will be damaged.

- Measure the secondary winding resistance as follows:
 - Set the hand tester to the $R \times 1 \text{ k}\Omega$ range.
 - Connect the tester between the iron core [A] and plug cap terminal [C].

Ignition Coil Secondary Winding Resistance

–	+	A	C
A		–	17 ~ 25 $\text{k}\Omega$
C		17 ~ 25 $\text{k}\Omega$	–

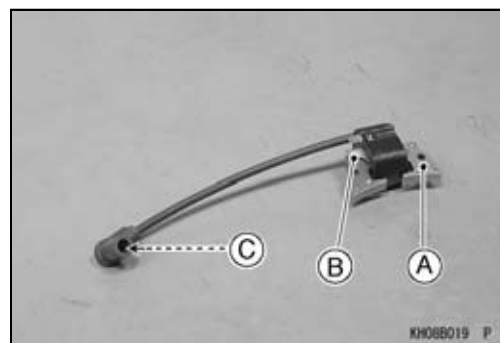
- ★ If the tester dose not read as specified, replace the coil.

Spark Plug Cleaning and Inspection

- Refer to the Spark Plug Cleaning and Inspection in the Periodic Maintenance chapter.

Spark Plug Gap Inspection

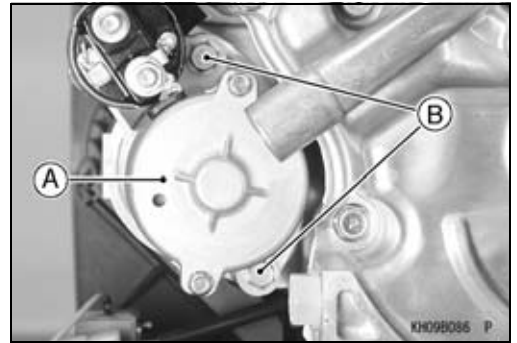
- Refer to the Spark Plug Gap Inspection in the Periodic Maintenance chapter.



Electric Starter System

Starter Motor Removal

- Disconnect the wire.
- Remove the mounting bolts [B] and pull the starter motor [A] from the engine with the switch lead attached.



Starter Motor Installation

- Clean the starter motor and engine mounting flanges to ensure good electrical contact and tighten the mounting bolts.

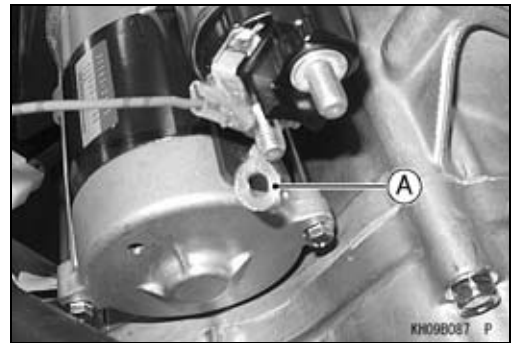
Torque - Starter Motor Mounting Bolts: 15 N·m (1.5 kgf·m, 11 ft·lb)

Starter Solenoid and Circuit Test

NOTE

○ Before this test, be sure the battery is fully charged.

- Disconnect the starter motor lead [A] from the solenoid terminal as shown and keep the lead away from the solenoid terminal.



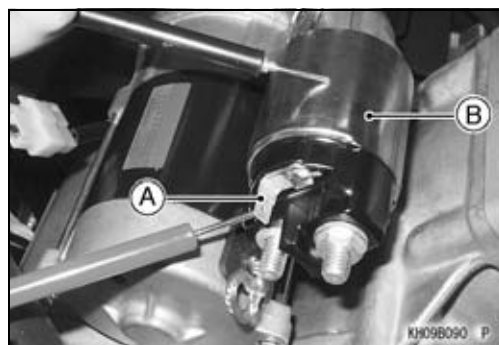
- Measure the continuity of the solenoid when activated.
- Set the hand tester selector switch to the $R \times 1 \Omega$ position and connect the leads across the large terminals [A] as shown.
- Turn the engine switch to the START (II) position and read the tester.
- ★ If the solenoid does not click or if the tester reads more than 0Ω the solenoid is faulty. Replace it.
- ★ If the solenoid makes a single clicking sound, the tester reads 0Ω and the rest of the starter circuit is good.
- ★ If solenoid clicks once but the tester does not read 0Ω , the solenoid is faulty. Replace it.
- ★ If the solenoid does not click at all, proceed with the following.
- Disconnect the switch lead [A] shown.



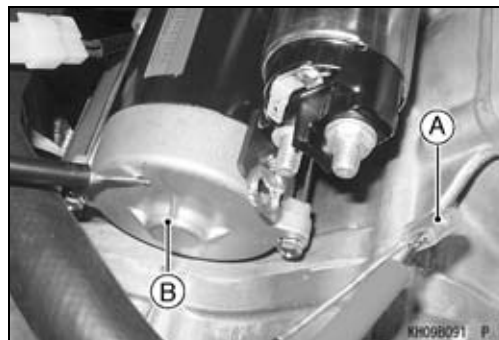
8-16 ELECTRICAL SYSTEM

Electric Starter System

- Set the hand tester to the $R \times 1 \Omega$ position and connect the leads as shown.
Switch Terminal [A]
To Ground [B]
- ★ If the tester does not read close to 0Ω , the solenoid is faulty. Replace it.
- ★ If the tester reads close to 0Ω , the solenoid may be good.



- Check the voltage to the solenoid from the engine switch.
- Set the hand tester selector switch to the 25 V DC position and connect it as shown.
Switch Lead Connector [A]
To Ground [B]
- Turn the engine switch to the START (II) position and read the tester.
- ★ If the tester reads battery voltage, the circuit is good.
- ★ If the tester reads much less than battery voltage or no voltage at all, either the wiring or the engine switch is bad. Check the engine switch or the wiring for damaged or broken wires and replace as required.



Starter Motor Test

NOTE

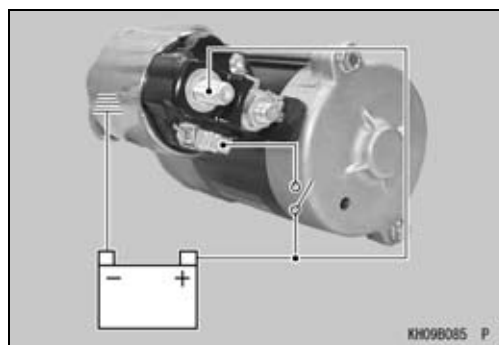
○ Always inspect the Starter Solenoid and Circuit Test section before starting following procedures.

- Remove the starter motor.
- Hold the starter motor with a vice.

CAUTION

Be careful not to deform the starter motor body when holding it with a vice.

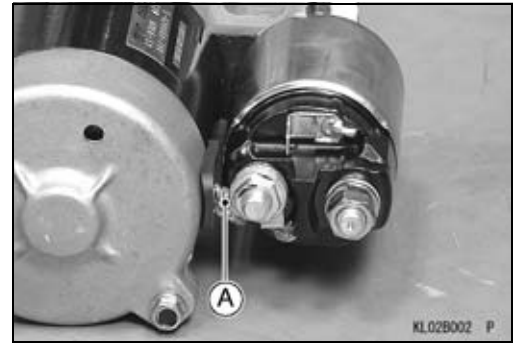
- Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal on the solenoid as shown.
- Connect the second jumper cable to the battery (–) terminal.
- Touch the switch intermittently for one second intervals.
- The pinion should rotate freely.
- ★ If the pinion does not rotate freely, replace the starter motor.



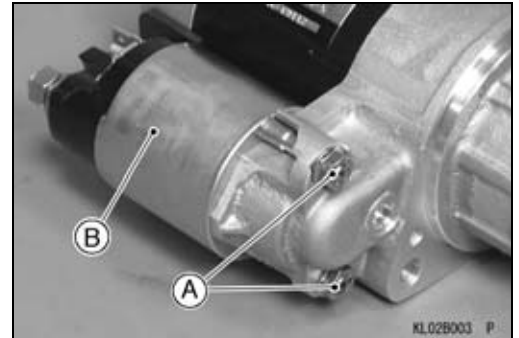
Electric Starter System

Starter Motor Disassembly

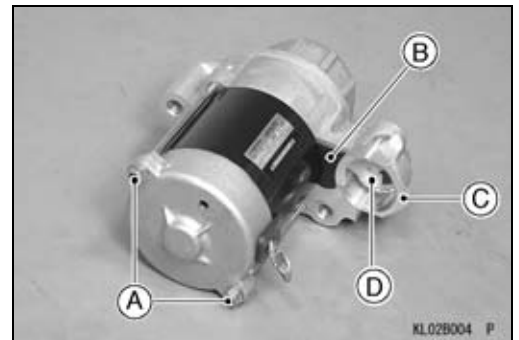
- Remove the lead [A] from the starter motor to the solenoid.



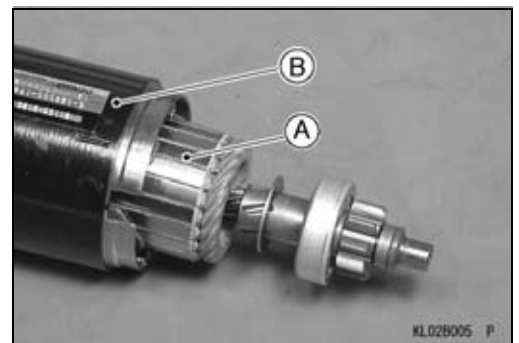
- Unscrew the mounting nuts [A] and remove the solenoid assembly [B].



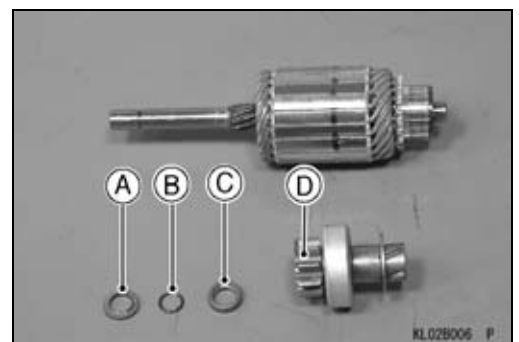
- Remove the through bolts [A].
- Pull the rubber insert [B] from the starter motor and remove the pinion gear cover [C] as shown.
- Slip the actuating arm [D] from the pinion gear.



- Pull the armature [A] from the yoke [B].



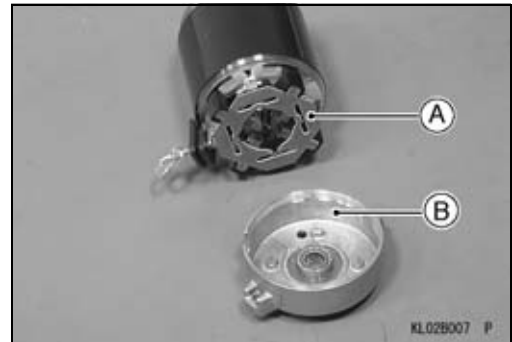
- Separate the front stopper [A] and rear stopper [C] each other and remove the front stopper to the left side.
- Push the rear stopper down the shaft and remove the snap ring [B].
- Pull the rear stopper and pinion gear [D] from the armature shaft.



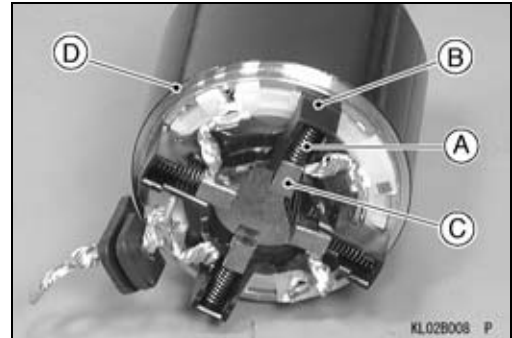
8-18 ELECTRICAL SYSTEM

Electric Starter System

- Gently pull the end cover [B] from the yoke and remove the insulator [A].

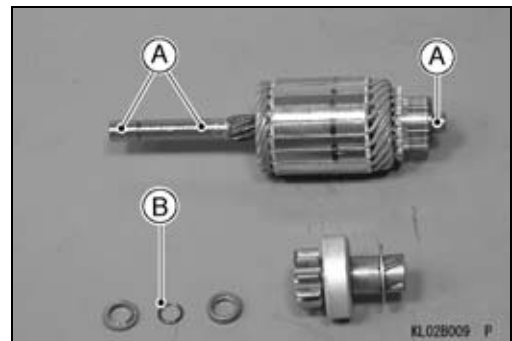


- Using a needle nose pliers, remove the brush springs [A] from the brush holder [B].
- Separate the brushes [C] from the holder and remove the holder from the yoke [D].

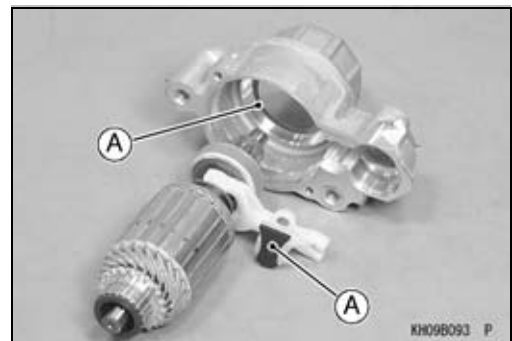


Starter Motor Assembly Notes

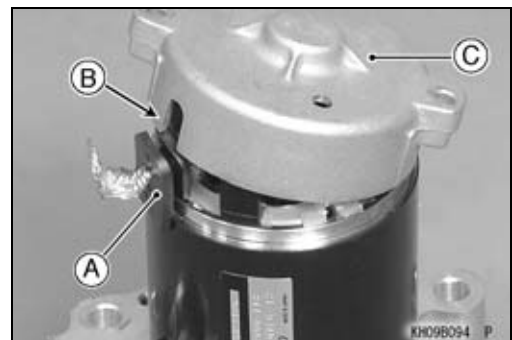
- Apply a small amount of grease to the armature shaft [A] as shown.
- Do not reuse the snap ring [B]. Replace it with a new one.



- Inspect the boots [A] for visible damage.
- ★ If it is damaged, replace it.

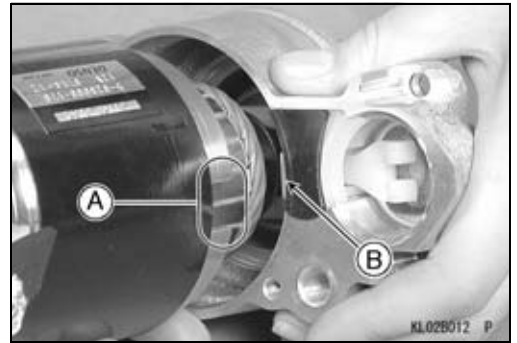


- Fit the notch [A] in the (-) lead grommet onto the projection [B] on the end cover [C].

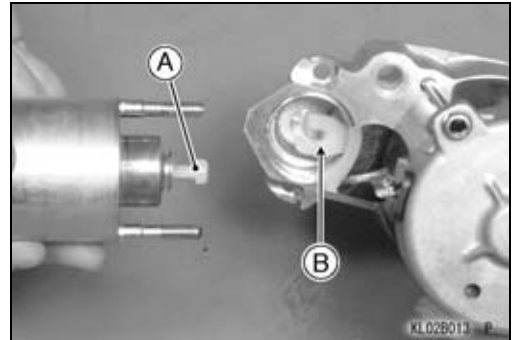


Electric Starter System

- Grease the pinion gear fork fingers.
- Set the pinion gear fork so that the fingers fit into the groove in the gear.
- Fit the notch [A] in the yoke onto the projection [B] on the pinion gear fork.



- Engage the hook on the starter solenoid with the hook [A] on the pinion gear fork [B].



Starter Motor Brush Inspection

- Measure the overall length of each brush [A].
- ★ If the brushes are shorter than the service limit, replace them.

Brush Length

Standard: 10 mm (0.394 in.)

Service Limit: 6.0 mm (0.24 in.)

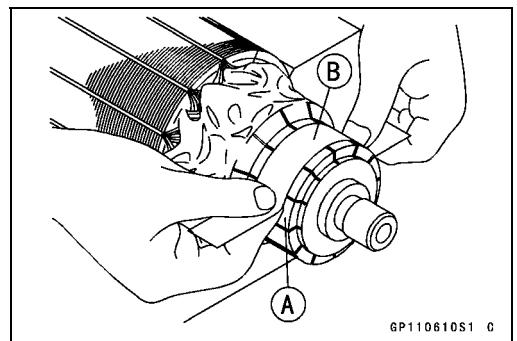


Brush Spring Inspection

- Inspect the brush springs for pitting, cracks, rusting and burrs. Replace the spring if necessary.
- Inspect the springs for weakened conditions and distortion. Replace the springs if necessary.
- ★ If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them.

Armature Inspection

- Inspect the surface of the commutator [A].
- ★ If it is scratched or dirty, polish it with a piece of very fine emery cloth [B], and clean out the grooves.



8-20 ELECTRICAL SYSTEM

Electric Starter System

- Measure the depth of the grooves between the commutator segments.
- ★ If the grooves are shallower than the specified limit, undercut the insulating material to the standard depth 0.5 ~ 0.8 mm (0.012 ~ 0.031 in.) using a thin file.
- ★ If the grooves are only dirty, clean them carefully.

Commutator Groove Depth

Standard: 0.5 ~ 0.8 mm (0.020 ~ 0.031 in.)

Service Limit: 0.2 mm (0.008 in.)

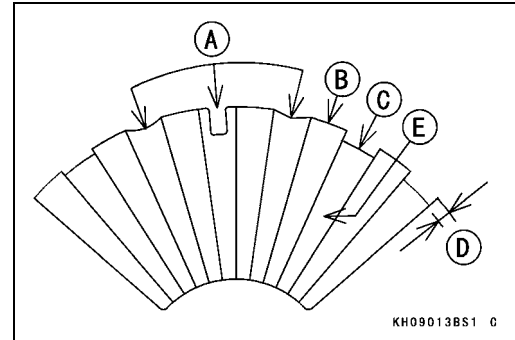
Bad [A]

Segment [B]

Good [C]

0.2 mm (0.008 in.) limit [D]

Mica [E]

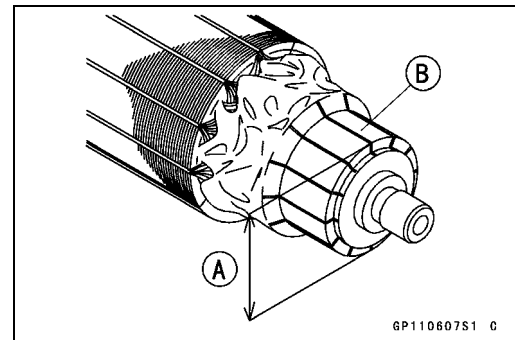


- Measure the commutator [B] outside diameter [A] at several points.
- ★ If the diameter is less than the service limit, replace the armature with a new one.

Commutator Outside Diameter

Standard: 28 mm (1.102 in.)

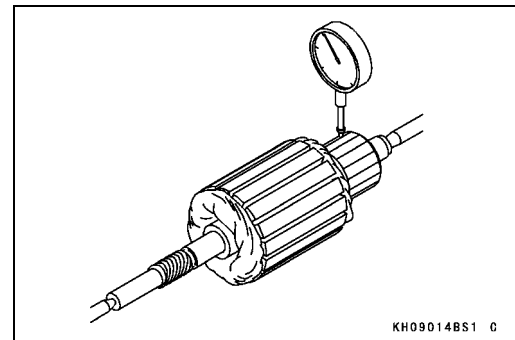
Service Limit: 27 mm (1.06 in.)



- Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.
- Rotate the armature slowly and read the commutator runout.
- ★ If runout is more than the service limit, replace the armature with a new one.

Commutator Runout

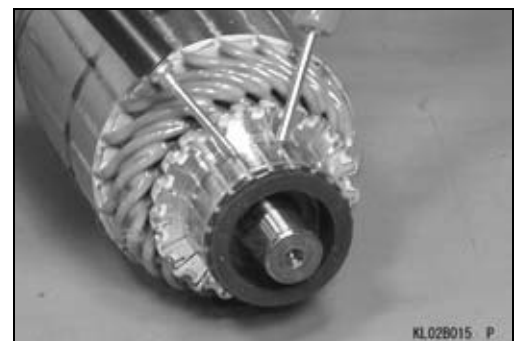
Service Limit: 0.4 mm (0.016 in.)



- Measure the armature winding resistance.
- Set the multimeter selector switch to the $R \times 1 \Omega$ position and check the resistance between each segment and all the others.
- ★ If the resistance is too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

Armature Winding Resistance

Close ~ 0 Ω



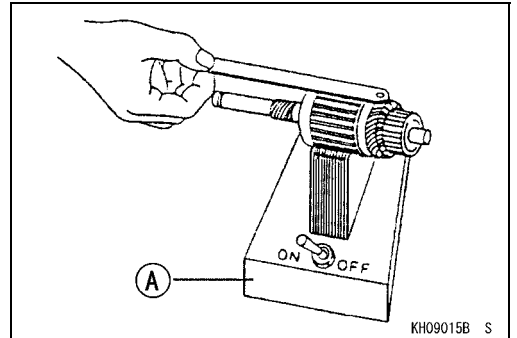
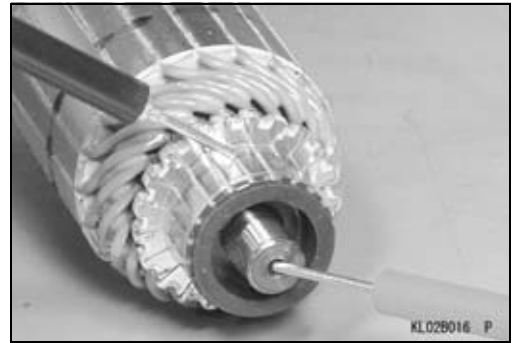
Electric Starter System

- Set the multimeter selector switch to the $R \times 1 \text{ k}\Omega$ position and measure the resistance between the commutator and the armature shaft.
- ★ If the resistance is less than infinite, the armature is shorted.

Commutator to Shaft Resistance

(∞)

- Test the armature winding for shorts.
- Place the armature on a growler [A].
- Hold a thin metal strip (e.g., hack saw blade) on top of the armature.
- Turn on the growler and rotate the armature one complete turn.
- ★ If the metal strip vibrates, the windings are internally shorted to each other and the starter motor must be replaced.



Yoke Assembly Inspection

- Set the multimeter selector switch to the $R \times 1 \text{ k}\Omega$ position and measure the resistance between the positive brushes [A] and stator motor yoke.
- ★ If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

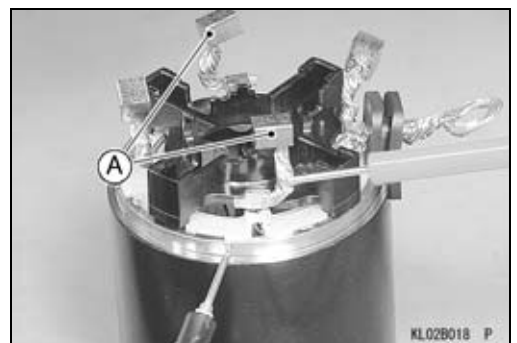
Positive Brush to Ground Resistance

(∞)

- Set the multimeter selector switch to the $R \times 1 \Omega$ position and measure the resistance between the negative brushes [A] and starter motor yoke.
- ★ If the meter does not read close $\sim 0 \Omega$, the yoke assembly is faulty. Replace it.

Negative Brush to Ground Resistance

Close $\sim 0 \Omega$



Pinion Clutch Inspection

- Remove the pinion clutch.
- Turn the pinion gear by hand. The pinion gear should turn counterclockwise freely, but should not turn clockwise.
- ★ If the pinion clutch does not operate as it should, or if it makes noise, replace the pinion clutch.



Troubleshooting

Table of Contents

Engine Troubleshooting Guide	9-2
Starter Motor Troubleshooting Guide	9-7

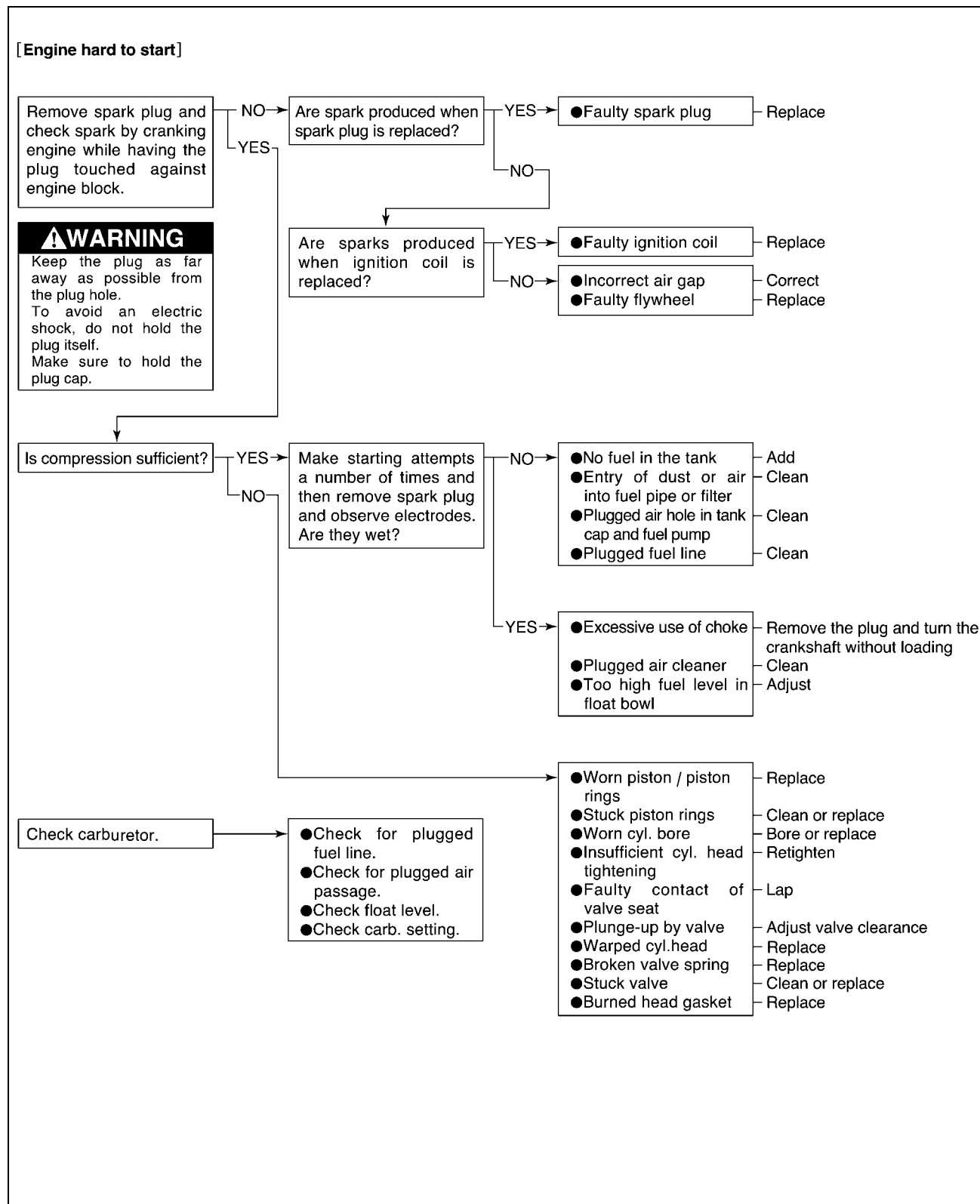
9-2 TROUBLESHOOTING

Engine Troubleshooting Guide

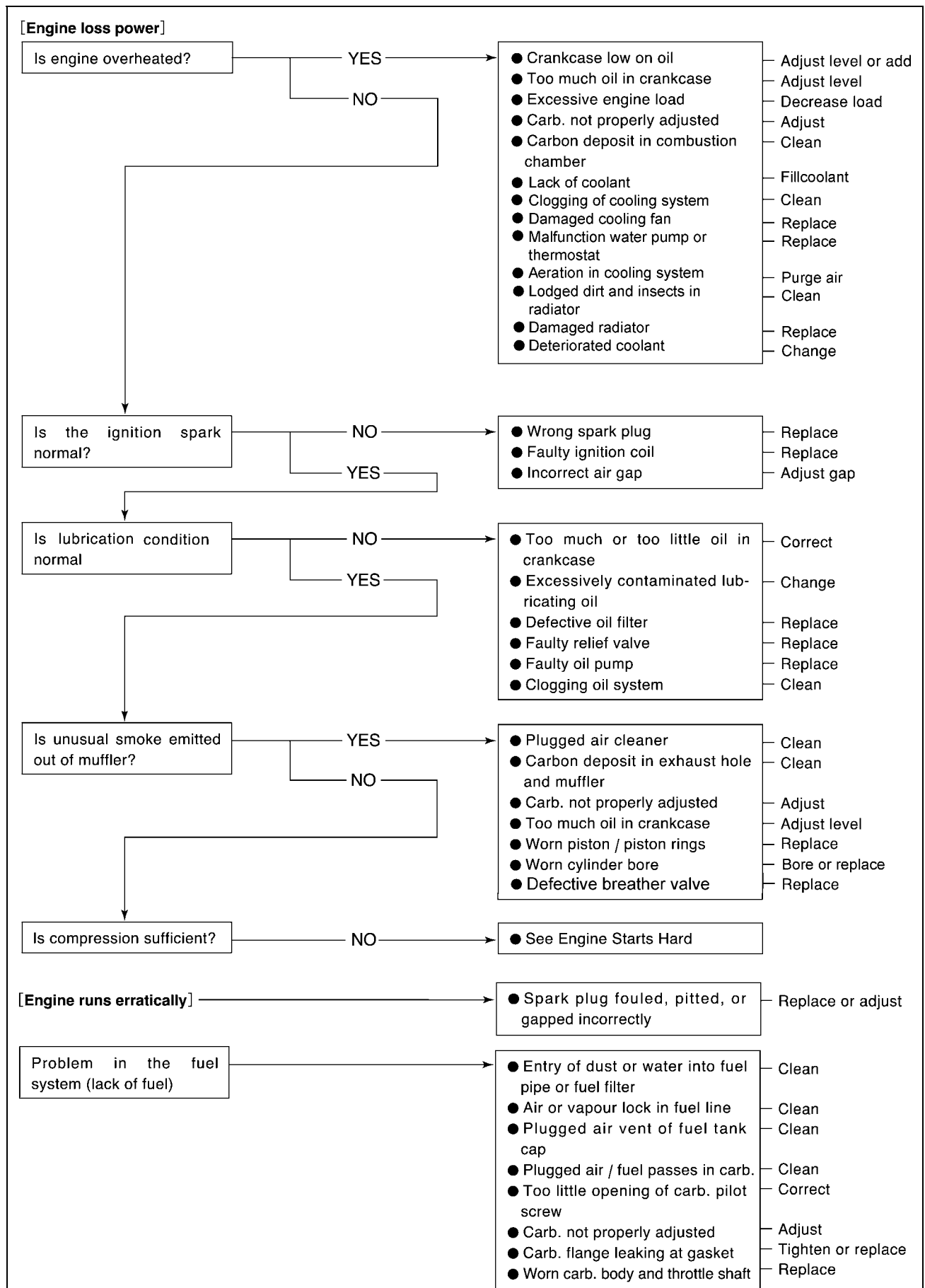
If the engine malfunctions, check if the way the engine is used is correct. If engine malfunctions even if engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

Do not unnecessarily disassemble carburetor, magneto or engine unless it has been found to be the cause of malfunctioning.



Engine Troubleshooting Guide

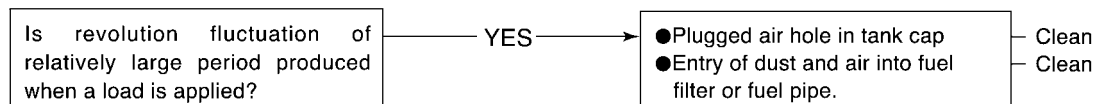


9-4 TROUBLESHOOTING

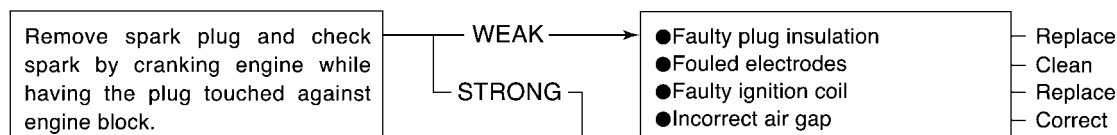
Engine Troubleshooting Guide



[Engine malfunctions at high speed]

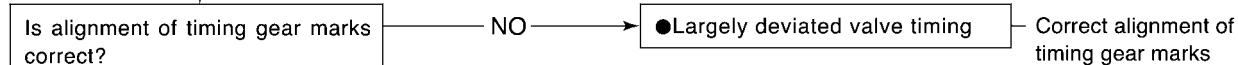
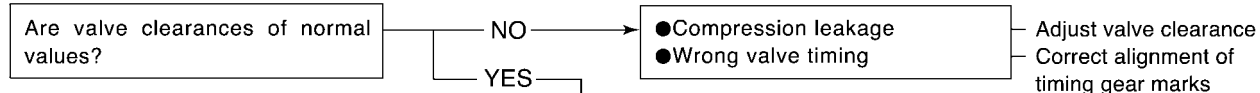
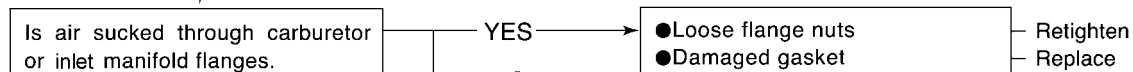
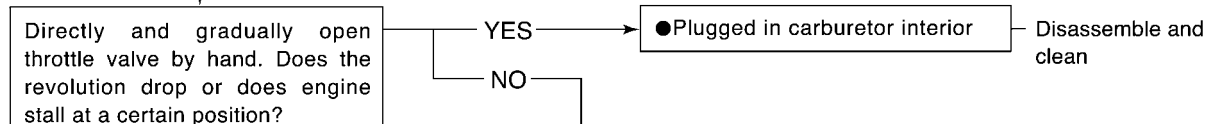
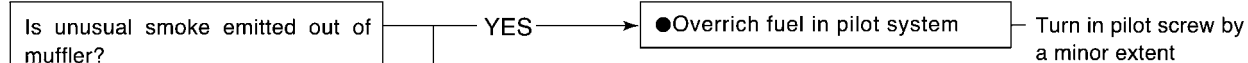


[Engine malfunctions at low speed]



⚠ WARNING

Keep the plug as far away as possible from the plug hole. To avoid an electric shock, do not hold the plug itself. Make sure to hold the plug cap.



Engine Troubleshooting Guide

[Fuel consumption is excessive]

Is compression sufficient?

YES

NO

- High fuel level in carb. float chamber (including overflow)
- High idling R.P.M
- Choke partially closed
- Excessively backed off carburetor pilot screw

Adjust

Adjust

Open choke

Adjust

- Worn piston / piston rings
- Stuck piston
- Worn cylinder bore
- Insufficient cyl. head tightness
- Faulty valve seat contact
- Plunge-up of valve
- Wrong valve timing
- Broken valve spring
- Stuck valve

Replace

Clean or replace

Bore or replace

Retighten

Lap

Adjust valve clearance

Adjust

Replace

Clean or replace

[Oil consumption is excessive]

Is compression sufficient?

YES

NO

- Plugged oil ring groove
- High oil level
- Worn valve stems and valve guide
- Oil leakage along governor shaft
- Oil leakage from oil seal
- Oil leakage from mounting surface
- Oil leakage from drain plug
- Clogged breather valve
- Drain-back hole in breather chamber plugged
- Incorrect oil viscosity

Clean

Adjust

Replace

Replace

Replace

Replace gasket

Retighten or replace gasket

Clean

Clean

Correct

- Worn piston rings
- Stuck piston rings
- Worn cylinder bore
- Broken piston ring

Replace

Clean or replace

Bore or replace

Replace

[Engine backfires]

- Loose carb. or inlet manifold
- Loose cyl. head or leaking head gasket
- Burned or sticking intake valve
- Faulty ignition coil
- Carb. not properly adjusted

Tighten

Tighten

Replace

Replace

Adjust

[Engine knocks]

- Stale fuel
- Excessive carbon deposit in engine
- Excessive engine load
- Engine overheating
- Faulty ignition coil

Change

Clean

Adjust

See engine loss power

Replace

9-6 TROUBLESHOOTING

Engine Troubleshooting Guide

<p>[Coolant leakage]</p>	<ul style="list-style-type: none">● Deleterious radiator hose● Mechanical failure of radiator● Loose cylinder head● Cracked or porous casting● Loose stud bolts and cap screw● Engine overheating● Damaged water pump sealing● Improperly installed gasket● Multifunction radiator cap	<ul style="list-style-type: none">— Replace— Repair or Replace— Tighten— Replace— Repair— See engine loss power— Replace— Correct or Replace— Replace
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Starter Motor Troubleshooting Guide

1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn engine switch to "START" position and check condition.

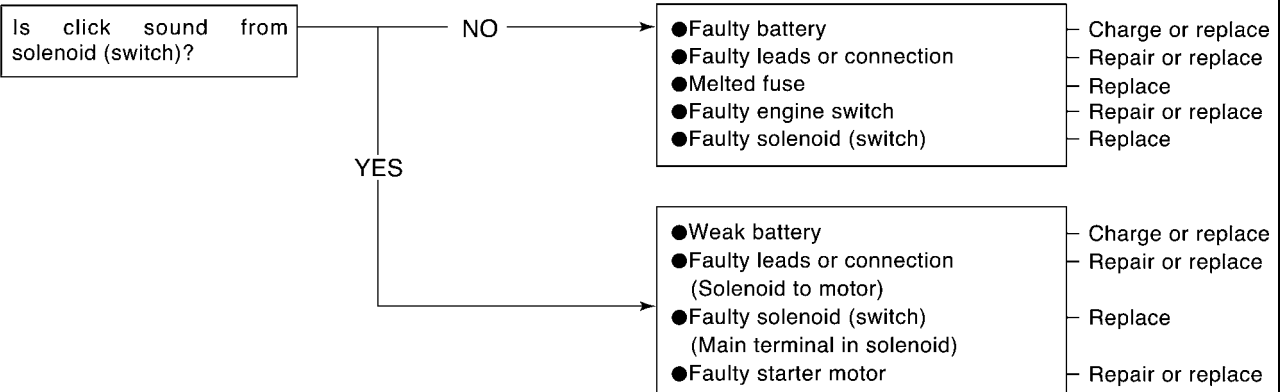
⚠ WARNING

Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

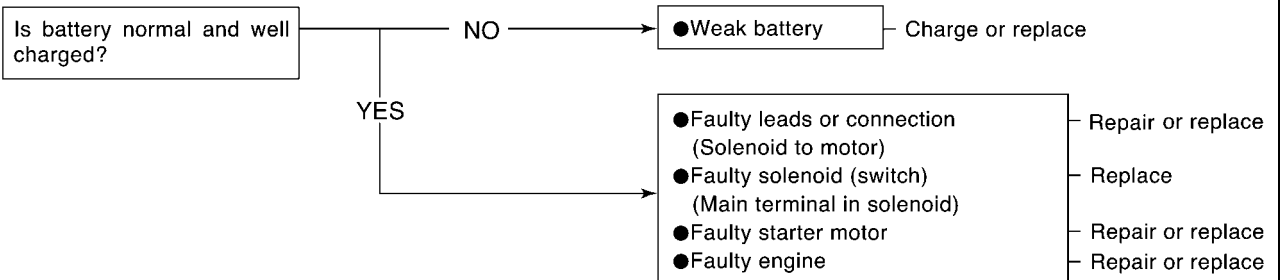
CAUTION

If starter does not stop by engine switch "OFF", disconnect negative (–) lead from battery as soon as possible.

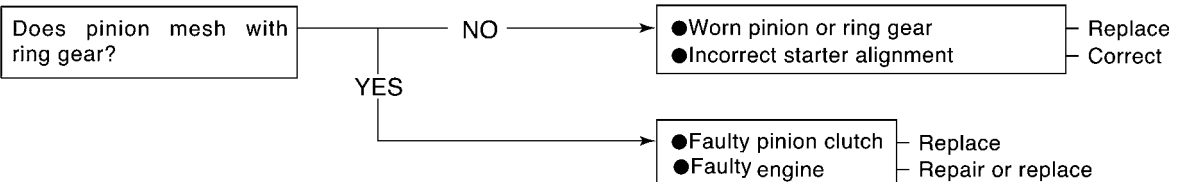
[STARTER DOES NOT ROTATE]



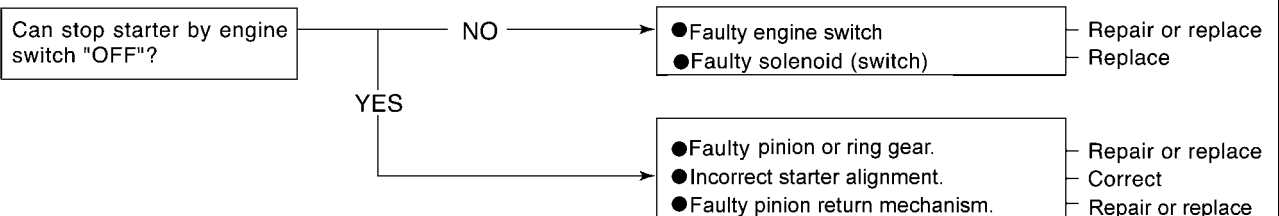
[STARTER ROTATES BUT SLOW]



[STARTER ROTATES BUT CAN NOT CRANK ENGINE]



[STARTER DOES NOT STOP IN ENGINE SWITCH "OFF"]





KAWASAKI HEAVY INDUSTRIES, LTD.
Consumer Products & Machinery Company

Part No.99924-2065-01

Printed in Japan