Kawasaki

FJ400D

4-stroke air-cooled 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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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 all live, Kawasaki has incorporated crankcase emission (1) and exhaust emission (2) control systems (EM) in compliance with applicable regulations of the United States Environmental Protection Agency and California Air Resources Board.

1. **Crankcase Emission Control System**

A sealed-type crankcase emission control system is used to eliminate blow-by gases. The blow-by gases are led to the breather chamber through the crankcase. Then, it is led to the air cleaner.

Oil is separated from the gases while passing through the inside of the breather chamber from the crankcase, and then returned back to the bottom of 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 plug
- Magneto or electronic ignition system
- Fuel filter element
- Air cleaner element
- Crankcase
- Cylinder head
- 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

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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) 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.

(3) 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.

(4) 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.

(5) 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.

(6) 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.

(7) 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.

(8) 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).

(9) 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.

(10) Ball Bearing, Needle Bearing
Do not remove a ball bearing or a needle bearing unless it is absolutely necessary. Replace any ball or needle bearings that were removed with new ones. Install bearings with the manufacturer and size marks facing out, applying pressure evenly with a suitable driver to the end of the race that contacts the press fit portion, and press it evenly over the base component.

(11) Oil Seal and Grease Seal
Replace any oil or grease seals that were removed with new ones, as removal generally damages seals.
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.

Before Servicing

(12)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.

(13)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.

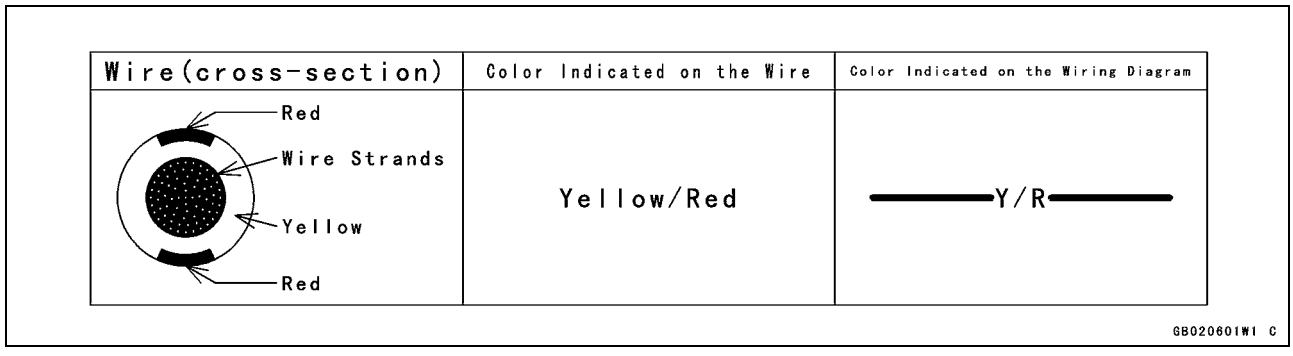
(14)Lubrication

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 (MoS_2) in the assembly of certain engine parts. Always check manufacturer recommendations before using such special lubricants.

(15)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.



(16)Replacement Parts

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

(17)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	

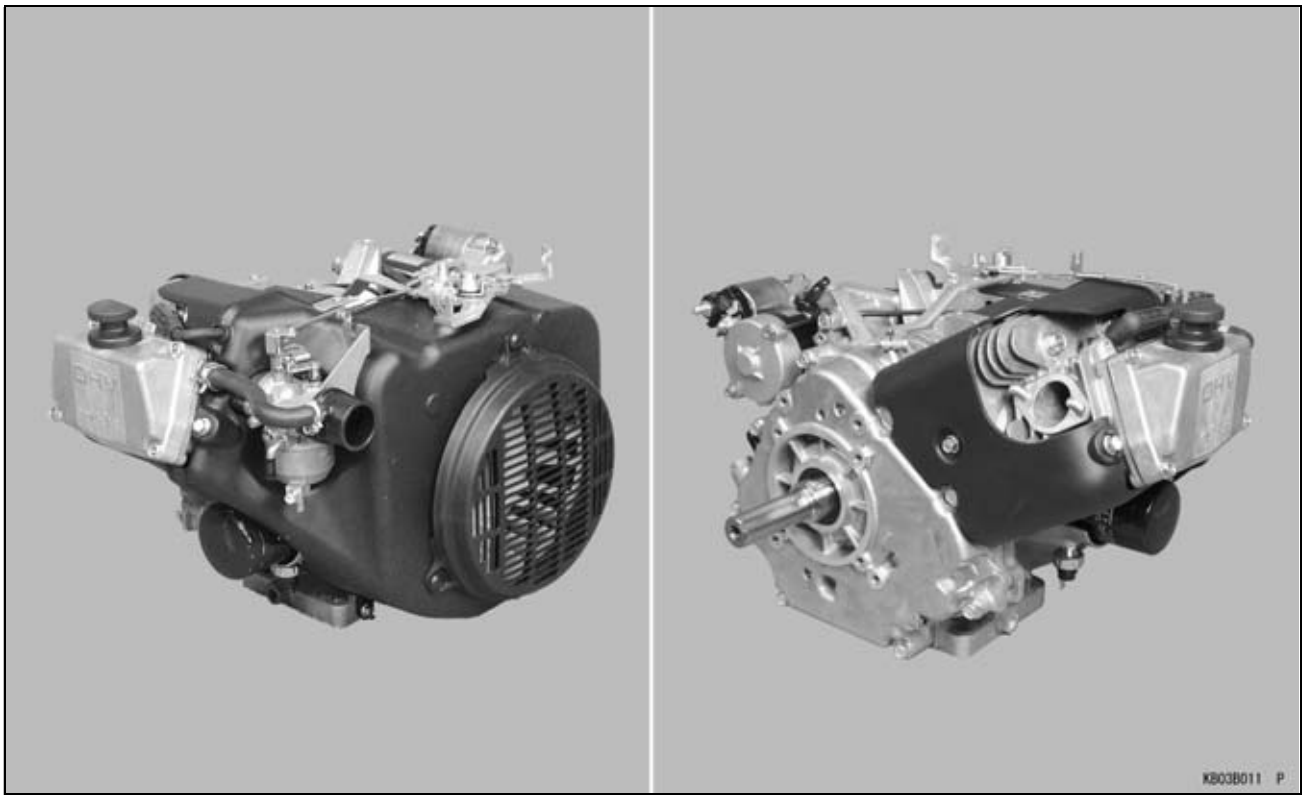
(18)Service Data

Service Data 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.

Model Identification



General Specifications

Item	FJ400D
Type of Engine	Air-cooled, 4-stroke, OHV, single cylinder gasoline engine
Bore × Stroke	82 mm × 76 mm (3.23 in. × 2.99 in.)
Piston Displacement	401 mL (24.5 cu in.)
Direction of Rotation	Counterclockwise facing the PTO shaft
Compression Release	Automatic compression release
Low Idle Speed	1 175 r/min (rpm)
High Idle Speed	4 000 r/min (rpm)
Ignition System	Transistorized-fly wheel magneto
RFI	Per Canada and U.S.A. requirements
Starting System	Shift type electric starter
Spark Plug	NGK BPR5ES
Carburetor	Float type
Fuel Pump	Diaphragm type pulse pump
Air Cleaner	– – –
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
Oil Capacity (when engine is completely dry)	1.3 L (1.37 US qt)
Cooling System	Forced air cooling by fan
Dimensions (L × W × H)	407 mm × 472 mm × 319 mm (16.0 in. × 18.6 in. × 12.6 in.)
Dry Weight	31.5 kg (69.5 lb)

Specifications subject to change without notice.

Periodic Maintenance

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2-2 PERIODIC MAINTENANCE

Periodic Maintenance Chart

To ensure satisfactory operation over an extended period of time, any engine requires normal maintenance regular intervals. The Periodic Maintenance Chart below shows periodic inspection and maintenance items and suitable intervals. The bullet mark (●) designates that the corresponding item should be performed at that interval.

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

OPERATION	INTERVAL						
	Daily	First 8 hr.	Every 25 hr.	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 300 hr.
Check or clean air inlet screen	●						
Check and add engine oil	●						
Check for fuel and oil leakage	●						
Check for loose or lost nuts and screws	●						
Clean dust and dirt from cylinder and cylinder head fins (1)					●		
Tighten nuts and screws					●		
Change engine oil		●			●		
Change oil filter						●	
Clean and re-gap spark plugs					●		
★Check and adjust valve clearance							●
★Clean and lap valve seating surface							●
★Clean combustion chamber							●

(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.

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.
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				
Inlet-Pipe Nuts	5.9	0.60	52 in·lb	
Control Panel Bolts	6.9	0.70	61 in·lb	
Governor Arm Clamp Nut	5.9	0.60	52 in·lb	
Choke Valve Screws	0.9	0.09	7.8 in·lb	L
Throttle Valve Screws	0.9	0.09	7.8 in·lb	L
Pilot Jet (Slow Jet)	0.7	0.07	6.1 in·lb	
Main Jet	2	0.20	17 in·lb	
Drain Screw	2	0.20	17 in·lb	
Float Chamber Mounting Bolt	9.8	1.0	87 in·lb	
Cooling System				
Fan Housing Bolts	5.9	0.60	52 in·lb	
Flywheel Bolt	56	5.7	41	
Engine Top End				
Spark Plug	22	2.2	16	
Cylinder Head Bolts	37	3.8	27	S
Connecting Rod Big End Cap Bolts	5.9	0.60	52 in·lb	O
Valve Clearance Lock Screws	6.9	0.70	61 in·lb	
Rocker Arm Bolts	28	2.9	21	
Lubrication System				
Oil Filter Joint	6.9	0.70	61 in·lb	
Oil Filter	9.8	1.0	87 in·lb	O
Oil Drain Plugs	6.9	0.70	61 in·lb	
Crankcase Cover Plug	6.9	0.70	61 in·lb	
Crankcase Cover Bolts	21.6	2.2	16	S
Cylinder Head Bolts	37	3.8	27	S
Oil Line Plugs	3.9	0.40	35 in·lb	L
Oil Pressure Switch	9.8	1.0	87 in·lb	SS
Camshaft/Crankshaft				
Valve Clearance Lock Screws	6.9	0.70	61 in·lb	
Rocker Arm Bolts	28	2.9	21	
Crankcase Cover Bolts	21.6	2.2	16	S
Connecting Rod Big End Cap Bolts	5.9	0.60	52 in·lb	O
Breather Valve Screw	3.4	0.35	30 in·lb	
Electrical System				
Flywheel Bolt	56	5.7	41	
Stator Coil Screws	3.4	0.35	30 in·lb	

Torque and Locking Agent

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Ignition Coil Bolts	5.9	0.60	52 in·lb	
Spark Plug	22	2.2	16	
Starter Motor Mounting Bolts	20	2.0	15	

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 dia. (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

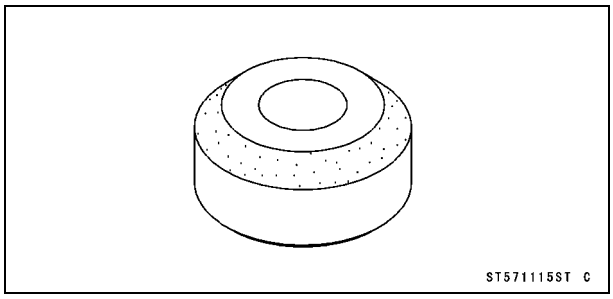
Specifications

Item	Standard
Fuel System	
Idle Speed: (1)	
Low Idle Speed	1 125 ±75 r/min (rpm)
High Idle Speed	3 750 ±50 r/min (rpm)
Air Cleaner:	
Type	– – –
Cleaner	– – –
Engine Top End	
Valve Clearance:	
Inlet, Exhaust	0.10 ~ 0.15 mm (0.0039 ~ 0.0059 in.)
Valve Seating Surface Angle:	
Inlet, Exhaust	45°
Valve Seating Surface Width:	
Inlet	1.1 ~ 1.7 mm (0.043 ~ 0.070 in.)
Exhaust	1.0 ~ 1.5 mm (0.039 ~ 0.059 in.)
Lubrication System	
Engine Oil:	
Type	SF, SG, SH or SJ class
Viscosity	SAE 40, SAE 30, SAE 10W-30/SAE 10W-40, or SAE 5W-20
Capacity	1.1 L (1.16 US qt) (When filter is not removed)
	1.3 L (1.37 US qt) (When filter is removed)
Level	Operating range (grid area) on dipstick
Electrical System	
Spark Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

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

Special Tools

Valve Seat Cutter, 45° - ϕ32:
57001-1115



Valve Seat Cutter, 45° - ϕ35:
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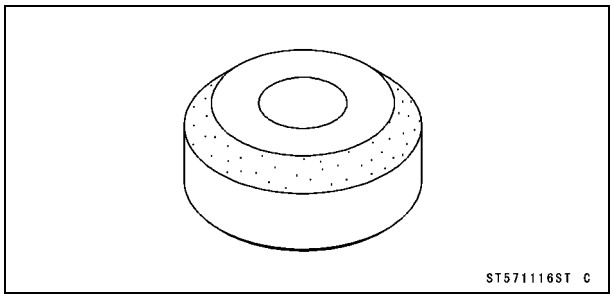
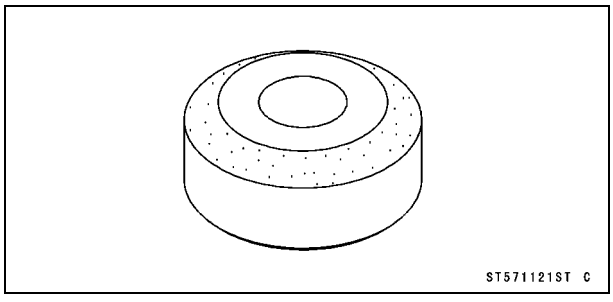
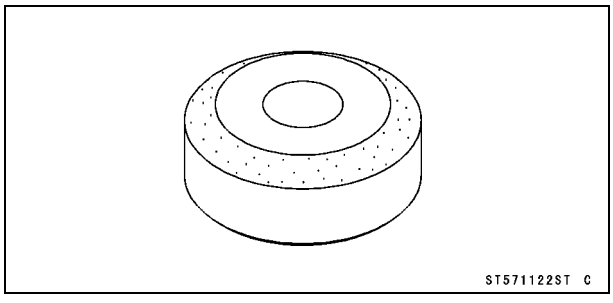


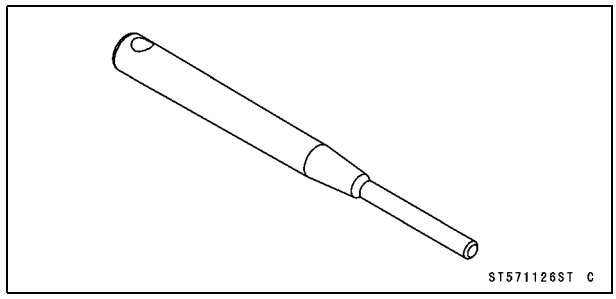
Valve Seat Cutter, 32° - ϕ35:
57001-1121



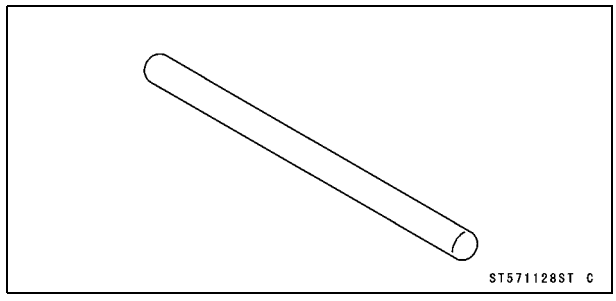
Valve Seat Cutter, 32° - ϕ38.5:
57001-1122



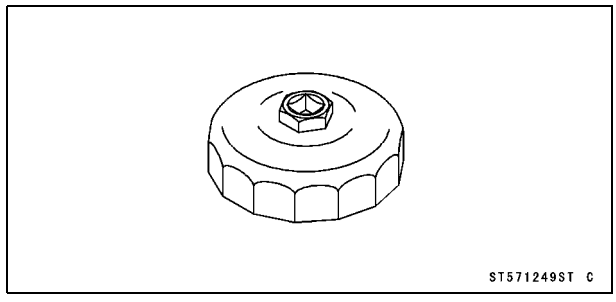
Valve Seat Cutter Holder, ϕ7:
57001-1126



Valve Seat Cutter Holder Bar:
57001-1128



Oil Filter Wrench:
57001-1249



Periodic Maintenance Procedures

Fuel System

NOTE

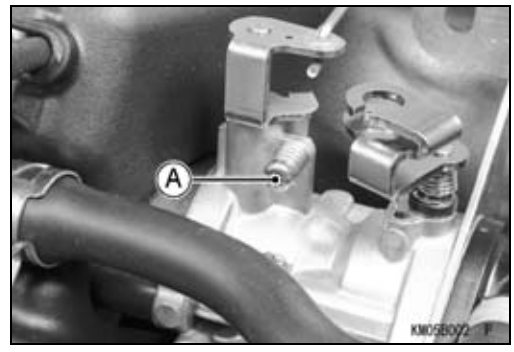
○*High and low idle speeds may very depending on the equipment on which the engine is used. Refer to the equipment specification.*

Low Idle Speed Adjustment

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

Idle Speed (Carburetor Idle rpm)
950 ±50 rpm (r/min)

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

Low Idle Speed (Governed Idle rpm)
1 125 ±75 rpm (r/min)

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.

Periodic Maintenance Procedures

⚠ WARNING

Always keep your hands clear of the moving parts.

- Move the throttle lever at a dash to the high idle position and adjust the high idle speed set screw [A] to obtain the specified high idle speed.

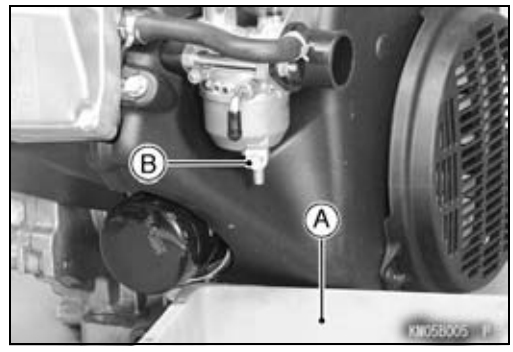
High Idle Speed (Governed Idle rpm)
3 750 ±50 rpm (r/min)

- Check the idle speed, and readjust the idle speed if necessary.

Fuel system Cleanliness Inspection

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the engine 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 container [A] under the carburetor drain screw [B].
- Loosen the drain screw 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 is found, clean the carburetor (see Carburetor Cleaning in the Fuel System chapter).

Periodic Maintenance Procedures

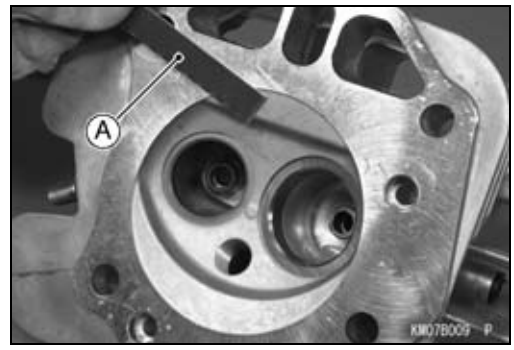
Engine Top End

Cylinder Head Cleaning and Inspection

- Remove the valves (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
- Scrape the carbon deposits from the head and exhaust port with a suitable tool [A].

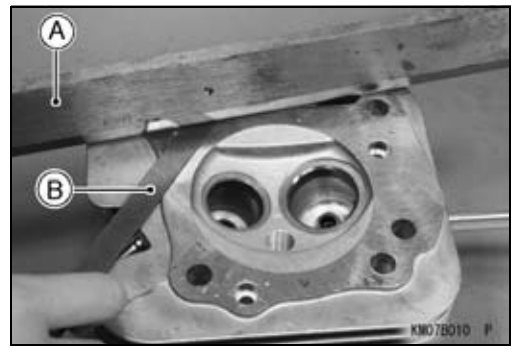
○To avoid gouging, use scrapers that are made of a material that will not cause damage.

- 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.



- Straight edge [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 detached by using a metal crack detection system (Visual color check: commonly found at automotive parts tore).
- If a crack is present in the cylinder head, replace it.
- Inspect the mating surface for burrs and nicks.

Valve Clearance Inspection

NOTE

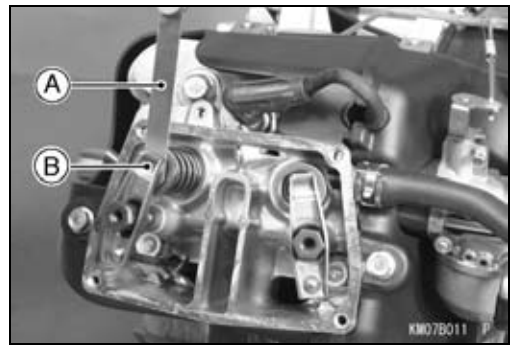
○*Valve clearance must be checked when the engine is cold (at room temperature).*

- Remove the rocker cover (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 rotational direction.

Periodic Maintenance Procedures

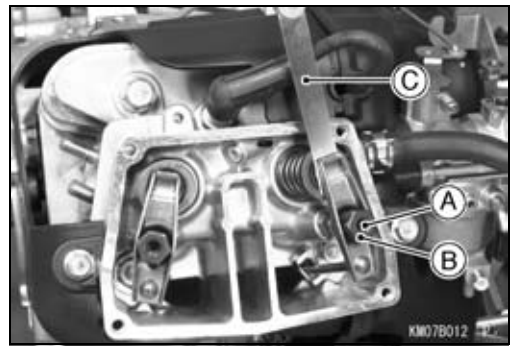
● Then check the valve clearance.
○Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.
★If the valve clearance is incorrect, adjust it.

Valve Clearance (when cold)
Inlet, Exhaust 0.10 ~ 0.15 mm (0.0039 ~ 0.0059 in.)



Valve Clearance Adjustment

● Since 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 to the proper direction until the piston is at TDC of the compression stroke (described above).
● Loosen the lock screw [A] and valve clearance adjusting nuts [B].
● Insert a thickness gauge [C] between the rocker arm and valve stem, and tighten the adjusting nut until the thickness gauge begins to bind between the rocker arm and valve stem end. Use a sweeping motion with the thickness gauge while making this adjustment.



Valve Clearance (when cold)
Inlet, Exhaust 0.10 ~ 0.15 mm (0.0039 ~ 0.0059 in.)

● Holding the adjusting nut with a wrench, tighten the lock screw to the specified torque.

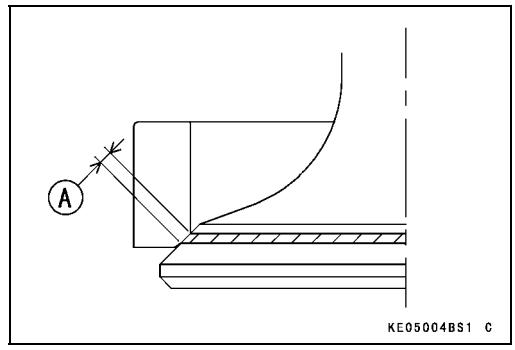
Torque - Valve Clearance Lock screw: 6.9 N·m (0.70 kgf·m, 61 in·lb)

CAUTION
Do not overtighten.

● Remeasure any clearance that was adjusted. Readjust if necessary.

Valve Seat Inspection

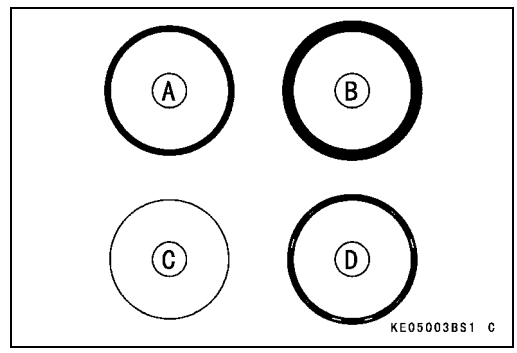
● Remove the valve (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
● Inspect the valve seats for damage.
★If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
● Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
● 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.



Periodic Maintenance Procedures

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 1.1 ~ 1.7 mm (0.043 ~ 0.070 in.)
Exhaust 1.0 ~ 1.5 mm (0.039 ~ 0.059 in.)

Valve Seat Repair

● Follow the manufacturer's instructions for use of valve seat cutters.

Special Tools - Valve Seat Cutter Holder, ϕ7: 57001-1126
Valve Seat Cutter Holder Bar: 57001-1128

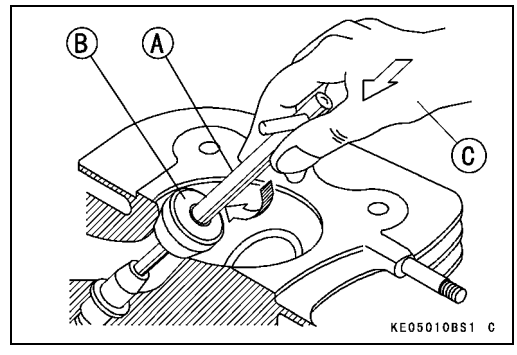
Inlet Valve
Valve Seat Cutter, 45° - ϕ35: 57001-1116
Valve Seat Cutter, 32° - ϕ38.5: 57001-1122

Exhaust Valve
Valve Seat Cutter, 45° - ϕ32: 57001-1115
Valve Seat Cutter, 32° - ϕ35: 57001-1121

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

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.*

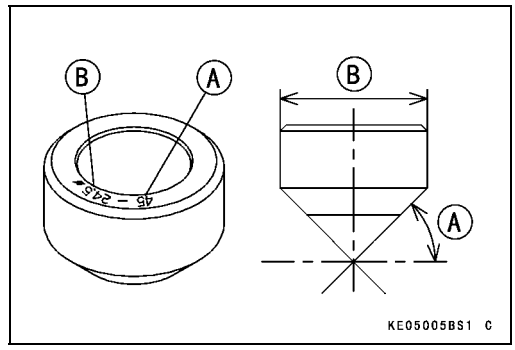
5. After use wash the cutter with washing oil and apply a thin layer of engine oil before storing.

Periodic Maintenance Procedures

Marks Stamped on the Cutter

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

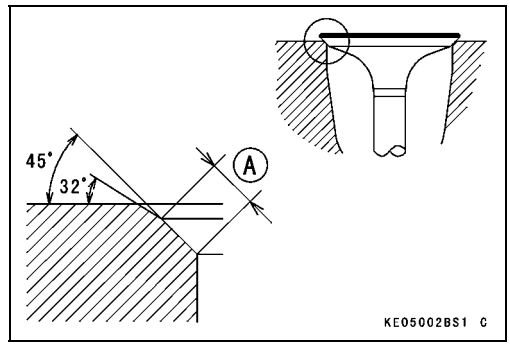
45°	Cutter angle [A]
ϕ24.5	Cutter diameter of cutter [B]



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.



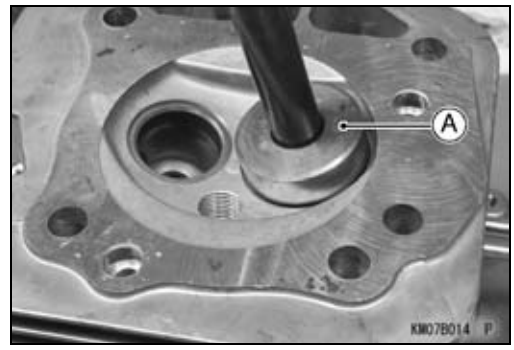
- Coat the seat with machinist's dye.
- Fit a 45° cutter [A] to the holder and slide it into the valve guide.

○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.

Periodic Maintenance Procedures



- 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.

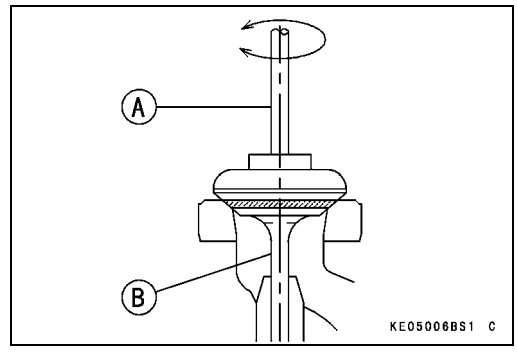
NOTE

○*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.

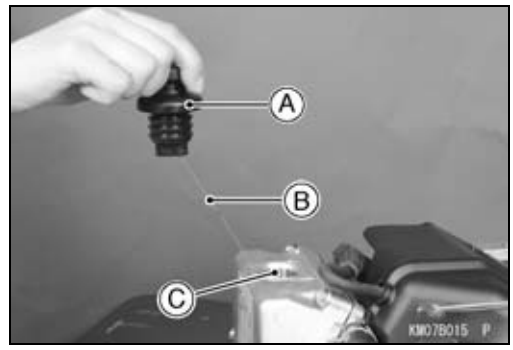
- When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
- Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the valve face.
- When the engine is assembled, be sure to adjust the valve clearances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

Periodic Maintenance Procedures

Lubrication System

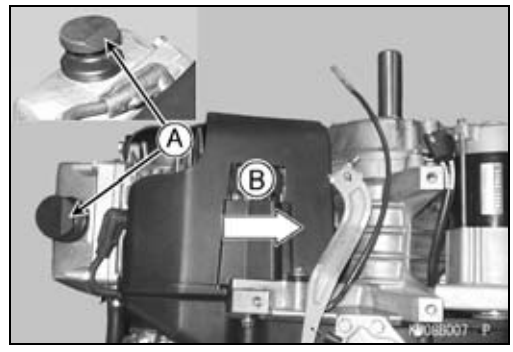
Oil Level Inspection

- Place the engine on a level surface.
- Remove the oil filler cap [A] and wipe its dipstick [B] with a clean cloth.
- Insert the dipstick into gauge hole [C] without screwing it in, then check the oil Level.



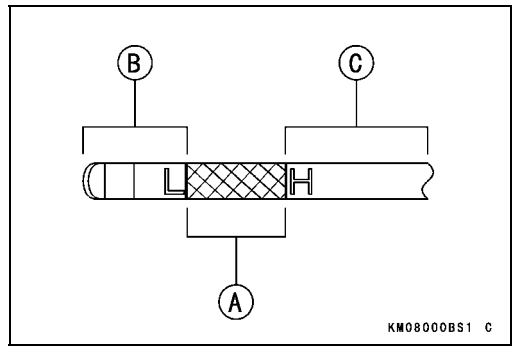
CAUTION

Always insert the dipstick into the gauge hole so that the taper part [A] of the oil filler cap is facing the starter side [B].



- The oil level should be in the range of “H” mark and “L” mark [A] (grid area) on the dipstick.

★If the oil level is “L” range [B] or below, add enough engine oil to bring oil level to the range of “H” mark and “L” mark.



CAUTION

Do not add more oil above the range of “H” mark and “L” mark. Excess oil will cause a smoking condition.

○Use the same type and make of oil that is already in the engine.

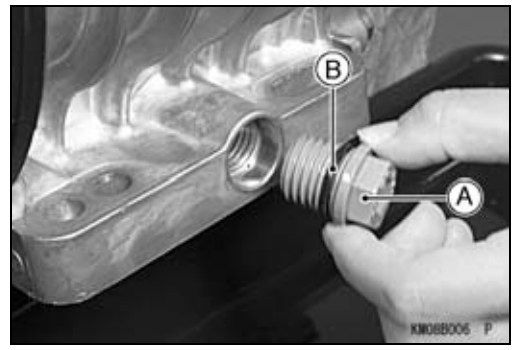
NOTE

○*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.*

★If the oil level is “H” range [C] or above, drain the excess oil by loosening the drain plug.

Periodic Maintenance Procedures

Oil Change



- Change the 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.

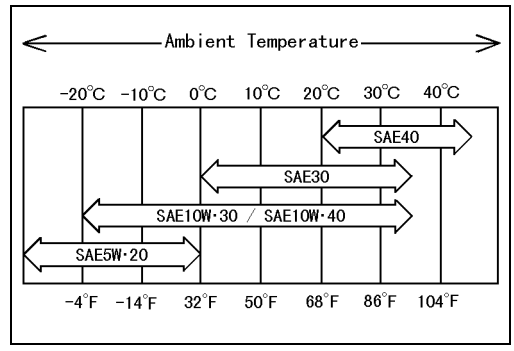
⚠ WARNING

Be careful of hot oil when drained. It may be hot enough to burn you severely.

- Replace the O-ring [B] with a new one.
- Install the drain plug with the O-ring and tighten it.

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

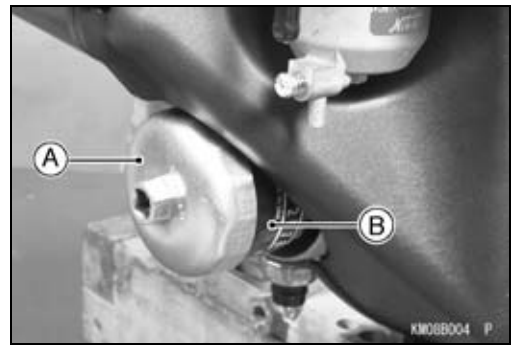
- Remove the oil filler cap and pour in the specified type and amount of oil.



Engine Oil

Type:	**SF, SG, SH or SJ Class**
Viscosity:	**SAE 40, SAE 30, SAE 10W-30/SAE 10W-40, or SAE 5W-20**
Capacity:	**1.1 L (1.16 US qt) (When filter is not removed)**
	1.3 L (1.37 US qt) (When filter is removed)

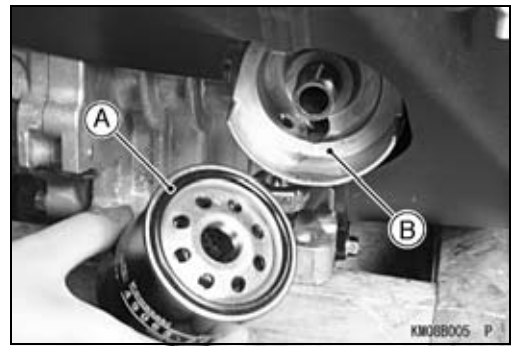
Oil Filter Replacement



- Drain the engine oil (see Oil Change in this chapter).
- 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 drip tray to receive oil from the oil filter and oil passages in the engine. Turn the filter counter-clockwise to remove it.



- Apply engine oil to the seal [A].
- Install new filter.

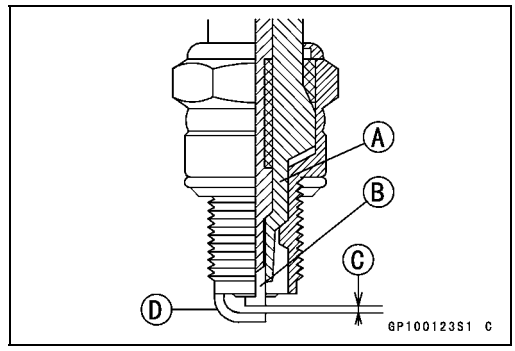
○Turn the filter until the seal contacts mounting surface [B] of the engine. Then turn the filter 2/3 to 3/4 rotations by HAND(S) to install it.

- Pour in the specified type and amount of oil (see Oil Change in this chapter).
- 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).

Periodic Maintenance Procedures

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: 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

Fuel System

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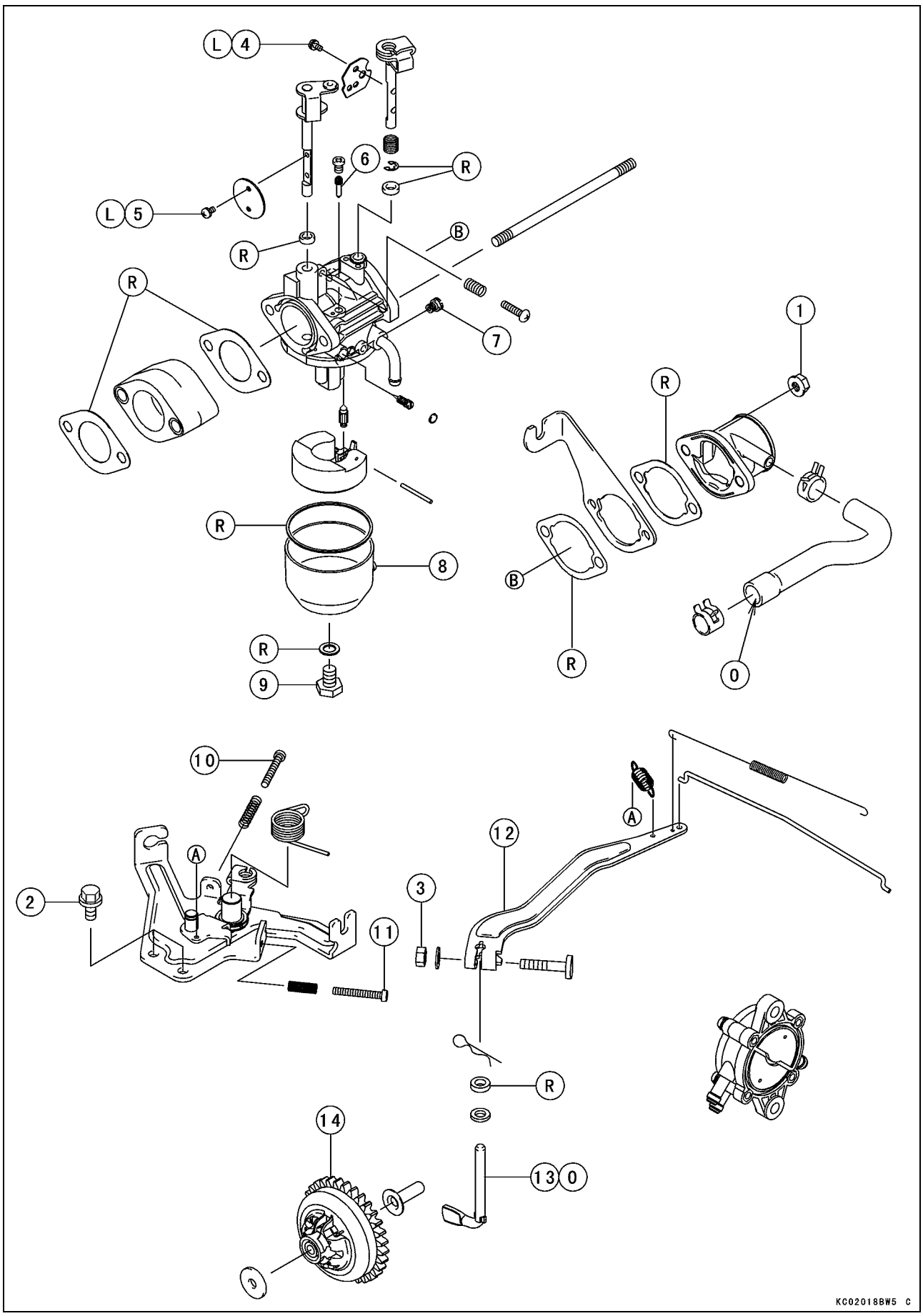
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Inlet-Pipe Nuts	5.9	0.60	52 in·lb	
2	Control Panel Bolts	6.9	0.70	61 in·lb	
3	Governor Arm Clamp Nut	5.9	0.60	52 in·lb	
4	Choke Valve Screws	0.9	0.09	7.8 in·lb	L
5	Throttle Valve Screws	0.9	0.09	7.8 in·lb	L
6	Pilot Jet (Slow Jet)	0.7	0.07	6.1 in·lb	
7	Main Jet	2	0.20	17 in·lb	
8	Drain Screw	2	0.20	17 in·lb	
9	Float Chamber Mounting Bolt	9.8	1.0	87 in·lb	

10. High Idle Speed Screw
11. Low Idle Speed Screw
12. Governor Arm
13. Governor Shaft
14. Governor Assembly

L: Apply a non-permanent locking agent to the threads.
O: Apply engine oil.
R: Replacement Parts

3-4 FUEL SYSTEM

Specifications

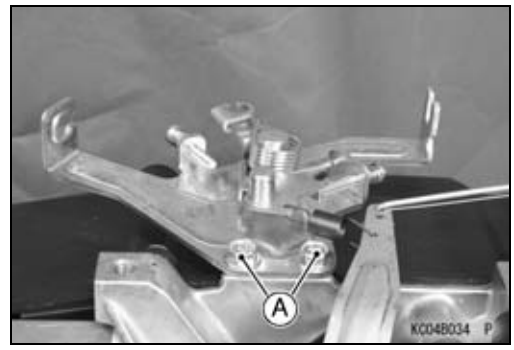
Item	Standard
Caburetors Specifications	
Make/ Type	NIKKI/6C1026-511
Throttle Bore Diameter	26 mm (1.02 in.)
Venturi Diameter	20 mm (0.79 in.)
Main Jet (MJ)	#110
Pilot Jet (PJ)	#50
Pilot Screw Turns Out (PS) (Idle Mixture Screw Turns Out)	2 3/4 ±3/8
Float Level	Float parallel to carburetor body
Idle Speed (1)	
Low Idle Speed	1 125 ±75 r/min (rpm)
High Idle Speed	3 750 ±50 r/min (rpm)
Air Cleaner	
Type	– – –
Cleaner	– – –
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 mounting equipment. Refer to the mounting equipment specification.

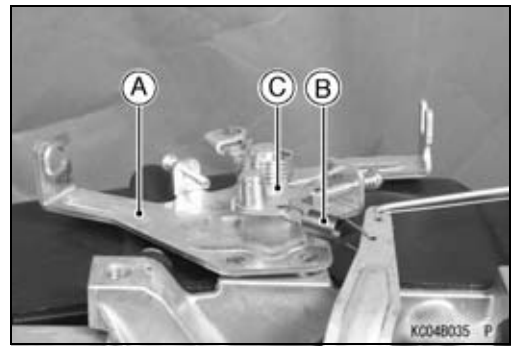
Governor Link Mechanism

Control Panel Assembly Removal

- Remove the control panel mounting bolts [A].



- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the engine speed control lever [C].

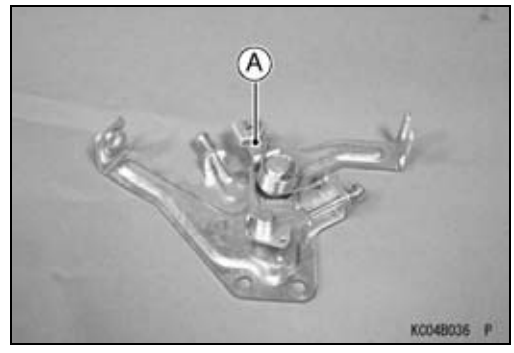


Control Panel Assembly Installation

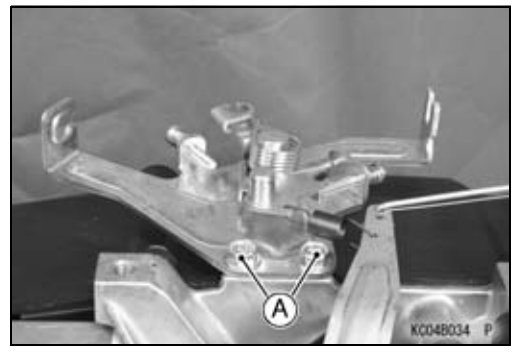
- Before installing the control panel assembly, check to see that the engine speed control lever [A] move smoothly in all directions.

★If any part is worn or damaged, replace the control panel assembly.

- Hook the governor spring end loop.

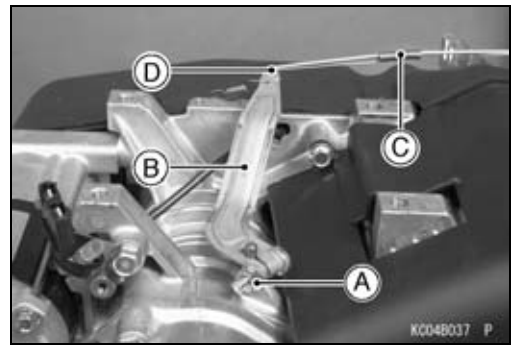


- Install the control panel assembly with the mounting bolts [A].
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter).



Governor Arm Removal

- Remove the control panel assembly (see Control Panel Assembly Removal in this chapter).
- Loosen the clamp nut [A] and take off the governor arm [B].
- Unhook the throttle link rod spring [C] end loop and clear the throttle link rod lower end [D].



Governor Link Mechanism

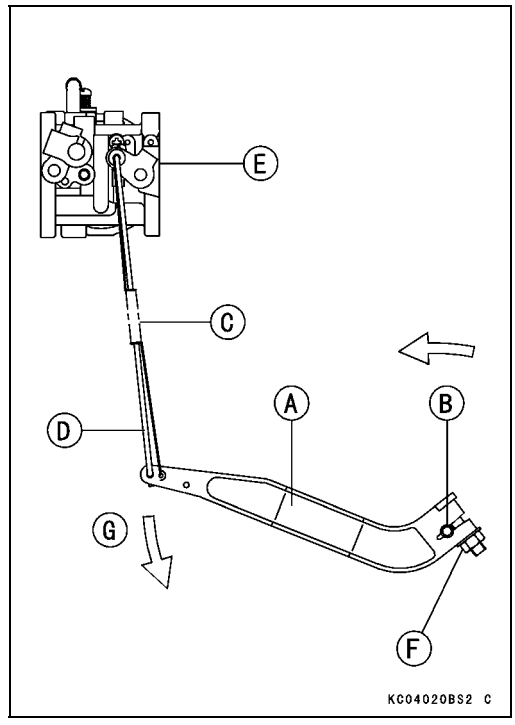
Governor Arm Installation

- Install the governor arm [A] onto the governor shaft [B] temporarily.
- Be sure the link spring [C] around the throttle link rod [D] is in place and that it pulls the governor arm and throttle lever [E] toward each other.
- Loosen the clamp nut [F] on the governor arm enough to move the governor shaft.
- Turn the top end of the governor arm counterclockwise [G] to fully open the carburetor throttle valve and hold it there.
- Turn the governor shaft counterclockwise, fully turn the shaft to end of its travel.
- Tighten the clamp nut.

○There should be no gap between the governor arm and the snap pin on the governor shaft.

Torque - Governor Arm Clamp Nut: 5.9 N·m (0.60 kgf·m, 52 in·lb)

- Install the control panel assembly, and connect the governor arm with the governor spring.



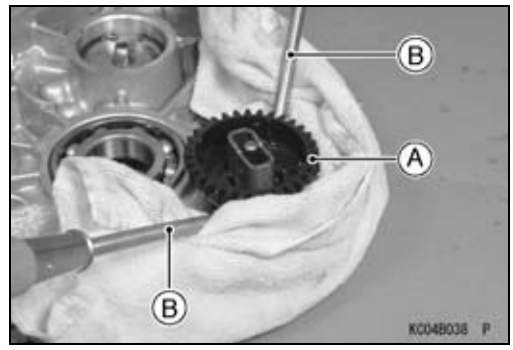
Governor Assembly Removal/Inspection

- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter).
- Visually check the governor assembly as built in the crankcase cover for damage or wear.

CAUTION
Do not remove the governor gear assembly unless the parts are to be replaced. The parts cannot be reused once they are removed.

- When removing the governor assembly [A] for replacing, use two screw drivers [B] of an appropriate size.

CAUTION
Protect the gasket-mount surface of the crankcase cover when removing the governor assembly with the screw drivers.



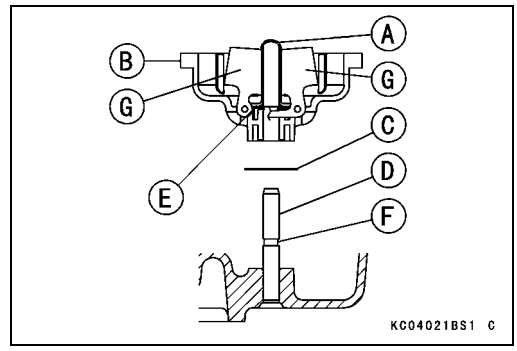
Governor Link Mechanism

Governor Assembly Installation

- Install the sleeve [A] on the governor assembly [B].

CAUTION

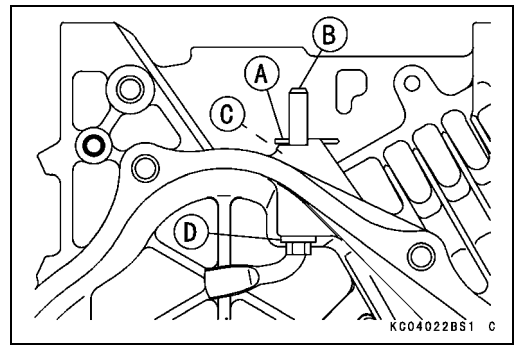
First install the sleeve.
The sleeve cannot be installed after the governor gear assembly has been installed.



- To install, first place the thrust washer [C] on the boss of the shaft [D]. Then, install the governor assembly (with the sleeve attached) on the shaft so that step [E] is fitted securely in groove [F].
- After installing the assembly, turn the governor by hand to make sure that the governor weights [G] and the sleeve move smoothly.

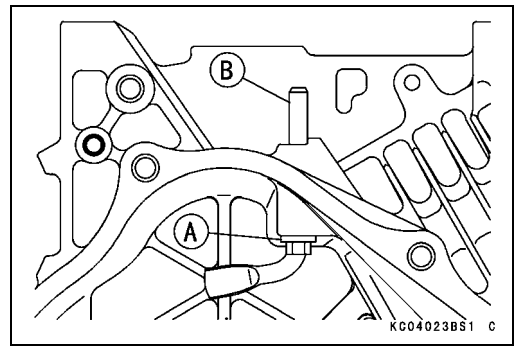
Governor Shaft Removal

- Remove:
  Crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankcase chapter)
  Crankshaft (see Crankshaft Removal in the Camshaft/Crankcase chapter)
  Governor arm (see Governor Arm Removal in this chapter).
  Snap Pin [A]
  Governor Shaft [B]
  Oil Seal [C]
  Washer [D]
- Be sure to replace any oil seal removed with a new seal.

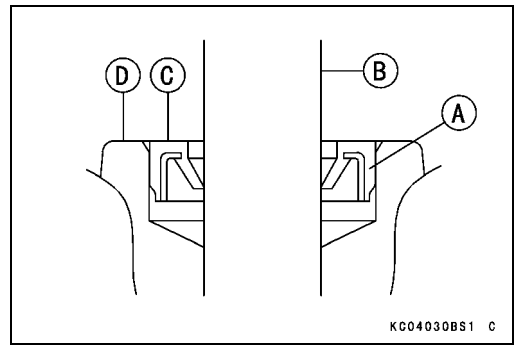


Governor Shaft Installation

- Apply engine oil to the governor shaft.
- Install the washer [A] to the governor shaft [B] and insert it from the crankcase inside.



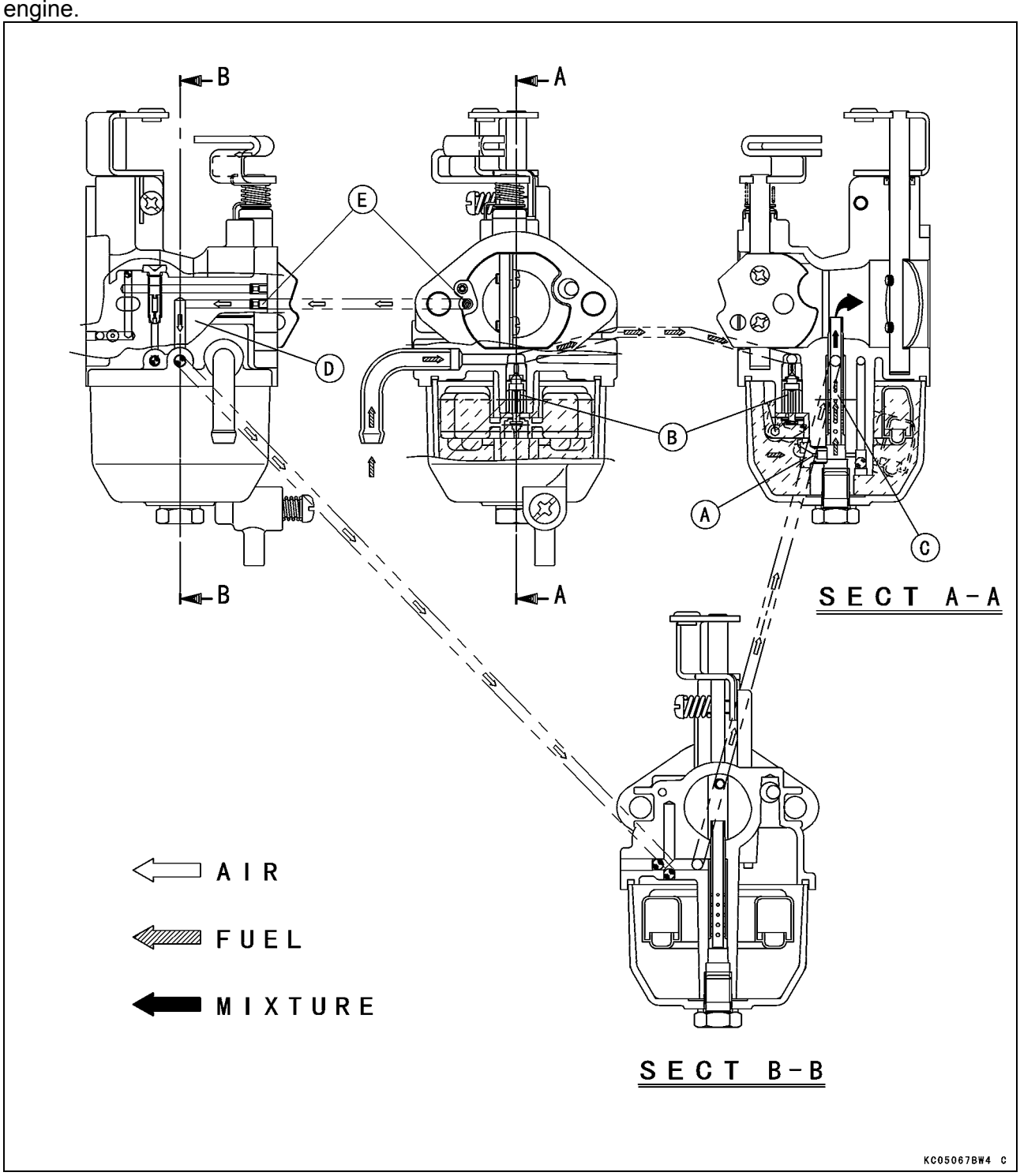
- Install the oil seal [A] into the crankcase after the governor shaft [B] is inserted in the crankcase, and so that the marks [C] face out.
- Press in the new oil seal using a press or suitable tools until it is flush with crankcase surface [D].
- Hold the governor shaft with the snap pin.
- Check that the governor shaft moves smoothly in its operating range.



Carburetor

Fuel and Air Flow

The main system of the carburetor consists of the main jet [A], valve seat [B] main nozzle [C], and the main air passage [D] (main air jet [E]). The main system meters fuel to the engine during moderate to heavy load conditions. Fuel flows through the main jet and into the main nozzle, 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.



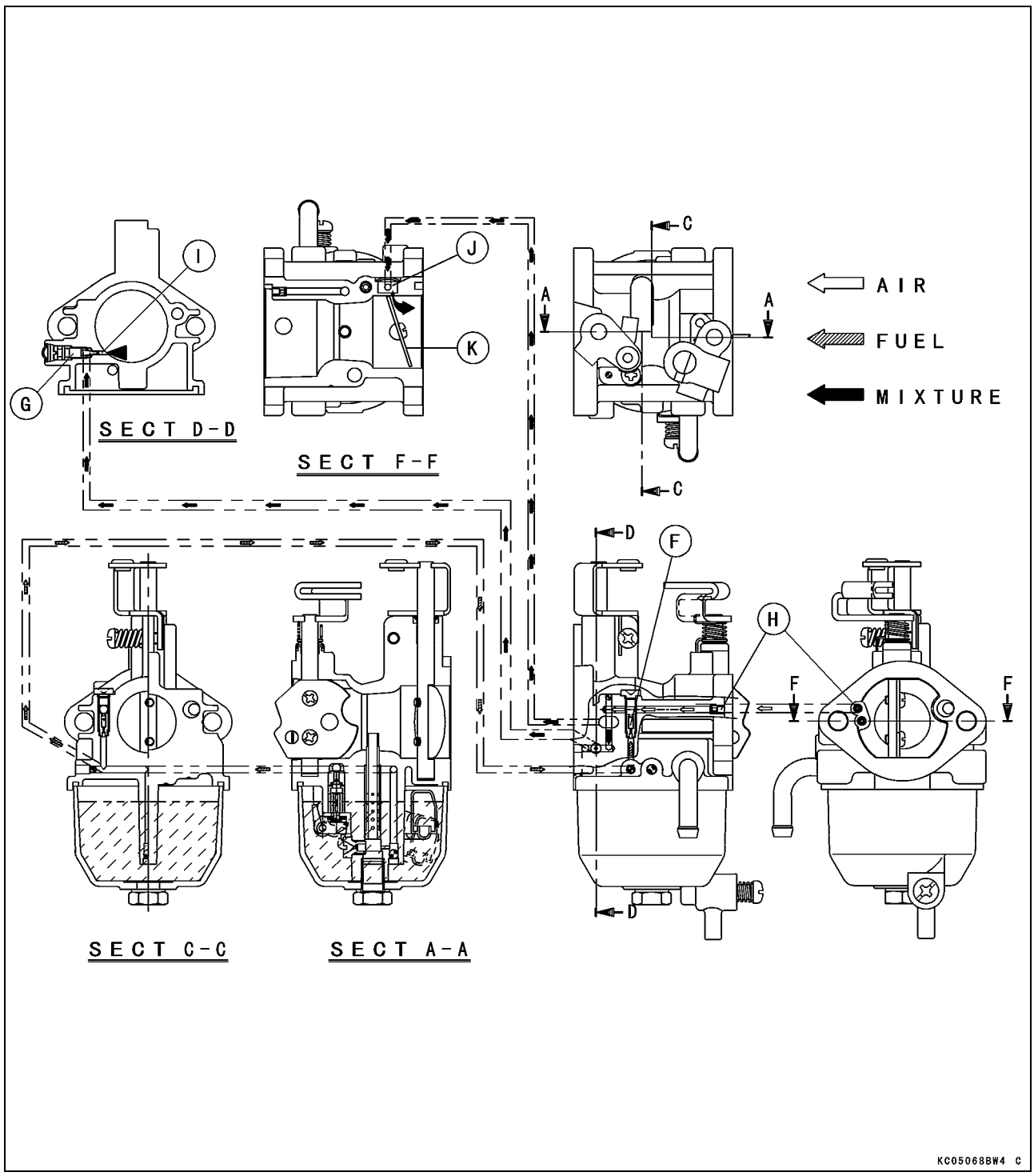
Dummy Page

Carburetor

The slow system includes the slow jet (pilot jet) [F], idle screw [G] (idle mixture screw), slow air breed jet [H], idle port [I], and the slow port [J]. The slow 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 slow system, since the nearly closed throttle valve [K] causes high speed air flow past the idle port and slow port (even at low engine speed).

Fuel flow in the slow system is metered by the slow jet (pilot jet). Air for better atomization is admitted via the air bleed jet in the mouth of the carburetor. The fuel/air mixture passes into the bore of the carburetor side stream of the throttle valve through the slow port and idle port. While the throttle valve is almost closed, it covers the small slow port opening into the bore from the slow system. As the throttle valve begins to open, it uncovers the slow port, 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 slow screw controls the amount of fuel/air mixture allowed through the idle port, but does not meter the slow port. A moderate amount of air comes in around the throttle valve at an idle, so adjusting the idle screw changes the fuel/air ratio. Turning the idle screw (idle mixture screw) out (counterclockwise) enrichens the mixture; turning it in (clockwise) leans the mixture.

Carburetor



Carburetor

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.

NOTE

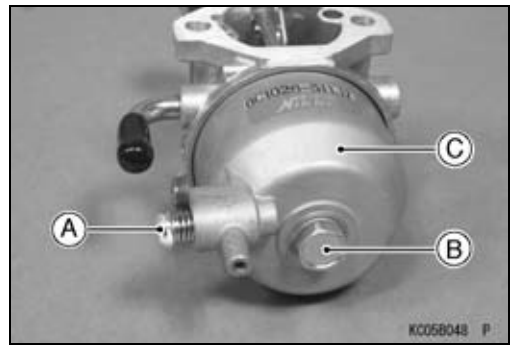
○*The main jet high altitude kits are available if the equipment is to be used in the high altitudes. The main jet numbers are stamped on ends of the main jets.*

High Altitude Main Jet

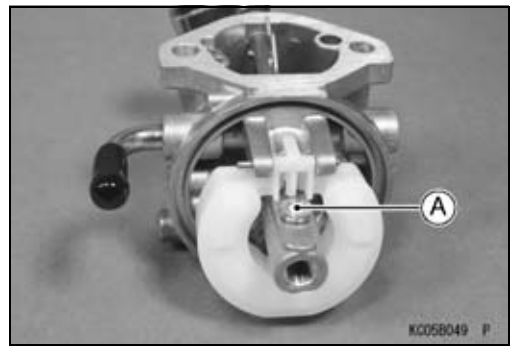
Altitude	Main Jet No.
0 ~ 1 000 m (0 ~ 3 000 ft)	#110
1 000 ~ 2 000 m (3 000 ~ 6 000 ft)	#108
2 000 m (6 000 ft) and higher	#106

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 (see Fuel System Cleanliness Inspection in the Periodic Maintenance chapter).
- Remove the carburetor (see Carburetor Removal in this chapter).
- Unscrew the float chamber mounting bolt [B] and take off the float chamber [C] and gasket.



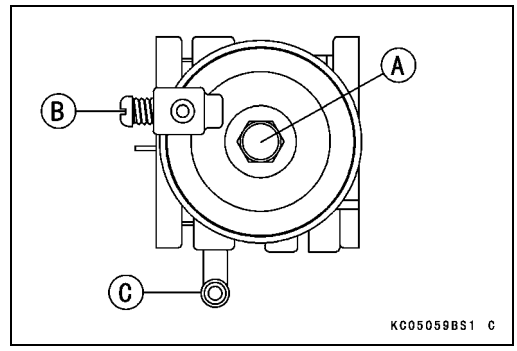
- Using a properly sized blade screw driver, carefully replace the main jet [A] with a new one for altitude expected.



Carburetor

- Replace the float chamber gasket with a new one.
- Install the float chamber and gasket.
- Tighten float chamber mounting bolt [A] as shown the figure.
  Drain Screw [B]
  Fuel Inlet Joint [C]

Torque - Float Chamber Mounting Bolt: 9.8 N·m (1.0 kgf·m, 87 in·lb)



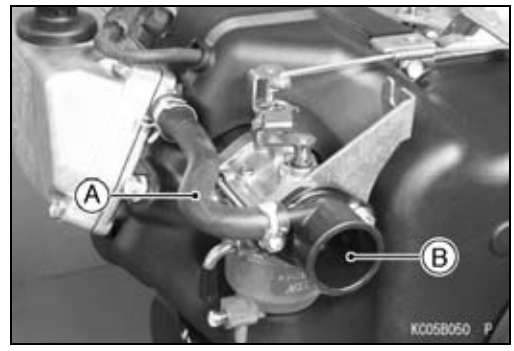
Fuel system Cleanliness Inspection

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

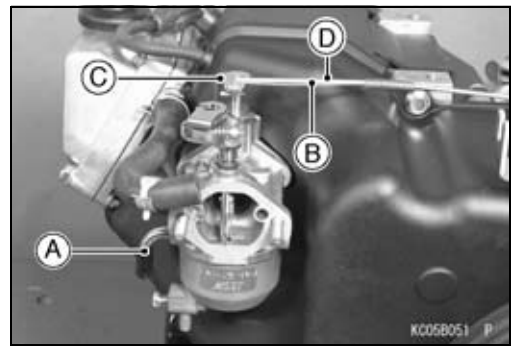
Carburetor Removal

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the engine 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 breather hose [A].
- Remove the inlet pipe [B].
- Turn the fuel shut off valve to the OFF position in the equipment.
- Drain the carburetor completely by unscrewing the drain screw at the bottom of the float chamber (see Fuel System Cleanliness Inspection in the Periodic Maintenance chapter).



- Disconnect the fuel tube (equipment part) at the fuel inlet joint [A] of the carburetor.
- Unhook the throttle link spring [B] at the throttle shaft lever [C] top end with a long nose pliers.
- Unhook the throttle link rod [D] from the throttle shaft lever.
- Remove the carburetor, the gasket, and the insulator.
- Check the insulator for damage.

★If the insulator is not in good condition, replace it with a new one.

Carburetor Installation

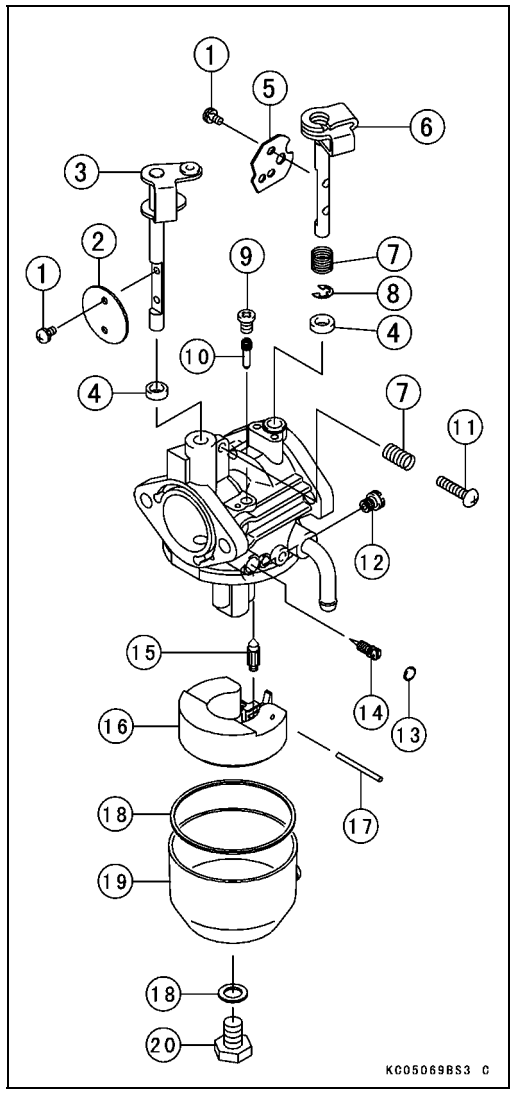
- Clean the mating surfaces of the carburetor and inlet pipe, and fit the new gaskets.
- Take care not to bend the throttle link rod during installation. Make sure that the link spring around the throttle link rod is in place and that it pulls the governor arm and carburetor throttle shaft lever toward each other.
- Adjust the idle speed (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter).

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 and throttle valves for assembling them.
- Install the choke valve and throttle valve on the shaft as the out side mark of them facing out side.
- Drive the float pin into the carburetor body.
- Assemble carburetor parts with recommended tightening torque (see Exploded View).

1. Screw
2. Throttle Valve
3. Throttle Shaft
4. Dust Seal
5. Choke Valve
6. Choke Shaft
7. Spring
8. Snap Ring
9. Pilot Jet Plug
10. Pilot Jet
11. Low Idle Speed Screw
12. Main Jet
13. Pilot Screw Plug
14. Pilot Screw
15. Float Valve
16. Float
17. Float Pin
18. Gasket
19. Float Chamber Assy
20. Float Chamber Bolt



Carburetor

Carburetor Cleaning

⚠ WARNING

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

CAUTION

Do not use compressed air on an assembled carburetor, or the floats may be crushed by the pressure. Remove as many rubber or plastic parts from the carburetor as possible before cleaning the carburetor with a washing. This will prevent to damage or deterioration of the parts.
The carburetor body has plastic parts that cannot be removed. Do not use a strong carburetor washing which could attack these parts; instead, use a mild high-flash point washing 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 (see Caburetor Disassembly/Assembly in this chapter).
- Immerse all the carburetor metal parts in a carburetor cleaning solution and clean them.
- Rinse the 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 (see Carburetor Disassembly/Assembly in this chapter).

Carburetor

Carburetor Inspection

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain. Turn the engine 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.
- 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 the gasket on the carburetor body.

★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.

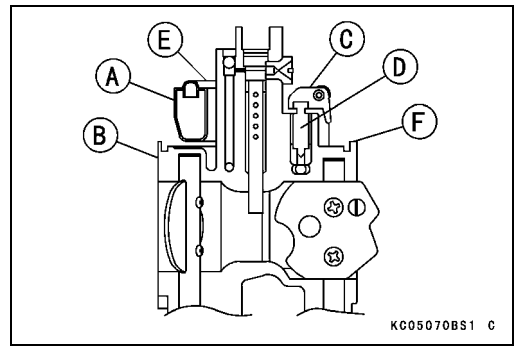
CAUTION

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

Carburetor

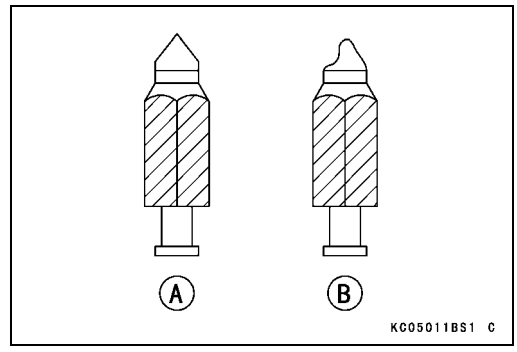
- With the float [A] assembly installed onto the carburetor body [B], hold the carburetor upside down at eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab [C] just touches the float valve [D]. The float lower surface [E] should be parallel with the carburetor body mating surfaces [F].

★If the float position is not correct, replace the float with a new one.



- 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.
  Good [A]
  Not Good [B]

★If either the needle or the seat is worn or damaged, replace the float assembly and carburetor body as a set.



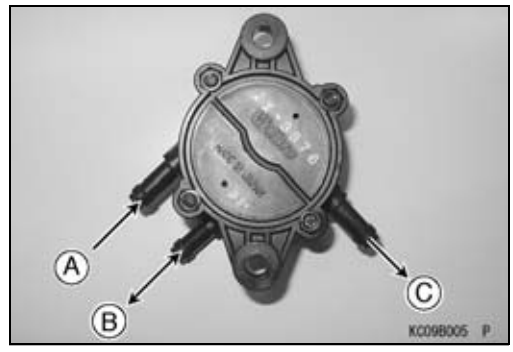
Fuel Pump, Fuel Filter

The diaphragm in the fuel pump operates by the pulse generated in the crankcase, and the fuel pump supplies fuel to the carburetor.

The fuel pump disassembly is not recommended, if any damage for the pump is noticed replace it with a new one.

Fuel Pump

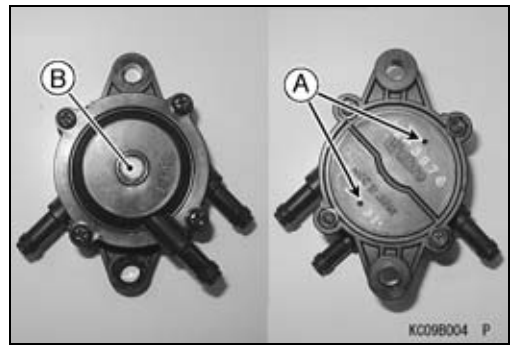
Inlet [A]
Pulse [B]
Outlet [C]



Fuel Pump Inspection

- Check the vent hole [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

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

⚠ 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 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.

Cooling System

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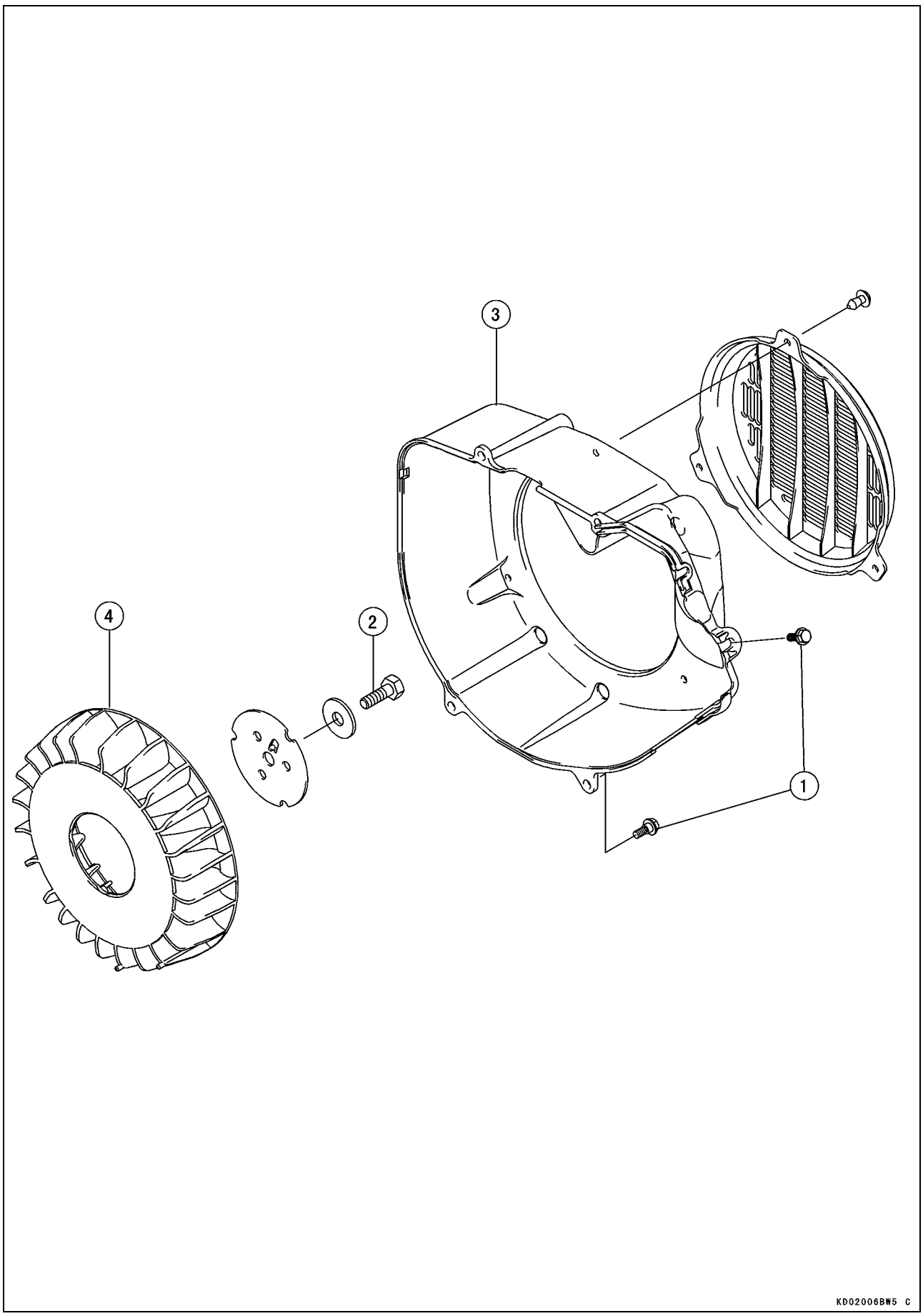
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Fan Housing Bolts	5.9	0.60	52 in·lb	
2	Flywheel Bolt	56	5.7	41	

3. Fan Housing
4. Fan

Cooling Fan

Cooling Fan Removal

- Refer to the Flywheel Removal in the Electrical System chapter.

Cooling Fan Installation

- Refer to the Flywheel Installation in the Electrical System chapter.

Cooling Fan Inspection

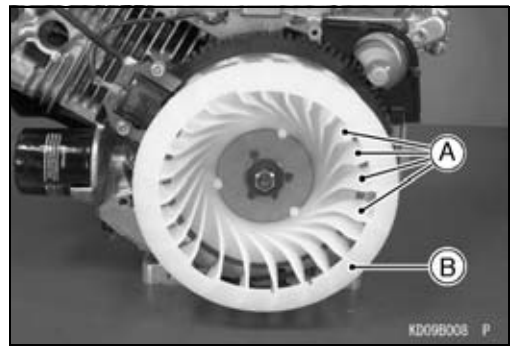
- Visually inspect the blades [A] in the cooling fan [B].

★If they are any cracks, warps or damage, replace the cooling fan.

★If any mud or dust have stuck to the cooling fan, clean it.

- Cooling fan is cleaned by washing in detergent and water.

CAUTION
Do not clean the cooling fan in solvents. It may be damaged by solvents.



Engine Top End

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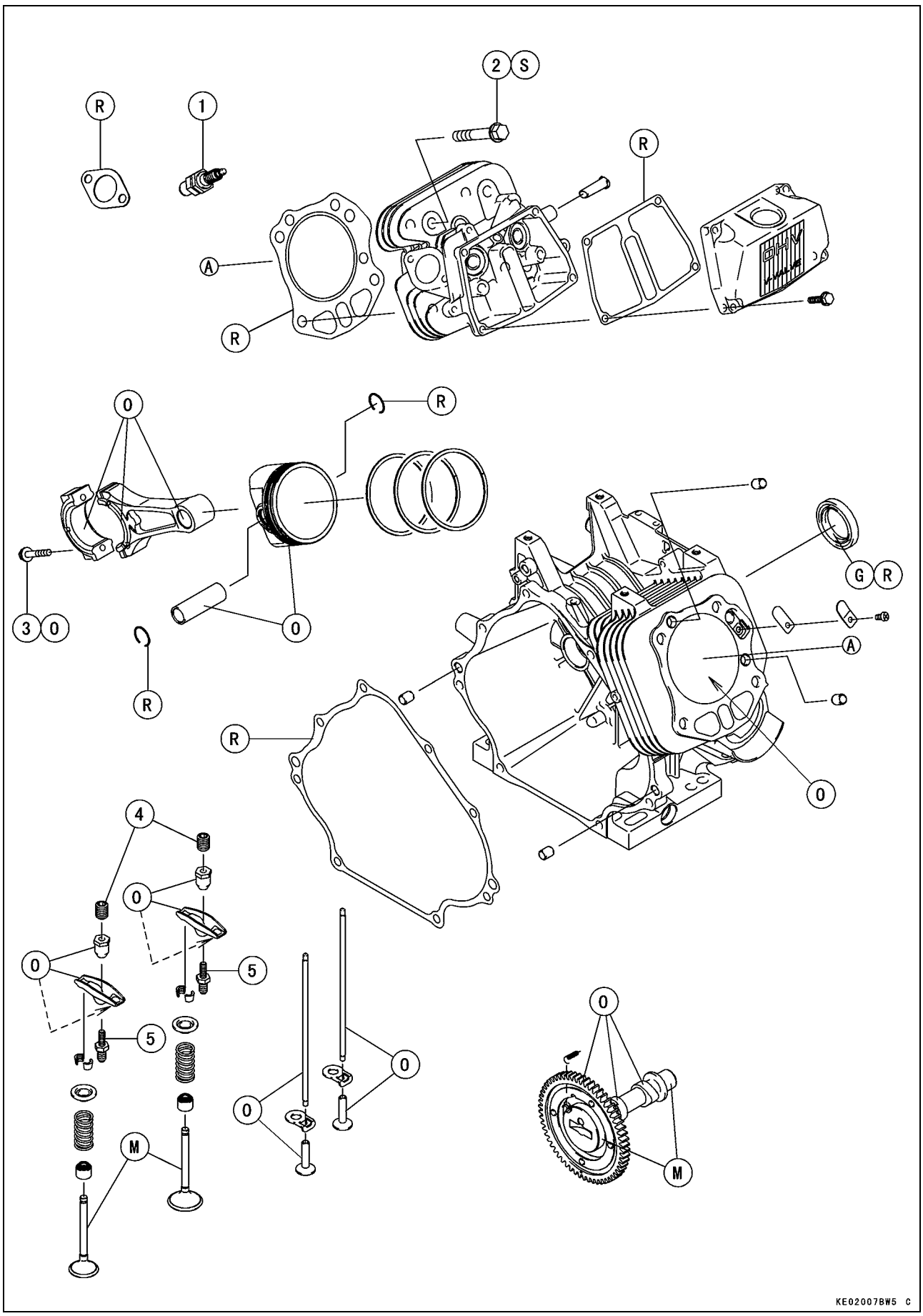
5-2 ENGINE TOP END

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Spark Plug	22	2.2	16	
2	Cylinder Head Bolts	37	3.8	27	S
3	Connecting Rod Big End Cap Bolts	5.9	0.60	52 in·lb	O
4	Valve Clearance Lock Screws	6.9	0.70	61 in·lb	
5	Rocker Arm Bolts	28	2.9	21	

G: Apply grease.
M: Apply molybdenum disulfide grease.
O: Apply engine oil.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

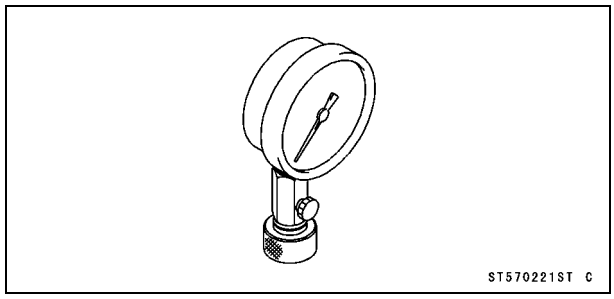
Specifications

Item	Service Limit
Cylinder Head	
Cylinder Compression (MIN)	[294 kPa (43 psi)] (MIN)
Cylinder Head Warp	0.03 mm (0.001 in.)
Valves	
Valve Head Thickness:	
Inlet, Exhaust	0.4 mm (0.016 in.)
Valve Stem Runout:	
Inlet, Exhaust	TIR 0.05 mm (0.002 in.)
Valve Stem Diameter:	
Inlet	6.95 mm (0.274 in.)
Exhaust	6.93 mm (0.273 in.)
Valve Guide Inside Diameter:	
Inlet, Exhaust	7.08 mm (0.279 in.)
Valve Spring Free Length:	
Inlet, Exhaust	32.6 mm (1.28 in.)
Rocker Arm Push Rod Runout:	
Inlet, Exhaust	TIR 0.5 mm (0.02 in.)
Cylinder, Piston	
Piston Diameter	81.77 mm (3.217 in.)
Piston Ring/Groove Clearance:	
Top	0.18 mm (0.00709 in.)
Second	0.18 mm (0.00709 in.)
Piston Ring Thickness:	
Top, Second	1.40 mm (0.0551 in.)
Piston Ring End Gap:	
Top	0.7 mm (0.028 in.)
Second	0.8 mm (0.031 in.)
Oil	1.0 mm (0.039 in.)
Piston Pin Outside Diameter	18.96 mm (0.746 in.)
Piston Pin Hole Inside Diameter	19.08 mm (0.751 in.)
Connecting Rod Small End Inside Diameter	19.06 mm (0.750 in.)
Cylinder Inside Diameter	82.10 mm (3.232 in.)
Cylinder Bore Out Round	0.056 mm (0.0022 in.)

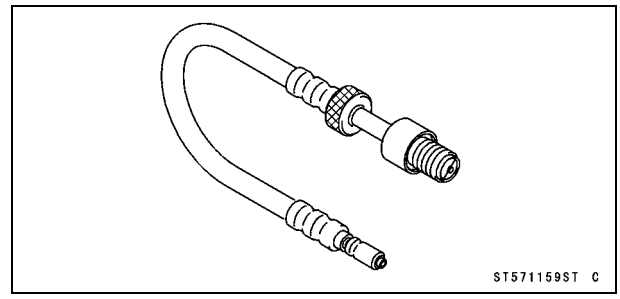
Item	Standard
Valve clearance	
Inlet, Exhaust	0.10 ~ 0.15 mm (0.0039 ~ 0.0059 in.)
Valve seating surface angle	
Inlet, Exhaust	45°
Valve seating surface width	
Inlet	1.1 ~ 1.7 mm (0.043 ~ 0.070 in.)
Exhaust	1.0 ~ 1.5 mm (0.039 ~ 0.059 in.)
Valves guide inside diameter	
Inlet, Exhaust	7.000 ~ 7.015 mm (0.2756 ~ 0.2762 in.)
Exhaust Valve Lift by ACR	1.1 mm (0.043 in.)
Cylinder inside diameter	81.980 ~ 82.000 mm (3.2276 ~ 3.2283 in.)

Special Tools

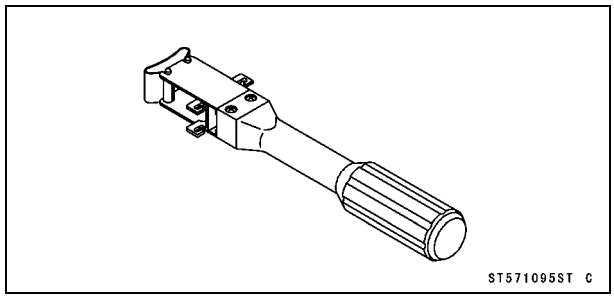
Compression Gauge, 20 kgf/cm²:
57001-221



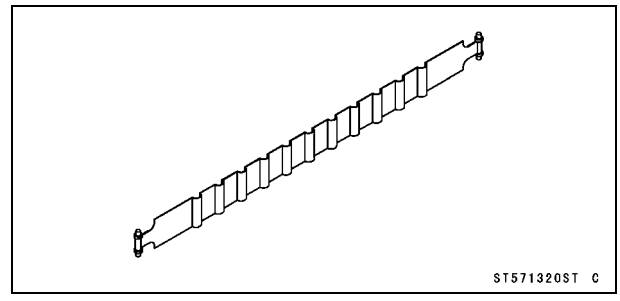
Compression Gauge Adapter, M14 × 1.25:
57001-1159



Piston Ring Compressor Grip:
57001-1095

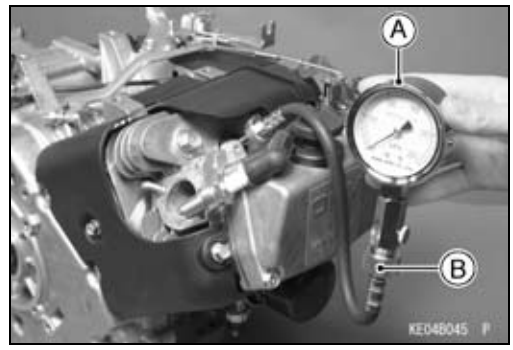


Piston Ring Compressor Belt, ϕ80 ~ ϕ91:
57001-1320



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 cap of the cylinder and remove the spark plug keeping the engine throttle and the choke valve fully open.
- Attach the compression gauge assembly firmly into the plug hole.

Special Tools - Compression Gauge, 20 kgf/cm²: 57001-221 [A]
Compression Gauge Adapter, M14 × 1.25: 57001-1159 [B]

- Ground the spark plug to the engine.

⚠ WARNING

To avoid fire, do not ground the spark plug in proximity to the plug hole. Keep the plug as far away as possible from the plug hole.

- Using the starter motor, turn the engine over with the throttle fully open until the compression gauge stops rising.

Cylinder Compression (MIN) 294 kPa (43 psi)

★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 crown and cylinder head - clean off any carbon on the piston crown 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 by worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.
4. Malfunction of ACR (Automatic Compression Release) with the camshaft.

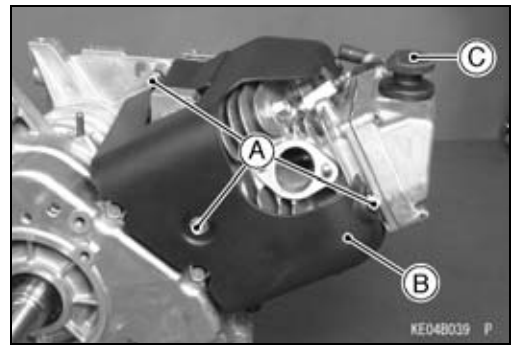
★If cylinder compression is lower than the (MIN), check the following:

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.

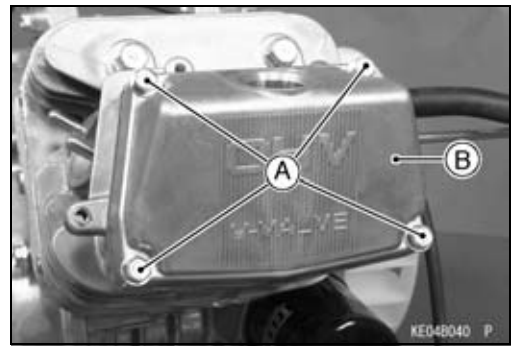
Cylinder Head

Cylinder Head Assembly Removal

- Remove:
  Cover Bolts [A] and Cover [B]
  Oil Gauge [C]
  Carburetor (see Carburetor Removal in the Fuel System chapter)
  Spark Plug (see Spark Plug Removal in the Electrical System chapter)
  Fan Housing (see Flywheel Removal in the Electrical System chapter)



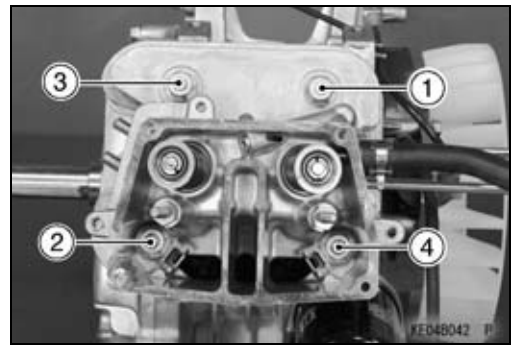
- Unscrew the rocker cover mounting bolts [A], and remove the cover [B] and gasket.
- When removing the cylinder head, set the cylinder at TDC of power stroke in.



- Remove the push rods (see Push Rod Removal in this chapter).
- 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.*

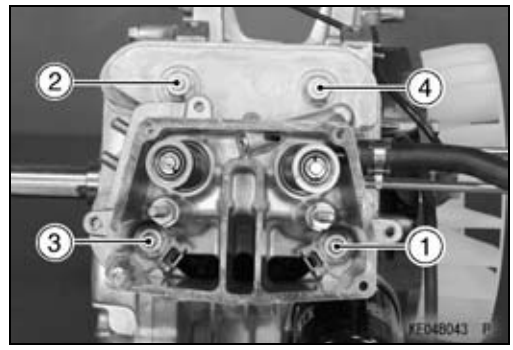
Cylinder Head Assembly Installation

- Clean the mating surfaces of the cylinder head and cylinder.
- Install the knock pins.
- Put new gasket and the cylinder head assembly on the cylinder, then align the push rods under the rocker arms.
- Install the push rods in their original positions on the cylinder (see Push Rod Installation in this chapter).
- Set the cylinder at TDC of power stroke in.

Cylinder Head

- Tighten the cylinder head bolts following the tightening sequence as shown in the figure.

Torque - Cylinder Head Bolts: 37 N·m (3.8 kgf·m, 27 ft·lb)



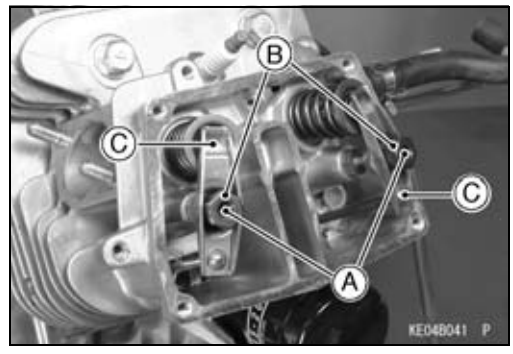
CAUTION

A torque wrench must be used to assure proper torque. Improper tightening of the head bolts can result in warping of the cylinder head.

- Check and adjust the valve clearance (see Valve Clearance Adjustment in the Periodic Maintenance chapter).
- Install the new gasket and rocker cover.

Push Rod Removal

- Set the cylinder at TDC of power stroke.
- Remove the rocker cover (see Cylinder Head Assembly Removal in this chapter).
- Loosen the lock screws [A] and the valve clearance adjusting nuts [B].
- Move the rocker arms [C] to clear the push rod upper ends.
- Pull out the push rods.



NOTE

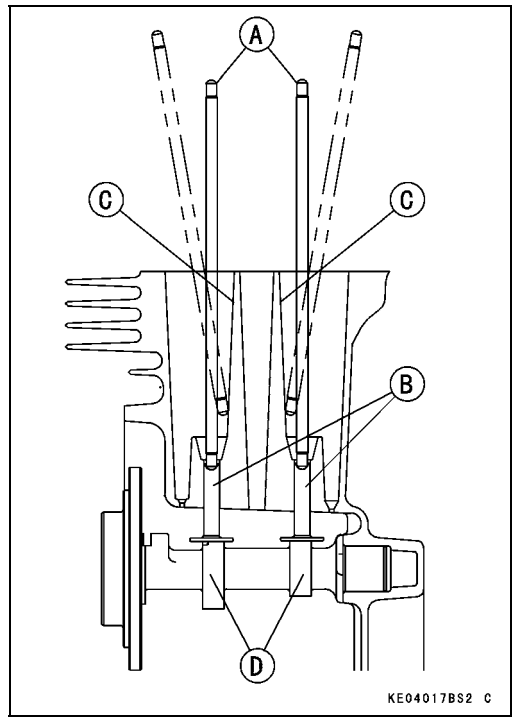
○*Mark the push rods so they can be installed in their original position during assembly.*

Push Rod Installation

- Set the cylinder at TDC of power stroke.
- Install the push rods [A] in their original positions on each cylinder.

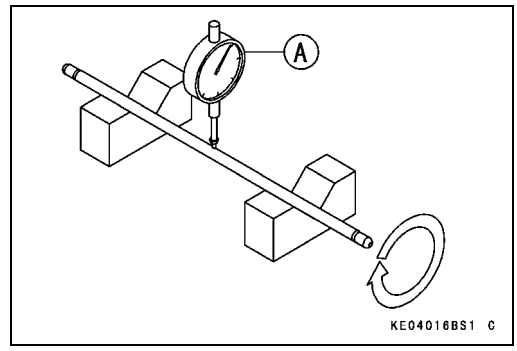
○To Install the push rod in the correct position on the tappet [B], insert the push rod so end of the push rod is sliding down along inside wall [C] of the crankcase and position the push rod end onto the tappet.

- Check that both inlet and exhaust push rods on the cylinder are at lowest position on the cam lobes [D], if not, turn the flywheel clockwise one turn (360°) and reset the cylinder at TDC of power stroke in.
- Be sure the both ends of the push rods are correctly seated on the tappets and rocker arms.
- Tighten the lock screws and the valve clearance adjusting nuts (see Valve Clearance Adjustment in the Periodic Maintenance chapter).
- Check and adjust the valve clearance (see Valve Clearance Adjustment in the Periodic Maintenance chapter).



Cylinder Head

Push Rod Inspection

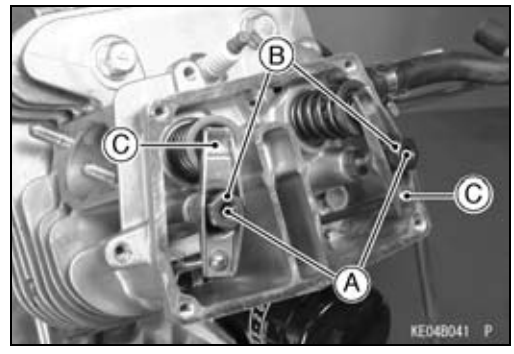


- Place the rocker arm push rod in V blocks that are as far apart as possible, and set a dial gauge [A] on the rod at a point halfway between the blocks. Turn the rod to measure the runout. The difference between highest and the lowest dial readings is the amount of runout.

★If the runout exceeds the service limit, replace the rod.

Rocker Arm Push Rod Runout
Service Limit: TIR 0.5 mm (0.02 in.)

Valve Mechanism Removal/Installation

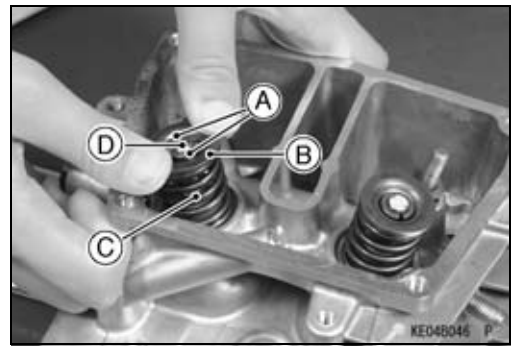


- Remove the cylinder head assembly (see Cylinder Head Assembly Removal in this chapter).

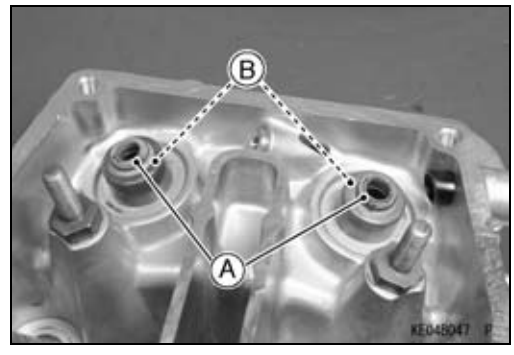
NOTE

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

- Remove:
  Lock Screws [A]
  Valve Clearance Adjusting Nuts [B]
  Rocker Arms [C]



- 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 valve retainer, 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.*
○*Valve guide [B] is not replaceable, do no remove it.*

- Apply engine oil to the valve stem and install the valve.
- Check to see that the valve moves smoothly up and down in the guide.
- Install the spring and the valve retainer.
- Install the valve retainer while push down the valve retainer with the thumbs.
- Soak the valve clearance adjusting nuts and rocker arm in the engine oil.
- Install the rocker arm by using the valve clearance adjusting nuts and lock screws.
- Adjust the valve clearance (see Valve Clearance Adjustment in the Periodic Maintenance chapter).

Cylinder Head

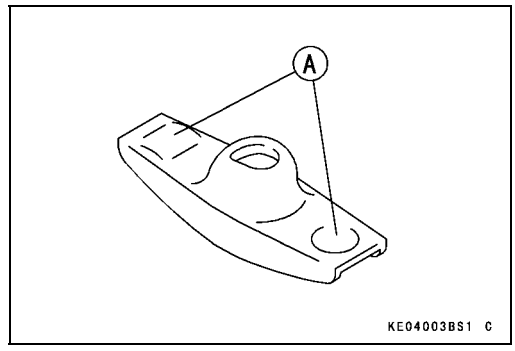
Cleaning and Inspection

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

Rocker Arm Inspection

- 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.



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

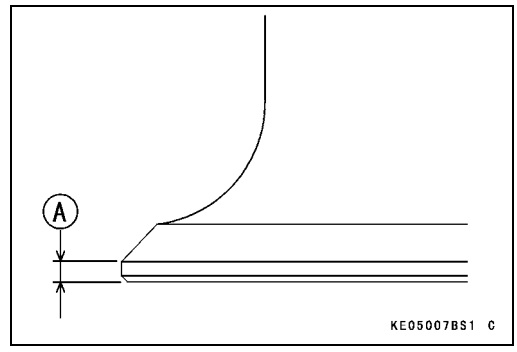
- Refer to the Valve Seat Repair in the Periodic Maintenance chapter.

Valve Head Thickness

- Remove the valve (see Valve Mechanism Removal/Installation in this chapter).
- 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 0.4 mm (0.016 in.)

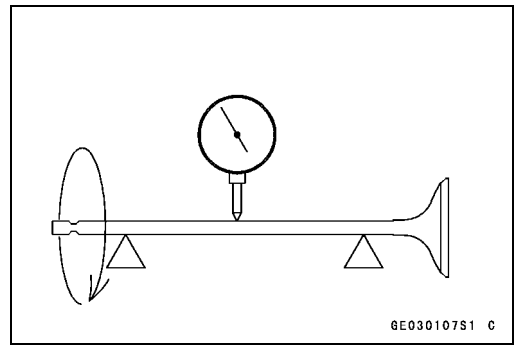


Valve Stem Runout

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

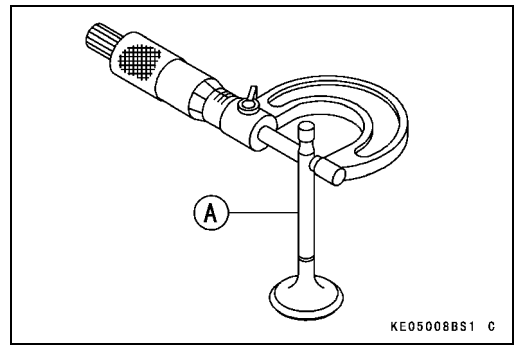


Valve Stem Diameter

- 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 6.95 mm (0.274 in.)
Exhaust 6.93 mm (0.273 in.)



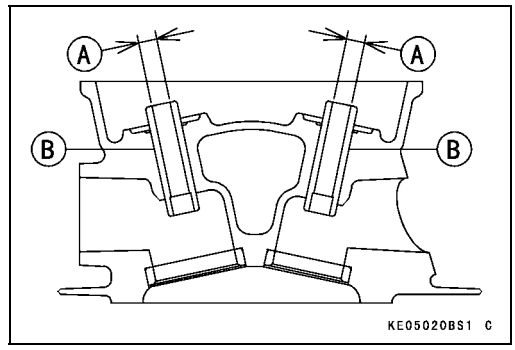
Valves

Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter [A] of the valve guide [B] at 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.)

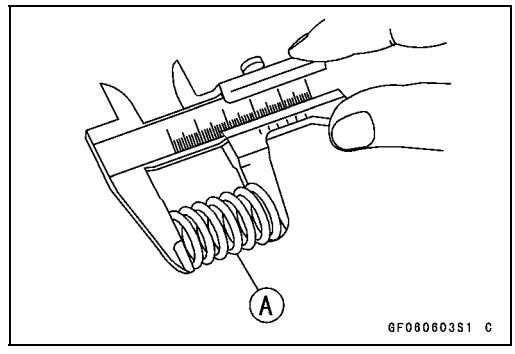


Valve Spring Inspection

- Inspect the valve spring for pitting, cracks, rusting, and burns. 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: 32.6 mm (1.28 in.)



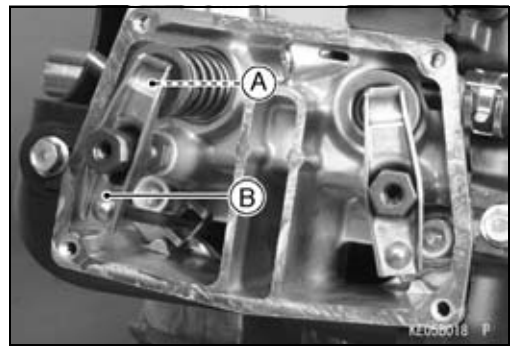
Automatic Compression Release (ACR) Inspection

ACR is the equipment which allows some of the compression pressure to escape, making it easy to turn over the crankshaft during starting.

- Remove:
  Rocker Cover (see Cylinder Head Assembly Removal in this chapter)
  Spark Plug (see Spark Plug Removal in the Electrical System chapter)
- Confirm that the valve clearance is the specified value (see Valve Clearance Adjustment in the Periodic Maintenance chapter).
- Observe the movement of the exhaust valve [A] and rocker arm [B] by turning slowly the crankshaft clockwise.

★If the exhaust valve is not pushed up to open by the rockerarm just after the inlet valve closed, ACR with the camshaft is out of order (see Camshaft Inspection in the Camshaft/Crankshaft chapter).

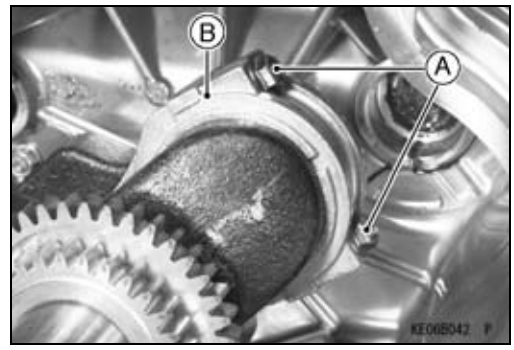
Exhaust Valve Lift by ACR
Standard: 1.1 mm (0.043 in.)



Cylinder, Piston

Piston Removal

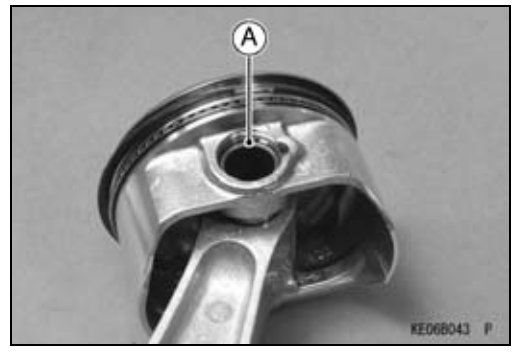
- Remove:
  Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter).
  Camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter).
  Balancer Shaft (see Balancer Shaft Removal in the Camshaft/Crankshaft chapter).
- Turn the crankshaft to expose the connecting rod cap bolts [A].
- Remove the bolts and take off the connecting rod cap [B].



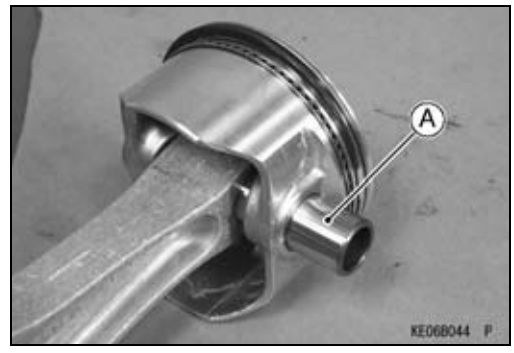
NOTE

○*Note the position of the connecting rod cap for reinstalling the cap.*

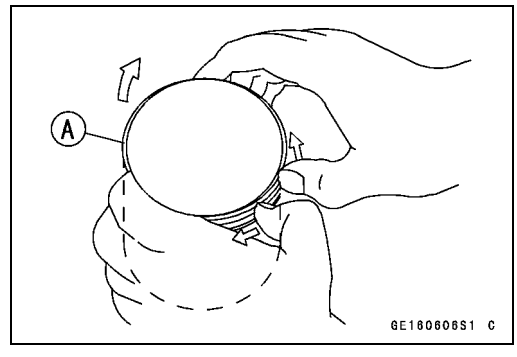
- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.
- Remove one of the piston pin snap rings [A] with needle nose pliers.



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



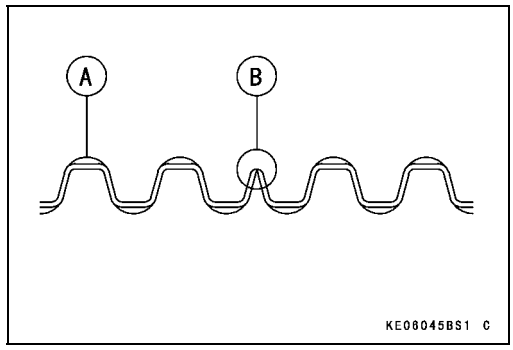
- Carefully spread the ring opening with your thumbs and then push up on the opposite side of the ring [A] to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.



Cylinder, Piston

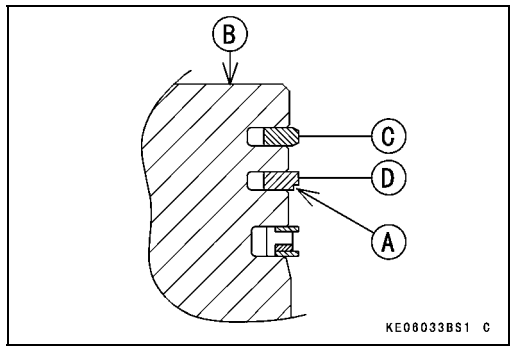
Piston Installation

- 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.



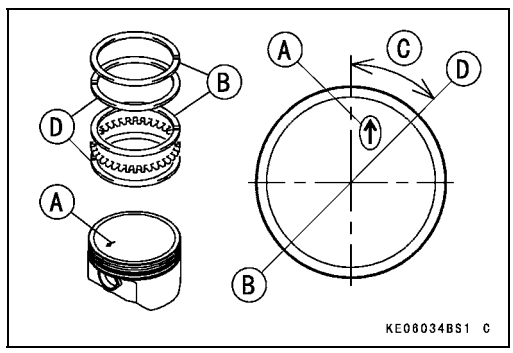
- Do not mix up the top and second rings.
- Install the second ring so that the notched edge [A] faces down.
- Install the top ring.
- The rings should turn freely in the grooves.

  Piston Head [B]
  Top Ring [C]
  Second Ring [D]

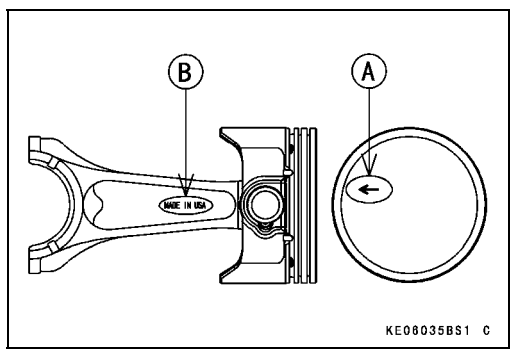


- Align the piston and rings with the piston ring end gap as shown.

  Arrow Match Marks [A]
  Top ring End Gap, Upper Steel Rail End Gap [B]
  About 45° [C]
  Second Ring End Gap, Lower Steel Rail End Gap [D]

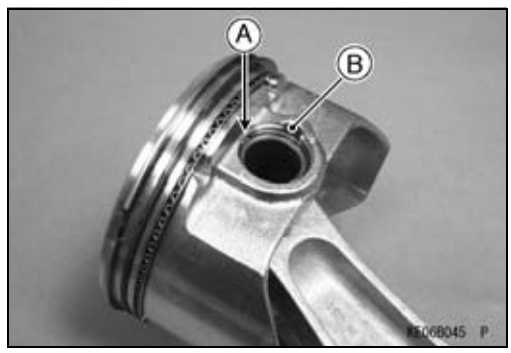


- Apply engine oil to the piston pins.
- Assemble the piston onto the connecting rod so that the arrow mark [A] on the top of the piston can be aligned with “MADE IN USA” [B] on the connecting rod.



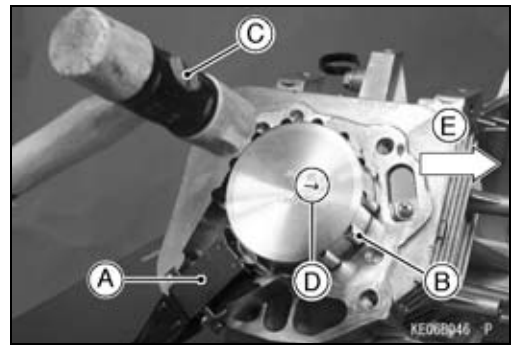
- Fit a new piston pin snap ring into the side of the piston so that the ring opening [A] does not coincide with the notch [B] in the edge of the piston pin hole.

○When installing a piston pin snap ring, compress it only enough to install it and no more.



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

Cylinder, Piston



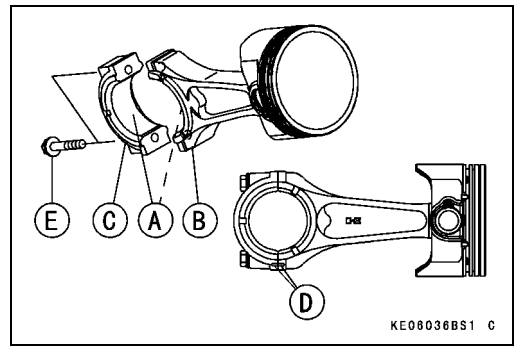
- Apply engine oil to the piston skirt and the cylinder bore.
- Using the piston ring compressor grip [A] and the belt [B], lightly tap the top of the piston with a plastic mallet [C] to insert the piston and connecting rod into the cylinder.

Special Tools - Piston Ring Compressor Grip: 57001-1095
Piston Ring Compressor Belt, ϕ80 ~ ϕ91: 57001-1320

- Facing the arrow mark [D] on the top of the piston toward the flywheel side [E].

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 cap [C].
- Install the connecting rod big end cap in their original position on the connecting rod big end by matching the marks [D].
- Apply a small amount of engine oil to the thread and seating surface of the cap bolts [E].
- Tighten the cap bolts.

Torque - Connecting Rod Big End Cap Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)

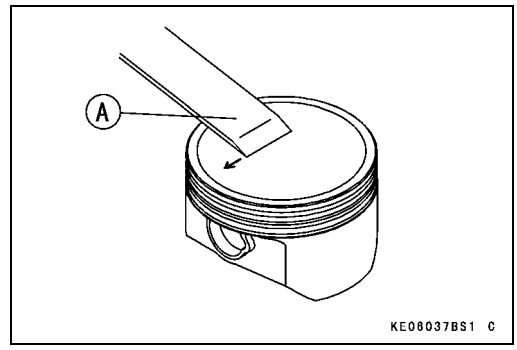
- Install:
  Camshaft (see Camshaft, Tappet Installation in the Camshaft/Crankshaft chapter)
  Crankcase Cover (see Crankcase Cover Installation in the Camshaft/Crankshaft chapter)

Piston Cleaning

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

CAUTION

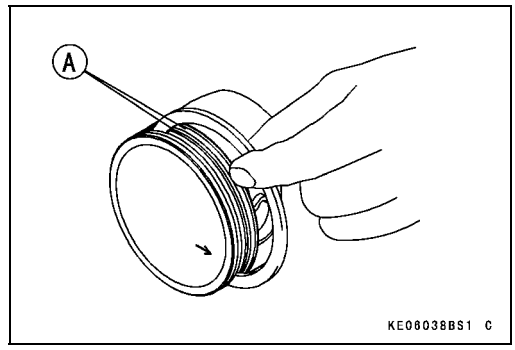
Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.



- 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.

Cylinder, Piston

● Clean the piston ring grooves [A] with a broken piston ring or other suitable tools.

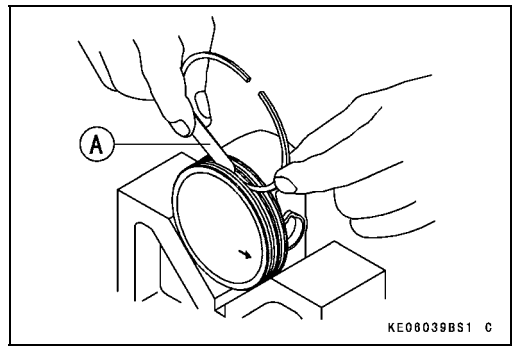


CAUTION

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 in this chapter).
● 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.
● 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.



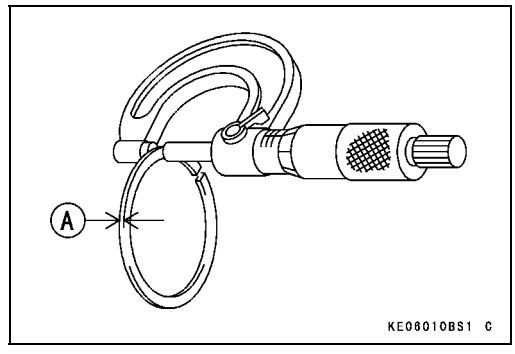
Piston Ring/Groove Clearance
Service Limit:

Top	**0.18 mm (0.00709 in.)**
Second	**0.18 mm (0.00709 in.)**

NOTE

○*The oil ring is a three piece assembled ring. It is difficult to measure the ring groove clearance and thickness, visually inspect only.*

● 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: 1.40 mm (0.0551 in.)
Top, Second

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.*

Cylinder, Piston

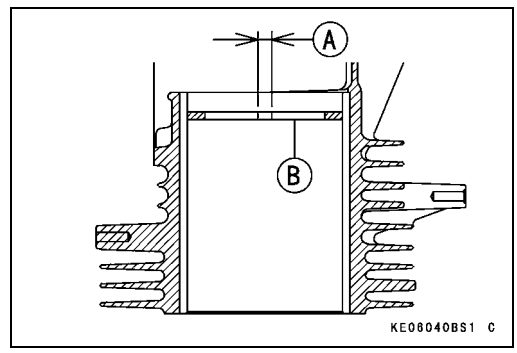
Piston Ring End Gap

- 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 [A] between the ends of the ring [B] with a thickness gauge.

★If the end gap of any ring is greater than the service limit, replace the entire set of rings.



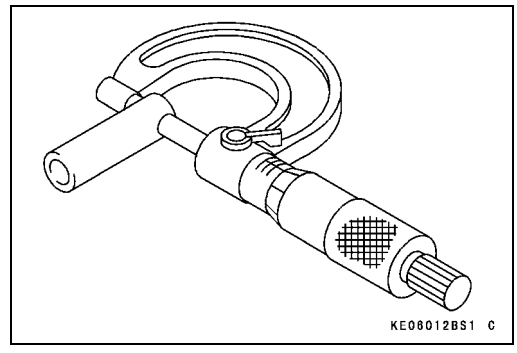
Piston Ring End Gap
Service Limit:

Top	**0.7 mm (0.028 in.)**
Second	**0.8 mm (0.031 in.)**
Oil	**1.0 mm (0.039 in.)**

Piston Pin, Piston Pin Hole, and Connecting Rod Wear

- Remove the piston pin.
- Measure the outside diameter of the piston pin with a micrometer at several points.

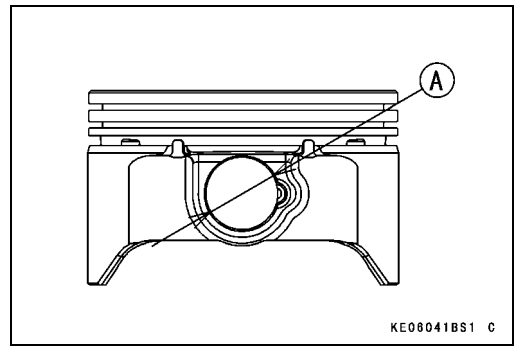
★If the outside diameter is less than service limit, replace the piston pin.



Piston Pin Outside Diameter
Service Limit: 18.96 mm (0.746 in.)

- Measure the inside diameter [A] of the piston pin hole at several points on both side. Use a dial bore gauge.

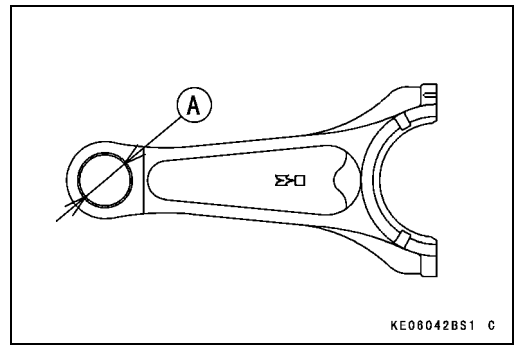
★If the inside diameter is more than the service limit, replace the piston.



Piston Pin Hole Inside Diameter
Service Limit: 19.08 mm (0.751 in.)

- 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: 19.06 mm (0.750 in.)

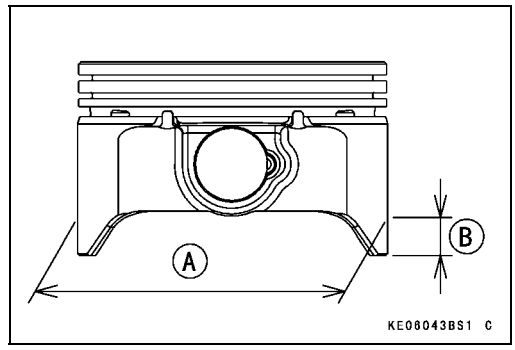
Cylinder, Piston

Piston Diameter

- Measure the outside diameter [A] of the piston 10 mm (0.39 in.) up [B] 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 Diameter
Service Limit: 81.77 mm (3.217 in.)



Cylinder Inside Diameter

- Clean and measure the cylinder inside diameter.

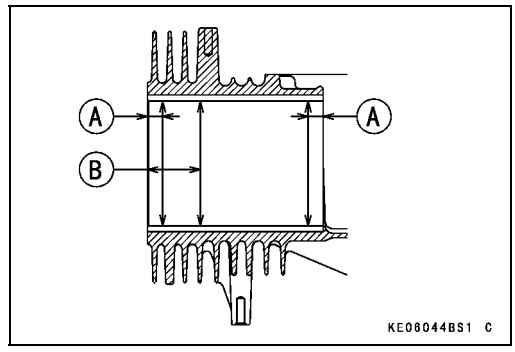
○Use a dial bore gauge to measure front-to-back and side-to-side at the points as shown in the figure.

★If any of the cylinder bore measurements is greater than the service limit, replace the cylinder.

10 mm (0.39 in.) [A]
35 mm (1.38 in.) [B]

Cylinder Inside Diameter
Standard: 81.980 ~ 82.000 mm (3.2276 ~ 3.2283 in.)
Service Limit: 82.10 mm (3.232 in.)

Cylinder Bore Out Round
Service Limit: 0.056 mm (0.0022 in.)



Lubrication System

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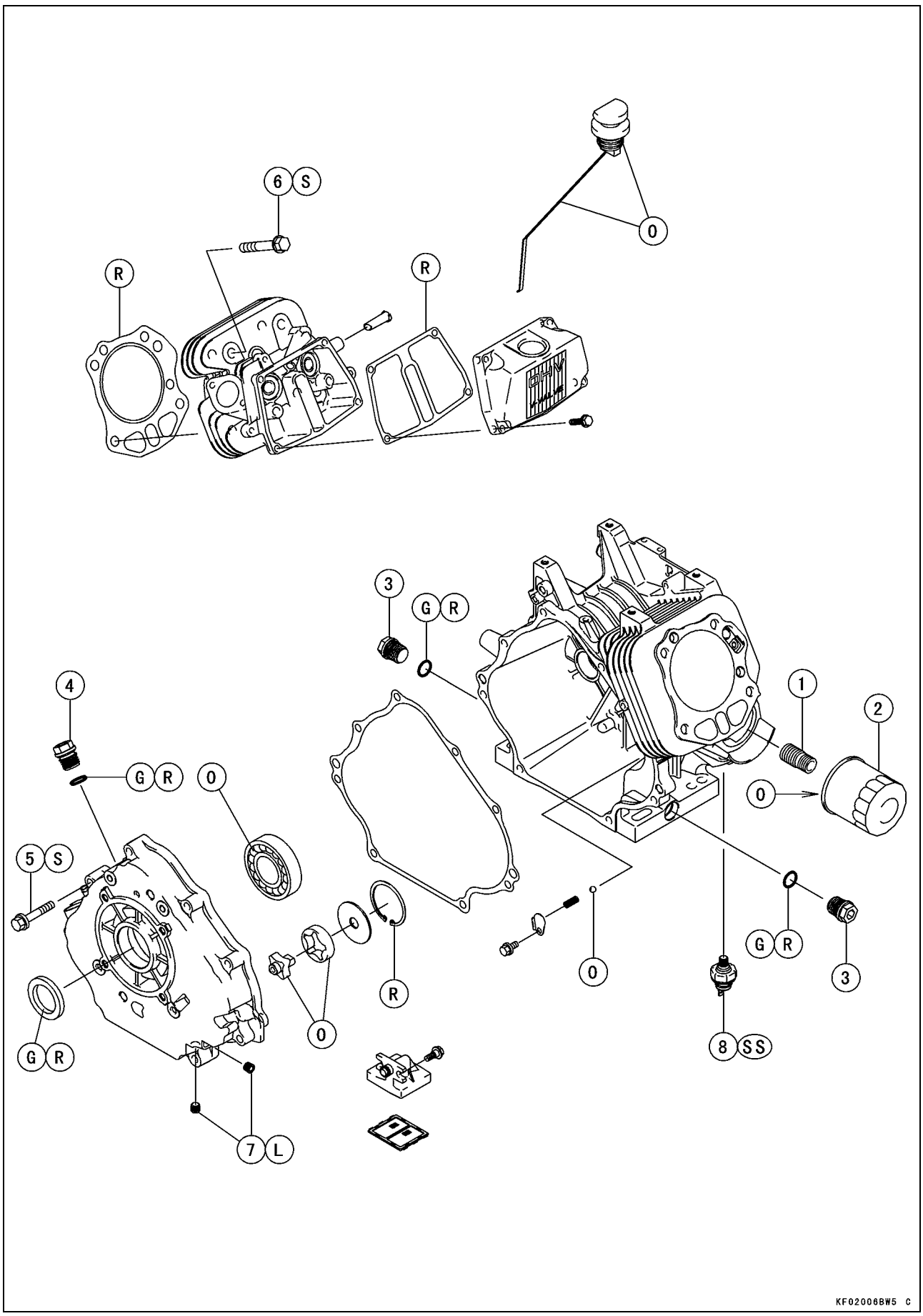
6-2 LUBRICATION SYSTEM

Exploded View

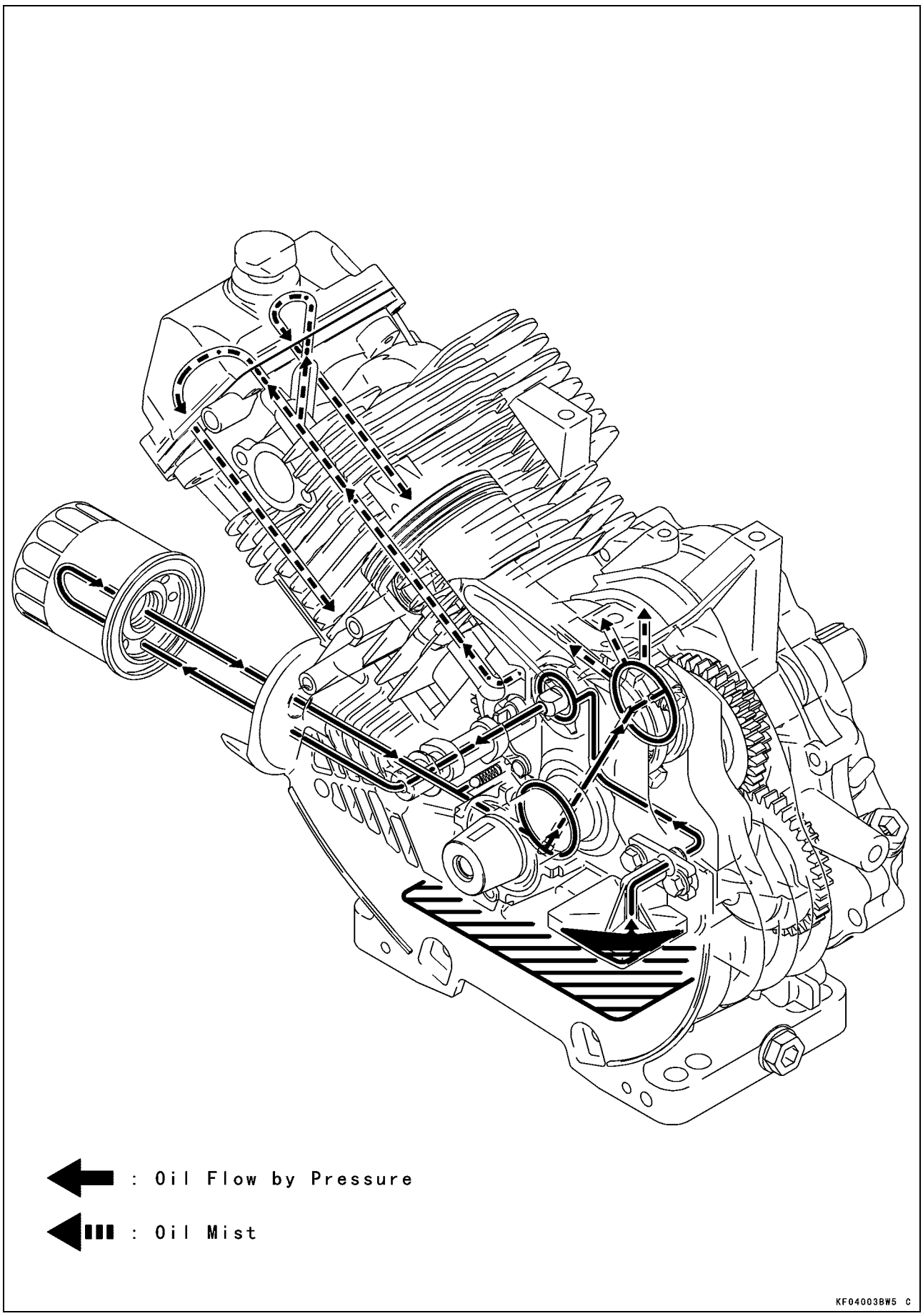


Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Oil Filter Joint	6.9	0.70	61 in·lb	
2	Oil Filter	9.8	1.0	87 in·lb	O
3	Oil Drain Plugs	6.9	0.70	61 in·lb	
4	Crankcase Cover Plug	6.9	0.70	61 in·lb	
5	Crankcase Cover Bolts	21.6	2.2	16	S
6	Cylinder Head Bolts	37	3.8	27	S
7	Oil Line Plugs	3.9	0.40	35 in·lb	L
8	Oil Pressure Switch	9.8	1.0	87 in·lb	SS

G: Apply grease.
L: Apply a non-permanent locking agent to the threads.
O: Apply engine oil.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.
SS: Apply silicone sealant.

Engine Oil Flow Chart



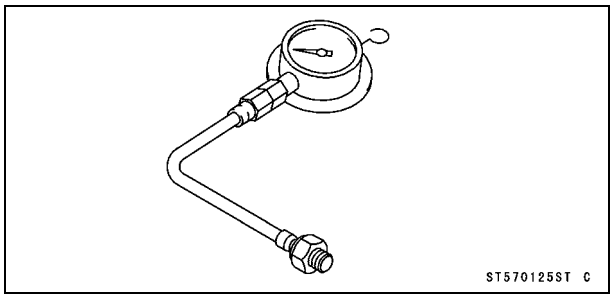
Specifications

Item	Standard
Engine Oil	
Type	SF, SG, SH or SJ class
Viscosity	SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20
Capacity	1.1 L (1.16 US qt) (When filter is not removed)
	1.3 L (1.37 US qt) (When filter is removed)
Level	Operating range (grid area) on dipstick
Oil Pressure	
Low Idle Speed (approx. 50°C)	196 ~ 343 kPa (2.0 ~ 3.5 kgf/cm², 28 ~ 50 psi)
High Idle Speed (approx. 70°C)	343 ~ 490 kPa (3.5 ~ 5.0 kgf/cm², 50 ~ 71 psi)
Oil Pressure Switch	
Detect Pressure	69 ~ 124 kPa (0.7 ~ 1.3 kgf/cm², 10 ~ 18 psi)
Screw	PT 1/8 pipe thread
Oil Filter By-pass Valve Opening	
Pressure	79.3 ~ 113.8 kPa (0.81 ~ 1.16 kgf/cm² 11.5 ~ 16.5 psi)

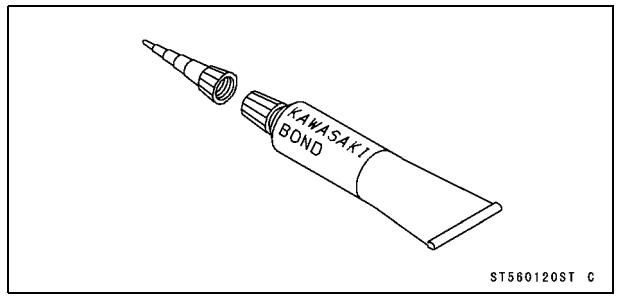
Item	Service Limit
Oil Pump	
Inner and Outer Rotor Clearance	0.20 mm (0.00787 in.)
Outer Rotor Outside Diameter	40.470 mm (1.5933 in.)
Outer Rotor Thickness	9.94 mm (0.391 in.)
Pump Housing Inside Diameter	40.801 mm (1.6063 in.)
Pump Housing Depth	10.160 mm (0.4000 in.)
Pump Shaft Outside Diameter	12.645 mm (0.4978 in.)
Pump Shaft Bearing Inside Diameter	12.811 mm (0.5044 in.)
Relief Valve Spring Free Length	15.70 mm (0.618 in.)

Special Tools and Sealant

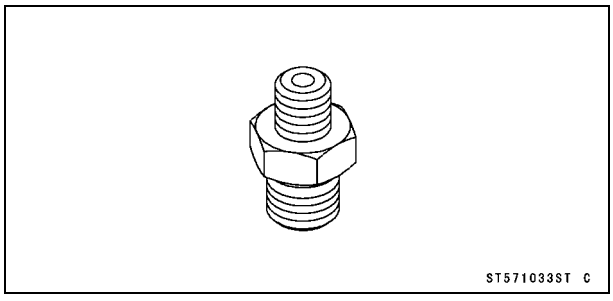
Oil Pressure Gauge, 5 kgf/cm²:
57001-125



Kawasaki Bond (Silicone Sealant):
56019-120



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



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. 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.

Oil Level Inspection

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

Oil Change

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

Oil Filter Replacement

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

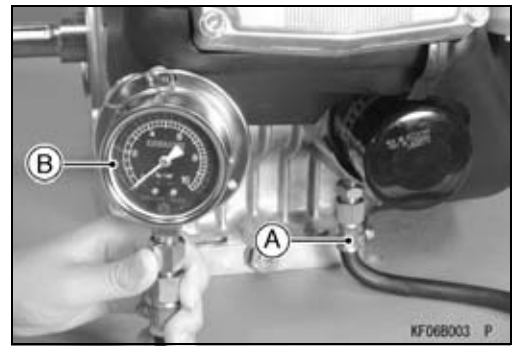
Pressurized Lubrication System

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 pressure relief valve is used between the oil filter and crankshaft bearing on the crankcase to relieve excessive oil pressure by returning excess oil to the crankcase (see Oil Flow Chart).

Oil Pressure Measurement

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

Special Tools - Oil Pressure Gauge, 5 kgf/cm²: 57001-125
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 thread of the oil pressure switch.

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

- Tighten the oil pressure switch.

○Remove excessive sealant after assembling.

★If the oil pressure is below the specification, inspect the oil pump and relief valve (see Oil Pump Inspection and Relief Valve Inspection in this chapter).

★If the oil pump and relief valve are not at fault, inspect the rest of the lubrication system.

Oil Pressure

Low Idle Speed	**196 ~ 343 kPa (2.0 ~ 3.5 kgf/cm², 28 ~ 50 psi)**
High Idle Speed	**343 ~ 490 kPa (3.5 ~ 5.0 kgf/cm², 50 ~ 71 psi)**

Measurement Condition

Engine Oil	**10W-30**
Engine Oil Temperature:	
Low Idle Speed	**approx. 50°C**
High Idle Speed	**approx. 70°C**

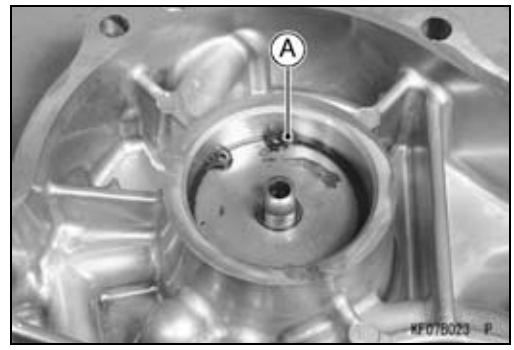
Oil Pressure Switch

Detect Pressure	**69 ~ 124 kPa (0.7 ~ 1.3 kgf/cm², 10 ~18 psi)**
Screw	**PT 1/8 pipe thread**

Oil Pump, Relief Valve

Oil Pump Removal

- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter).
- Remove the circlip [A] and oil pump parts assembly (pump cover plate, inner rotor, and outer rotor).

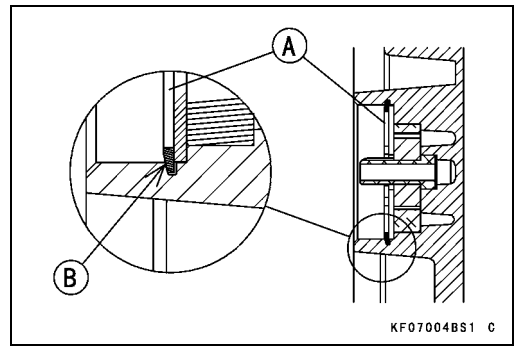


CAUTION
Do not damage camshaft bore with the circlip.

Oil Pump Installation

- Fill the rotor housing with engine oil for initial lubrication.
- Install the pump parts assembly and circlip in the crankcase cover.
- Reinstall pump cover, the same side down.

○Install the circlip [A] with the tapered side out [B], as shown in figure.



CAUTION
Do not damage camshaft bore with the circlip.

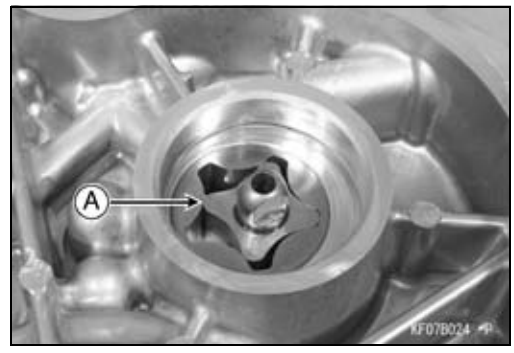
Oil Pump Inspection

- Remove the oil pump (see Oil Pump 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: 0.20 mm (0.00787 in.)

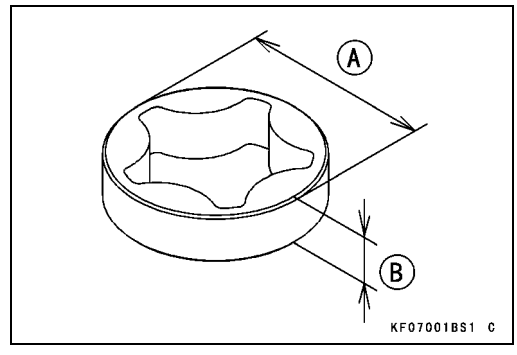
- Measure the outside diameter [A] of the outer rotor with a micrometer at several points.

★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.



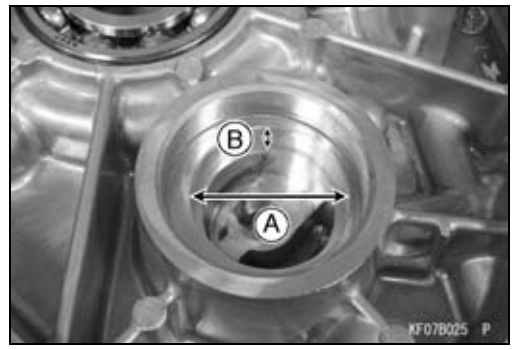
Outer Rotor Thickness
Service Limit: 9.94 mm (0.391 in.)

Oil Pump, Relief Valve

- Measure the inside diameter [A] of the pump housing with an 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.

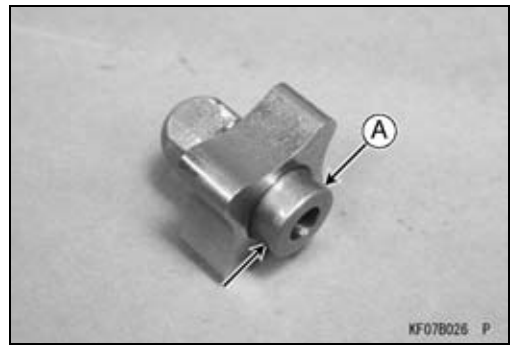
★If any of measurement is more than the service limit, replace the crankcase cover.

Pump Housing Depth
Service Limit: 10.160 mm (0.4000 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: 12.645 mm (0.4978 in.)



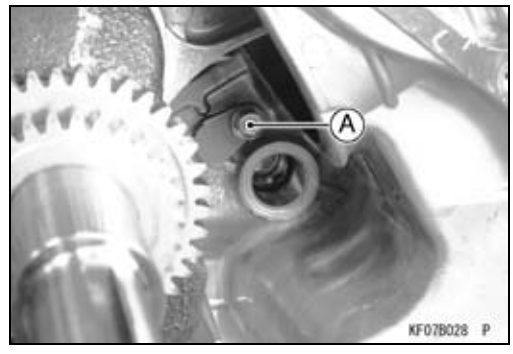
- Measurer the inside diameter [A] of the pump shaft bearing in the crankcase cover with a inside micrometer at several points.

★If the inside diameter is more than the service limit replace the crankcase cover.

Pump Shaft Bearing Inside Diameter
Service Limit: 12.811 mm (0.5044 in.)

Relief Valve Removal

- Remove:
  Camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter)
  Relief Valve Cover Bolt [A]



Relief Valve Installation

- Install the relief valve ball and spring in position and tighten the relief valve cover bolt.

Oil Pump, Relief Valve

Relief Valve Inspection

- Visually inspect the relief valve spring, steel ball and valve seat in the crankcase.

★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.

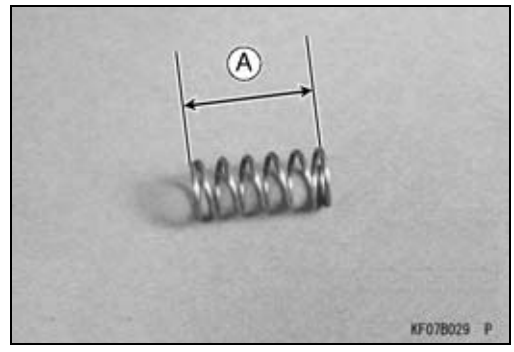
★If cleaning does not solve the problem, replace the relief valve parts.

★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.

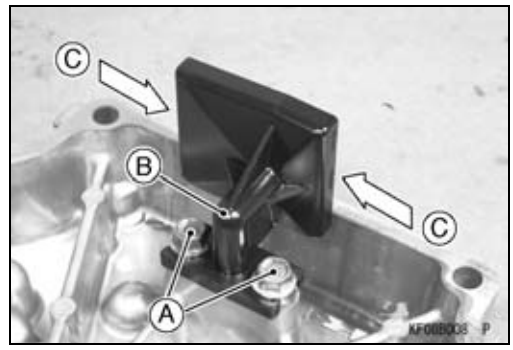
Relief Valve Spring Free Length
Service Limit: 15.70 mm (0.618 in.)



Oil Screen

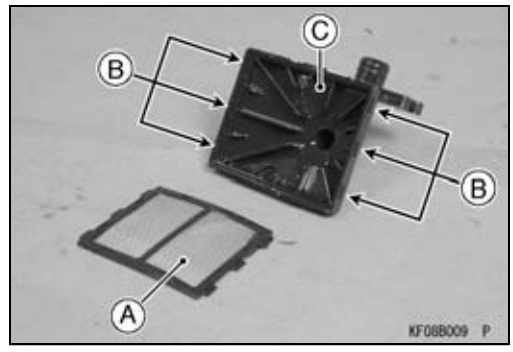
Oil Screen Removal

- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankcase chapter).
- Unscrew the mounting bolts [A] and remove the pipe [B].
- Push [C] the oil screen with thumbs and remove it.



Oil Screen Installation

- Clean the oil screen thoroughly whenever it is removed for any reason.
- Insert the oil screen [A] into slots [B] in the pipe [C], and install the pipe on the crankcase cover with the mounting bolts and spacers.



Cleaning and Inspection

- Clean the oil screen 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 it.

Camshaft/Crankshaft

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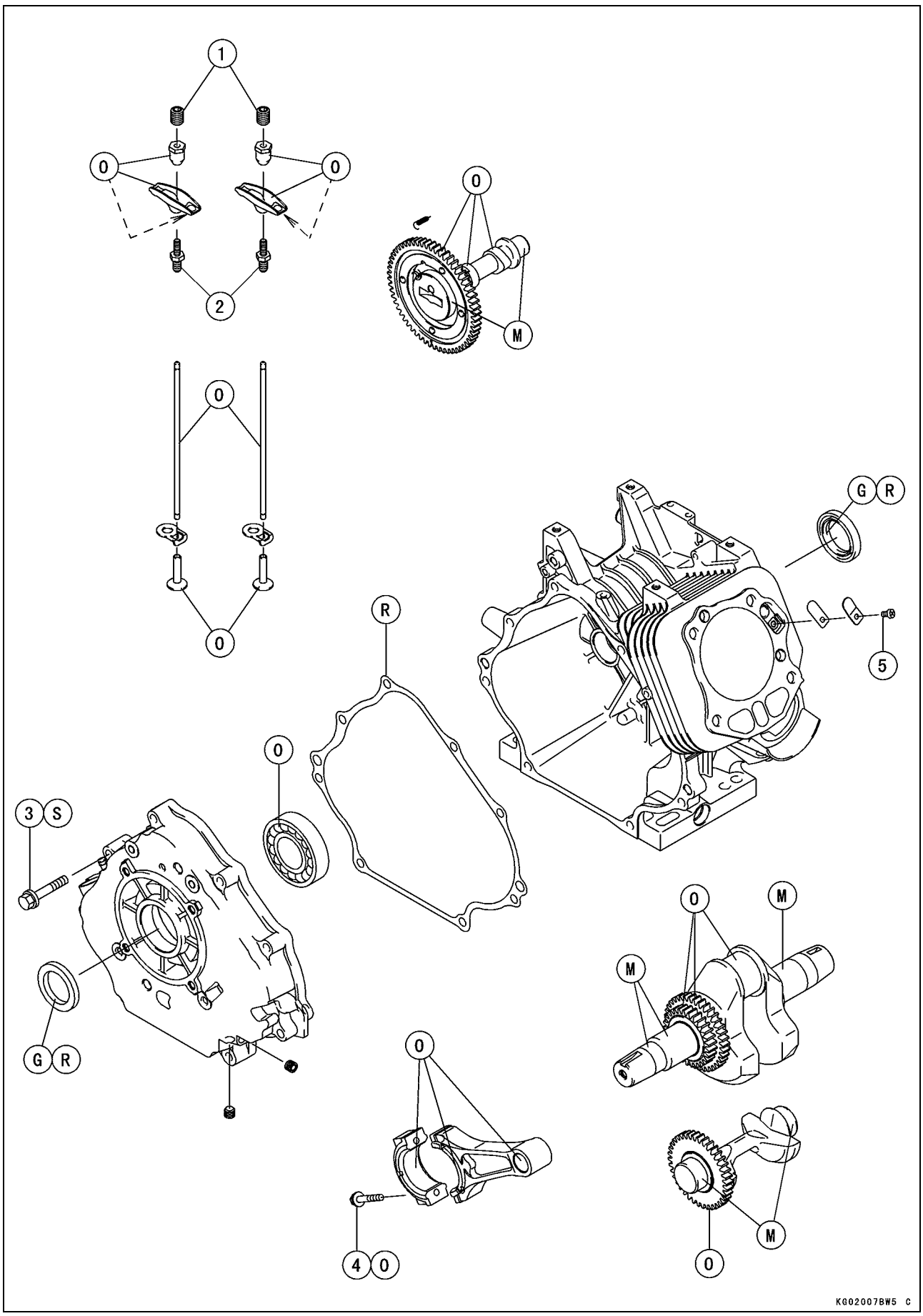
7-2 CAMSHAFT/CRANKSHAFT

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Valve Clearance Lock Screws	6.9	0.70	61 in·lb	
2	Rocker Arm Bolts	28	2.9	21	
3	Crankcase Cover Bolts	21.6	2.2	16	S
4	Connecting Rod Big End Cap Bolts	5.9	0.60	52 in·lb	O
5	Breather Valve Screw	3.4	0.35	30 in·lb	

G: Apply grease.
M: Apply molybdenum disulfide grease.
O: Apply engine oil.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

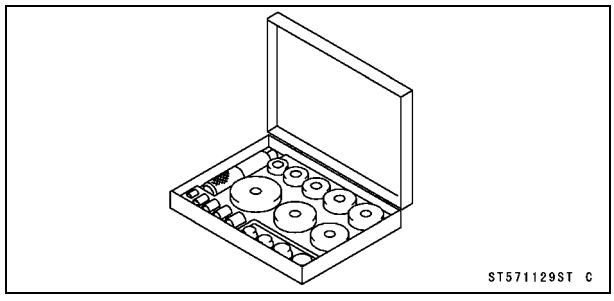
7-4 CAMSHAFT/CRANKSHAFT

Specifications

Item	Service Limit
Camshaft, Tappet	
Cam Lobe Height:	
Inlet	29.86 mm (1.176 in.)
Exhaust	29.86 mm (1.176 in.)
Camshaft Journal Diameter:	
PTO Side	49.93 mm (1.966 in.)
Flywheel Side	19.97 mm (0.786 in.)
Camshaft Bearing Inside Diameter:	
Crankcase	20.07 mm (0.790 in.)
Crankcase Cover	50.09 mm (1.972 in.)
Crankshaft, Connecting Rod	
Connecting Rod Bend	0.2/100 mm (0.008/3.94 in.)
Connecting Rod Twist	0.2/100 mm (0.008/3.94 in.)
Connecting Rod Big End Width	27.0 mm (1.063 in.)
Crankpin Width	28.4 mm (1.112 in.)
Connecting Rod Big End Inside Diameter	43.08 mm (1.696 in.)
Crankpin Outside Diameter	42.95 mm (1.691 in.)
Crankshaft Runout	TIR 0.05 mm (0.002 in.)
Crankshaft Journal Diameter:	
Flywheel Side	34.978 mm (1.377 in.)
Crankcase	
Crankshaft Bearing Inside Diameter:	
Crankcase	35.055 mm (1.380 in.)
Balancer Shaft	
Balancer Shaft Journal Diameter	31.935 mm (1.258 in.)
Balancer Shaft Bearing Inside Diameter:	
Crankcase Cover	32.06 mm (1.262 in.)
Crankcase	32.06 mm (1.262 in.)

Special Tool

Bearing Driver Set:
57001-1129

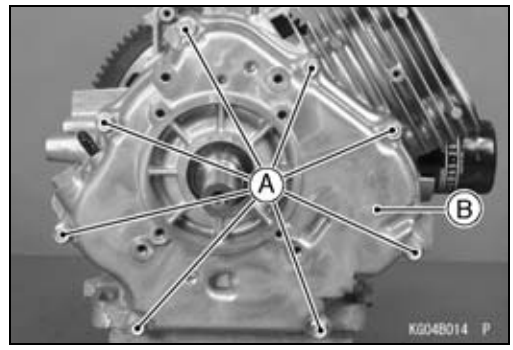


Crankcase

Crankcase Cover Removal

- Drain the oil (see Oil Change in the Periodic Maintenance chapter).
- Unscrew the mounting bolts [A] and remove the crankcase cover [B] from the crankcase.

○There are two dowel pins on the crankcase mating surface. To loosen the crankcase cover, gently tap it with wooden or plastic mallet.

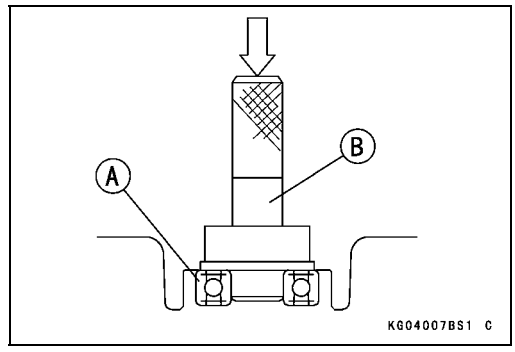


CAUTION

Do not remove the ball bearing or the oil seal unless it is necessary. If removed, replace it with a new one.

- Remove the oil seal with a screw driver.
- Using the bearing driver set [B] push out the ball bearing [A].

Special Tool - Bearing Driver Set: 57001-1129



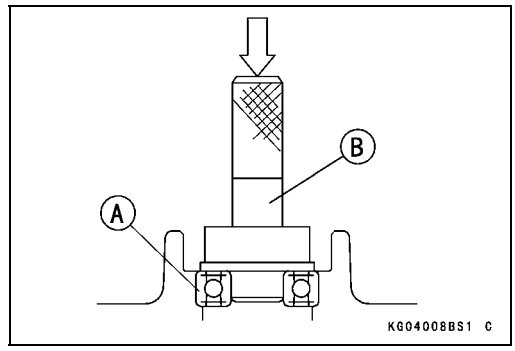
Crankcase Cover Installation

- Scrape off the old gasket from the mating surfaces of the crankcase and the cover.
- With a high-flash point solvent, clean off the mating surfaces of the crankcase and the cover, and wipe dry.

⚠ WARNING

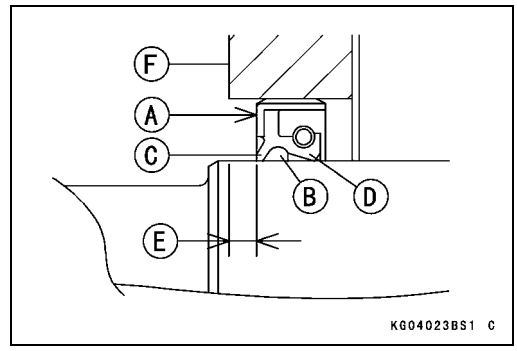
Clean the crankcase and cover in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean parts. A fire or explosion could result.

- Clean the bearing housing.
- Apply oil to a new ball bearing [A].
- Using the bearing driver set [B], install the new ball bearing until it stops at the bottom of its housing.

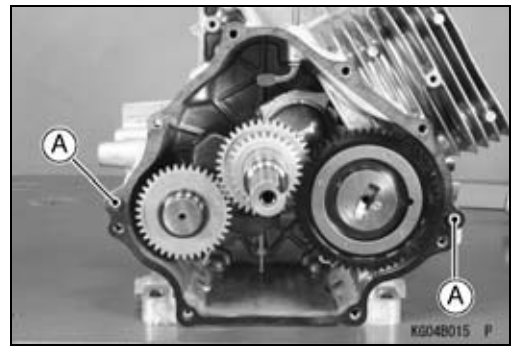


Crankcase

● Be sure to replace any oil seal removed with a new seal.
○Install the oil seal so that the marks [A] face out.
○Pack high temperature grease [B] to 60% volume into the space between the seal lip [C] and dust lip [D]. Press in the new oil seal 4 ~ 4.5 mm (0.16 ~ 0.18 in.) [E] below the crankcase cover surface [F] using a press or suitable tools. Do not damage the seal lip.



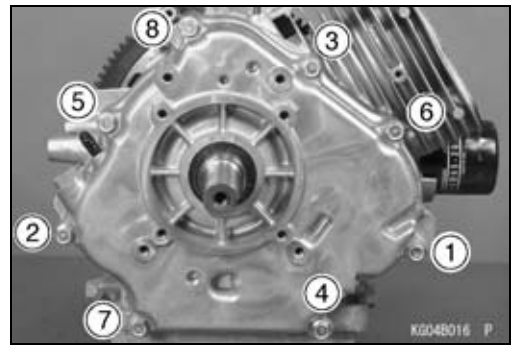
● Check to see that the crankcase dowel pins [A] are in place on the crankcase.
● Install the gasket on the crankcase.



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

Torque - Crankcase Cover Bolts: 21.6 N·m (2.2 kgf·m, 16 ft·lb)

○Do not turn one bolt down completely before the others, as it may cause the crankcase cover to warp.



Inspection

● Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase at several points. Replace the crankcase if the inside diameter is more than the service limit.

Crankshaft Bearing Inside Diameter
Service Limit: 35.055 mm (1.380 in.)

Crankcase

Cleaning

- Remove:
  Camshaft and Tappets (see Camshaft, Tappet Removal in this chapter)
  Crankshaft (see Crankshaft Removal in this chapter)
  Balancer Shaft (Balancer Shaft Removal in this chapter)
- Clean up the crankcase and cover with a high-flash point solvent, and blow out any foreign particles that may be in the pockets inside of the crankcase with compressed air.

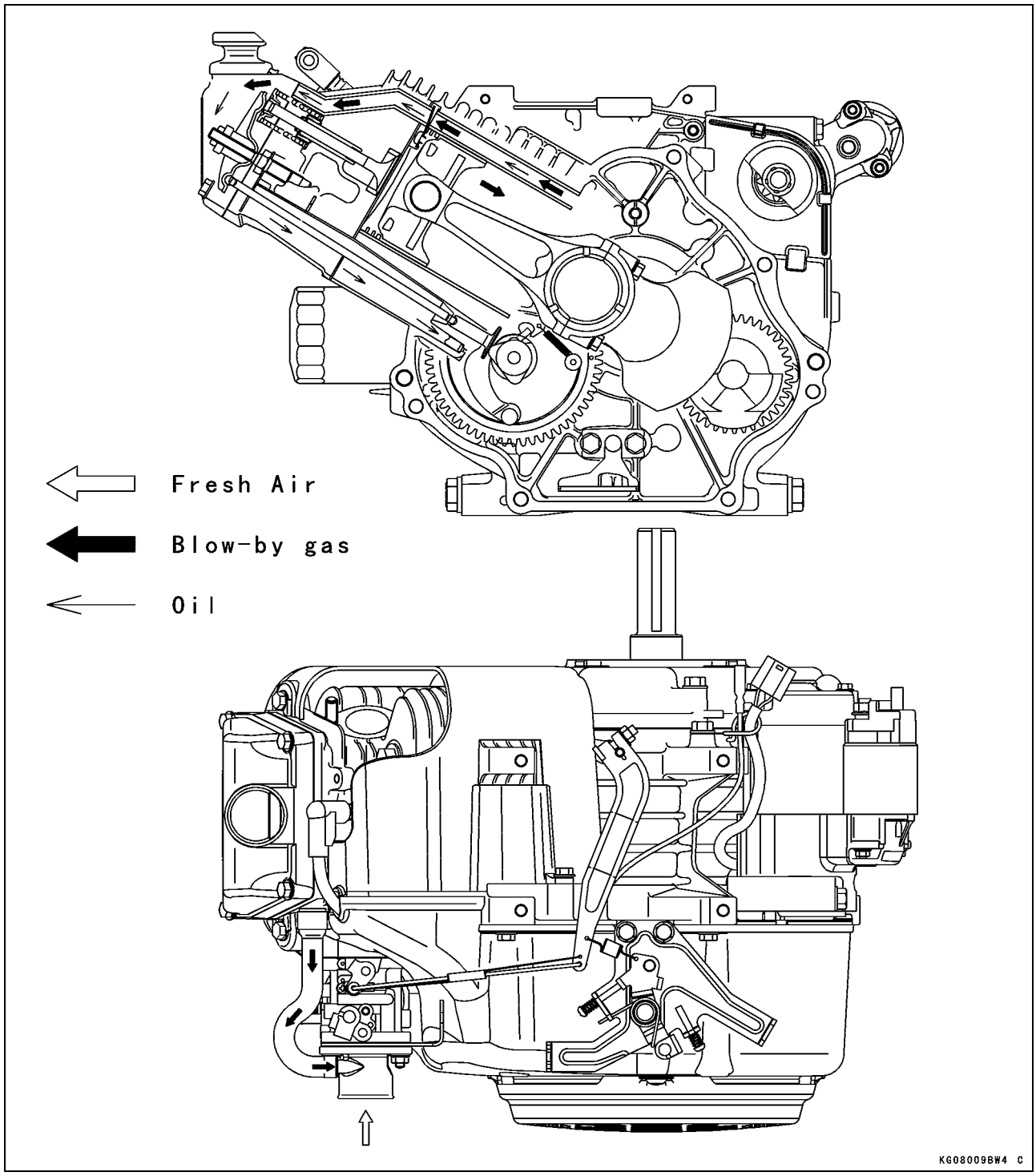
⚠ WARNING

Clean the crankcase and cover 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 washing.

Breather

The function of the breather is to create a negative pressure in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. A sealed-type crankcase emission control system is used to prevent blow-by gases from emitting in the air. The blow-by gases are drawn into the clean side of the air cleaner through the crankcase and the cylinder head and mixed with the clean air flow, and subsequently comes into the combustion chamber through the carburetor.

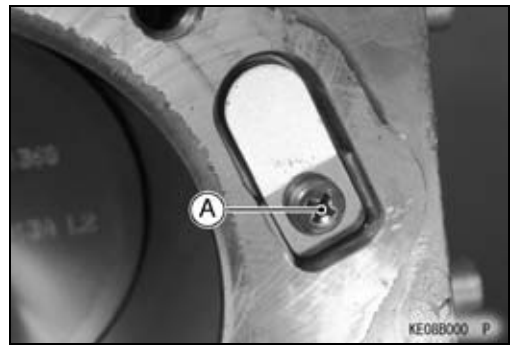
Oil is primarily separated from the gases while passing through the inside of the rocker chamber from the crankcase, and secondly separated from the gases in the breather chamber, and then brought back to the crankcase.



Breather

Breather Valve Removal

- Remove the cylinder head assembly (see Cylinder Head Assembly Removal in the Engine Top End chapter).
- Unscrew the breather valve screw [A].

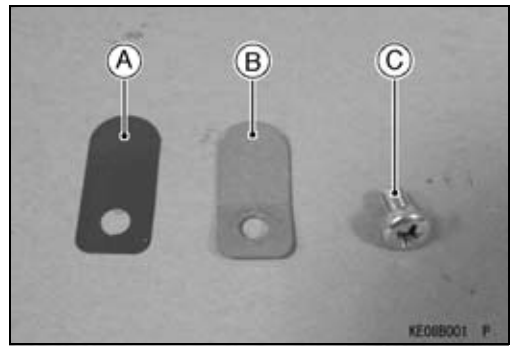


Breather Valve Installation

- Install the reed valve [A] and back plate [B] , Then tighten the breather valve screw [C].

  Torque - Breather Valve Screw: 3.4 N·m (0.35 kgf·m, 30 in·lb)

- Install the cylinder head assembly (see Cylinder Head Assembly Installation in the Engine Top End chapter).



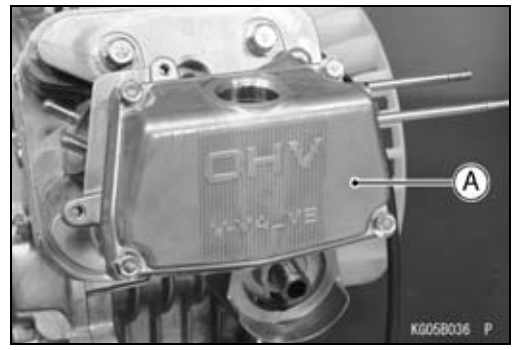
Breather Valve Inspection

- Remove the breather valve (see Breather Valve Removal in this chapter).
- 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.
- Align center of the valve seat with center of the reed valve and back plate, then tighten the breather valve screw.

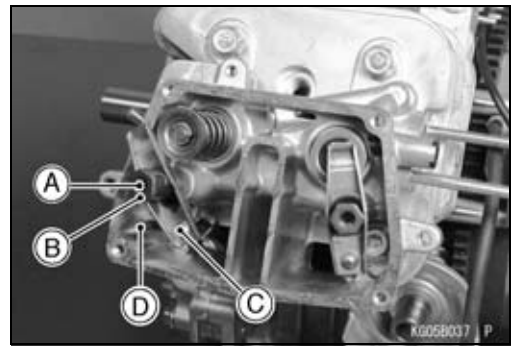
Camshaft, Tappet

Camshaft, Tappet Removal

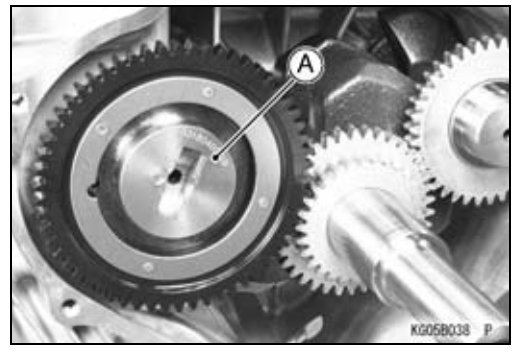
- Drain the oil (see Oil Change in the Periodic Maintenance chapter).
- Remove:
  Crankcase Cover (see Crankcase Cover Removal in this chapter)
  Rocker Cover [A]



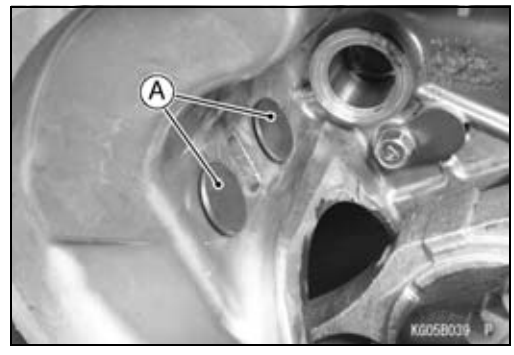
- Position the piston TDC at the end of the compression stroke.
- Remove the lock screws [A] and the valve clearance adjusting nuts [B] which are installed on the rocker arms [C], and pull the rocker arms off the push rods [D].
- Remove the push rods and mark them so they can be installed in their original positions during assembly.



- Pull the camshaft [A] 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
- Install the tappets in their original positions.
- Align the punch marks [A] on the crankshaft gear and on the camshaft gear.

Camshaft, Tappet

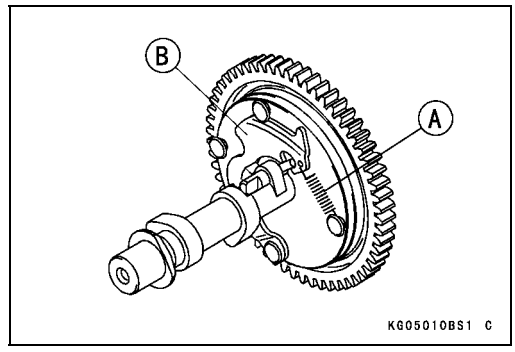
- Install the crankcase cover (see Crankcase Cover Installation in this chapter).
- Install the push rods (see Push Rod Installation in the Engine Top End chapter).
- Mount the rocker arms on the push rods, and install the valve clearance adjusting nuts and the lock screws.

Torque - Valve Clearance Lock Screws: 6.9 N·m (0.70 kgf·m, 61 in·lb)

- Adjust the valve clearance (see Valve Clearance Adjustment in the Periodic Maintenance chapter).
- Install the rocker cover.

Camshaft Disassembly

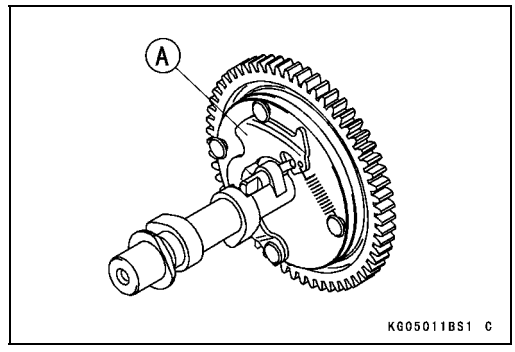
- Remove the governor assembly (see Governor Assembly Removal/Inspection in the Fuel System chapter).
- Remove:
  Spring [A]
- Do not remove the ACR (Automatic Compression Release) weight [B].



Camshaft Assembly

- Install the governor assembly (see Governor Assembly Installation in the Fuel System chapter).
- After assembling the camshaft, check the following items.

○While shaking the camshaft, ACR weight [A] swings smoothly.



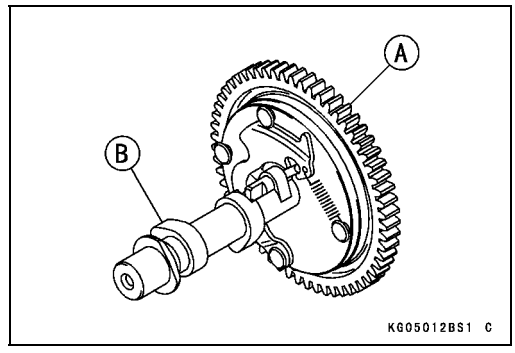
Camshaft Inspection

- 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.

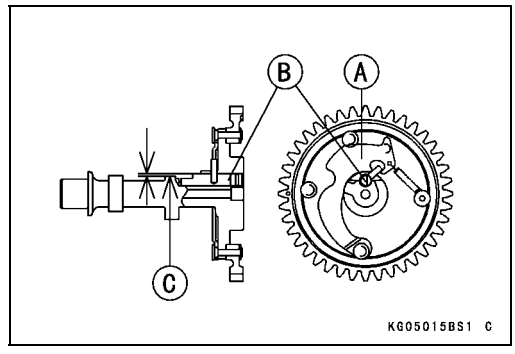


- Inspect the camshaft to make sure that its Automatic Compression Release (ACR) function operates smoothly and does not have any damage or abnormal wear.

★If ACR parts are worn, replace the camshaft.

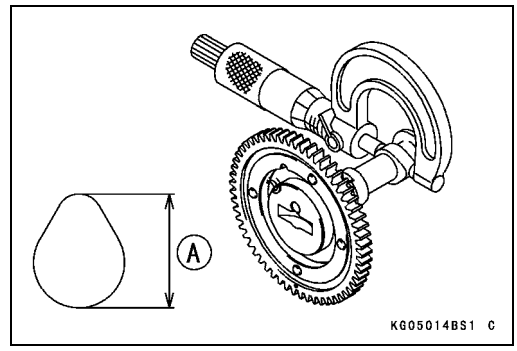
★When the weight [A] is closed, if the top of the shaft [B] is lower than the base [C], replace the camshaft with a new one.

★When weight is pulled entirely outward with your finger, if the top of the shaft is higher than the cam base, replace the camshaft with a new one.



Camshaft, Tappet

Camshaft Bearing/Journal Wear

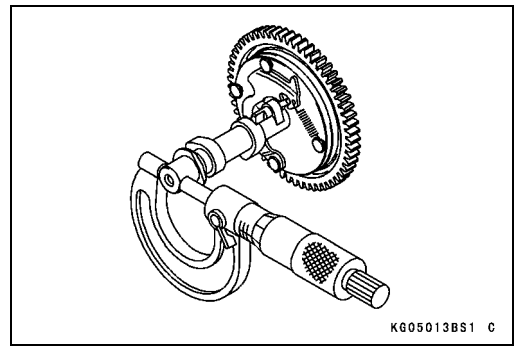


- Measure the height of each cam lobe [A].

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

Cam Lobe Height
Service Limit:

Inlet	**29.86 mm (1.176 in.)**
Exhaust	**29.86 mm (1.176 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.

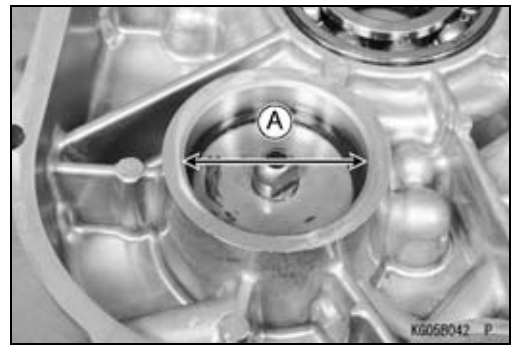
PTO Side Camshaft Journal Diameter
Service Limit: 49.93 mm (1.966 in.)

Flywheel Side Camshaft Journal Diameter
Service Limit: 19.97 mm (0.786 in.)

- Measure the inside diameter [A] of the camshaft bearing on the crankcase at several points.

★Replace the crankcase if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase)
Service Limit: 20.07 mm (0.790 in.)



- Measure the inside diameter [A] of the camshaft bearing on the crankcase cover at several points.

★Replace the crankcase cover if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase Cover)
Service Limit: 50.09 mm (1.972 in.)

Crankshaft, Connecting Rod

Connecting Rod Removal

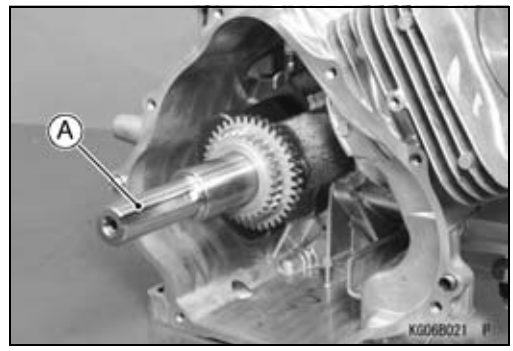
- Refer to the Piston Removal in the Engine Top End chapter.

Connecting Rod Installation

- Refer to the Piston Installation in the Engine Top End chapter.

Crankshaft Removal

- Drain the oil (see Oil Change in the Periodic Maintenance chapter).
- Remove:
  Flywheel (see Flywheel Removal in the Electrical System chapter)
  Camshaft (see Camshaft, Tappet Removal in this chapter)
  Balancer shaft (see Balancer shaft Removal in this chapter)
  Connecting Rod Cap (see Piston Removal in the 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

- Check that the pivot arm for the governor is installed (see Governor Arm Installation in the Fuel System chapter).
- Clean up the crankshaft and crankcase thoroughly, especially at the bearing contact surfaces.
- Pack some amount of high temperature grease to 60% volume between the lips of the oil seal on the crankcase. Press in the new oil seal 0 ~ 1 mm (0 ~ 0.04 in.) below the crankcase surface.
- Apply engine oil to the PTO side, journal crank pin and bearing.
- Insert the crankshaft into the crankcase.

Cleaning/Inspection

- After removing, clean the crankshaft and connecting rods with a high-flash point washing and dry them with compressed air.
- Inspect the teeth of the crankshaft gear for pitting, fatigue cracks, burrs and evidence of improper tooth contact.

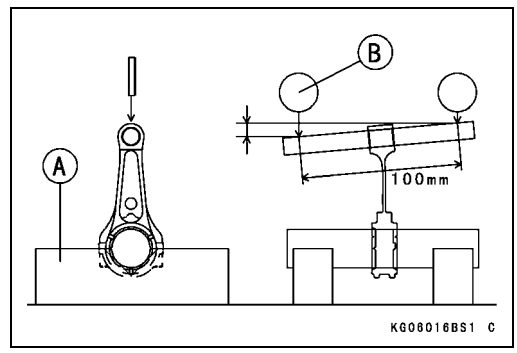
★Replace the gear if necessary.

- 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 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.

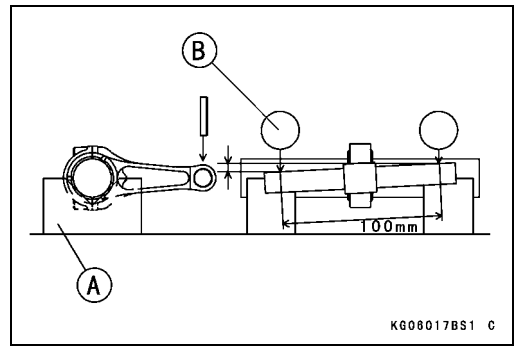
○Select an arbor of the same diameter as the piston pin and at least 100 mm long, and insert the arbor through the connecting rod small end.

○On a surface plate, set the big-end arbor on V blocks [A].

○With the connecting rod held vertically, use a height gauge [B] 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.)



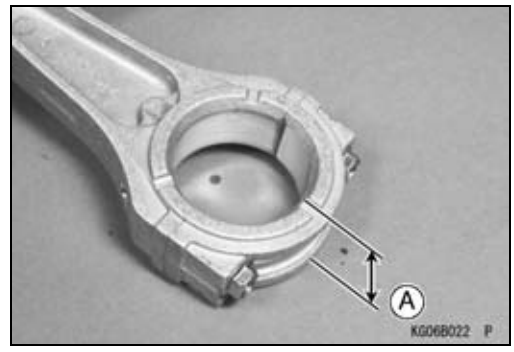
- Measure connecting rod twist.

○With the big-end arbor still on the V blocks [A], hold the connecting rod horizontally and measure the amount that the small end arbor varies from being parallel with the surface plate over a 100 mm length of the arbor to determine the amount of connecting rod twist by using a height gauge [B].

★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.)

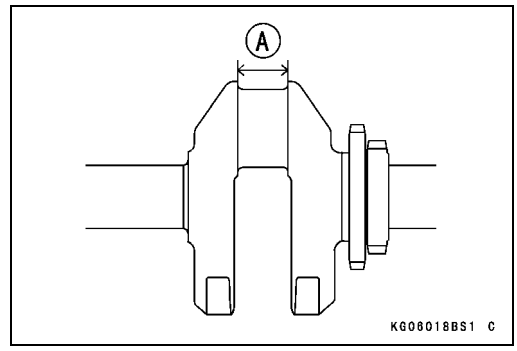
Connecting Rod Big End/Crankpin Width Wear



- 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: 27.0 mm (1.063 in.)



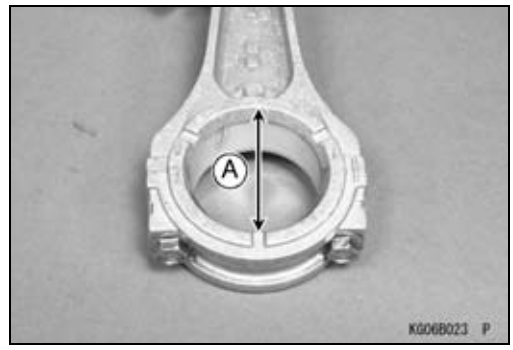
- Measure the crankpin width [A] with a dial caliper.

★If the crankpin width is more than the service limit, replace the crankshaft.

Crankpin Width
Service Limit: 28.4 mm (1.112 in.)

Crankshaft, Connecting Rod

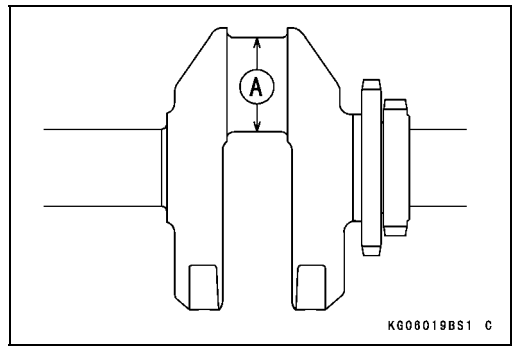
Connecting Rod Big End Bearing/Crankpin Wear



- Apply a thin 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 big end 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: 43.08 mm (1.696 in.)



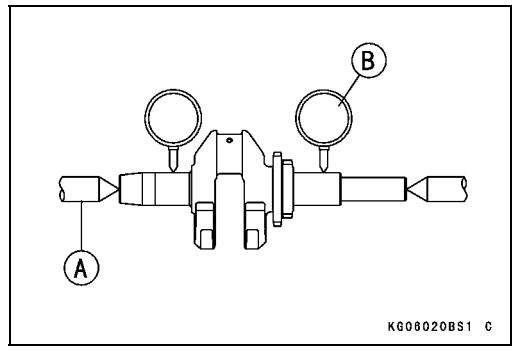
- Measure the crankpin outside diameter [A].

○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: 42.95 mm (1.691 in.)

Crankshaft Runout



- Measure the crankshaft runout.

○Set the crankshaft in a flywheel alignment jig [A] or on V blocks gauge.

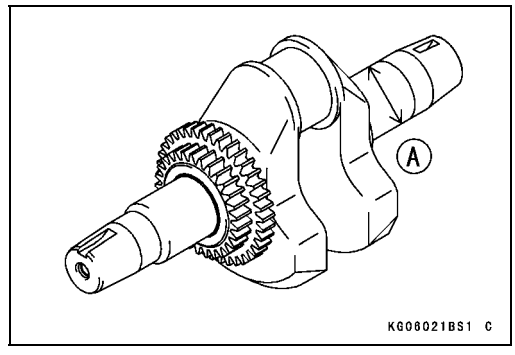
○Set a dial gauge [B] against both bearing journals.

○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.

Flywheel Side Crankshaft Journal Diameter [A]
Service Limit: 34.978 mm (1.377 in.)

Balancer Shaft

Balancer Shaft Removal

- Remove:
  Crankcase Cover (see Crankcase Cover Removal in this chapter).
  Balancer Shaft [A].

Balancer Shaft Installation

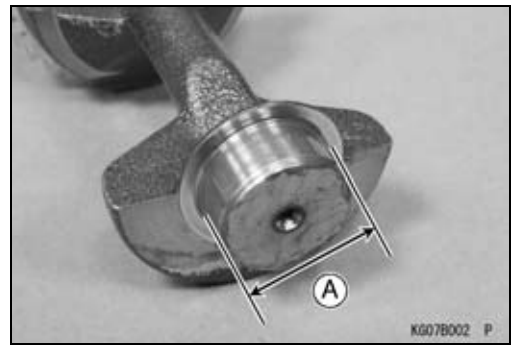
- Install the balancer shaft [A] to the balancer shaft bearing on the crankcase.
- Install the crankcase cover (see Crankcase Cover Installation in this chapter).
- Align the punch marks [A] on the crankshaft gear and on the balancer shaft gear.

Balancer Shaft Bearing/Journal Wear

- Measure both balancer shaft journals diameter [A] at several points around the journal circumference.

★If journal diameter is less than the service limit, replace the balancer shaft with a new one.

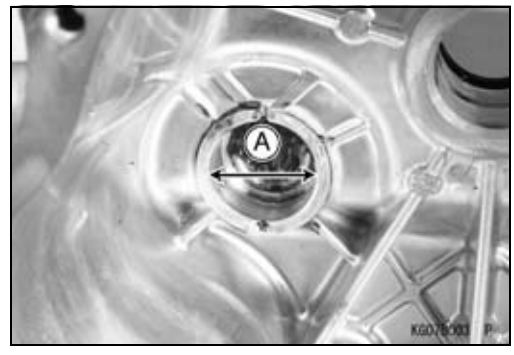
Balancer Shaft Journal Diameter
Service Limit: 31.935 mm (1.258 in.)



- Measure the inside diameter [A] of the balancer shaft bearing on the crankcase at several points.

★If inside diameter is more than the service limit, replace the crankcase with a new one.

Balancer Shaft Bearing Inside Diameter (Crankcase)
Service Limit: 32.06 mm (1.262 in.)



- Measure the inside diameter [A] of the balancer shaft bearing on the crankcase cover at several points.

★If inside diameter is more than the service limit, replace the crankcase cover with a new one.

Balancer Shaft Bearing Inside Diameter (Crankcase cover)
Service Limit: 32.06 mm (1.262 in.)

Electrical System

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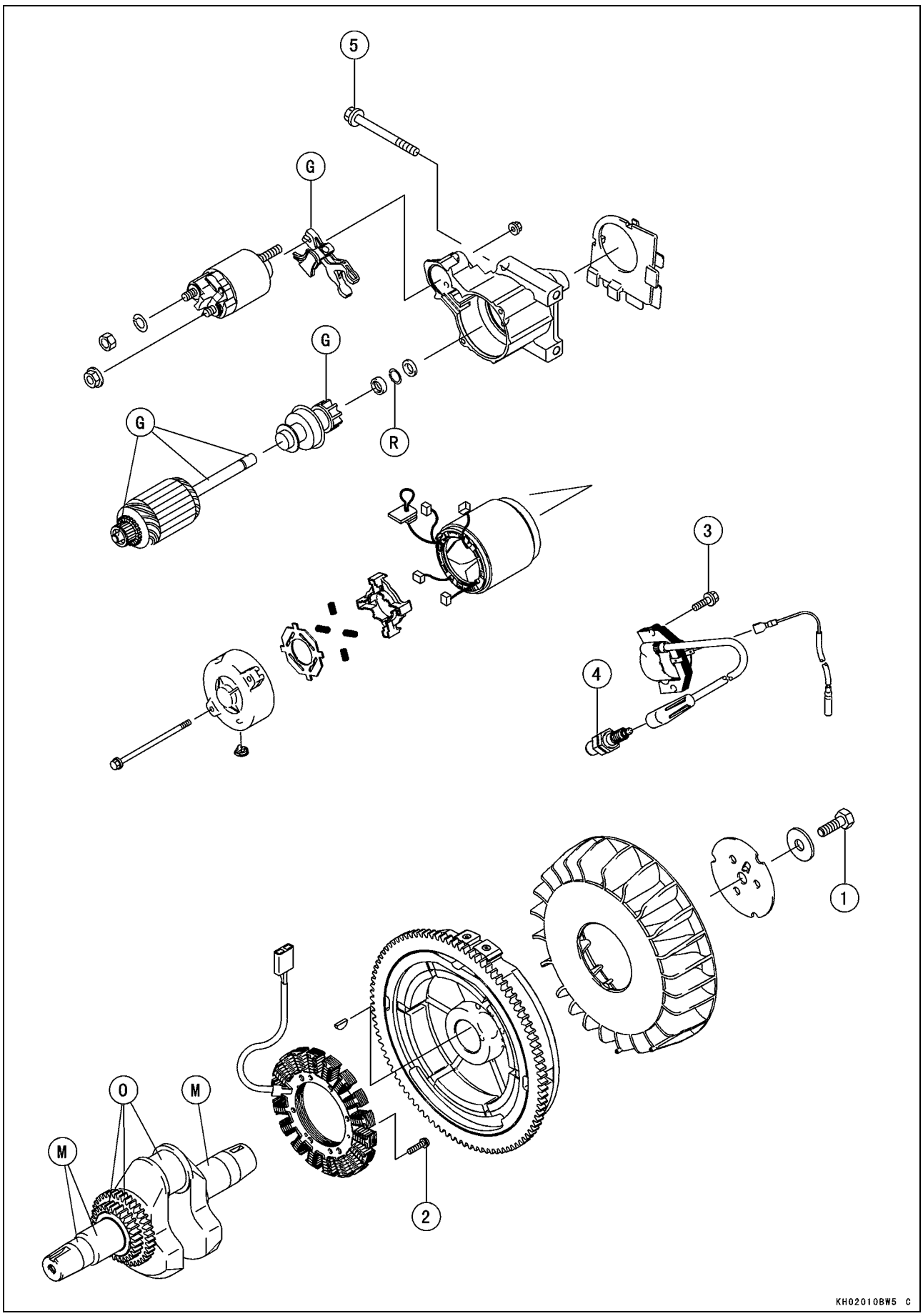
Exploded View



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 Bolts	5.9	0.60	52 in·lb	
4	Spark Plug	22	2.2	16	
5	Starter Motor Mounting Bolts	20	2.0	15	

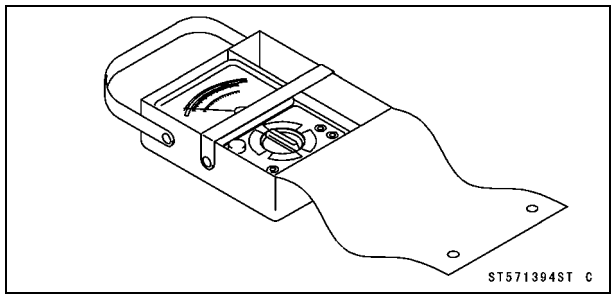
G: Apply grease.
M: Apply molybdenum disulfide grease.
O: Apply engine oil.
R: Replacement Parts

Specifications

Item	Standard	Service Limit
Charging System		
Alternator Stator Coil Resistance	0.01 ~ 0.1 Ω	– – –
Unregulated Stator Output	28.4 V AC/3 000 rpm	26 V AC/3 000 rpm
Ignition System		
Ignition Coil:		
Coil Air Gap	0.2 ~ 0.4 mm (0.0079 ~ 0.0157 in.)	– – –
Primary Winding Resistance	in the text	– – –
Secondary Winding Resistance	8 ~ 11 kΩ	– – –
Spark Plug:	NGK BPR5ES	– – –
Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)	– – –
Electric Stater System		
Starter Motor:		
Carbon Brush Length	10 mm (0.394 in.)	6.0 mm (0.236 in.)
Commutator Groove Depth	0.5 ~ 0.8 mm (0.02 ~ 0.031 in.)	0.2 mm (0.008 in.)
Commutator Outside Diameter	28 mm (1.102 in.)	27 mm (1.063 in.)
Commutator Runout	– – –	0.4 mm (0.016 in.)

Special Tool

Hand Tester:
57001-1394



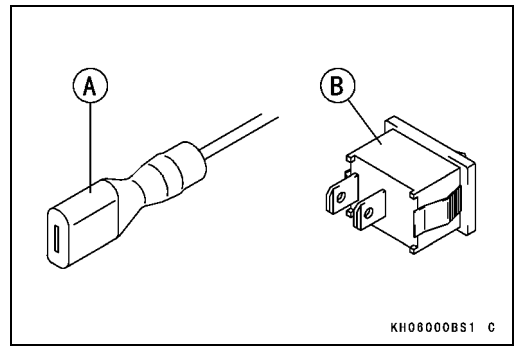
Wiring Diagram

Precautions

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

- 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.
- 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]

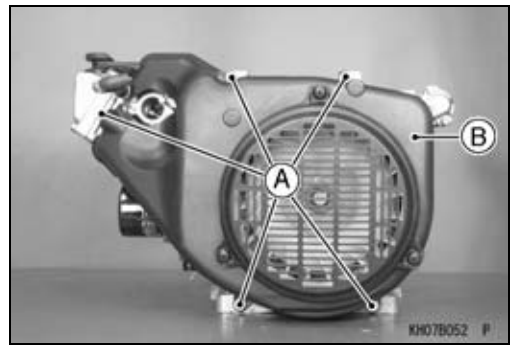


Charging, Ignition System

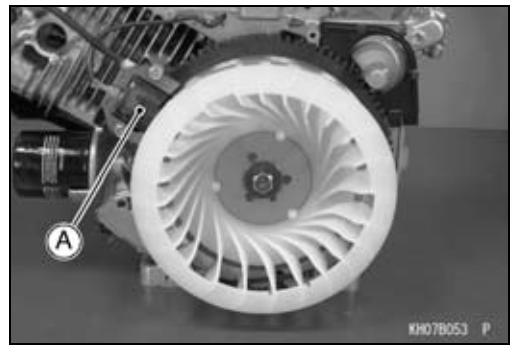
Flywheel, Stator Coil Removal

- Remove:
  Control Panel Assembly (see Control Panel Assembly Removal in the Fuel System chapter)
  Carburetor (see Carburetor Removal in the Fuel System chapter)

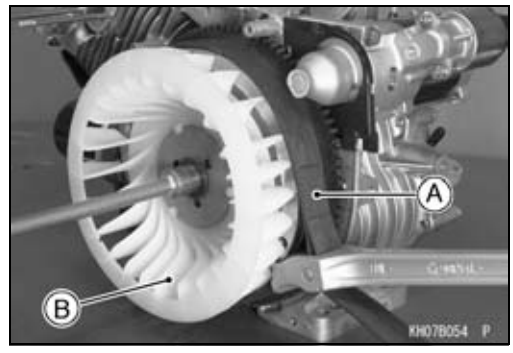
- Loosen the fan housing bolts [A] and remove the fan housing [B].



- Remove the ignition coil [A] (see Ignition Coil Removal in this chapter).



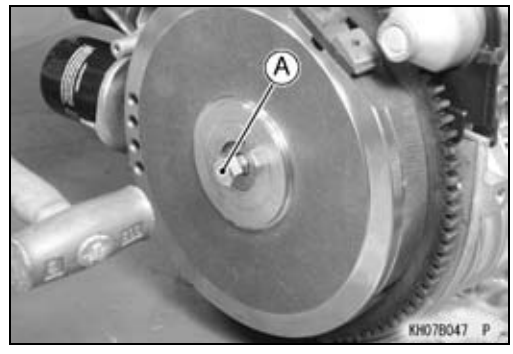
- Hold the flywheel with a suitable tool [A].
- Remove the flywheel bolt, washer, and plate, then remove the fan [B].



- Using a suitable flywheel puller remove the flywheel.

NOTE

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

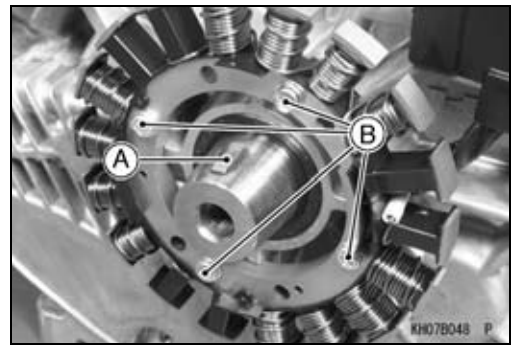


CAUTION

Do not attempt to strike the flywheel itself. Striking the flywheel can cause the magnets to lose their magnetism.

Charging, Ignition System

- Remove:
  Woodruff Key [A]
  Stator Coil Screws [B]



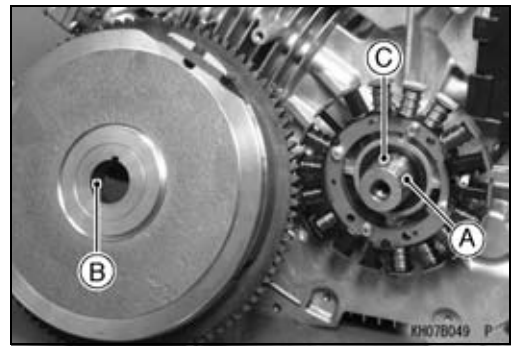
Flywheel, Stator Coil Installation

- Install the stator coil and tighten the screws.

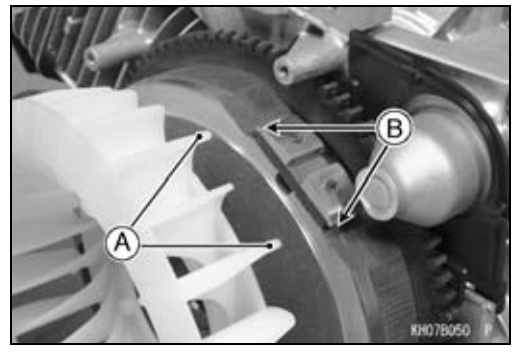
Torque - Stator Coil Screws: 3.4 N·m (0.35 kgf·m, 30 in·lb)

- 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]

○Treat deoiling the tapered portion of the flywheel and crankshaft.



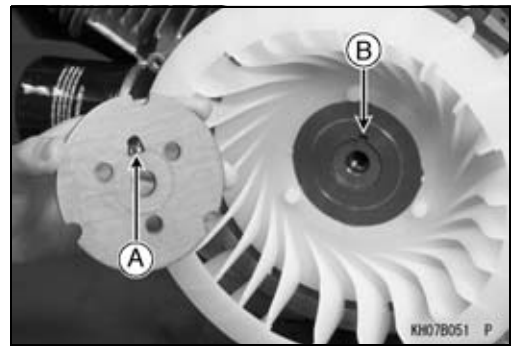
- Fit the woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.
- Install the flywheel onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.
- Insert the projections [A] of the fan to the flywheel recess [B].



- Insert the projection [A] of the plate to the hole [B] between the crankshaft and the flywheel.
- Install the washer and tighten the flywheel bolt.

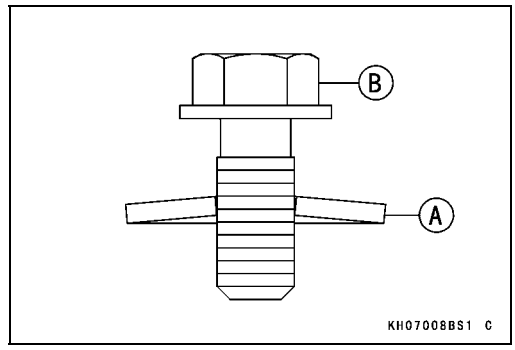
Torque - Flywheel Bolt: 56 N·m (5.7 kgf·m, 41 ft·lb)

○See the following instruction for installing the washer.



○Install the washer [A] with its convex surface upward as shown in the figure.
Flywheel Bolt [B]

● Install the ignition coil (see Ignition Coil Installation in this chapter).



● Install the fan housing and tighten the bolts.

Torque - Fan Housing Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)

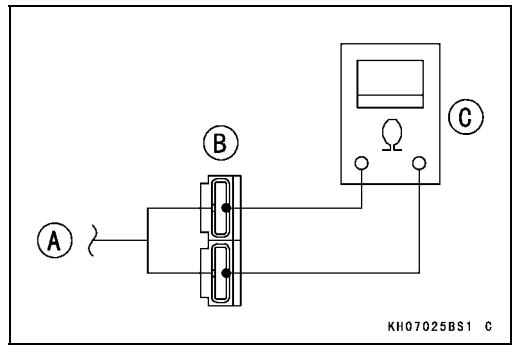
● Install the control panel on the fan housing with the mounting bolts (see Control Panel Assembly Installation in the Fuel System chapter).

Stator Coil Resistance

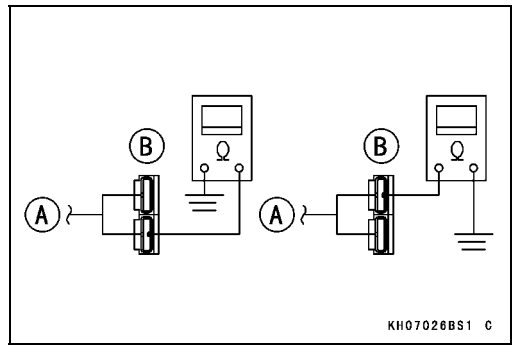
● Disconnect the stator coil connector.
● Measure the stator coil resistance.
○Connect an ohmmeter between stator pins.

Stator Coil Resistance
Standard: 0.01 ~ 0.1 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]
Stator Coil Connector [B]
Ohm Meter [C]



● 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]

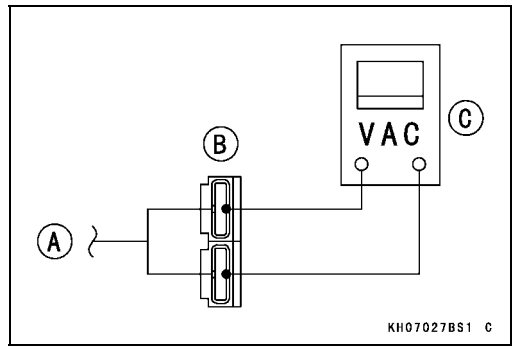


Unregulated Stator Output

● 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 VAC/3 000 rpm.
★If the AC voltage reading is less than the specification replace the stator.

Unregulated Stator Output
Standard: 28.4 V AC/3 000 rpm
Service Limit: 26 V AC/3 000 rpm

To Stator [A]
Stator Coil Connector [B]
AC Voltmeter [C]

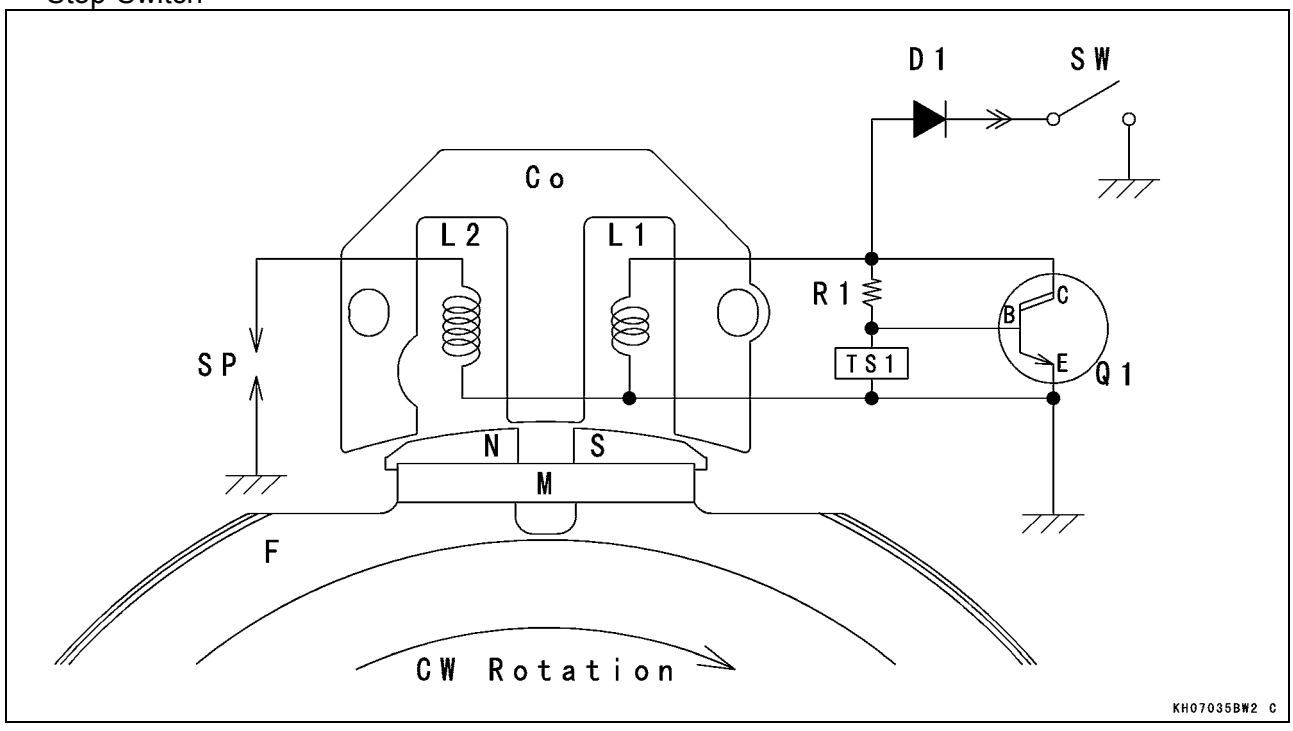


Charging, Ignition System

This engine ignition is controlled by a solid state ignition assembly and requires no periodic maintenance except for the spark plug.

The system consists of the following:

Inductive Ignition Assembly
Permanent Magnet Flywheel
Spark Plug
Stop Switch



B: Base
C: Collector
Co: Core (Lamination)
D1: Diode
E: Emitter
F: Flywheel
L1: Primary Coil
L2: Secondary Coil
M: Magnet
N: North Pole
R1: Control Resistor
S: South Pole
SP: Spark Plug
SW: Stop Switch
TS1: Trigger Sensor
Q1: Transistor

Ignition Theory of Operation

Mounted to the periphery of a flywheel are a pair of magnetic poles (south leading in clockwise rotation), generated by a permanent magnet.

By rotating the flywheel (magnetic poles) clockwise past the ignition module on a laminated core group, a voltage is generated in the primary winding (L1).

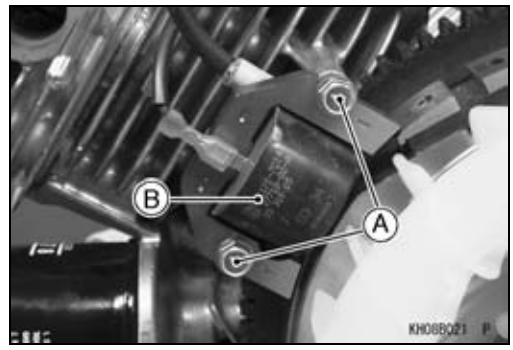
This generates a small bias current to flow through the control resistor (R1) to the base (B) of Transistor (Q1). This base drive causes the transistor to conduct (turns on) completing the primary circuit. Current flows from the high side of the primary winding through the transistor (collector (C) to emitter (E)) to ground.

The trigger sensor (TS1) senses the optimum time (peak current) to remove the base drive from the transistor. This abrupt “turning off” of the transistor causes an interruption in current flow which allows its associated flux collapse, and several hundred volts is induced through the primary winding (L1) inducing a very large voltage in the secondary winding (L2). When the secondary voltage reaches several thousand volts the spark plug (SP) gap is ionized and ignition occurs. The placement of the trigger sensor internal to the ignition insures constant timing over speed and temperature and prevents counterclockwise operation.

The diode (D1) in the ignition shut off circuit blocks inadvertent application of battery voltage, protecting the internal components of the ignition. With the stop switch (SW) in the closed position primary voltage is routed to ground, preventing ignition operation.

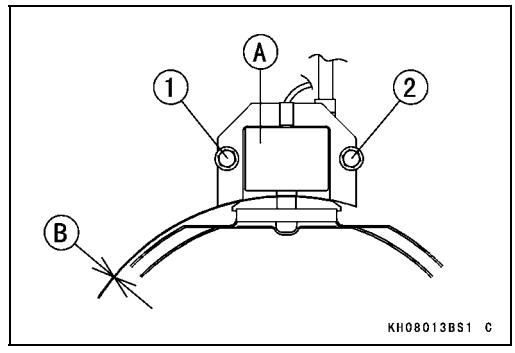
Charging, Ignition System

Ignition Coil Removal



- Remove:
  Control Panel Assembly (see Control Panel Assembly Removal in the Fuel System chapter)
  Carburetor (see Carburetor Removal in the Fuel System chapter)
  Fan Housing (see Flywheel, Stator Coil Removal in this chapter)
  Spark Plug Cap
  Bolts [A]
  Ignition Coil [B]

Ignition Coil Installation



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

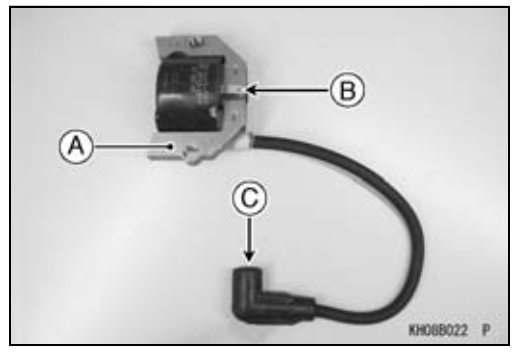
Torque - Ignition Coil Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)

Ignition Coil Air Gap
Standard: 0.2 ~ 0.4 mm (0.0079 ~ 0.0157 in.)

NOTE

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

Ignition Coil Inspection



- Remove the ignition coil (see Ignition Coil Removal in this chapter).
- Measure the winding resistance as follows:

○Set the hand tester to the R × 1 kΩ range.

Special Tool - Hand Tester: 57001-1394

○Make the measurements shown in the table.

Ignition Coil Winding Resistance

+ / –	A	B	C
A	–	2 ~ 18 kΩ	2 ~ 18 kΩ
B	∞	–	∞
C	2 ~ 18 kΩ	10 ~ 30 kΩ	–

CAUTION

Use only Tester 57001-1394 with new battery at room temperature for this test. A tester other than the Kawasaki Hand Tester may show different readings.
If a meter with a large-capacity battery is used, the ignition coil will be damaged.

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

Spark Plug Removal

- Carefully pull the plug cap from the spark plug.
- Remove the spark plugs using a suitable plug wrench.

Charging, Ignition System

Spark Plug Installation

- Screw the spark plug gently into the plug hole with the plug installed in the plug wrench.
- Tighten the plugs.

Torque - Spark Plug: 22 N·m (2.2 kgf·m, 16 ft·lb)

- Fit the plug cap securely.
- Pull up the spark plug cap lightly to make sure of the installation of the spark plug cap.

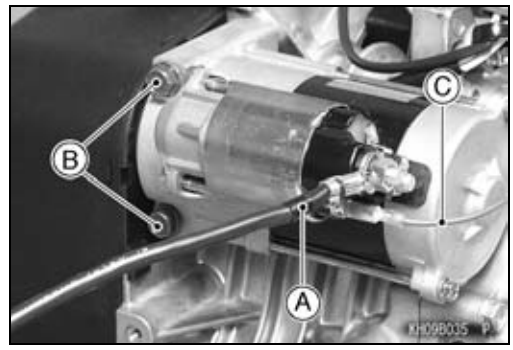
Spark Plug Cleaning and Gap Inspection

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

Electric Starter System

Starter Motor Removal

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



Starter Motor Installation

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

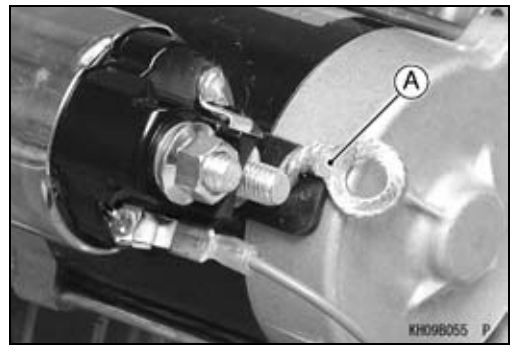
Torque - Starter Motor Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

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 × 1 Ω 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.

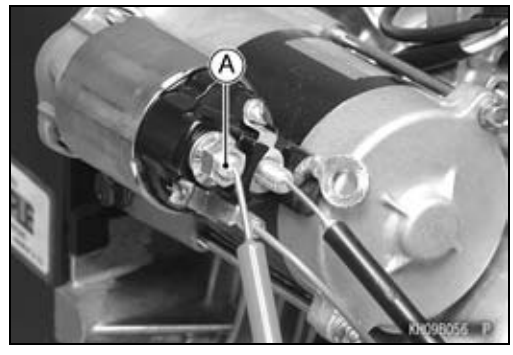
★If the solenoid does not click or if the tester reads more than 0 Ω the solenoid is faulty. Replace it.

★If the solenoid makes a single clicking sound, the tester reads 0 Ω and the rest of the starter circuit is good.

★If solenoid clicks once but the tester does not read 0 Ω, the solenoid is faulty. Replace it.

★If the solenoid does not click at all, proceed with the following.

- Disconnect the switch lead [A] shown.

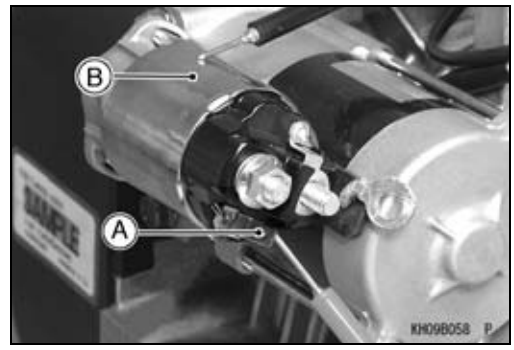


Electric Starter System

- Set the hand tester to the R × 1 Ω position and connect the leads as shown.
  Switch Terminal [A]
  To Ground [B]

★If the tester does not read close to 0 Ω, the solenoid is faulty. Replace it.

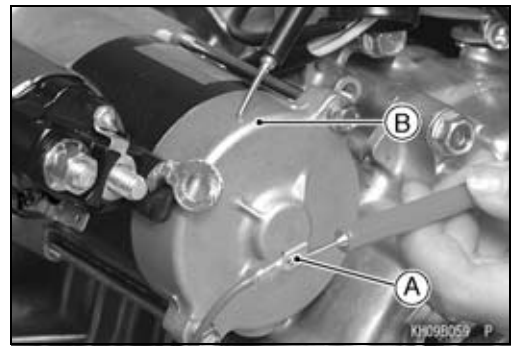
★If the tester reads close to 0 Ω, the solenoid may be good.



- Check the voltage to the solenoid from the engine switch.
- Set the hand tester selector switch to the 25V 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

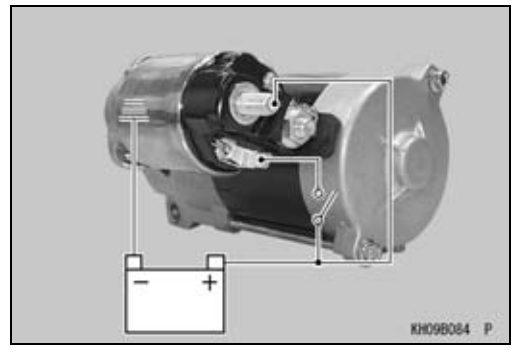
NOTE

○*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.



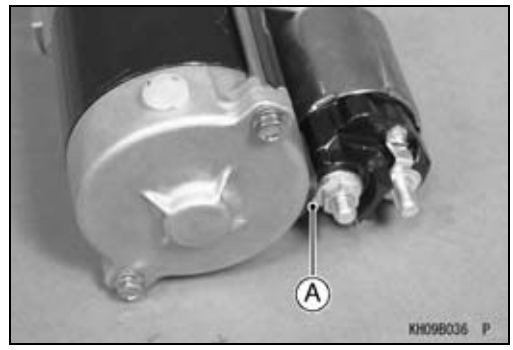
- Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal on the solenoid as shown.
- Connect the second jumper cable to the battery (–) terminal.
- Turn on the switch intermittently for one second intervals.
- The pinion should rotate freely.

★If the pinion does not rotate freely, replace the starter motor.

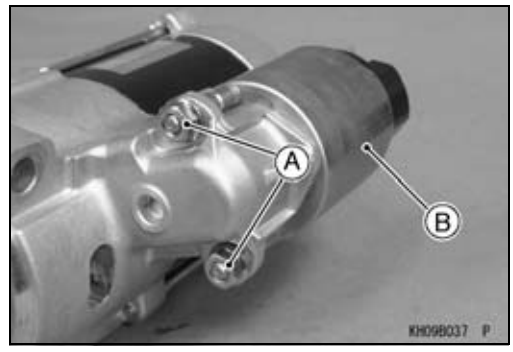
Electric Starter System

Starter Motor Disassembly

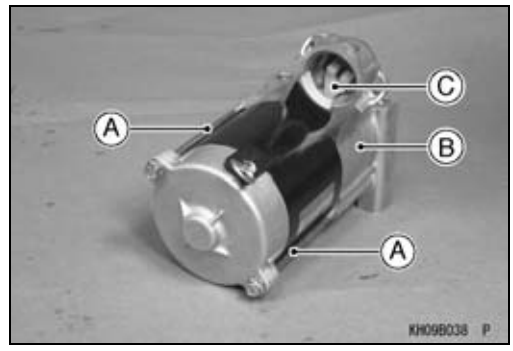
- Remove the lead [A] from the starter motor to the solenoid.



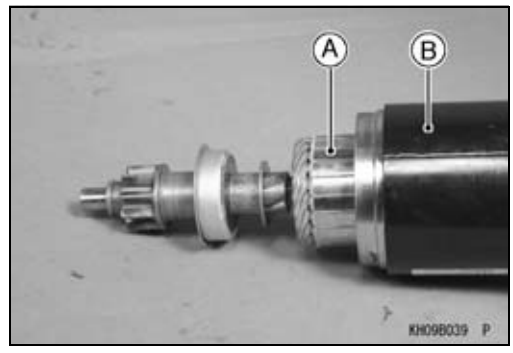
- Unscrew the mounting nuts [A] and remove the solenoid assembly [B].



- Remove:
  Through Bolts [A]
  Pinion Gear Cover [B]
- Slip the actuating arm [C] from the pinion gear.

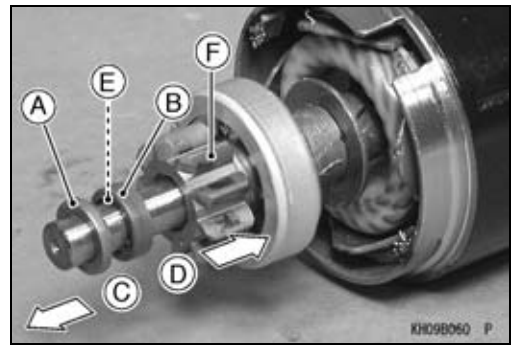


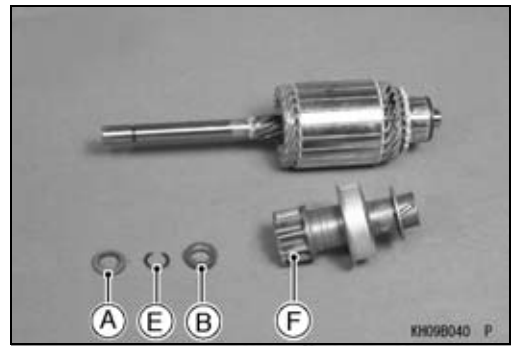
- Pull the armature [A] from the yoke [B].



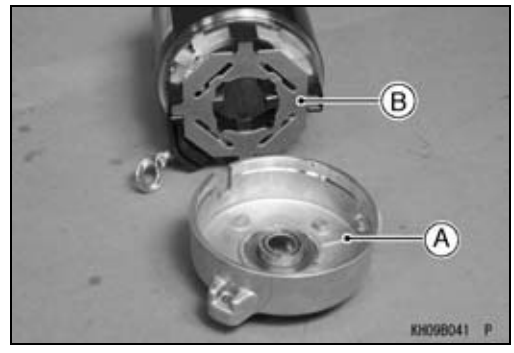
Electric Starter System

- Separate the front stopper [A] and rear stopper [B] each other and remove the front stopper to left side [C] as shown in the figure.
- Push the rear stopper to right side [D] and remove the snap ring [E] as shown in the figure.
- Pull the rear stopper and pinion gear [F] from the armature shaft.

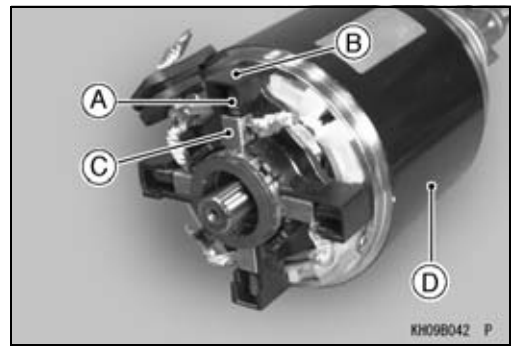




- Gently pull the end cover [A] from the yoke and remove the insulator [B].

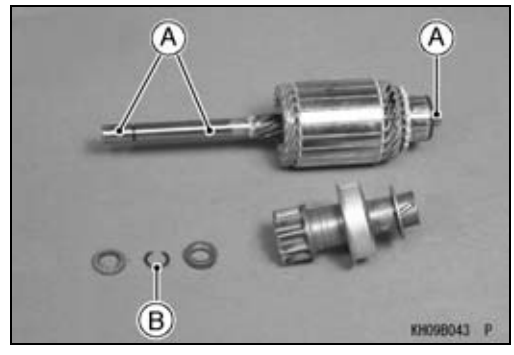


- Using a needle nose pliers, remove the brush springs [A] from the brush holder [B].
- Separate the brushes [C] from the holder and remove the holder from the yoke [D].



Starter Motor Assembly Notes

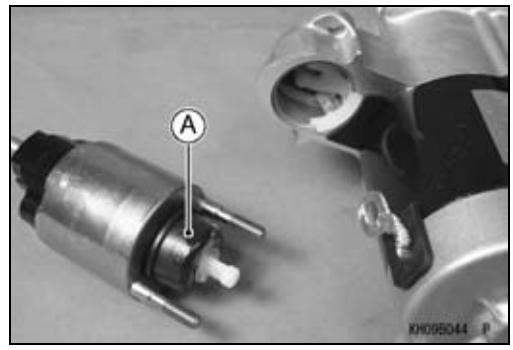
- Apply a small amount of grease to the armature shaft [A] as shown.
- Do not reuse the snap ring [B]. Replace it with a new one.

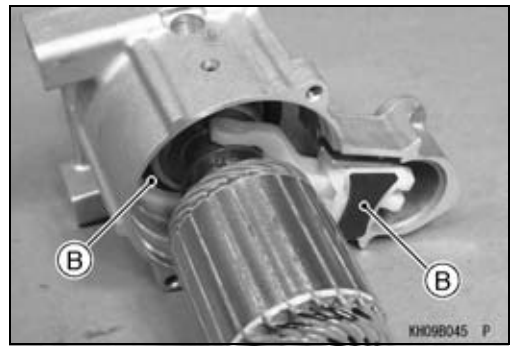


Electric Starter System

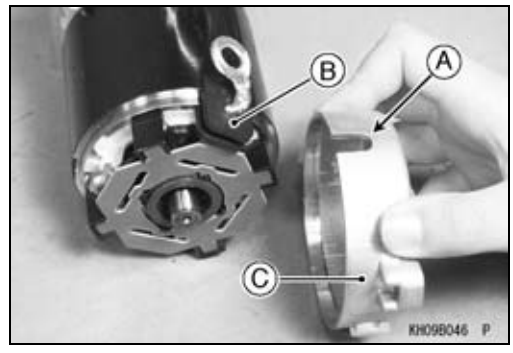
- Inspect the rubber insert [A] and/or boot [B] for visible damage.

★If they are damaged, replace them.

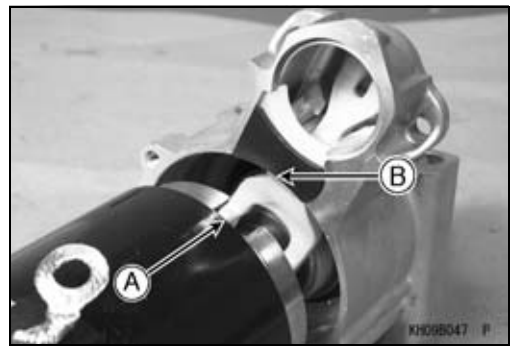




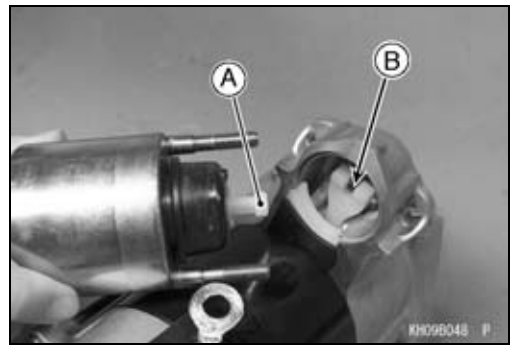
- Fit the notch [A] in the (–) lead grommet onto the projection [B] on the end cover [C].



- 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.

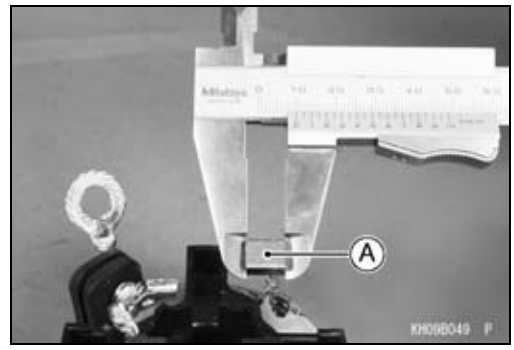


- Engage the hook on the starter solenoid with the hook [A] on the pinion gear fork [B].



Electric Starter System

Starter Motor Brush Inspection



- Measure the overall length of each brush [A].

★If the brushes are shorter than the service limit, replace them.

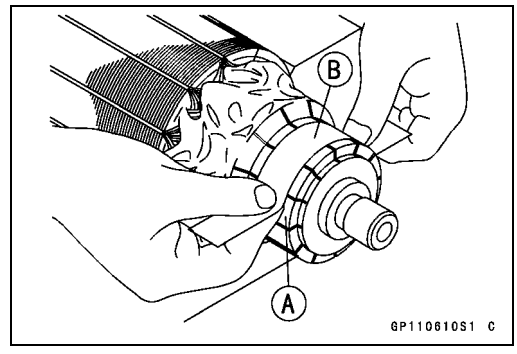
Carbon Brush Length
Standard: 10 mm (0.394 in.)
Service Limit: 6.0 mm (0.236 in.)

Brush Spring Inspection

- Inspection 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.

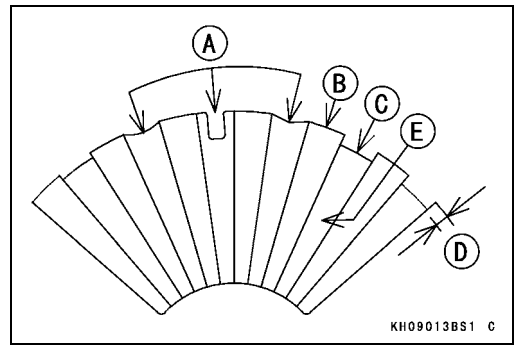
★If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them.

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.



- 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 to 0.8 mm (0.012 to 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 (0.02 ~ 0.031 in.)
Service Limit: 0.2 mm (0.008 in.)

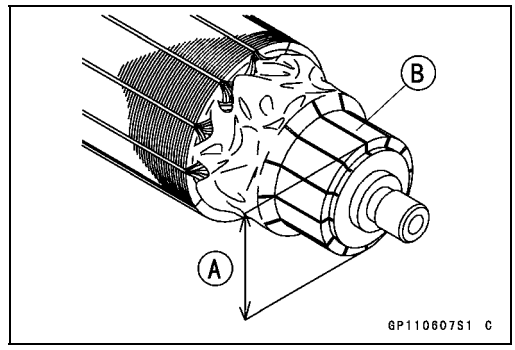
Bad [A]
Segment [B]
Good [C]
0.2 mm (0.008 in.) limit [D]
Mica [E]

Electric Starter System

● 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 (1.063 in.)

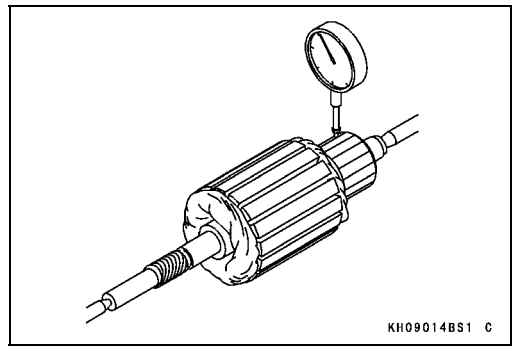


● Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.

● 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.)

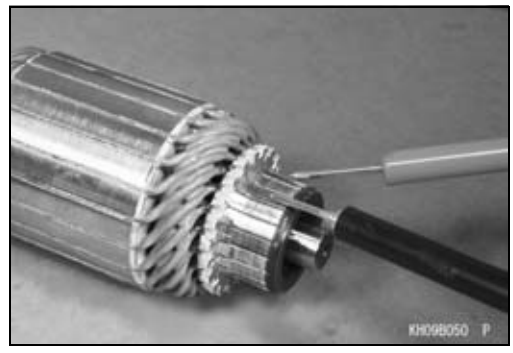


● Measure the armature winding resistance.

○Set the multimeter selector switch to the R × 1 Ω 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.

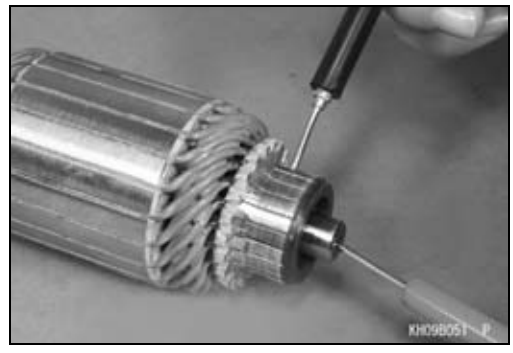
Armature Winding Resistance
Close to 0 Ω



● Set the multimeter selector switch to the R × 1 kΩ 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
(∞)



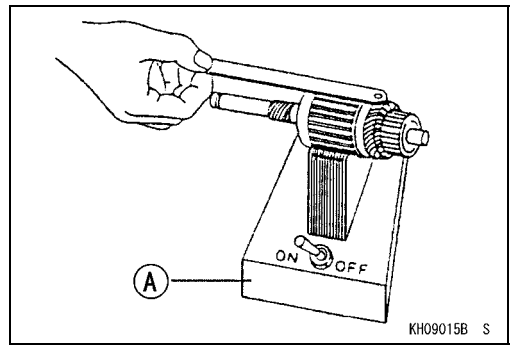
● Test the armature winding for shorts.

○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.



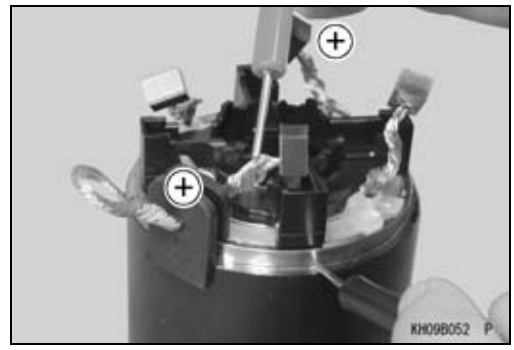
Electric Starter System

Yoke Assembly Inspection

- Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the positive brushes and stator motor yoke.

★If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

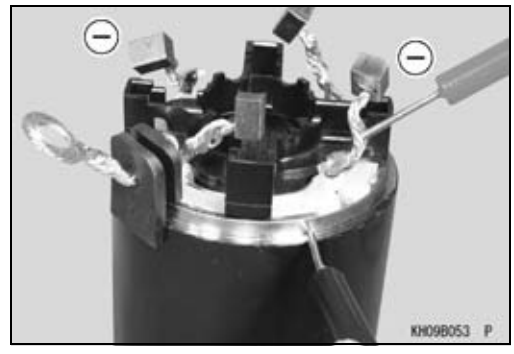
Positive Brush to Ground Resistance
(∞)



- Set the multimeter selector switch to the R × 1 Ω position and measure the resistance between the negative brushes and starter motor yoke.

★If the meter dose not read close to 0 Ω, the yoke assembly is faulty. Replace it.

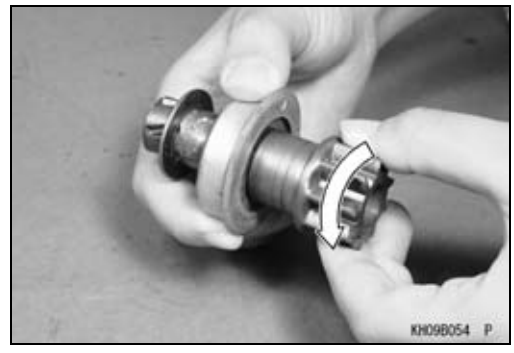
Negative Brush to Ground Resistance
Close to 0 Ω



Pinion Clutch Inspection

- Remove the pinion clutch.
- Turn the pinion gear by hand. The pinion gear should turn clockwise freely, but should not turn clockwise.

★If the pinion clutch dose not operate as it should, or if it makes noise, replace the pinion clutch.



Troubleshooting

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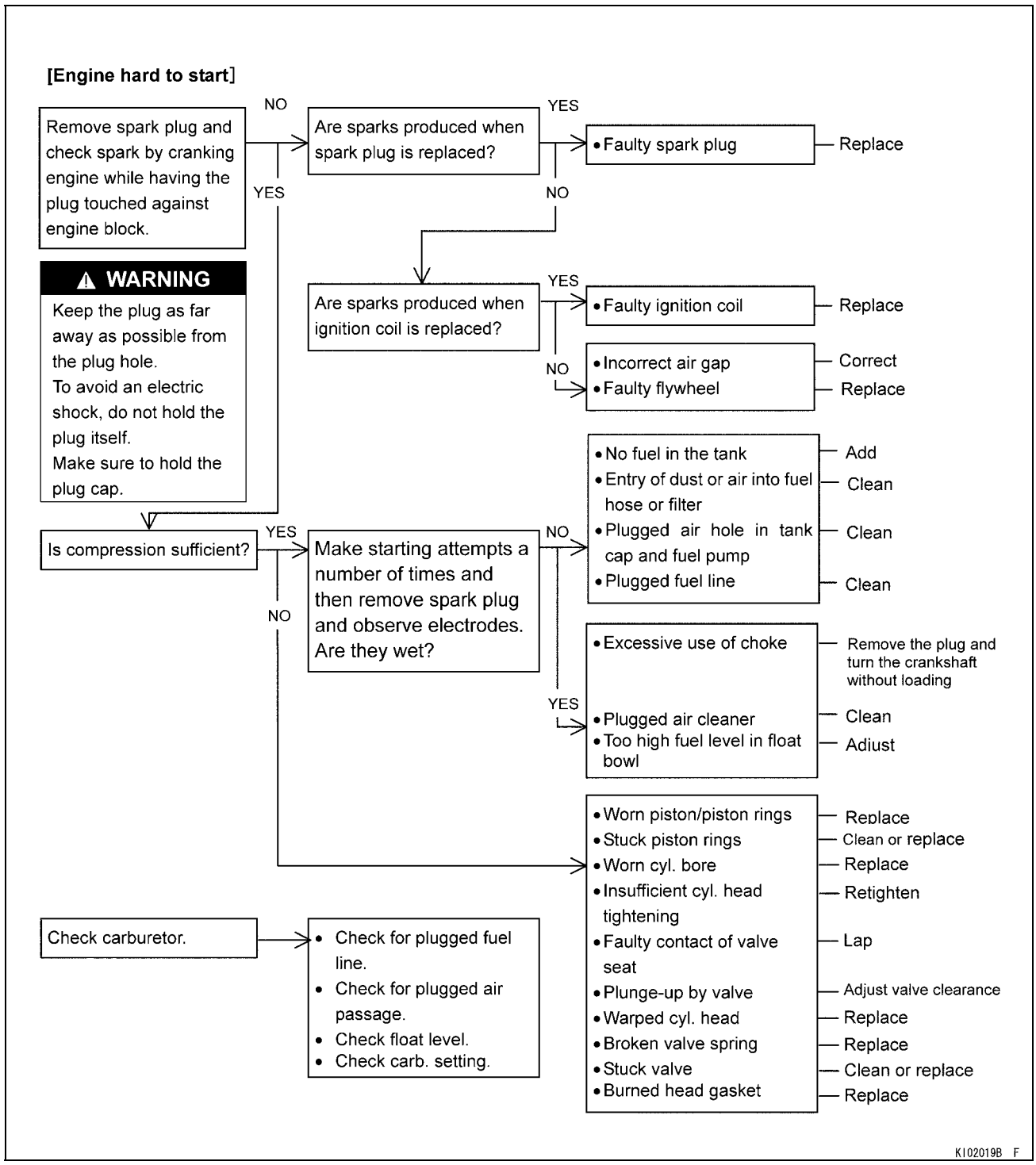
9-2 TROUBLESHOOTING

Engine Troubleshooting Guide

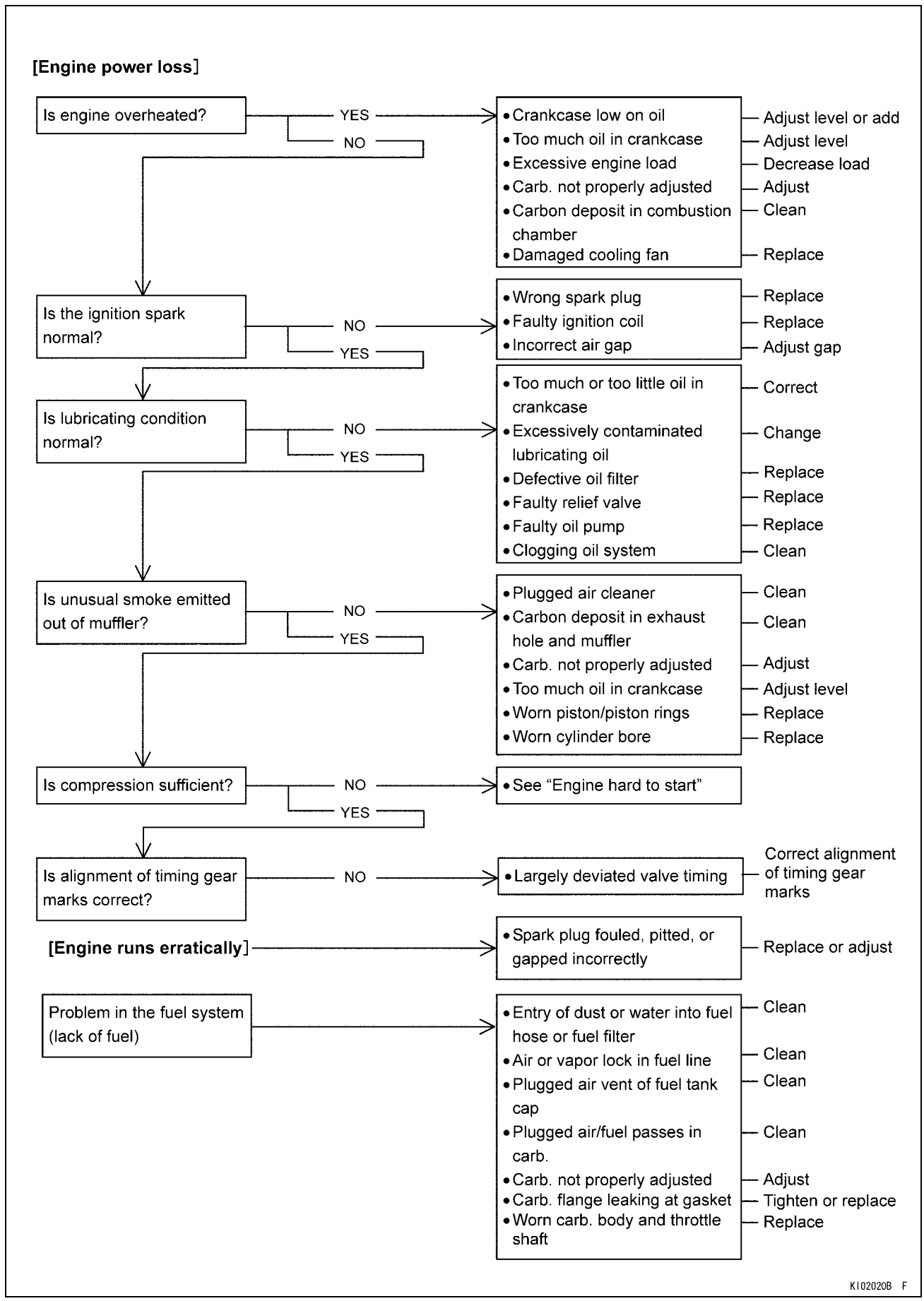
If the engine malfunctions, check if the way the engine is used is correct. If engine malfunctions even if engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

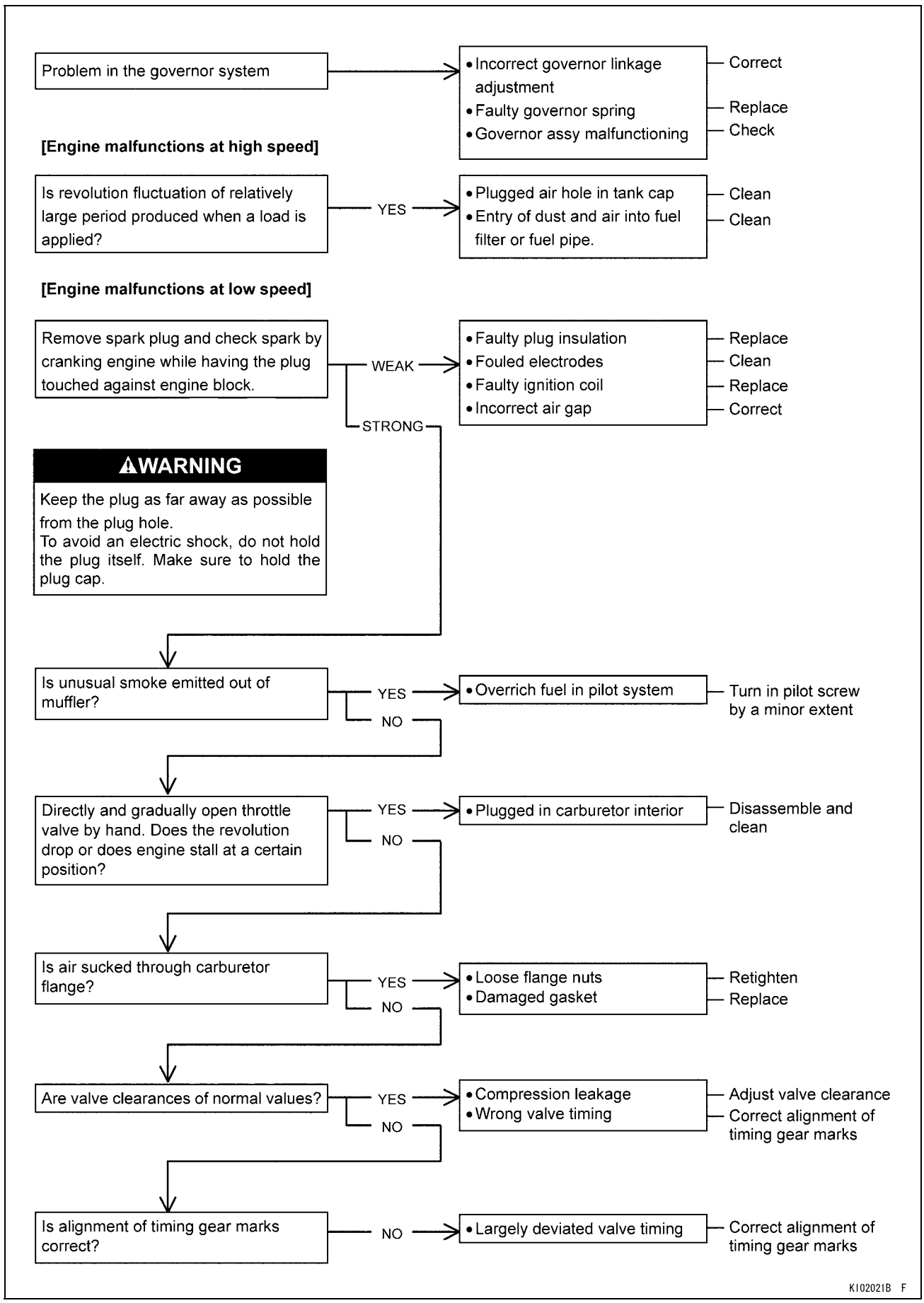
Do not unnecessarily disassemble carburetor, magneto or engine unless it has been found to be the cause of the malfunction.



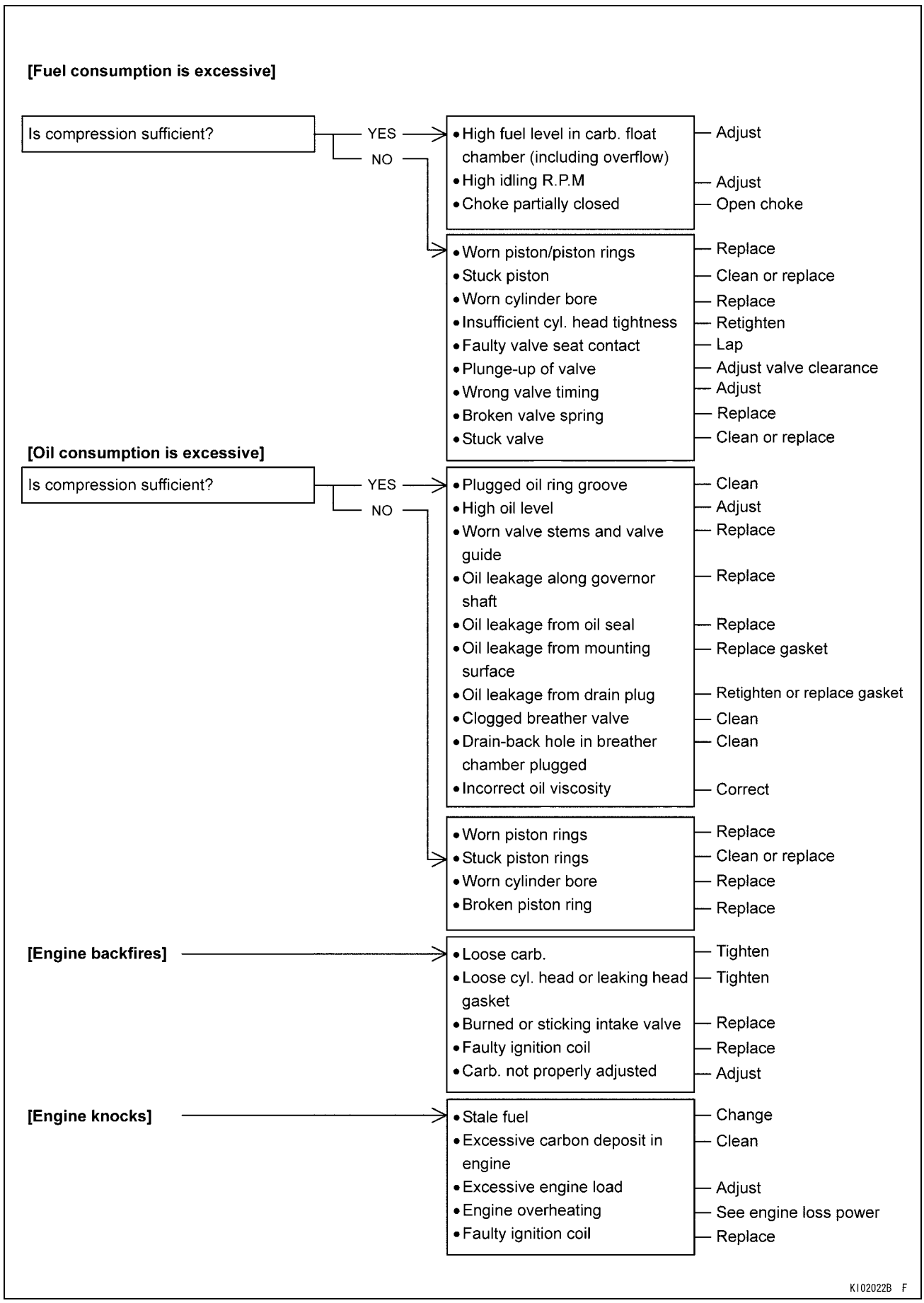
Engine Troubleshooting Guide



Engine Troubleshooting Guide



Engine Troubleshooting Guide



Starter Motor Troubleshooting Guide

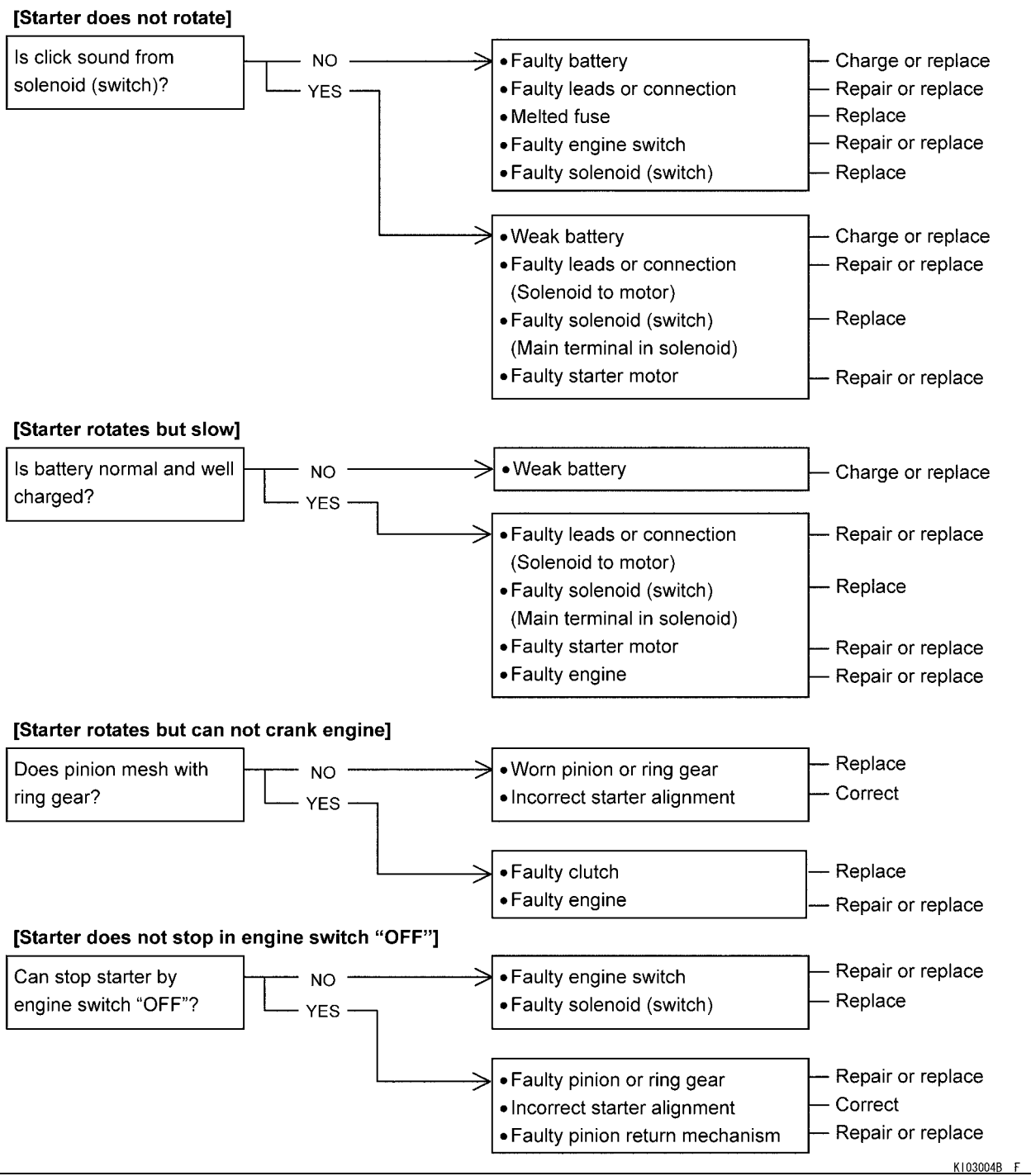
1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn engine switch to “START” position and check condition.

⚠ 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.



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