Kawasaki

# FX751V
# FX801V
# FX850V


## 4-Stroke Air-Cooled V-Twin Gasoline Engine

# Service Manual

# Quick Reference Guide



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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First Edition (1):Oct. 31, 2007 (K)

## 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) | | |

# EMISSION CONTROL INFORMATION

To protect the environment in which we all live, Kawasaki has incorporated an exhaust emission control system in compliance with applicable regulations of the United States Environmental Protection Agency and the California Air Resources Board. Additionally, Kawasaki has incorporated an evaporative emission control system in compliance with applicable regulations of the 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.

3. **Evaporative Emission Control System**

The evaporative emission control system for this engine consists of a low permeation fuel hose.

# TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

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

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

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

# Foreword

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

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

To get the longest life out of your engine:

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

## How to Use This Manual

In preparing this manual, we divided the product into its major systems. These systems became the manual's chapters. All information for a particular system from adjustment through disassembly and inspection is located in a single chapter.

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.

The Periodic Maintenance Chart is located in the General Information chapter. The chart gives a time schedule for required maintenance operations.

If you want spark plug information, for example, go to the Periodic Maintenance Chart first. The chart tells you how frequently to clean and gap the plug. Next, 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 Spark Plug 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

## Table of Contents

# 1-2 GENERAL INFORMATION

## Before Servicing

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

**Especially note the following:**

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

(2) Battery Ground
Remove the ground (–) lead from the battery before performing any disassembly operations on the equipment. This prevents:
(a) the possibility of accidentally turning the engine over while partially disassembled.
(b) sparks at electrical connections which will occur when they are disconnected.
(c) damage to electrical parts.

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

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

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

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

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

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

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

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

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

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

## Before Servicing

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

(13)Seal Guide

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

(14)Circlip, Retaining Ring

Replace any circlips and retaining rings that were removed with new ones, as removal weakens and deforms them. When installing circlips and retaining rings, take care to compress or expand them only enough to install them and no more.

(15)Cotter Pin

Replace any cotter pins that were removed with new ones, as removal deforms and breaks them.

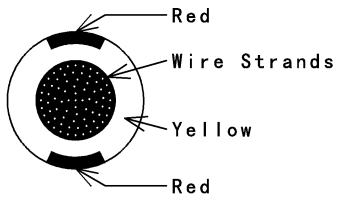
(16)Lubrication

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

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

(17)Electrical Wires

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

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

GB020601W1 C

(18)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.

(19)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 | |

(20)Specifications

Specification terms are defined as follows:

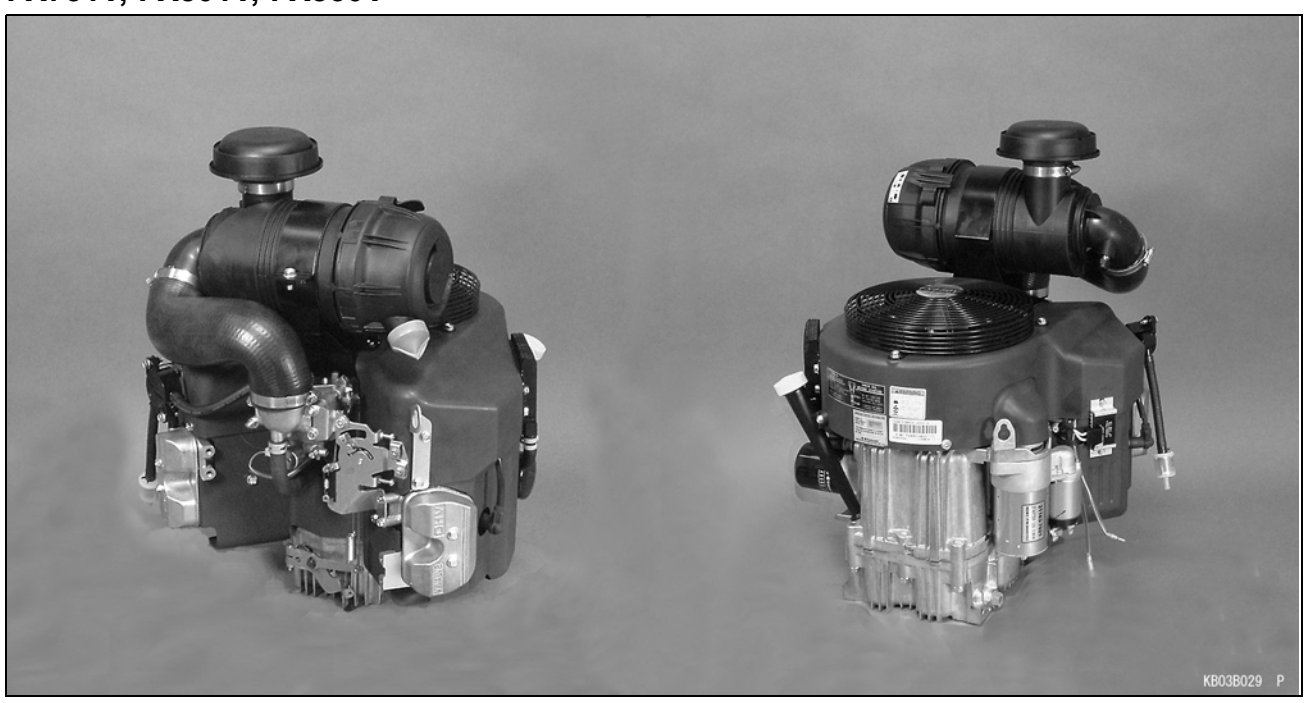
"Standards" show dimensions or performances which brand-new parts or systems have.

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

# 1-4 GENERAL INFORMATION

## Model Identification

### FX751V, FX801V, FX850V




### Cylinder Number Designation:

No.1 Cylinder is the left-hand cylinder viewed from the air cleaner.

No.2 Cylinder is the right-hand cylinder viewed from the air cleaner.

## General Specifications

| Item | FX751V, FX801V, FX850V |
|---|---|
| Type | Forced air-cooled, vertical shaft, OHV 4 valves, 4-stroke gasoline engine. |
| Cylinder Layout | 90° V-Twin |
| Bore × Stroke | 84.5 mm × 76 mm (3.33 in. × 2.99 in.) |
| Displacement | 852 cm³ (52.0 cu. in.) |
| Direction of Rotation | Counterclockwise facing the PTO shaft |
| Compression Release | Automatic compression release |
| Low Idle Speed | 1 550 rpm |
| High Idle Speed | 3 600 rpm |
| Ignition System | Transistorized-flywheel magneto |
| RFI | Per Canada and U.S.A. requirements |
| Starting System | Shift type electric starter |
| Charging System | 12 V - 15 amp with regulator |
| Spark Plug | NGK BPR4ES |
| Carburetor | Float type, fixed main jet, two barrel |
| Fuel Pump | Diaphragm type pulse pump |
| Air Cleaner | Dual stage element, Heavy duty type |
| Governor | Flyweight all speed governor |
| Lubrication System | Pressure feed by positive displacement pump |
| Oil Filter | Cartridge type full flow filter |
| Oil Capacity (when engine is completely dry) | 2.4 L (2.5 US-qt) |
| Cooling System | Forced air cooling by fan with oil cooler |
| Dimensions (L × W × H ) | 480 mm × 460 mm × 615 mm (18.9 in. × 18.1 in. × 24.2 in.) |
| Dry Weight (without muffler) | 56.4 kg (124 lb) |

Specifications subject to change without notice.

# Periodic Maintenance

## Table of Contents

## 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 100 hr. | Every 200 hr. | Every 250 hr. | Every 300 hr. | Every 500 hr. |
| Check and clean air inlet screen (1) | ● | | | | | | |
| Check and add engine oil | ● | | | | | | |
| Check for fuel and oil leakage | ● | | | | | | |
| Check for loose or lost nuts and screws | ● | | | | | | |
| Check battery electrolyte level | ● | | | | | | |
| Replace air cleaner primary element (1) | | | | | ● | | |
| Check air cleaner secondary element (1) | | | | | ● | | |
| Replace air cleaner secondary element (1) | | | | | | | ● |
| Clean cylinder and cylinder head fins (1) | | | ● | | | | |
| Tighten nut and screws | | | ● | | | | |
| Change engine oil | | ● | ● | | | | |
| Clean and re-gap spark plugs | | | ● | | | | |
| Check and clean oil cooler fins (1) | | | ● | | | | |
| Change oil filter | | | | ● | | | |
| ♦Check and adjust valve clearance | | | | | | ● | |
| ♦Clean and lap valve seating surface | | | | | | ● | |
| ♦Clean combustion chambers | | | | | | ● | |

(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 lists 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:
EO: Apply oil to the threads.
L: Apply a non-permanent locking agent to the threads.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

| Fastener | Torque | | | Remarks |
|---|---|---|---|---|
| | N·m | kgf·m | ft·lb | |
| **Fuel System** | | | | |
| Carburetor and Inlet Pipe Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| Carburetor and Inlet Pipe Mounting Nuts | 5.9 | 0.60 | 52 in·lb | |
| Air Creaner Bracket Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| Air Creaner Holder Bracket Bolt | 19.6 | 2.00 | 14.4 | |
| Fuel Pump Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| Inlet Manifold Bolts | 5.9 | 0.60 | 52 in·lb | S |
| Governor Shaft Plate Screws | 2.0 | 0.20 | 18 in·lb | |
| Governor Arm Joint Bolt | 5.9 | 0.60 | 52 in·lb | |
| Governor Arm Clamp Nut | 7.8 | 0.80 | 69 in·lb | |
| Carburetor and Inlet Pipe Stud Bolts | 5.9 | 0.60 | 52 in·lb | |
| Control Panel Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| Fuel Pump Bracket Bolt | 5.9 | 0.60 | 52 in·lb | |
| **Cooling System** | | | | |
| Engine Shroud Bolts (Non-locking Agent) | 5.9 | 0.60 | 52 in·lb | |
| Engine Shroud Bolts (Locking Agent) | 7.8 | 0.80 | 69 in·lb | L |
| Cooling Fan Screen Bolts | 5.9 | 0.60 | 52 in·lb | |
| Cooling Fan Plate Mounting Stud Bolts | 5.9 | 0.60 | 52 in·lb | |
| Fan Housing Bolts | 5.9 | 0.60 | 52 in·lb | |
| Guard Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| **Engine Top End** | | | | |
| Cylinder Head Bolts | 46 | 4.7 | 34 | S |
| Rocker Cover Bolts | 5.9 | 0.60 | 52 in·lb | |
| Valve Clearance Adjusting Locknuts | 11 | 1.1 | 97 in·lb | |
| Connecting Rod Big End Cap Bolts | 20.6 | 2.10 | 15.2 | EO |
| Rocker Arm Bracket Bolts | 21 | 2.10 | 15.0 | L |
| **Lubrication System** | | | | |
| Oil Pump Cover Plate Bolts | 5.9 | 0.60 | 52 in·lb | |
| Oil Filter | 11.8 | 1.20 | 104 in·lb | R |
| Engine Oil Drain Plugs | 6.9 | 0.70 | 61 in·lb | EO |
| Oil Filler Mounting Bolt | 5.9 | 0.60 | 52 in·lb | |
| Oil Cooler Bolts | 5.9 | 0.60 | 52 in·lb | |
| **Camshaft/Crankshaft** | | | | |
| Connecting Rod Big End Cap Bolts | 20.6 | 2.10 | 15.2 | EO |
| Oil Passage Plugs | 3.9 | 0.40 | 34 in·lb | L |
| Crankcase Cover Bolts | 46 | 4.7 | 34 | S |
| Breather Valve Mounting Screw | 2.0 | 0.20 | 18 in·lb | |

## 2-4 PERIODIC MAINTENANCE

### Torque and Locking Agent

| Fastener | Torque | | | Remarks |
|---|---|---|---|---|
| | N·m | kgf·m | ft·lb | |
| Breather Chamber Cover Bolts | 5.9 | 0.60 | 52 in·lb | |
| **Starter System** | | | | |
| Starter Motor Mounting Bolts | 19.6 | 2.00 | 14.4 | |
| **Electrical System** | | | | |
| Ignition Coil Bolts | 5.9 | 0.60 | 52 in·lb | |
| Stator Coil Screws | 3.4 | 0.35 | 30 in·lb | |
| Flywheel Bolt | 56 | 5.7 | 41 | |
| Regulator Bolts | 1.8 | 0.18 | 16 in·lb | |
| Spark Plugs | 22 | 2.2 | 16 | |

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 |

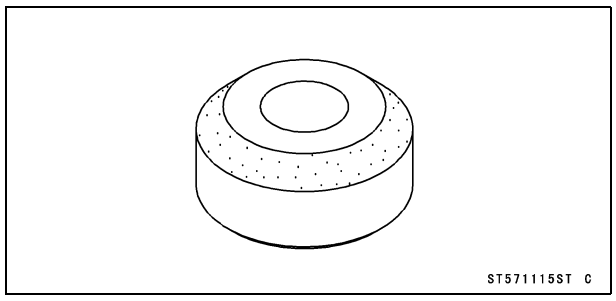
## Specifications

| Item | Standard |
|---|---|
| **Fuel System** | |
| Idle Speed: (1) | |
| Low Idle Speed (Carburetor idle rpm) | 1 450 r/min (rpm) |
| Low Idle Speed (Governor idle rpm) | 1 550 r/min (rpm) |
| High Idle Speed | 3 600 r/min (rpm) |
| Air Cleaner: | |
| Type | Heavy duty type |
| Pre-cleaner | Primary element |
| Second-stage cleaner | Secondary element |
| **Engine Top End** | |
| Valve Clearance: | |
| Inlet, Exhaust | 0.05 ~ 0.10 mm (0.0020 ~ 0.0039 in.) |
| Valve Seating Surface Angle: | |
| Inlet, Exhaust | 45° |
| Valve Seating Surface Width: | |
| Inlet | 1.1 ~ 1.7 mm (0.043 ~ 0.067 in.) |
| Exhaust | 1.0 ~ 1.5 mm (0.039 ~ 0.059 in.) |
| **Lubrication System** | |
| Engine Oil: | |
| Type | SF, SG, SH, SJ or SL class |
| Viscosity | SAE 40, SAE 30, SAE 10W-30/SAE 10W-40, or SAE 5W-20 |
| Capacity | 2.1 L (2.2 US qt) (When the oil filter is not removed) |
| | 2.3 L (2.4 US qt) (When the oil filter is removed) |
| Level | Operating range (grid area) on dipstick |
| **Electrical System** | |
| Spark Plug | NGK BPR4ES |
| Spark Plug Gap | 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.) |

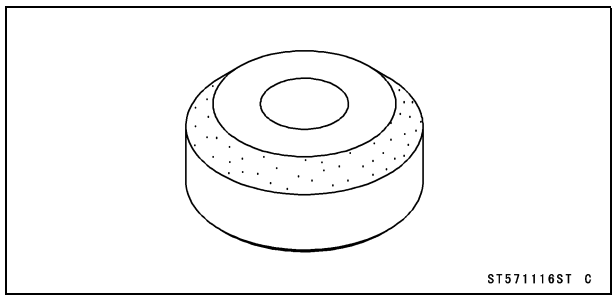
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

## Special Tools

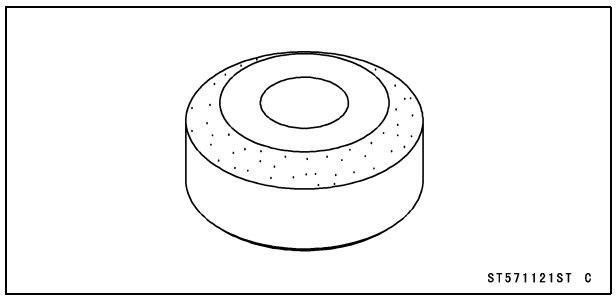
**Valve Seat Cutter, 45° - $\phi$32:**
**57001-1115**



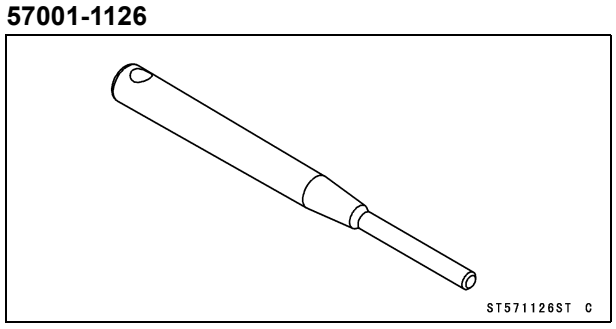

**Valve Seat Cutter, 45° - $\phi$35:**
**57001-1116**



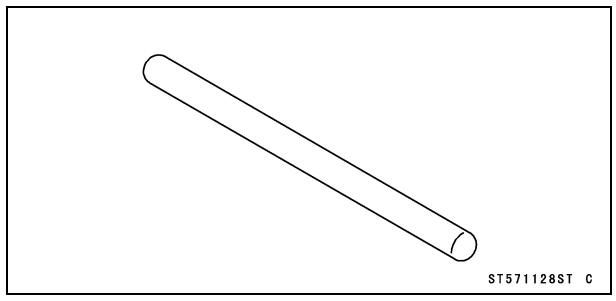

**Valve Seat Cutter, 32° - $\phi$35:**
**57001-1121**



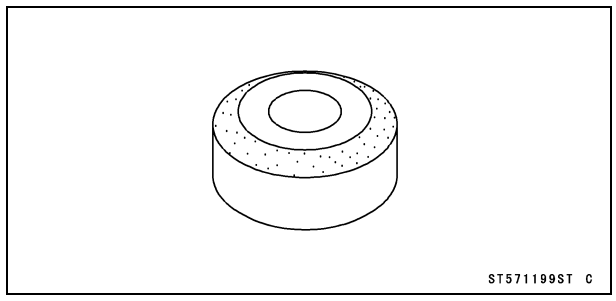

**Valve Seat Cutter Holder, $\phi$7:**
**57001-1126**



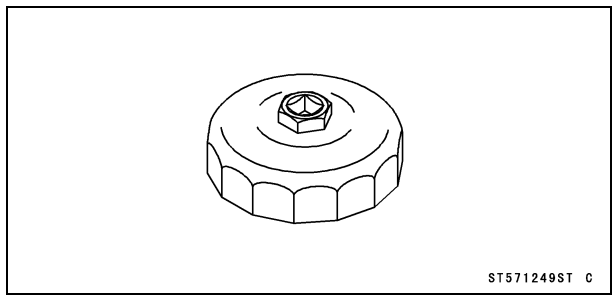

**Valve Seat Cutter Holder Bar:**
**57001-1128**




**Valve Seat Cutter, 32° - $\phi$33:**
**57001-1199**




**Oil Filter Wrench:**
**57001-1249**



## Periodic Maintenance Procedures

### Fuel System

**NOTE**

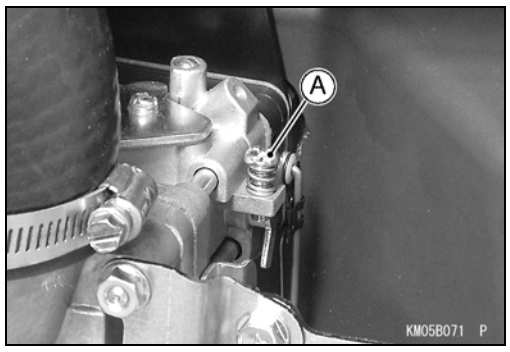
○*High and low idle speeds may vary depending on the equipment on which the engine is used. Refer to the equipment specification.*

#### *Low Idle Speed Adjustment*

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

**⚠ WARNING**

**Always keep your hands clear of the moving parts.**



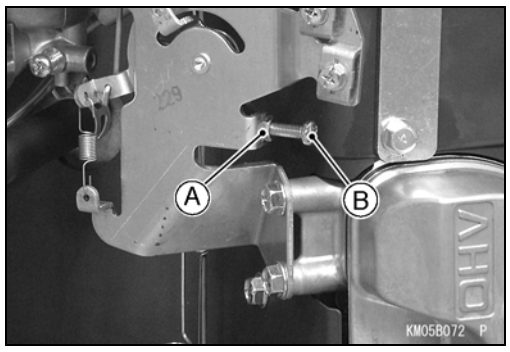

- Move the throttle lever at a dash to the idle position.
- Hold the throttle lever on the carburetor in closed position (turn the governor arm clockwise all the way) and adjust the low idle speed screw [A] until the engine idles at specified speed.

**Low Idle Speed (Carburetor idle rpm)**
**1 450 rpm**

- Release the throttle lever.
- Loosen the locknut [A].
- Adjust the low idle speed set screw [B] on the control plate to obtain the specified governor low idle speed.

**Low Idle Speed (Governor idle rpm)**
**1 550 rpm**

- Tighten the locknut.




#### *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.**

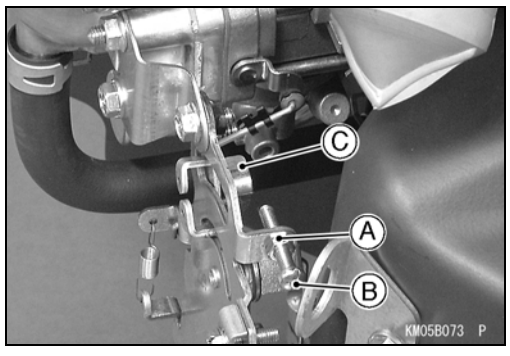
- Start and warm up the engine thoroughly.

## 2-8 PERIODIC MAINTENANCE

### Periodic Maintenance Procedures

**⚠ WARNING**

**Always keep your hands clear of the moving parts.**




- Loosen the locknut [A], and unscrew the high idle set screw [B] few turns.
- Move the throttle lever on dash to obtain the specified high idle speed and leave it there.

**High Idle Speed**
**3 600 rpm**

- Turn the high idle set screw so that the end of it just touches the speed control lever [C], and tighten the lock nut.
- Check the idle speed, and readjust the idle speed if necessary.

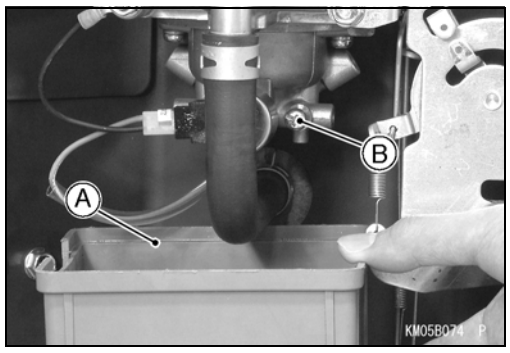
**CAUTION**

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

#### *Fuel System Cleanliness Inspection*

**⚠ WARNING**

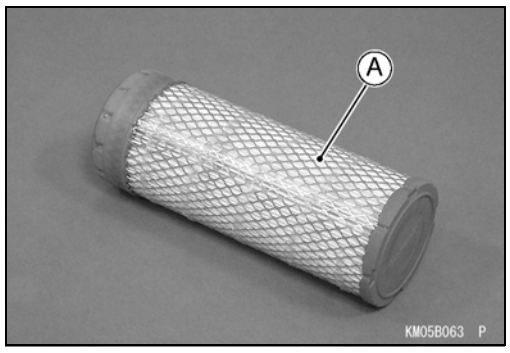
**Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.**




- Place a suitable container [A] under the drain screw [B] on the carburetor.
- Turn out the drain screw a few turns to drain the carburetor and check 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) and fuel tank. And check the fuel filter.

#### *Element Cleaning and Inspection*

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



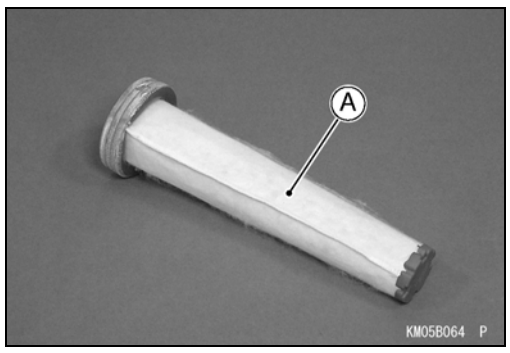

**NOTE**

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

- Remove the elements (see Element Removal in the Fuel System chapter).
- Replace the primary element [A] every 250 hrs.

## Periodic Maintenance Procedures

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




**CAUTION**

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

### *Air Cleaner Housing (Cap and Body) Inspection*

- Remove:
  Element (see Element Removal in the Fuel System chapter)
  Air Cleaner Housing (see Air Cleaner Body and Bracket Removal in the Fuel System chapter)
- Clean the housing with detergent and water and dry the housing thoroughly.
- Check the housing for deformation or other damage.

○Seal the housing well and permit only filtered air to reach the carburetor.

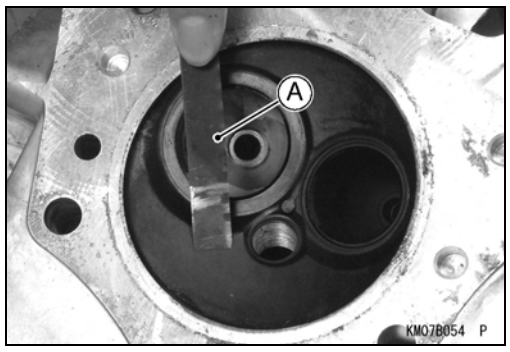
★If the housing is damaged, replace the housing with a new one.

- Check that no foreign material obstructs the air passage.

## Engine Top End

### *Cylinder Head Cleaning*

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




**⚠ WARNING**

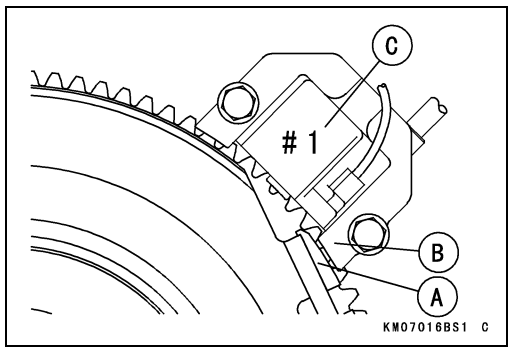
**Clean the cylinder head in a well ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean the cylinder head. A fire or explosion could result.**

## Periodic Maintenance Procedures

### *Valve Clearance Inspection*

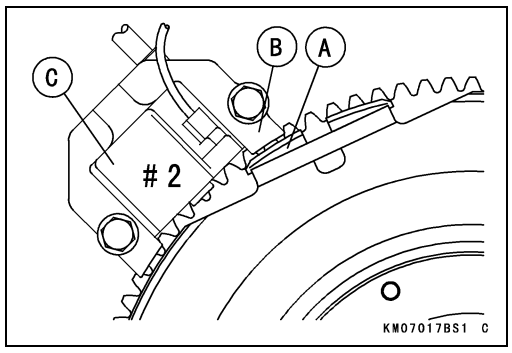
**NOTE**

○*Check the valve clearance when the engine is cold (at room temperature).*



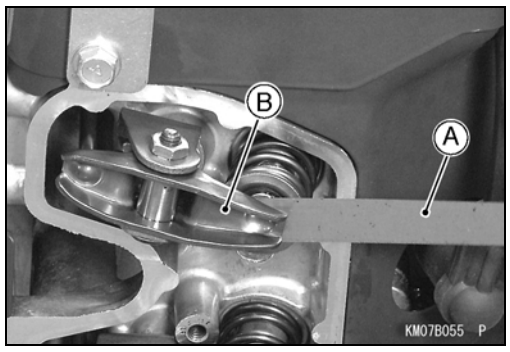

● Remove the rocker cover (see Cylinder Head Assembly Removal in the Engine Top End chapter).
● Place the piston at the top dead center (TDC) of the compression stroke by turning the crankshaft clockwise facing the flywheel.

No.1 Cylinder:
○The left projection [A] on the flywheel is faced with the right leg [B] on the #1 ignition coil [C] as shown in the figure.
○Check the inlet and exhaust valves are closed completely, if they are not closed, turn the flywheel one turn (360°) clockwise and face the left projection with the right leg again.




No.2 Cylinder:
○The left projection [A] on the flywheel is faced with the right leg [B] on the #2 ignition coil [C] as shown in the figure. Follow No.1 Cylinder alignment.

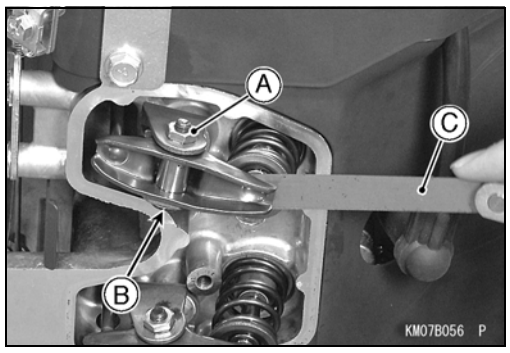
● Check the valve clearance.
○Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.
★If the valve clearance is no correct, adjust it.




**Valve Clearance (when cold)**
**Inlet, Exhaust 0.05 ~ 0.10 mm (0.0020 ~ 0.0039 in.)**

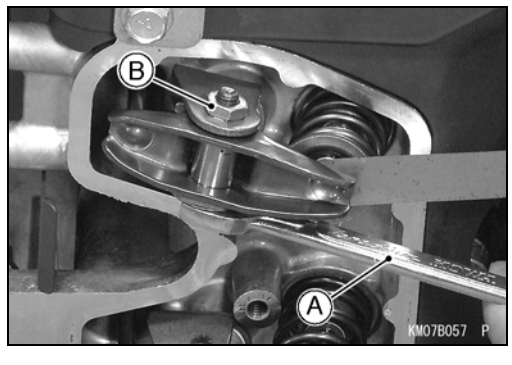
### *Valve Clearance Adjustment*

● Since valve repairs change the valve clearance, adjust the valve clearance as specified.
● 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 in proper direction until the piston is at the TDC of the compression stroke (as described above).
● Loosen the locknut [A] and adjusting bolt [B].
● Insert a 0.05 mm (0.0020 in.) thickness gauge [C] between the rocker arm and valve stem end, and turn the adjusting bolt until the thickness gauge begins to bind between the rocker arm and valve stem end. Sweep the thickness gauge during this adjustment.




**Valve Clearance (when cold)**
**Inlet, Exhaust: 0.05 ~ 0.10 mm (0.0020 ~ 0.0039 in.)**

## Periodic Maintenance Procedures

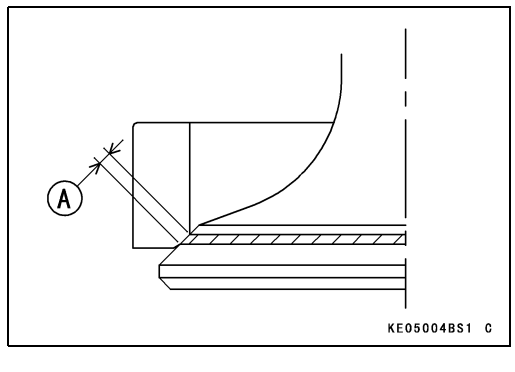



- Holding the adjusting bolt with a spanner [A], tighten the adjusting locknut [B] to the specified torque.

  **Torque - Valve Clearance Adjusting Locknuts: 11 N·m (1.1 kgf·m, 87 in·lb)**

- Do not overtighten the valve clearance adjusting locknuts.
- After the valve clearance adjustment, measure the valve clearance again. Readjust the valve clearance if necessary.

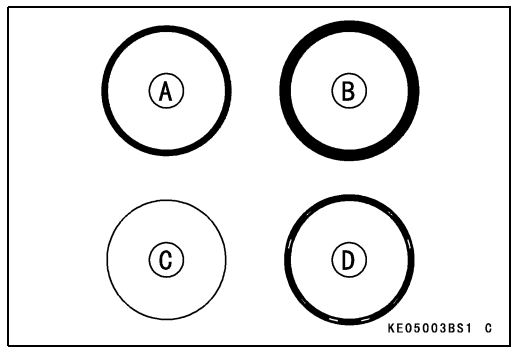
### *Valve Seat Inspection*




- 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 with a new one.
- 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 lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.

**NOTE**

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




Good [A]
Too Wide [B]
Too Narrow [C]
Uneven [D]

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

**Valve Seating Surface Width (STD)**

| | |
|---|---|
| **Exhaust** | **1.0~ 1.5 mm (0.039 ~ 0.059 in.)** |
| **Inlet** | **1.1 ~ 1.7 mm (0.043 ~ 0.067 in.)** |

### *Valve Seat Repair*

- Follow the manufacture's instructions for use of valve seat cutters

**Special Tools**

| | | |
|---|---|---|
| **Inlet Valve:** | | |
| **Valve Seat Cutter** | **45° - $\phi$35** | **57001-1116** |
| **Valve Seat Cutter** | **32° - $\phi$35** | **57001-1121** |
| **Valve Seat Cutter Holder** | **$\phi$7** | **57001-1126** |
| **Exhaust Valve:** | | |
| **Valve Seat Cutter** | **45° - $\phi$32** | **57001-1115** |
| **Valve Seat Cutter** | **32° - $\phi$33** | **57001-1199** |
| **Valve Seat Cutter Holder** | **$\phi$7** | **57001-1126** |
| **Valve Seat Cutter Holder Bar:** | | **57001-1128** |

## Periodic Maintenance Procedures

★If the manufacture'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. Do not use the valve seat cutter for other purpose.
2. Do not drop or hit the valve seat cutter, or the diamond particles may fall off.
3. Be sure 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**

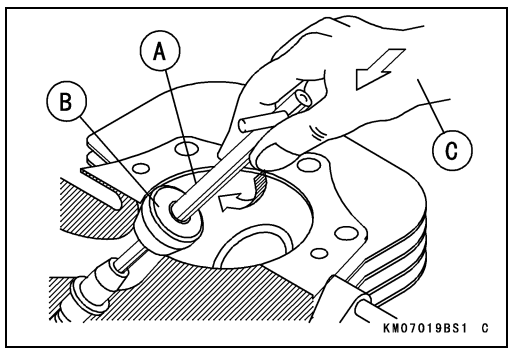
○*Do not use a wire brush to remove the metal particles from the cutter. It will take off the diamond particles.*

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.*

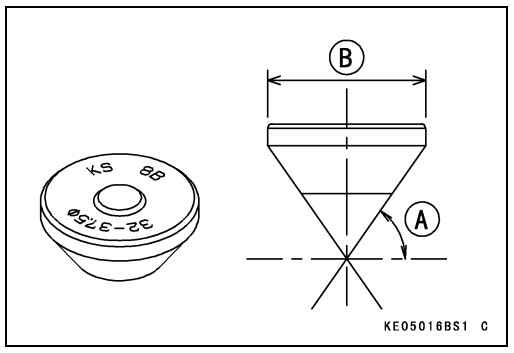
5. After use, wash the cutter with washing oil and apply thin layer of engine oil before storing.




**Marks Stamped on the Cutter**

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

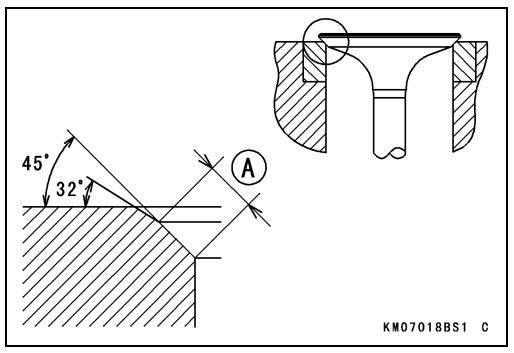
| | |
|---|---|
| 32° | Cutter angle [A] |
| 37.5 | Cutter diameter [B] |
| KS8B | Manufactured lot number |




**Operating Procedures**

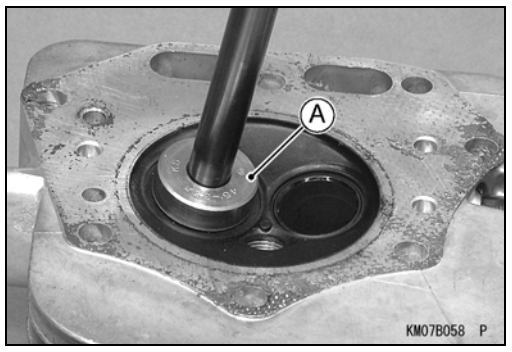
- Clean the seat area carefully.
- Recondition the valve seats with the valve seat cutters (45°, 32°) and lap the valves.
- Check the seats for good contact all the way around with machinist's dye.
- Measure the seat width [A]. If it is greater than the STD width, reface the seating surface.

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



## Periodic Maintenance Procedures

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




**CAUTION**

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

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


**CAUTION**

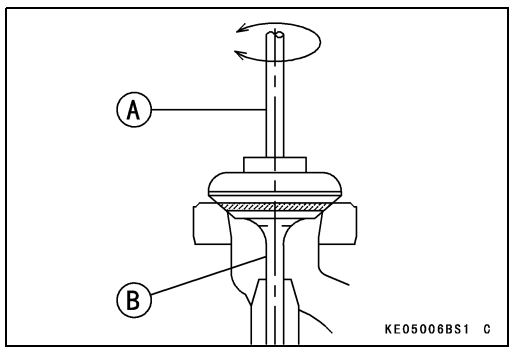
**The 32° cutter removes material very quickly. Check the seat width frequently to prevent over grinding.**

**NOTE**

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

● Make a light contact on the valve seat 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 valve face sparingly with a fine lapping compound.
● Use the lapper [A], to grip the 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.



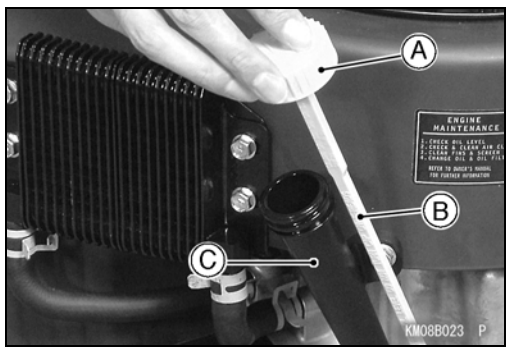
## Periodic Maintenance Procedures

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

## Lubrication System

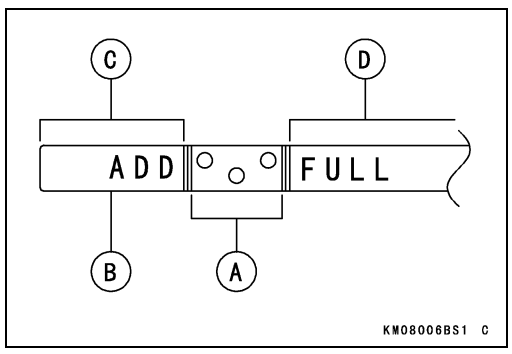
### *Engine Oil Level Inspection*

- 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 tube [C] without screwing it in, then check the oil level.




- The oil level should be the operating range [A] (patterned area) on the dipstick [B].

★If the oil level is “ADD” range [C], add enough engine oil to bring oil level to the operating range.




**CAUTION**

**Do not add more oil above the operating range. Excess oil will cause a smoking condition.**

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

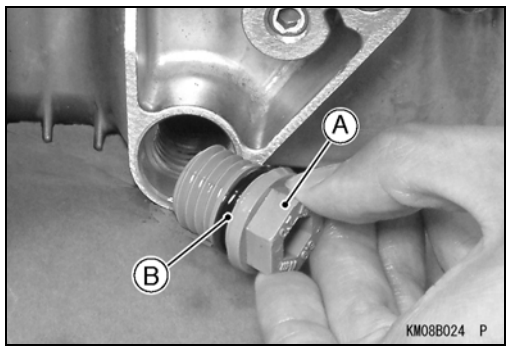
**NOTE**

○*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 “FULL” range [D], drain the excess oil by loosening the drain plug.

## Periodic Maintenance Procedures

### *Engine Oil Change*




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

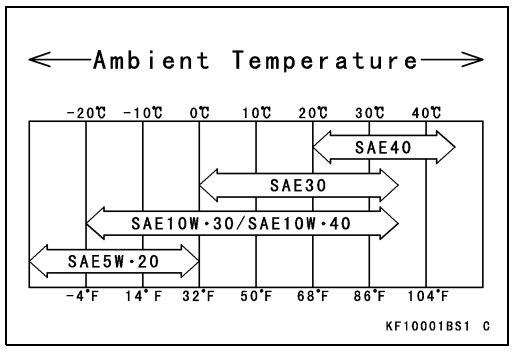
**⚠ WARNING**

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

- Replace the O-ring [B] with a new one.
- Apply engine oil to the thread of the plugs and O-rings if necessary.
- Install the oil drain plugs with the O-rings and tighten them.

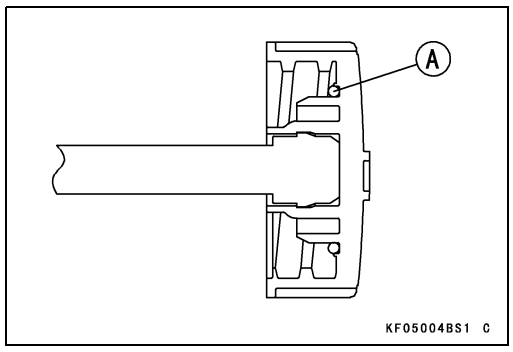
**Torque - Engine Oil Drain Plugs: 6.9 N·m (0.70 kgf·m, 61 in·lb)**

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




**Engine Oil:**

| | |
|---|---|
| **Grade:** | **SF, SG, SH, SJ or SL Class** |
| **Viscosity:** | **SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20** |
| **Capacity:** | **[When the oil filter is not removed]** |
| | **2.1 L (2.2 US qt)** |
| | **[When the oil filter is removed]** |
| | **2.3 L (2.4 US qt)** |



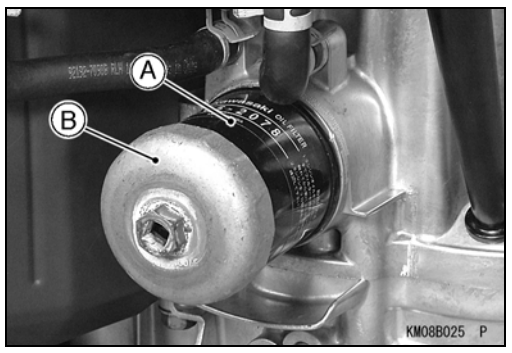

- Check the O-ring [A] on the oil filler cap for damage. Replace the oil filler cap with a new one if O-ring is damaged.

★When checking the oil level, do not turn oil filler cap on threads.

**NOTE**

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

### *Oil Filter Replacement*




- Drain the engine oil (see Engine Oil Change).
- Remove the oil filter [A] with the oil filter wrench [B] or strap wrench.

**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.

## Periodic Maintenance Procedures

- Replace the oil filter [A] with a new one.
- Apply light film of engine oil to the seal [B].
- Install the oil filter.

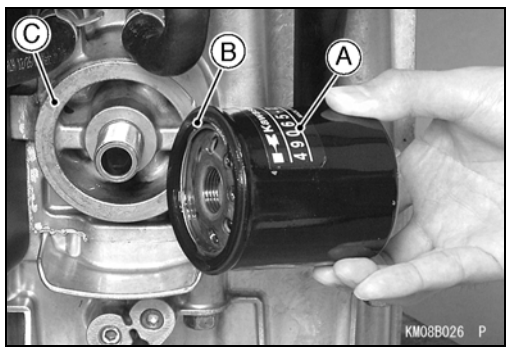
**Torque - Oil Filler: 11.8 N·m (1.20 kgf·m, 104 in·lb)**

○Turn the filter until the seal contacts mounting surface [C] of the engine. Then turn the filter BY HAND (S) 2/3 to 3/4 turn.

- Run the engine at slow idle speed for 3 minutes.

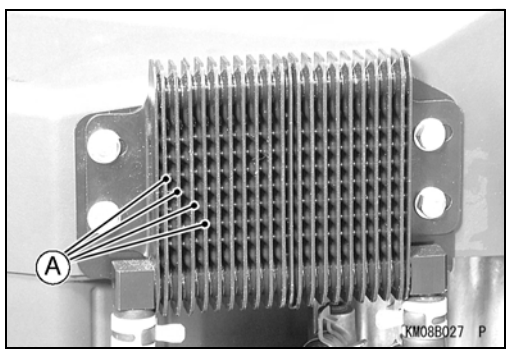
○While running the engine, check for oil leaks around it.

- Stop the engine and check the oil level (see Engine Oil Level Inspection).




### *Oil Cooler Fin Cleaning*

- Clean dirt off the outside fins [A] with brush or with compressed air.




## Electrical System

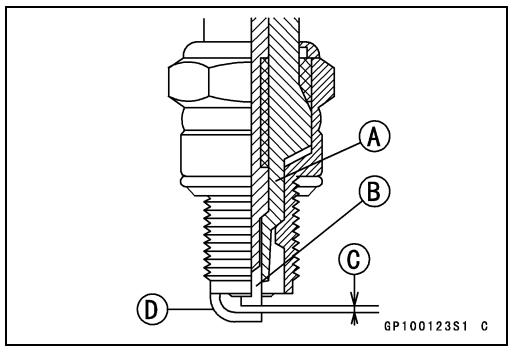
### *Spark Plug Cleaning and Inspection*

- Carefully pull the plug cap from the spark plug, and remove the spark plug.

★If the plug is oily or has carbon built up on it, clean the plug using a high-flash point solvent and a wire brush or other suitable tools.

★If the spark plug electrodes are corroded or damaged, or if the insulator is cracked replace the plug with a new one. Use the standard spark plug or its equivalent.

Insulator [A]
Center Electrode [B]
Plug Gap [C]
Side Electrode [D]




### *Spark Plug Gap Inspection*

- Measure the gap with a wire-type thickness gauge.

★If the gap is not correct, carefully bend the side electrode with a suitable tool to obtain the correct gap.

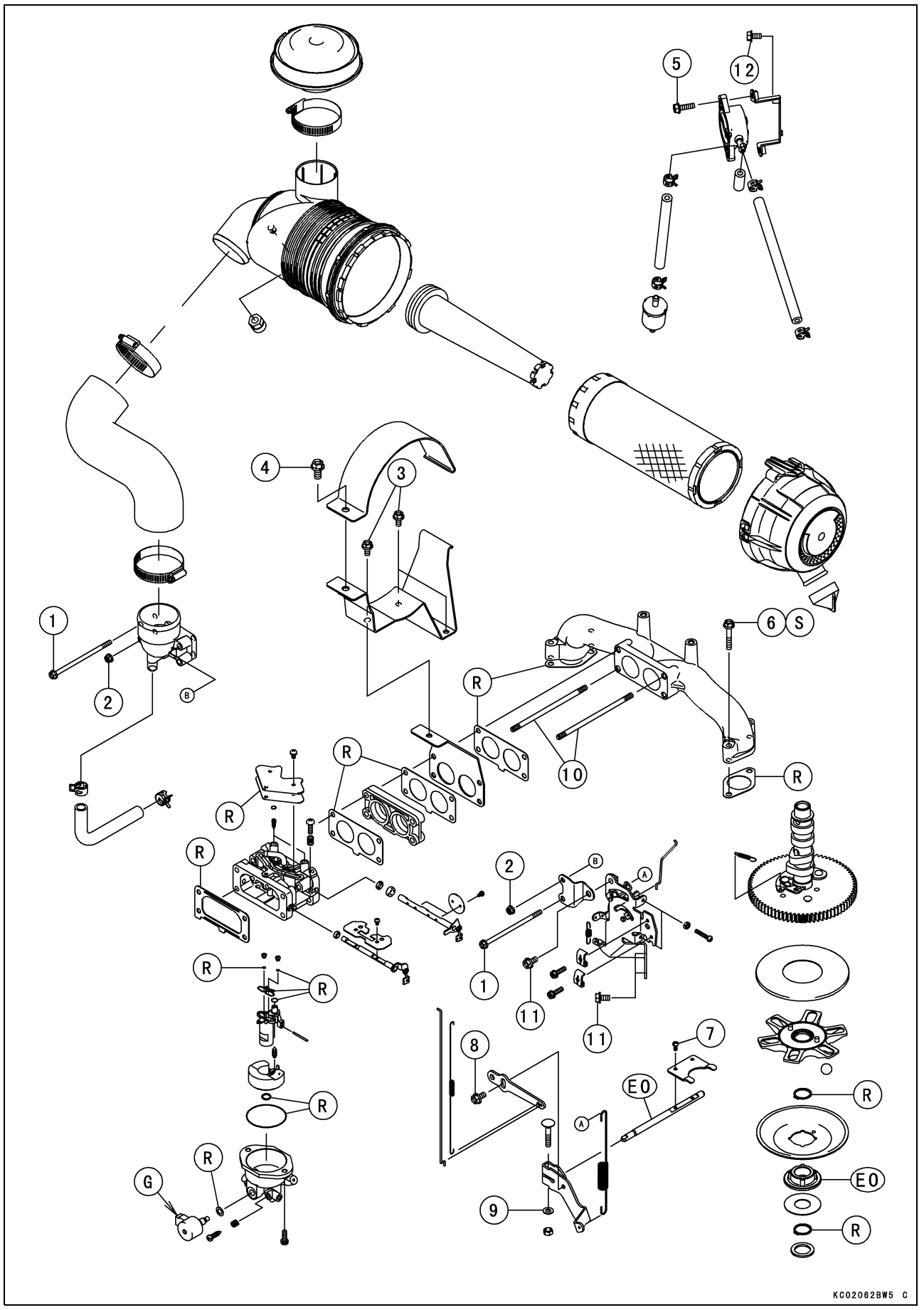
**Spark Plug Gap**
**Standard: 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)**

# Fuel System

## Table of Contents

## 3-2 FUEL SYSTEM

### Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Carburetor and Inlet Pipe Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| 2 | Carburetor and Inlet Pipe Mounting Nuts | 5.9 | 0.60 | 52 in·lb | |
| 3 | Air Cleaner Bracket Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| 4 | Air Cleaner Holder Bracket Bolt | 19.6 | 2.00 | 14.4 | |
| 5 | Fuel Pump Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| 6 | Inlet Manifold Bolts | 5.9 | 0.60 | 52 in·lb | |
| 7 | Governor Shaft Plate Screws | 2.0 | 0.20 | 18 in·lb | |
| 8 | Governor Arm Joint Bolt | 5.9 | 0.60 | 52 in·lb | S |
| 9 | Governor Arm Clamp Nut | 7.8 | 0.80 | 69 in·lb | |
| 10 | Carburetor and Inlet Pipe Stud Bolts | 5.9 | 0.60 | 52 in·lb | |
| 11 | Control Panel Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |
| 12 | Fuel Pump Bracket Bolt | 5.9 | 0.60 | 52 in·lb | |

EO: Apply engine oil.
G: Apply grease (Three Bond: TB2585G or equivalent).
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

## 3-4 FUEL SYSTEM

### Specifications

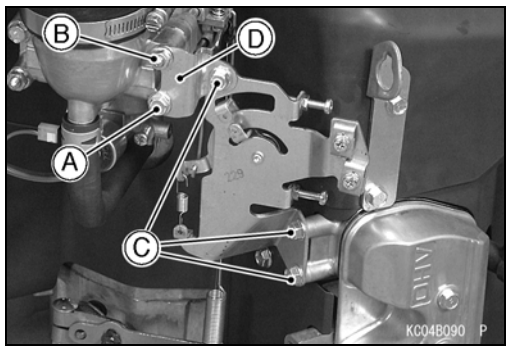
| Item | Standard |
|---|---|
| **Carburetor Specifications:** | |
| Make/Type | |
| FX751V | Nikki 621266-881 |
| FX801V | Nikki 621266-871 |
| FX850V | Nikki 621266-861 |
| Throttle Bore Diameter | 26 mm (1.0 in.) |
| Venturi Diameter | 21 mm (0.83 in.) |
| Main Jet (MJ) | L: #118<br>R: #120 |
| Pilot jet (PJ) | #56 |
| Pilot Air Screw Turns out (PS) (Idle Mixture Screw Turns Out) | 3 1/4 |
| Float Level | Float parallel to carburetor body |
| **Idle Speed: (1)** | |
| Low Idle Speed (Carburetor idle rpm) | 1 450 r/min (rpm) |
| Low Idle Speed (Governor idle rpm) | 1 550 r/min (rpm) |
| High Idle Speed | 3 600 r/min (rpm) |
| **Air Cleaner:** | |
| Type | Heavy duty type |
| Pre-cleaner | Primary element |
| Second-stage cleaner | Secondary element |
| **Fuel** | |
| Fuel Requirement | Unleaded regular grade gasoline |
| **Fuel Pump** | |
| Type | Pulse-diaphragm pump |
| **Governor** | |
| Type | Flyweight all speed governor |

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

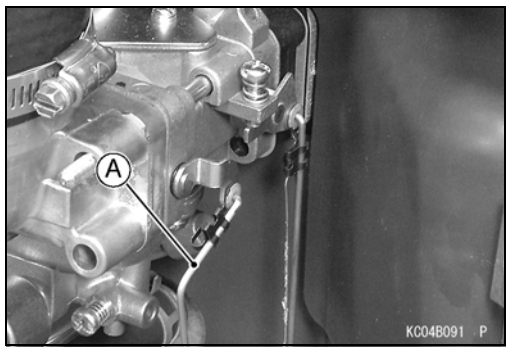
## Governor Link Mechanism

### *Control Panel Assembly Removal*

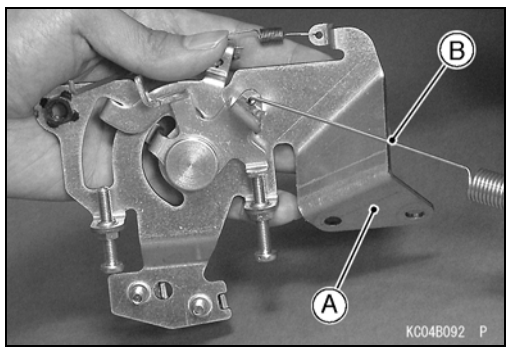
- Remove:
  Inlet Pipe Mounting Bolt [A] and Nuts [B]
  Control Panel Mounting Bolts [C]
  Bracket [D]




- Unhook the choke link rod [A] from the choke shaft lever clip end.



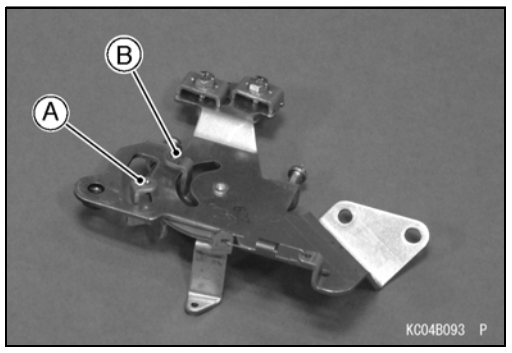

- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the panel bracket.




### *Control Panel Assembly Installation*

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

★If any part is worn or damaged, replace the control panel assembly with a new one.



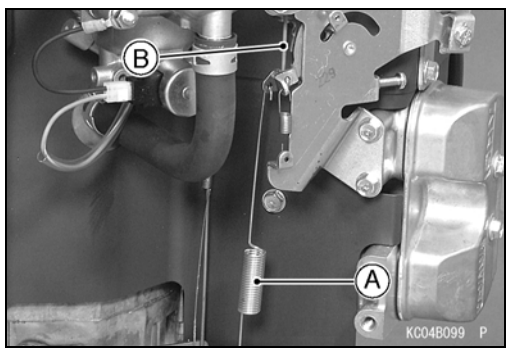

- Install the governor spring [A] and choke link rod [B].

○The long leg side of the governor spring faces control panel, and direction of the spring end as shown.

- Tighten:

**Torque - Control Panel Mounting Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**

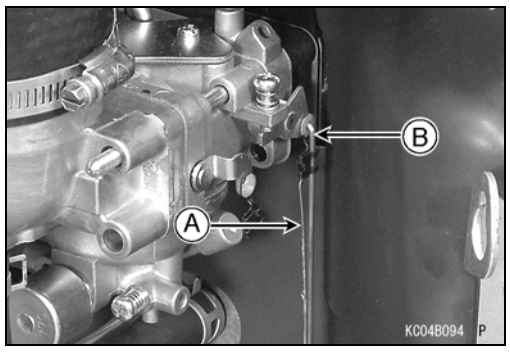
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low Idle Speed and High Idle Speed adjustment in the Periodic Maintenance chapter).



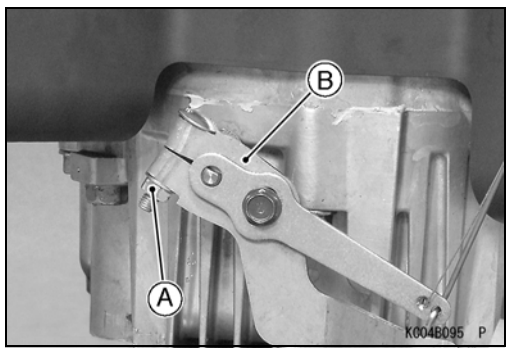
## Governor Link Mechanism

### *Governor Arm Removal*

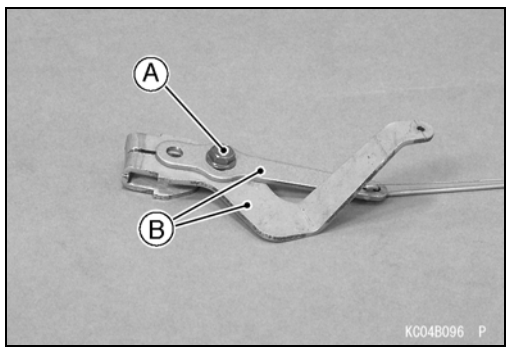
- Remove:
  Control Panel Assembly (see Control Panel Assembly Removal)
- Unhook the throttle link rod spring [A] end loop and clear the throttle link rod lower end [B].




- Loosen the clamp nut [A] and take off the governor arm [B].




- Remove the bolt [A] to separate the governor arms [B].

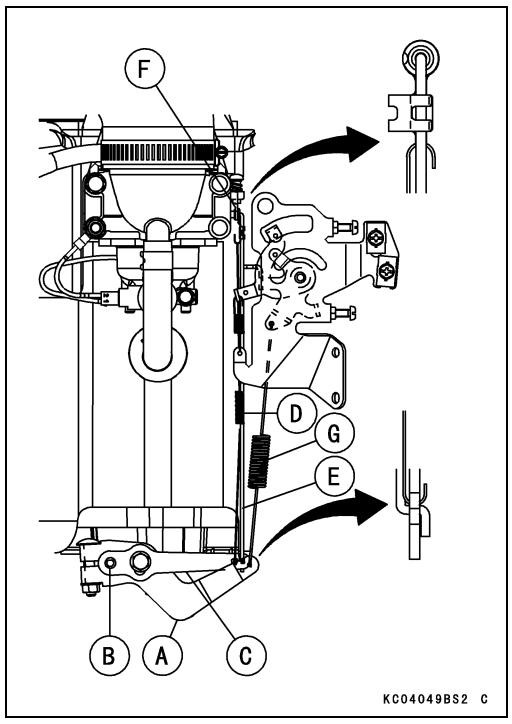



### *Governor Arm Installation*

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

  **Torque - Governor Arm Clamp Nut: 7.8 N·m (0.80 kgf·m, 69 in·lb)**

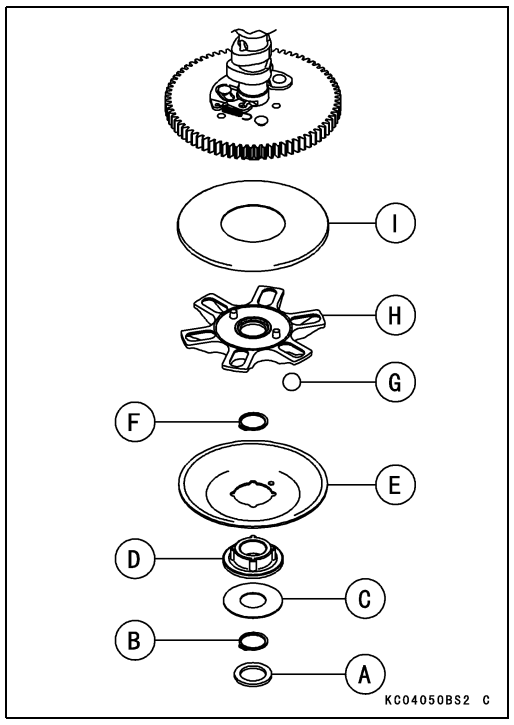
- Install the control panel assembly, and connect the governor arm with the governor spring [G].



## Governor Link Mechanism

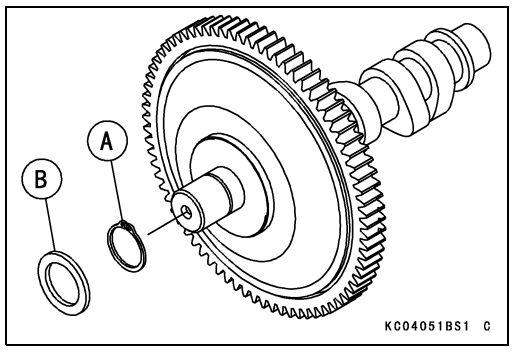
### *Governor Assembly Removal*

- Remove:
  Camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter)
  Washer ($\phi$29) [A]
  Snap Ring [B]
  Washer ($\phi$46) [C]
  Sleeve [D]
  Governor Plate [E]
  Circlip [F]
  Steel Balls [G]
  Ball Guide [H]
  Ball Plate [I]




### *Governor Assembly Installation*

- Fit the circlip [A] into the groove securely.
- Turn the governor plate by hand and check that the steel balls and governor plate operate freely.
- Be sure to install the washer [B].



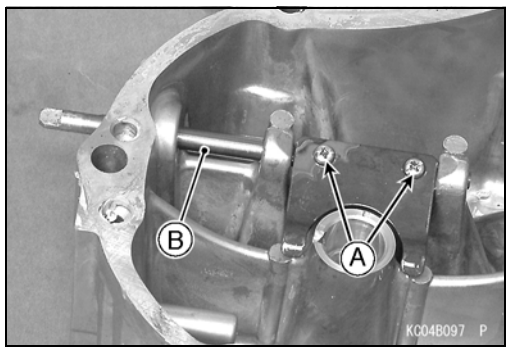

### *Governor Assembly Inspection*

- Visually check all governor parts for wear or damage.

★If any parts are worm or damaged, replace them with new ones.

### *Governor Shaft Removal*

- Split the crankcase (see Crankcase Cover Removal in the Camshaft/Crankcase chapter).
- Unscrew the governor shaft plate screws [A], and pull out the governor shaft [B].
- Replace the oil seal with a new one if the lip shows signs of leakage or it has been damaged (see Crankcase Cover Assembly in the Camshaft/Crankshaft chapter).



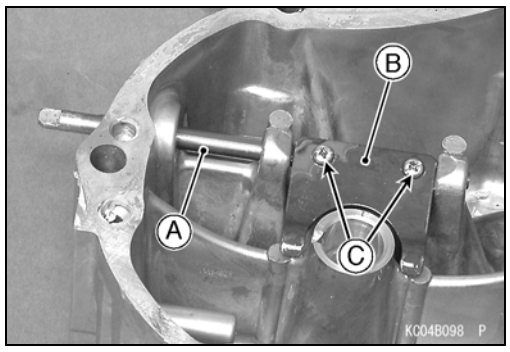
## Governor Link Mechanism

### *Governor Shaft Installation*

- Apply engine oil to the governor shaft.
- Insert the governor shaft [A] into the crankcase cover.
- Install the governor shaft plate [B] to the shaft as shown.
- Tighten:

**Torque - Governor Shaft Plate Screws [C]: 2.0 N·m (0.20 kgf·m, 18 in·lb)**

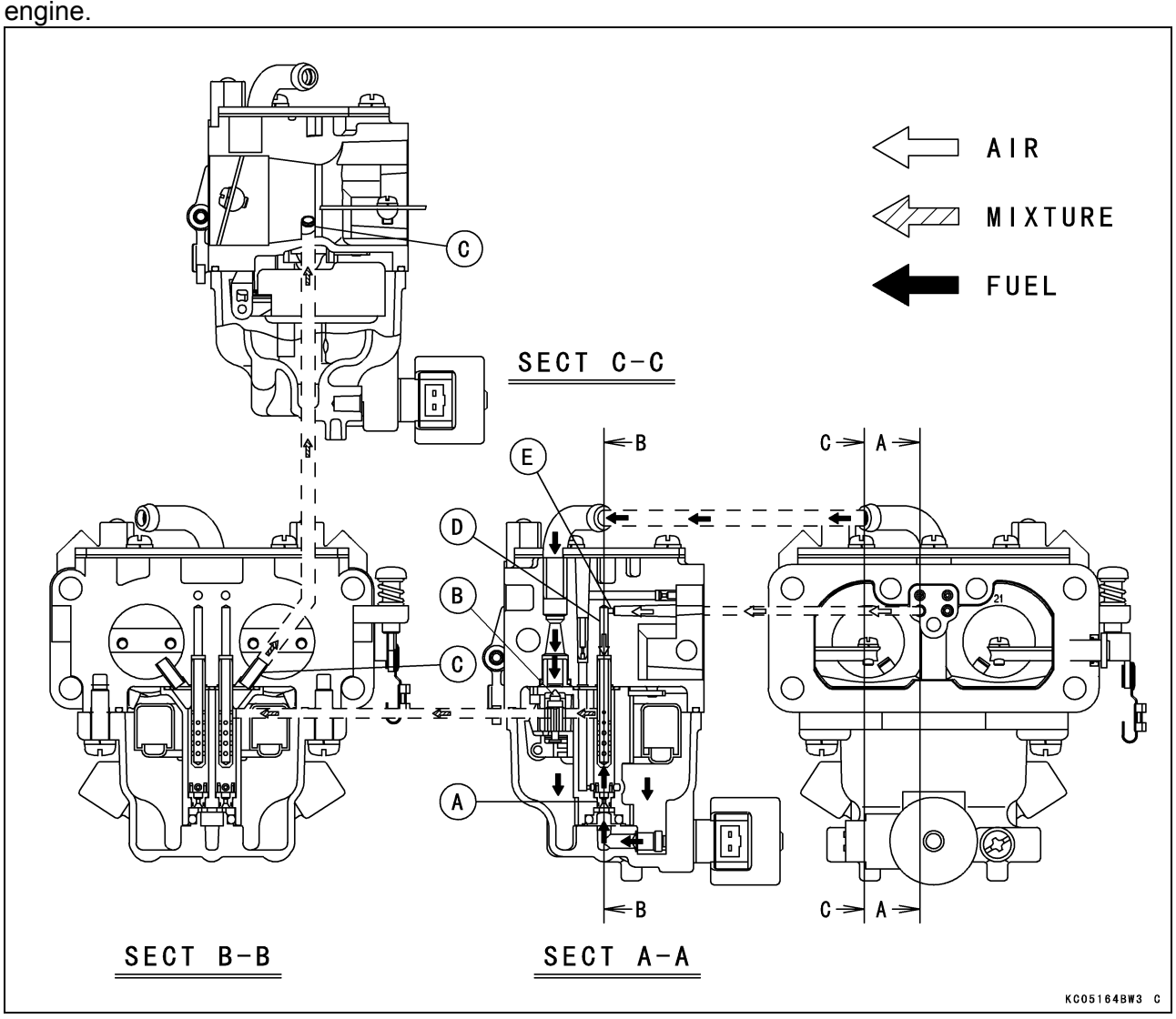
- Check that the governor shaft moves freely in its operating range.



## 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 orifice). 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.

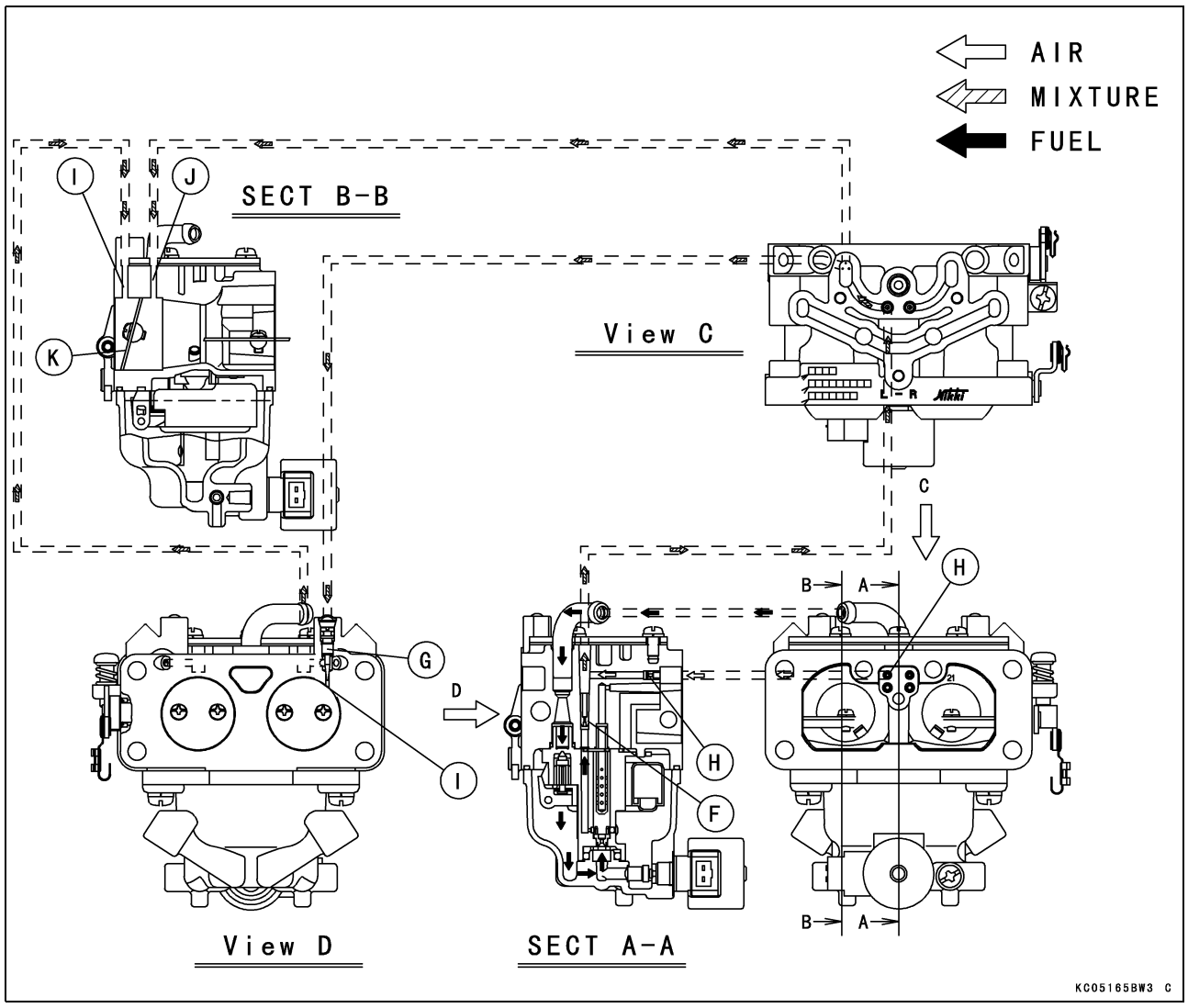


## 3-10 FUEL SYSTEM

### Carburetor

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

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

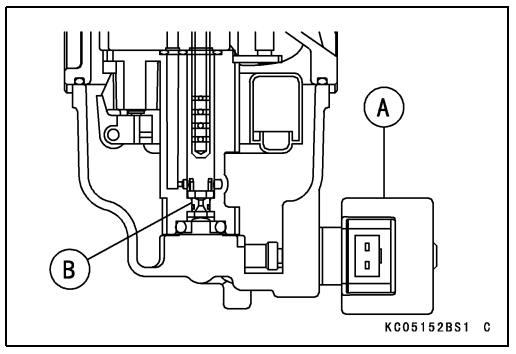


## Carburetor

### *Fuel Shut Off Solenoid Valve*

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

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




### *Low Idle Speed Adjustment*

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

### *High Idle Speed Adjustment*

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

### *High Altitude Operation*

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

**NOTE**

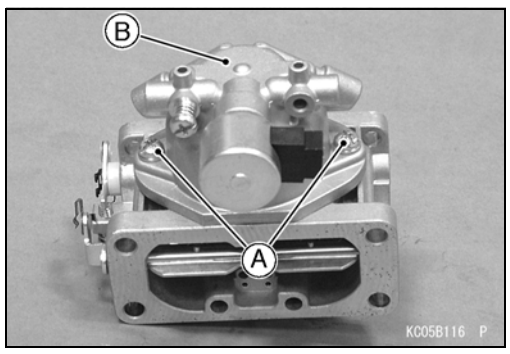
○*The main jet high altitude kits are available for the equipment used in the high altitude. The main jet numbers are stamped on the ends of the main jets.*

**High Altitude Main Jet**

| Altitude | Main Jet No. |
|---|---|
| 0 ~ 1 000 m (0 ~ 3 000 ft) | L: #118<br>R: #120 |
| 1 000 ~ 2 000 m (3 000 ~ 6 000 ft) | L: #115<br>R: #117 |
| 2 000 m (6 000 ft) and higher | L: #112<br>R: #114 |

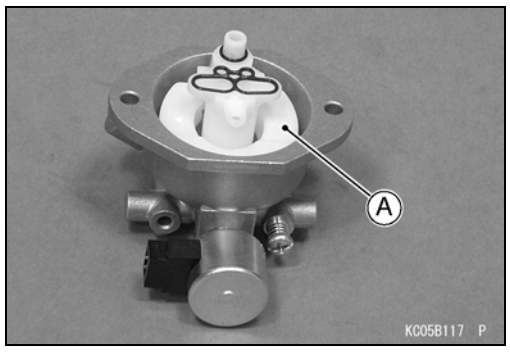
### *Main Jet Replacement*

- Close the fuel shut off valve in the equipment.
- Remove the carburetor (see Carburetor Removal).
- Drain the fuel in 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).
- Unscrew the chamber screws [A] and take off the float chamber [B].

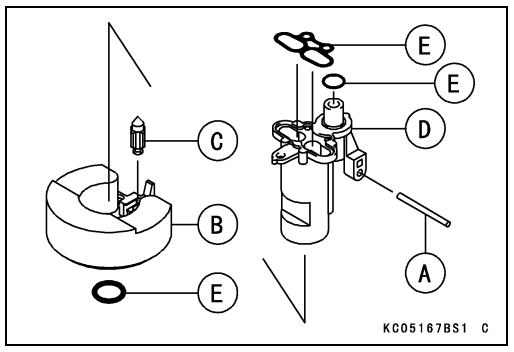


## Carburetor

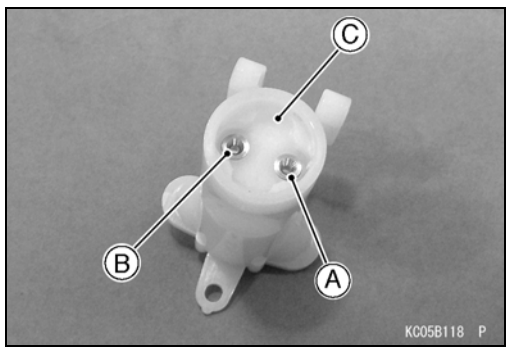
● Remove the float assembly [A] from the float chamber.



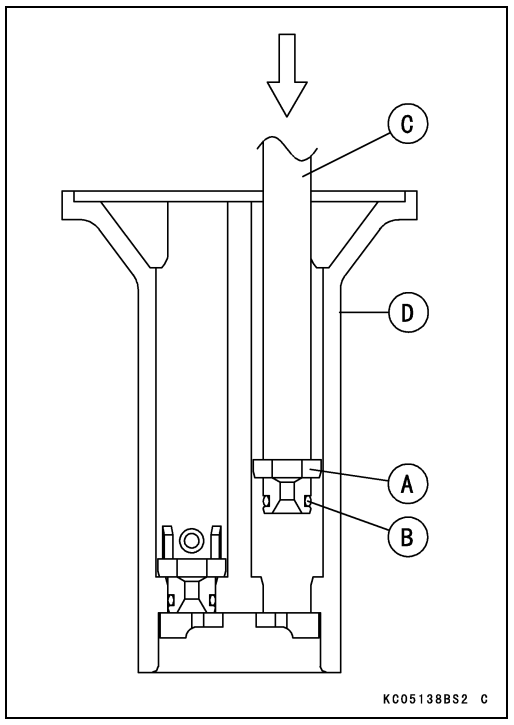

● Remove:
Pin [A]
Float [B]
Float Valve [C]
Spacer [D]
O-rings [E]




● Use the rod to push the main jet “L” [A] and “R” [B] out from the bottom side of the spacer [C].




● Replace the main jet [A] with a new one for altitude expected (see High Altitude Operation).
● Install the new O-ring [B] to the main jet.
● Using the suitable rod [C], press the main jet until they are bottomed to the spacer [D].
● Assemble the carburetor (see Carburetor Disassembly/Assembly).

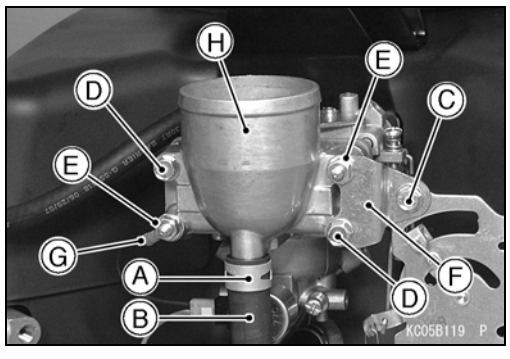



### *Fuel System Cleanliness Inspection*

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

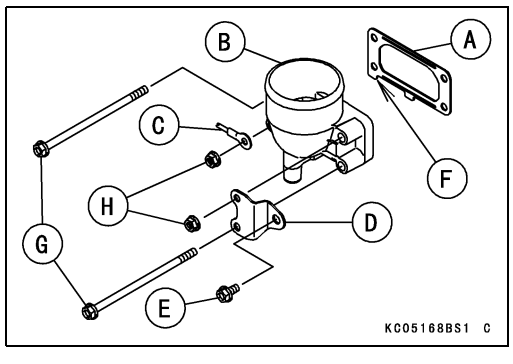
## Carburetor

### *Inlet Pipe Removal*



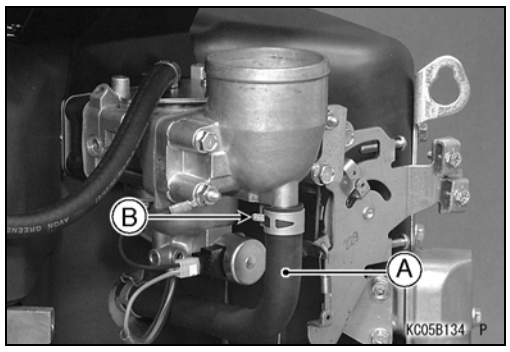

● Remove:
Air Cleaner (see Air Cleaner Body and Bracket Removal)
Clamp [A]
Breather Hose [B]
Bracket Bolt [C]
Inlet Pipe Mounting Bolts [D] and Nuts [E]
Bracket [F]
Ground Lead [G]
Inlet Pipe [H]

### *Inlet Pipe Installation*




● Replace the gasket [A] with a new one.
● Install:
Gasket
Inlet Pipe [B]
Ground Lead [C]
Bracket [D]
Bracket Bolt [E]
○The side tongue [F] of the gasket faces #1 cylinder and PTO side as shown.
● Tighten:

**Torque - Carburetor and Inlet Pipe Mounting Bolts [G]: 5.9 N·m (0.60 kgf·m, 52 in·lb)**
**Carburetor and Inlet Pipe Mounting Nuts [H]: 5.9 N·m (0.60 kgf·m, 52 in·lb)**




● Connect the breather hose [A] so that the clamp knob [B] faces inside.

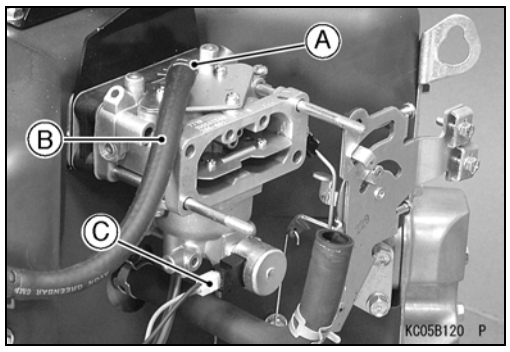
### *Carburetor Removal*

**⚠ WARNING**

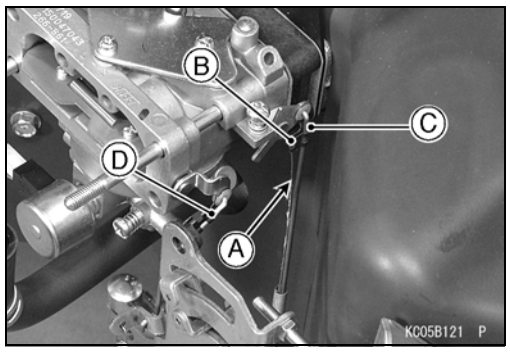
**Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well- ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.**

## Carburetor

- Remove:
  Inlet Pipe (see Inlet Pipe Removal)
- Close the fuel shut off valve in the equipment.
- Remove the clamp [A].
- Disconnect:
  Fuel Tube [B]
  Solenoid Valve Connector [C]



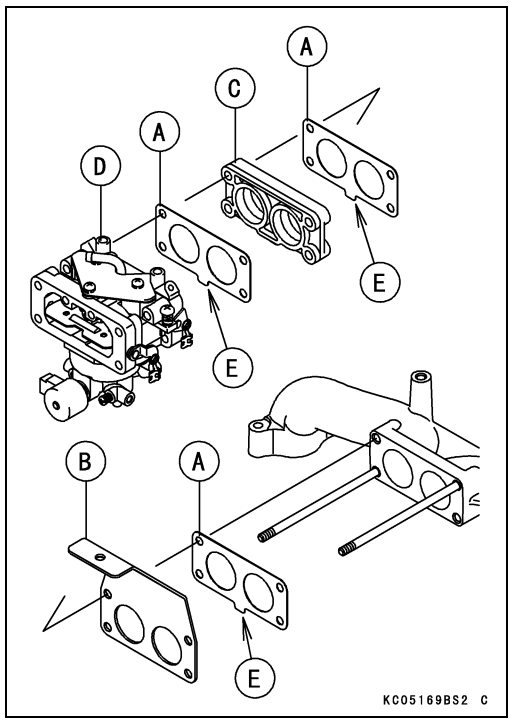

- Unhook the throttle link spring [A] at the throttle shaft lever clip end [B] with a long nose plier.
- Unhook the throttle link rod [C] from the throttle shaft lever clip end.
- Unhook the choke link rod [D] from the choke shaft lever clip end.
- Remove the carburetor.




### *Carburetor Installation*

- Clean the mating surface of the carburetor and inlet manifold.
- Replace the gaskets [A] with new ones.
- Connect the solenoid valve connector.
- Install the plate bracket [B], insulator [C], carburetor [D] and gaskets sequence as shown.

○The tongue [E] of the gaskets face the PTO side.

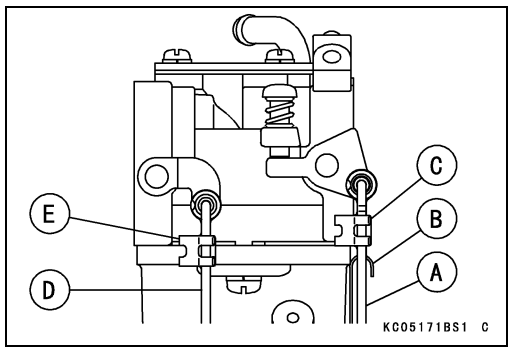



- Install the throttle link rod [A] and spring [B] to the throttle shaft lever clip [C].
- Install the choke link rod [D] to the choke shaft lever clip [E].

**NOTE**

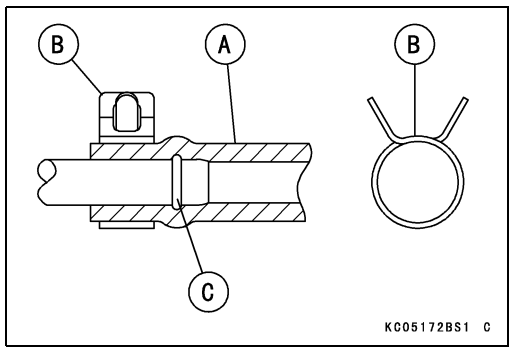
○*Take care not to bend the throttle link and choke rod during installation.*

- Make sure that the link spring around the throttle link rod is inplace and that it pulls the governor arm and carburetor throttle shaft lever toward each other.



## Carburetor

- Install the fuel tube [A] onto the pipe fully and install the clamp [B] beyond the raised rib [C].
- Apply grease (Three Bond: TB2585G) to the solenoid valve terminal.
- Connect the solenoid valve connector.
- Install the air cleaner (see Air Cleaner Body and Bracket Installation).
- After installation, adjust the idle speed (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter).



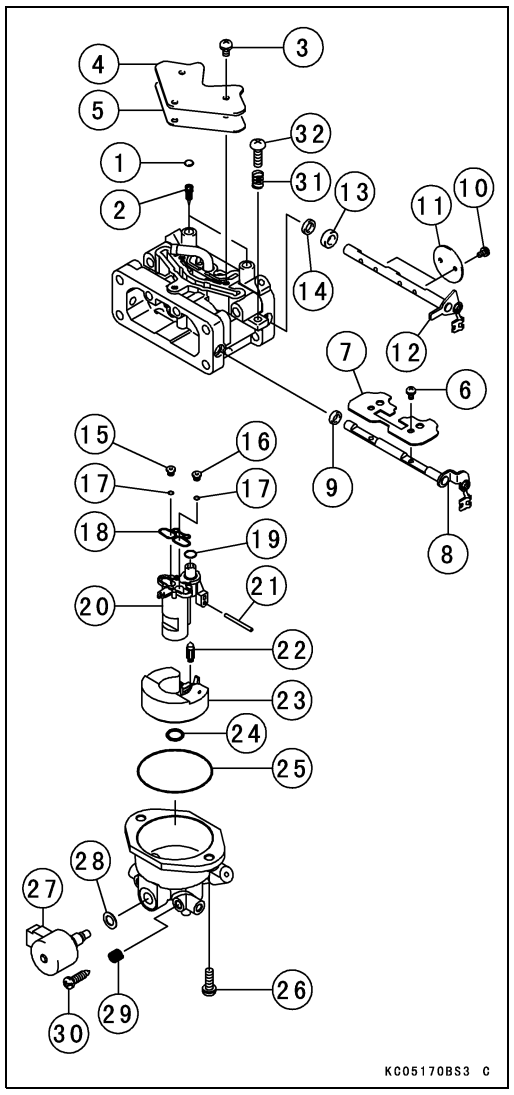

### *Carburetor Disassembly/Assembly*

- Refer to the illustration shown for disassembly and assembly.

○There are several passage plugs (Ball plugs) in the carburetor body. Do not remove.

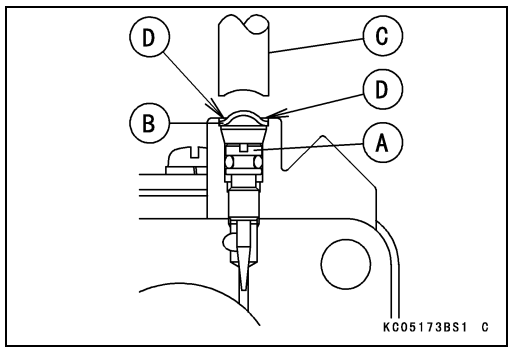
- Before disassembly, mark the outside of choke valve and throttle valves for assembling them.

1. Pilot Screw Plugs
2. Pilot Screws
3. Screws
4. Cover Plate
5. Gasket
6. Screws
7. Choke Valve
8. Choke Shaft
9. Seal
10. Screws
11. Throttle Valves
12. Throttle Shaft
13. Collar
14. Seal
15. Main Jet (L)
16. Main Jet (R)
17. O-rings
18. Gasket
19. O-ring
20. Spacer
21. Pin
22. Float Valve
23. Float
24. O-ring
25. Gasket
26. Screws
27. Solenoid Valve
28. Gasket
29. Spring
30. Drain Screw
31. Spring
32. Screw



## Carburetor

● Replace the pilot screw [A] in accordance with the following procedure if necessary.
○Remove the pilot screw plug [B] (material: Stainless steel) as follows: Punch a hole in the plug and pry it out with an awl or other suitable tool.
○Turn in the pilot screw and count the number of turns until it seats fully but not tightly, and then remove the screw. This is to set the screw to its original position when assembling.
○Turn in the new pilot screw fully but not tightly, and then back it out the same number of turns counted during disassembly.
○Install a new pilot screw plug in the pilot screw hole by pressing with the rod [C], and apply a small amount of a bonding agent [D] to the circumference of the plug to fix the plug.




● When assemble the carburetor, note the following
○Apply engine oil (SAE30 equivalent) to the seals of the choke and throttle shaft.
○Install the choke valve and throttle valve on the shaft as the out side mark of them facing out side, and apply a small amount of a bonding agent to the valve screw threads.

| CAUTION |
| --- |
| **Do not apply too much bonding agent to the valve screws itself or they may be fixed.** |

○Fit the stopper of the carburetor body into the hole in the spacer.
○Assemble the carburetor parts with recommended tightening torque (see Exploded View).

## 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 appliance with a pilot light. Because of the danger of highly flammable liquids, do not use gasoline or low flash -point solvents to clean the carburetors.**

**CAUTION**

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

- Disassemble the carburetor (see Carburetor Disassembly/Assembly).
- Immerse all the metal parts in a carburetor cleaning solution.
- 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).

## Carburetor

### *Carburetor Inspection*

**⚠ WARNING**

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

- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burns and nicks. Replace the gasket with a new one if necessary.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.

★If the valves do not move smoothly, replace the carburetor body and/or throttle shaft and choke shaft assembly with new ones.

- Check the gasket on the carburetor body.

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

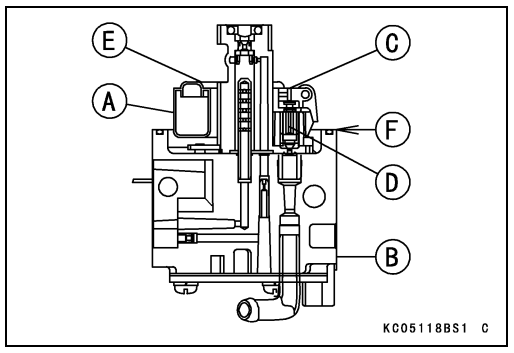
- Check the other parts of the carburetor for any wear or damage. Replace the part with a new one if necessary.
- Clean and check the float level as follows.

**CAUTION**

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

- With the float [A] assembly installed onto the carburetor body [B], hold the carburetor upside down at 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.

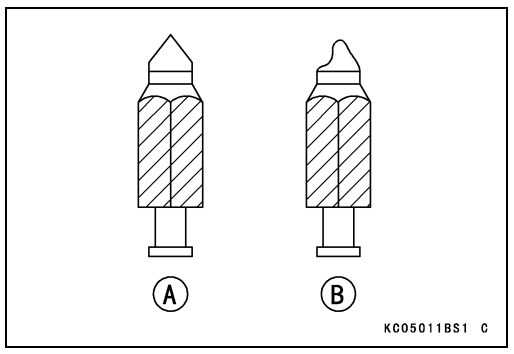



- Inspect the float valve for excessive wear or damage. The tip should be smooth, without any grooves, scratches, or tears. The rod at the other end of the needle should move smoothly when pushed in and released.

  [A] Good

  [B] Not Good

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

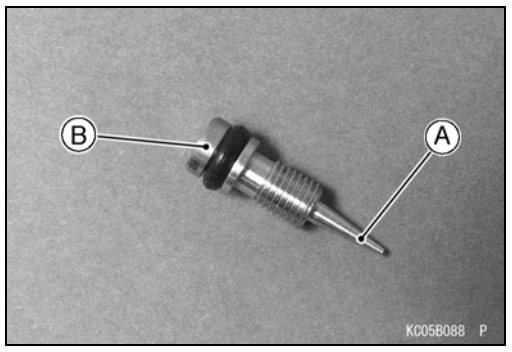


## Carburetor

- Inspect the tapered portion [A] of the pilot screw [B] for wear or damage.

★If the pilot screw is worn or damaged on the taper portion, replace it with a new one.

- Check the spring condition, replace it with a new one if necessary.



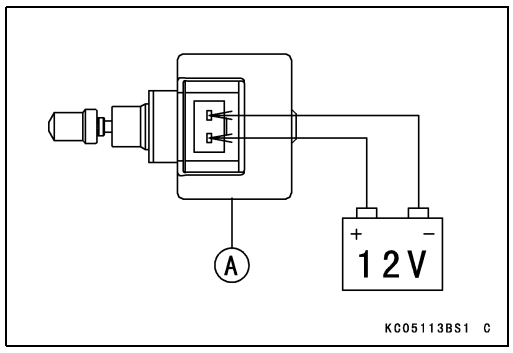

### *Fuel Shut Off Solenoid Valve Test*

- Unscrew the fuel shut off valve [A] and remove it.
- Connect a 12 VDC source to the solenoid as shown.

★If the actuated solenoid plunger (Needle Valve) does not pop out when the Test Voltage is applied, replace it with a new one.

**NOTE**

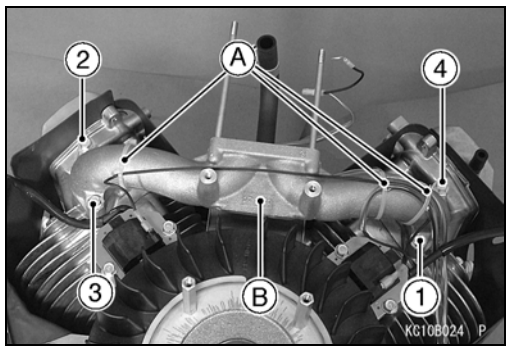
○*If necessary, push the plunger slightly for the plunger to withdraw.*



## Inlet Manifold

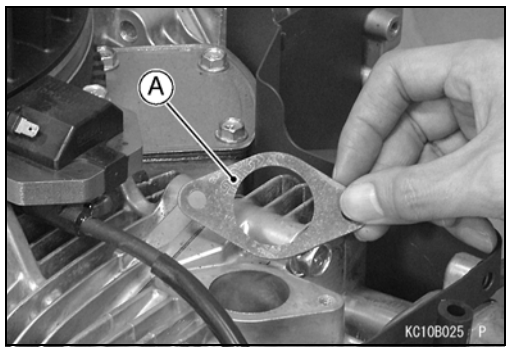
### *Inlet Manifold Removal*

- Remove:
  Fan Housing (see Flywheel and Stator Coil Removal in the Electrical System chapter)
  Carburetor (see Carburetor Removal)
- Cut off the bands [A] holding the wire lead and/or harness.
- Unscrew the inlet manifold bolts in the order shown [1 to 4].
- Remove:
  Inlet Manifold [B]



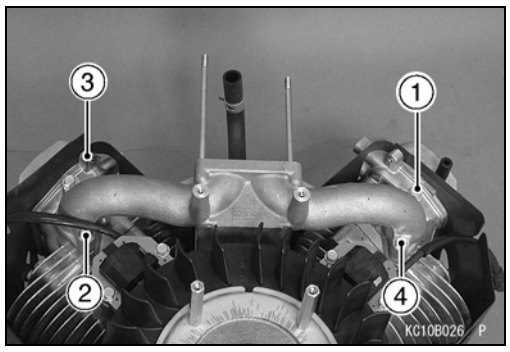

### *Inlet Manifold Installation*

- Replace the inlet manifold gaskets [A] with new ones.
- Clean the mating surfaces of the cylinders and Inlet manifolds.
- Install the inlet manifold gasket.




- Tighten the inlet manifold bolts following the tightening sequence.

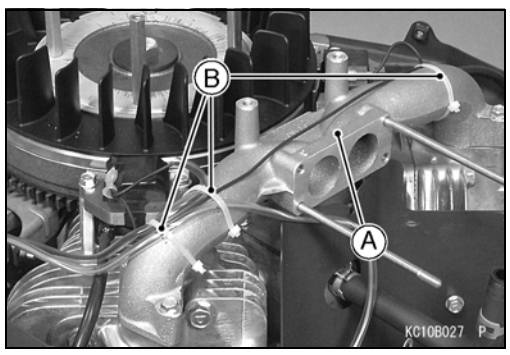
  **Torque - Inlet Manifold Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**



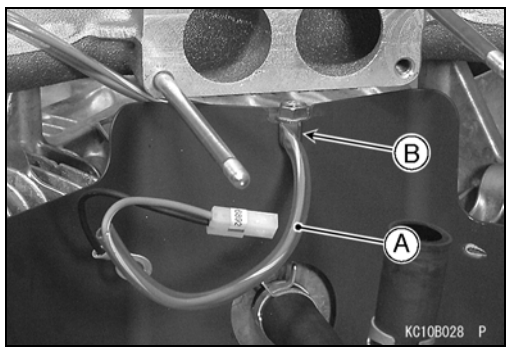

- Fix the wire lead and the harness to the inlet manifold [A] with bands [B].

○Position the wire lead and/or harness on top of the manifold as shown.

○Cut excess the band off.




- Run the solenoid valve and ground lead [A] through the engine shroud groove [B].
- Install the removed parts (see appropriate chapters).



## Inlet Manifold

### *Inlet Manifold Inspection*

- Inspect the intake manifold for cracks or porous casting.
- Cracks not visible to the eye may be detected by using a metal crack detection system. (Visual color check: commonly found at automotive parts store.)

★If a crack is present in the intake manifold, replace it.

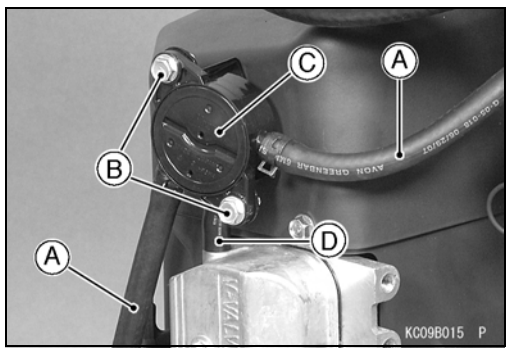
- Inspect the gasket surfaces for burns and nicks.

## Fuel Pump, Fuel Filter

The fuel pump cannot be disassembled. If any damage of the pump is noticed replace it with a new one.

### *Fuel Pump Removal*

- Remove:
  Fuel Tubes [A]
  Bolts [B]
  Fuel Pump [C]
  Pulse Tube [D]

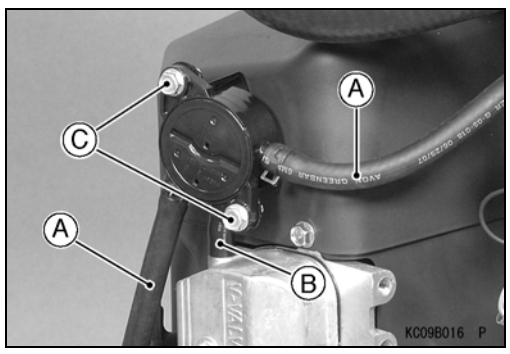



### *Fuel Pump Installation*

- Connect the fuel tubes [A] and pulse tube [B] fully.
- Tighten:

**Torque - Fuel Pump Mounting Bolts [C]: 5.9 N·m (0.60 kgf·m, 52 in·lb)**

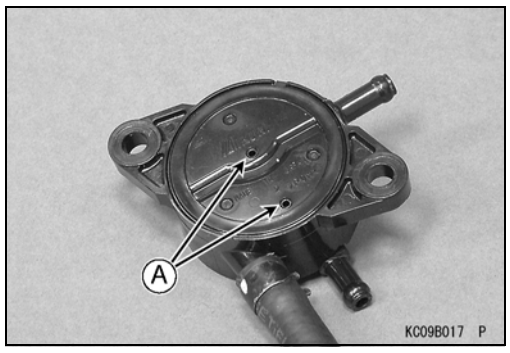
- Position the fuel tube clamps beyond the raised rib (see Carburetor Installation).

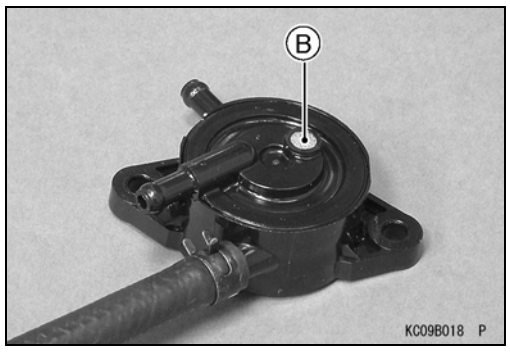



### *Fuel Pump Inspection*

- Check the vent holes [A] and filter [B] for plugging or clogging.

★If the vent hole and the filter are plugged or clogged, remove the foreign material from them.



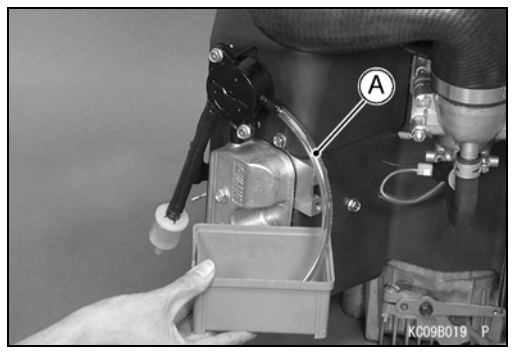



## Fuel Pump, Fuel Filter

**Fuel Flow Test:**

**⚠ WARNING**

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



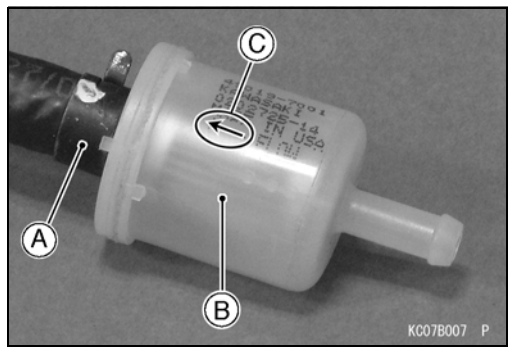

- Disconnect the fuel pump outlet nozzle from the tube.
- Connect a suitable hose [A] to the outlet nozzle.
- Run the lower end of the hose into a container.
- Start the engine. Check the fuel flow.

★If fuel flow is none or little, replace the fuel pump with a new one.

★Check the tubes and the fuel filter for clogging or damage. Replace the clogged or damaged tubes of fuel filter with new ones.

### *Fuel Filter Removal/Installation*

- Remove:
  Clamp [A]
  Fuel Filter [B]
- When install the fuel filter, arrow mark [C] faces fuel pump side.

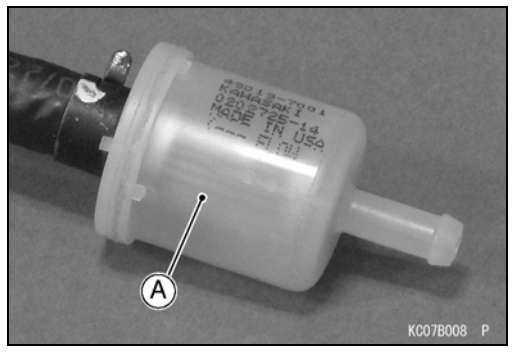



### *Fuel Filter Inspection*

- Visually inspect the fuel filter [A].

★If the filter is clear with no signs of dirt or other contamination, replacement of the fuel filter is not necessary.

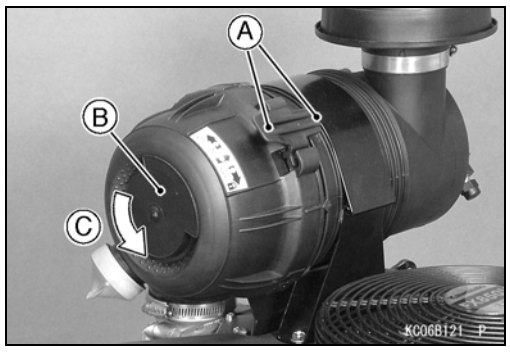
★If the filter is dark or looks dirty, replace it with a new one. Also check the rest of the fuel system for contamination.



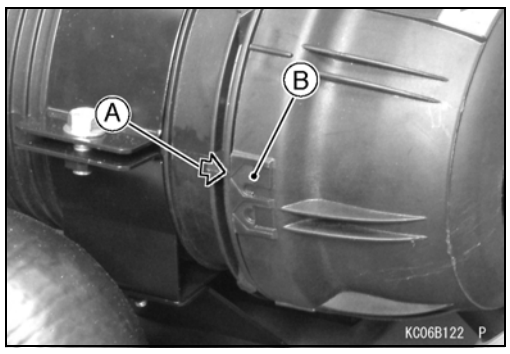
## Air Cleaner

### *Element Removal*

- While pulling up the two knobs [A], turn the cap [B] to counterclockwise [C].

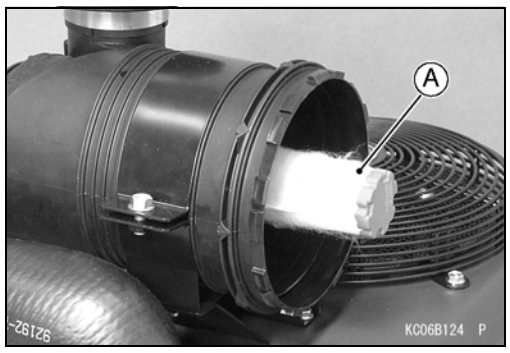



- Align the arrow mark [A] and unlock mark [B] to remove the cap.



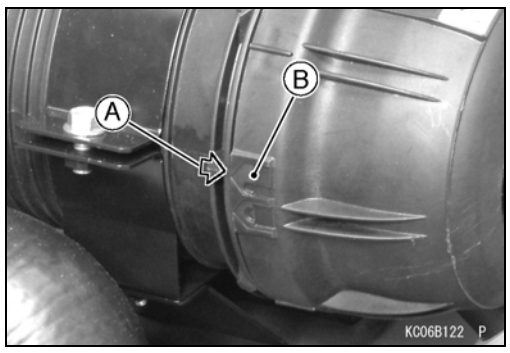

- Remove:
  Primary Element [A]


- Remove:
  Secondary Element [A]



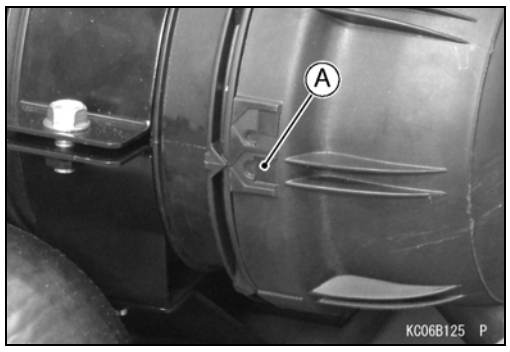

### *Element Installation*

- Slide the secondary element and primary element into place in the air cleaner body.
- Align the arrow mark [A] on the body and unlock mark [B] on the cap.



## Air Cleaner

● Turn the cap to the clockwise until the lock mark [A].



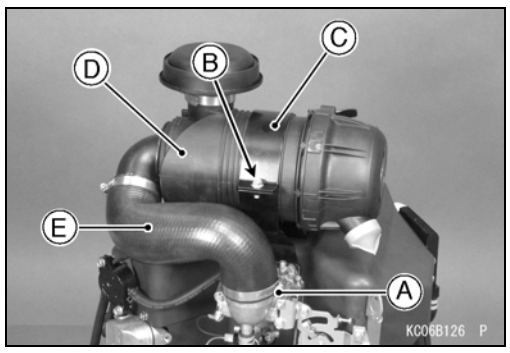

### *Element Cleaning and Inspection*

Air cleaner elements are not recommended to be cleaned, and each air cleaner element should be replaced with new ones.

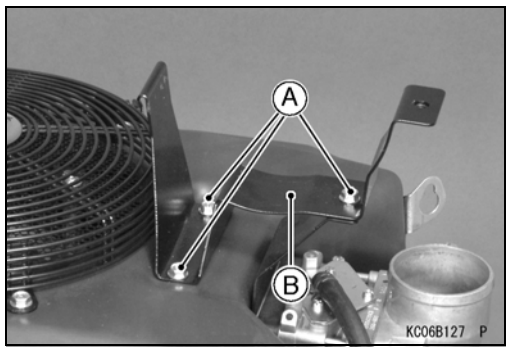
● Refer to the Element Cleaning and Inspection in the Periodic Maintenance chapter.

### *Air Cleaner Body and Bracket Removal*

● Remove the air cleaner elements, if necessary (see Element Removal).
● Loosen the clamp [A].
● Remove:
  Bolt [B]
  Holder Bracket [C]
● Take out the air cleaner body [D] together with the inlet hose [E].



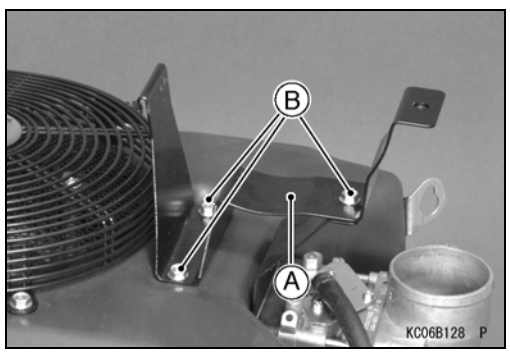

● Remove:
  Bolts [A]
  Bracket [B]




### *Air Cleaner Body and Bracket Installation*

● Install the air cleaner bracket [A].
● Tighten:

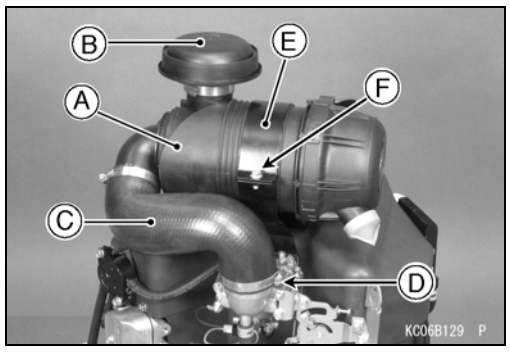
**Torque - Air Cleaner Bracket Mounting Bolts [B]: 5.9 N·m (0.60 kgf·m, 52 in·lb)**



## Air Cleaner

- Set the air cleaner body [A] onto the lower bracket so that the air inlet duct [B] is facing upward.
- Install the inlet hose [C], and tighten the clamp [D].
- Install the upper bracket [E].
- Tighten:

**Torque - Air Cleaner Holder Bracket Bolt [F]: 19.6 N·m (2.00 kgf·m, 14.4 ft·lb)**




### *Air Cleaner Housing (Cap and Body) Inspection*

- Refer to the Air Cleaner Housing (Cap and Body) Inspection in the Periodic Maintenance chapter.

# Cooling System

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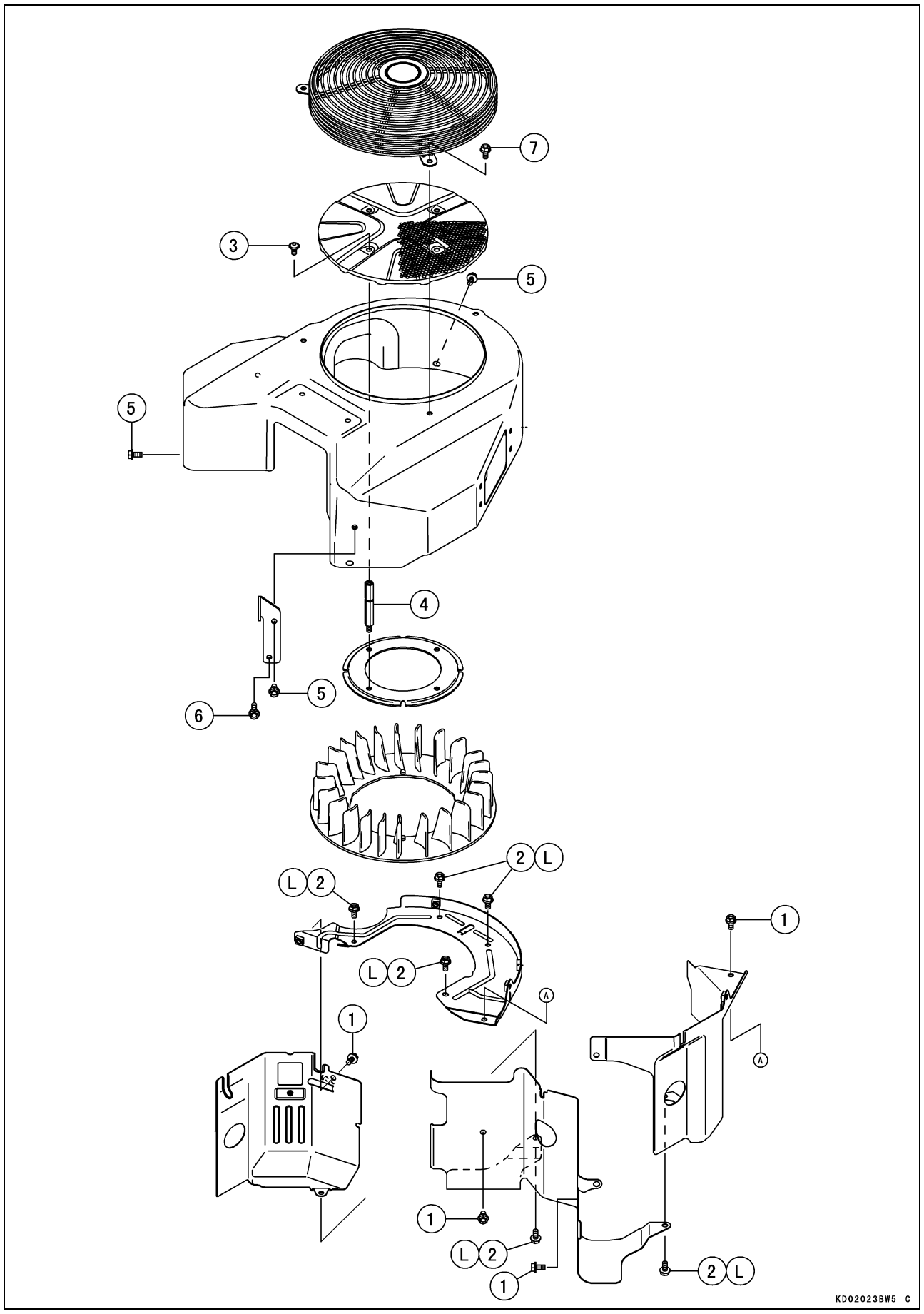
## 4-2 COOLING SYSTEM

### Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Engine Shroud Bolts (Non-locking Agent) | 5.9 | 0.60 | 52 in·lb | |
| 2 | Engine Shroud Bolts (Locking Agent) | 7.8 | 0.80 | 69 in·lb | L |
| 3 | Cooling Fan Screen Bolts | 5.9 | 0.60 | 52 in·lb | |
| 4 | Cooling Fan Plate Mounting Stud Bolts | 5.9 | 0.60 | 52 in·lb | |
| 5 | Fan Housing Bolts (L = 12 mm) | 5.9 | 0.60 | 52 in·lb | |
| 6 | Fan Housing Bolt (L = 20 mm) | 5.9 | 0.60 | 52 in·lb | |
| 7 | Guard Mounting Bolts | 5.9 | 0.60 | 52 in·lb | |

# 4-4 COOLING SYSTEM

## Cooling Fan

### *Cooling Fan Removal*

- Refer to the Flywheel and Stator Coil Removal in the Electrical System chapter.

### *Cooling Fan Installation*

- Refer to the Flywheel and Stator Coil Installation in the Electrical System chapter.

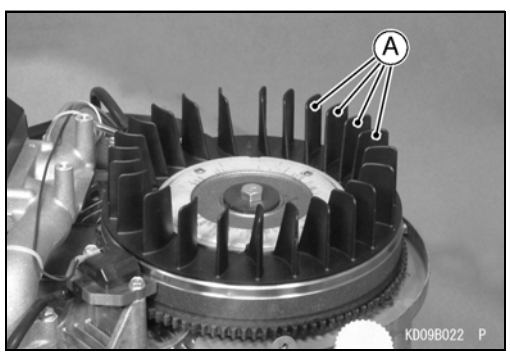
### *Cooling Fan Inspection*

- Remove the fan housing (see Flywheel and Stator Coil Removal in the Electrical System chapter).
- Visually inspect the blades [A] in the cooling fan.

★If they have any crack, warp or damage, replace the cooling fan with a new one.

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

- Wash the cooling fan in detergent and water.

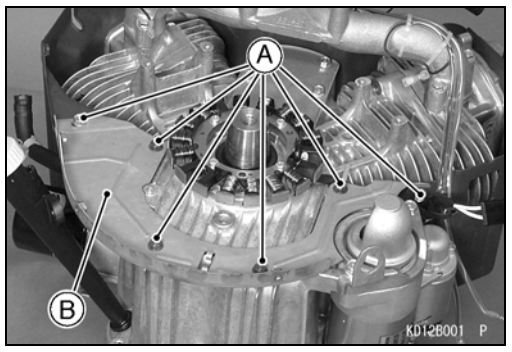



| CAUTION |
| --- |
| **Do not clean the cooling fan in oil solvent. It may be damage by oil solvent.** |

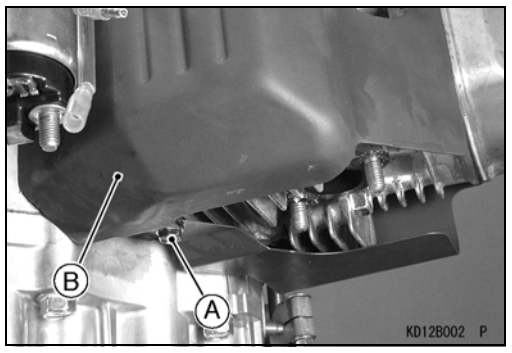
## Engine Shroud

### *Engine Shroud Removal*

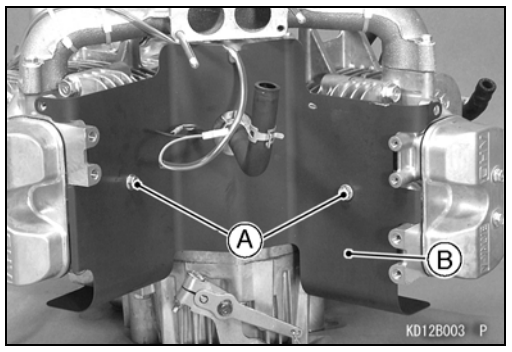
● Remove:
Flywheel (see Flywheel and Stator Coil Removal in the Electrical System chapter)
Control Panel (see Control Panel Removal in the Fuel System chapter)
Carburetor (see Carburetor Removal in the Fuel System chapter)
Engine Shroud Bolts [A]
Engine Shroud (Upper) [B]




● Remove:
Engine Shroud Bolts [A] (both side)
Engine Shrouds [B] (#1/#2 side)



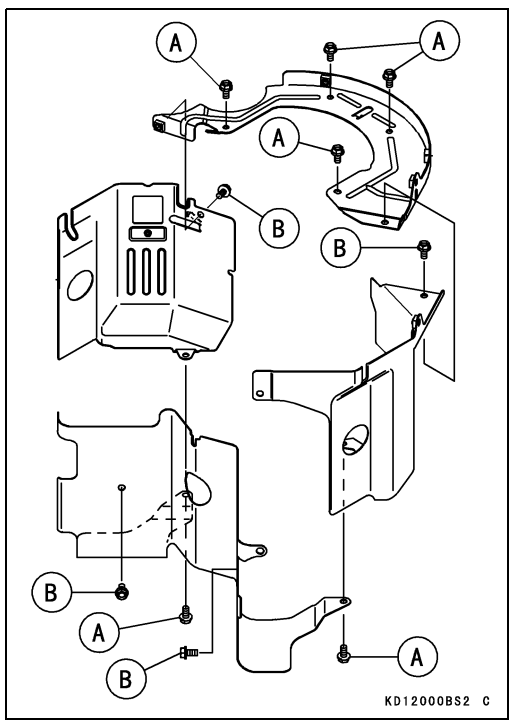

● Remove:
Engine Shroud Bolts [A]
Engine Shroud [B] (Carburetor side)




### *Engine Shroud Installation*

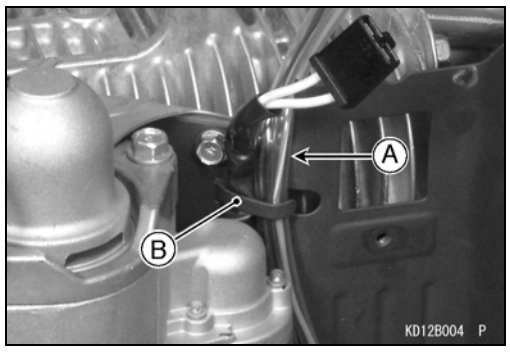
● Apply a non-parmanent locking agent to the engine shroud bolts [A].
● Tighten:

**Torque - Engine Shroud Bolts [A]: 7.8 N·m (0.80 kgf·m, 69 in·lb)**
**Engine Shroud Bolts [B]: 5.9 N·m (0.60 kgf·m, 52 in·lb)**



## Engine Shroud

- Run the wire lead and harness into the groove [A] and clamp [B] of the engine shroud (#1 side).



# Engine Top End

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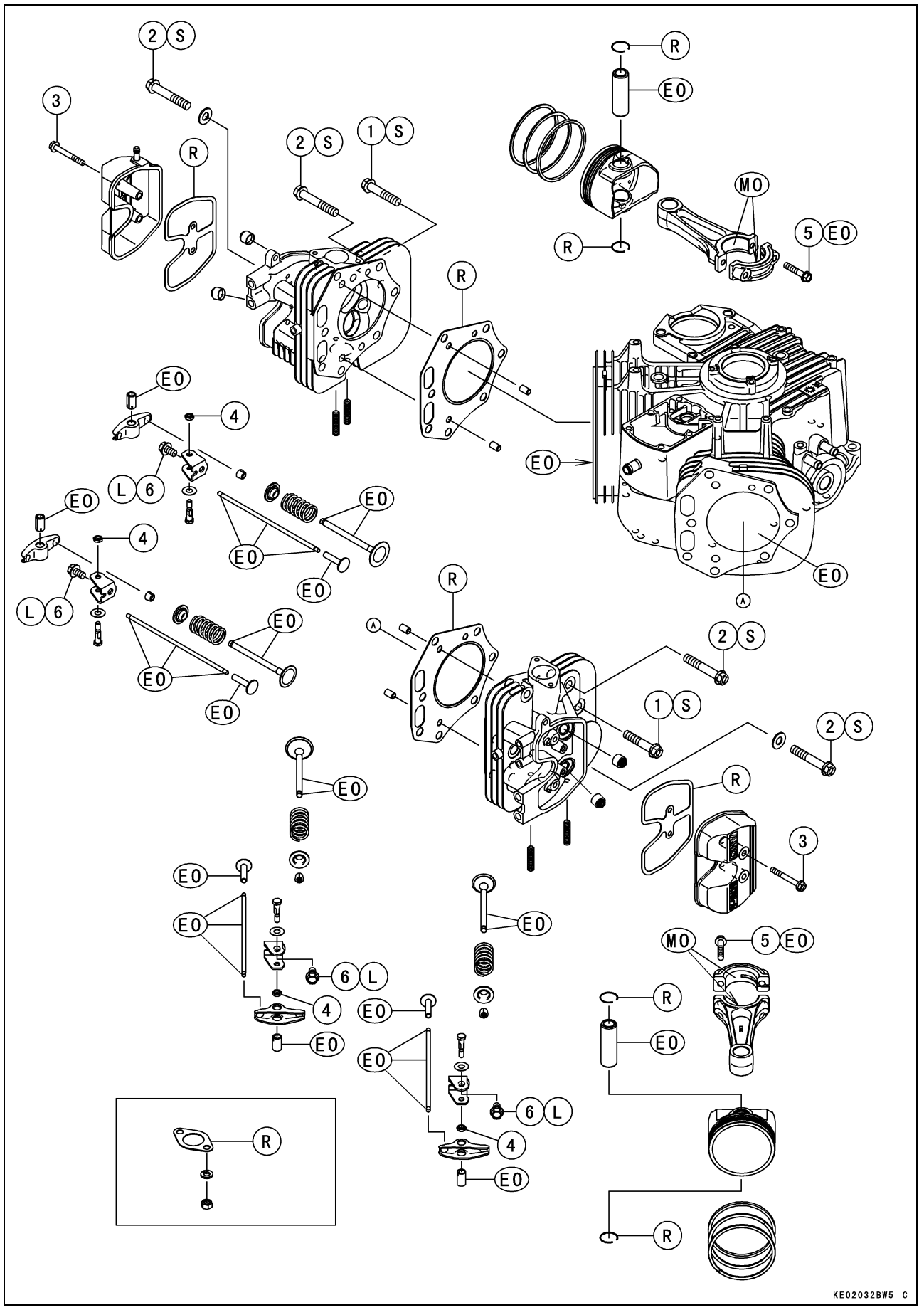
## 5-2 ENGINE TOP END

### Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Cylinder Head Bolts (L = 50 mm) | 46 | 4.7 | 34 | S |
| 2 | Cylinder Head Bolts (L = 60 mm) | 46 | 4.7 | 34 | S |
| 3 | Rocker Cover Bolts | 5.9 | 0.60 | 52 in·lb | |
| 4 | Valve Clearance Adjusting Locknuts | 11 | 1.1 | 97 in·lb | |
| 5 | Connecting Rod Big End Cap Bolts | 20.6 | 2.10 | 15.2 | EO |
| 6 | Rocker Arm Bracket Bolts | 21 | 2.1 | 15 | L |

EO: Apply engine oil.
L: Apply a non-parmanent locking agent.
MO: Apply molybdenum disulfide oil.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

## 5-4 ENGINE TOP END

### Specifications

| Item | Service Limit |
|---|---|
| **Cylinder Head:** | |
| Cylinder Compression (MIN) | 440 kPa (64 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 144°F), Cranking Speed 450 rpm/5 Seconds |
| 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 | 0.05 mm (0.002 in.) |
| Valve Stem Diameter | |
| Inlet | 6.94 mm (0.2732 in.) |
| Exhaust | 6.93 mm (0.2728 in.) |
| Valve Guide Inside Diameter | |
| Inlet, Exhaust | 7.08 mm (0.279 in.) |
| Valve Spring Free Length | |
| Inlet, Exhaust | 38.3 mm (1.51 in.) |
| Rocker Arm Push Rod Runout | |
| Inlet, Exhaust | 0.2 mm (0.008 in.) |
| Rocker Shaft Outside Diameter | |
| Inlet, Exhaust | 10.91 mm (0.4295 in.) |
| Rocker Arm Inside Diameter | |
| Inlet, Exhaust | 11.13 mm (0.4382 in.) |
| **Cylinder, Piston:** | |
| Piston Diameter | 84.24 mm (3.316 in.) |
| Piston Ring/Groove Clearance | |
| Top | 0.15 mm (0.0059 in.) |
| Second | 0.18 mm (0.0071 in.) |
| Piston Ring Thickness | |
| Top | 1.13 mm (0.0445 in.) |
| Second | 1.08 mm (0.0425 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 | 19.96 mm (0.7858 in.) |
| Piston Pin Hole Inside Diameter | 20.57 mm (0.8098 in.) |
| Connecting Rod Small End Inside Diameter | 20.06 mm (0.7898 in.) |
| Cylinder Inside Diameter | 84.55 mm (3.329 in.) |
| Cylinder Inside Diameter Out Round | 0.05 mm (0.002 in.) |

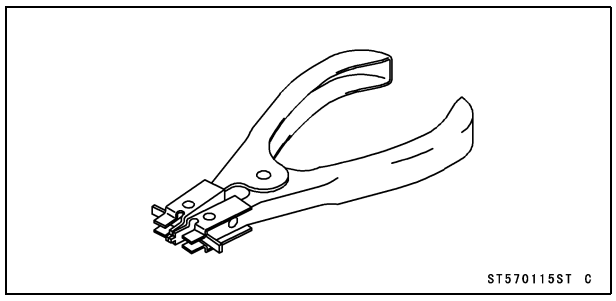
## Specifications

| Item | Standard |
|---|---|
| Valve Clearance: | |
| Inlet, Exhaust | 0.05 ~ 0.10 mm (0.0020 ~ 0.039 in.) |
| Valve Seating Surface Angle: | |
| Inlet, Exhaust | 45° |
| Valve Seating Surface Width: | |
| Inlet | 1.1 ~ 1.7 mm (0.043 ~ 0.067 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.) |
| Cylinder Inside Diameter | 84.48 ~ 84.50 mm (3.326 ~ 3.327 in.) |

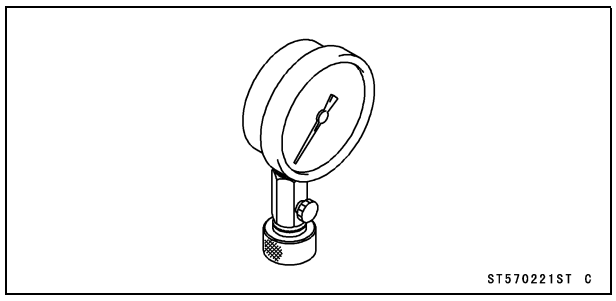
# 5-6 ENGINE TOP END

## Special Tools

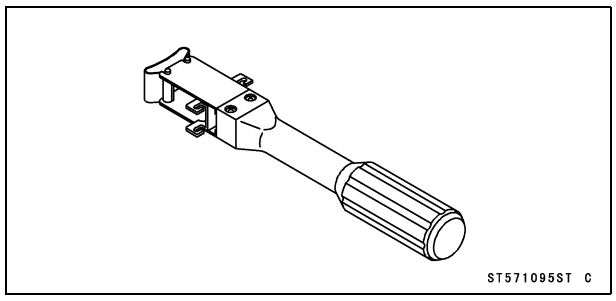
**Piston Ring Pliers:**
**57001-115**



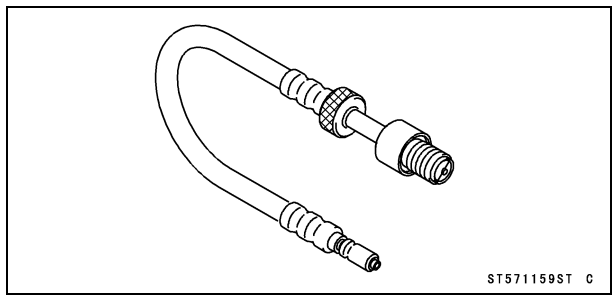

**Compression Gauge, 20 kgf/cm²:**
**57001-221**



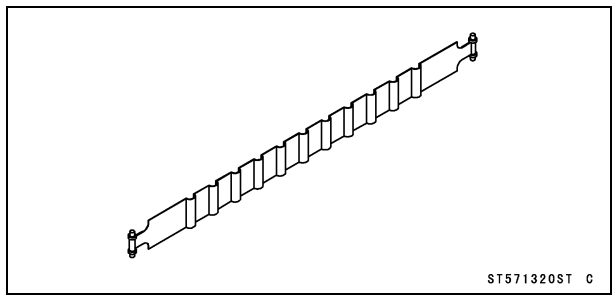

**Piston Ring Compressor Grip:**
**57001-1095**




**Compression Gauge Adapter, M14 × 1.25:**
**57001-1159**

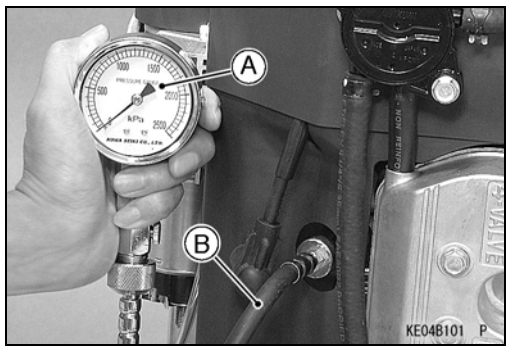



**Piston Ring Compressor Belt, $\phi$80 ~ $\phi$91:**
**57001-1320**



## Cylinder Head

### *Compression Measurement*




● Before measuring compression, check 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 sealing the compression as it does during normal running.
○Stop the engine.
● Disconnect the spark plug caps of each cylinder and remove the spark plugs.
● Attach the compression gauge assembly firmly into one plug hole.

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

● Ground the spark plugs to the engine.

**⚠ WARNING**

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

● Open the throttle fully. Run the engine by turning the engine switch key several times until the compression gauge stops rising. Read the highest compression value.

**Cylinder Compression (MIN) 440 kPa (64 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 450 rpm/5 Seconds**

● Repeat the measurement on the other cylinder.
★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 - worn valve guides and/or worn piston oil rings may cause rapid carbon accumulation in the combustion chamber. This may be indicated by white exhaust smoke.

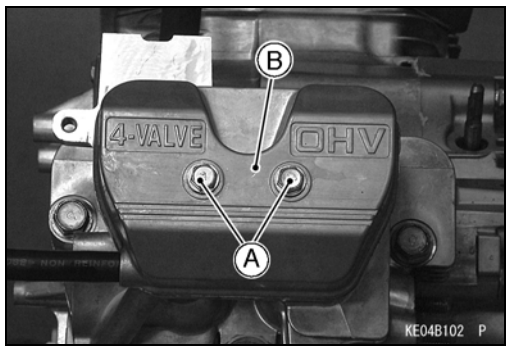
★If the cylinder compression is lower than the (MIN), check the following:
1. Gas leakage around the cylinder head - replace the damaged gasket with a new one and check the cylinder head warp.
2. Condition of the valve seating.
3. Valve clearance.
4. Piston/cylinder wear, piston seizure.
5. Piston ring, piston ring groove.

# 5-8 ENGINE TOP END

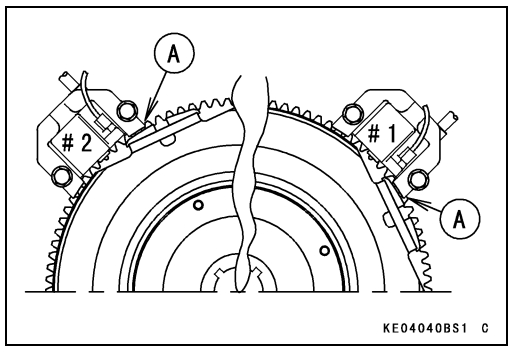
## Cylinder Head

### *Cylinder Head Assembly Removal*

- Remove:
  Inlet Manifold (see Inlet Manifold Removal in the Fuel System chapter)
  Spark Plug
  Engine Shrouds (see Engine Shroud Removal/Installation in the Cooling System chapter)
- Unscrew the rocker cover bolts [A], and remove the cover [B] and the gasket.



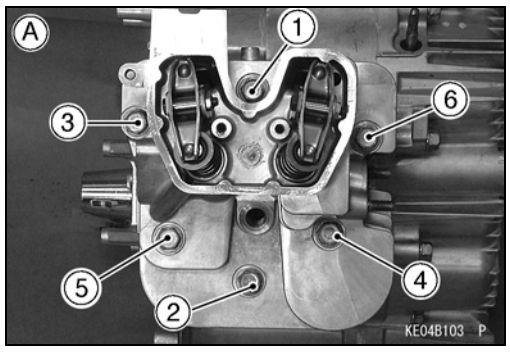

- When removing the #1, #2 cylinder head, set each piston at the top dead center (T.D.C) [A] of the compression stroke.




- Loosen the cylinder head bolts 1/4 turn in the sequence as shown.
  [A] #1 Cylinder
  [B] #2 Cylinder

**CAUTION**

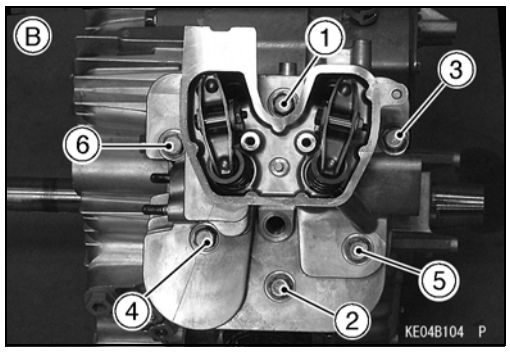
**If the above procedure is not followed, the cylinder head may be warped during removal.**




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

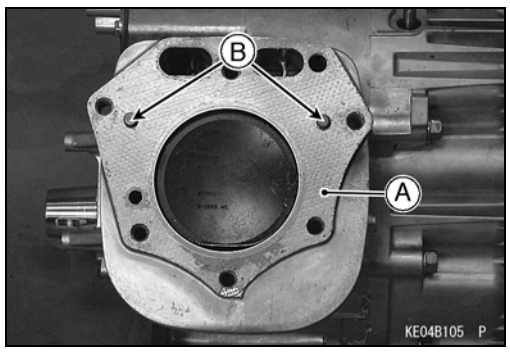
**NOTE**

○*Mark the push rods to reinstall in their original position during assembly.*




### *Cylinder Head Assembly Installation*

- Clean the mating surfaces of the cylinder heads and cylinders.
- Install the push rods in their original positions on each cylinder (see Push Rod Installation).
- Replace the gaskets [A] with new ones.
- Install the knock pins [B]

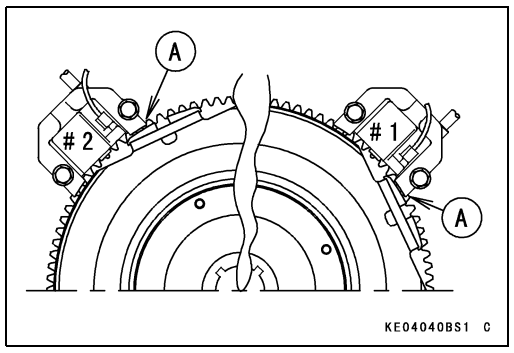


## Cylinder Head

● Set each piston at the T.D.C [A] of the compression stroke.
● Put new gaskets and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms.

**NOTE**

○*As the head gaskets are coated with sealing agents, be careful not to damage the surfaces.*

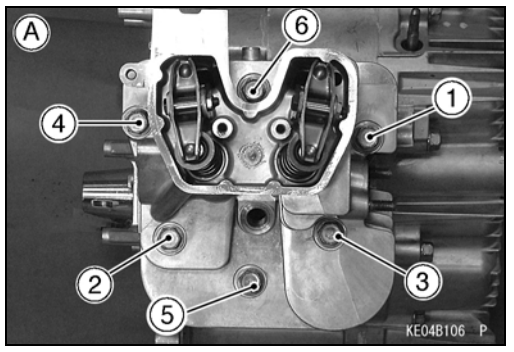


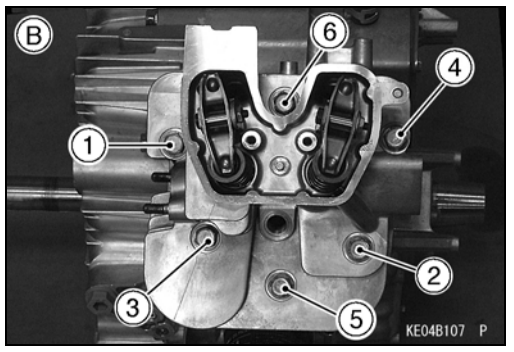

● Tighten the cylinder head bolts following the tightening sequence as shown.
○Install the washer to the third tightening bolt.
[A] #1 Cylinder
[B] #2 Cylinder

**Torque - Cylinder Head Bolts: 46 N·m (4.7 kgf·m, 34 ft·lb)**

**CAUTION**

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

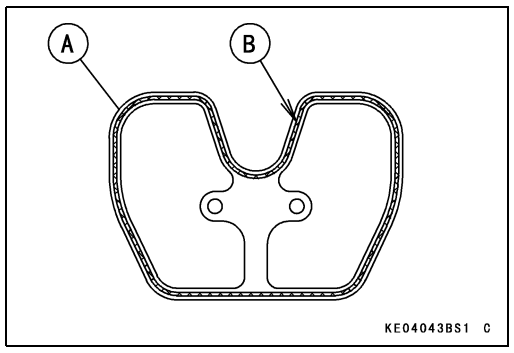



● Check to see that push rod ends are in the hollow of the rocker arms.
● Check and adjust the valve clearance.
● Install the new gaskets [A] so that the silicone bead side [B] face the rocker cover.
● Install the rocker covers.

**Torque - Rocker Cover Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**

● Install the other removed parts.

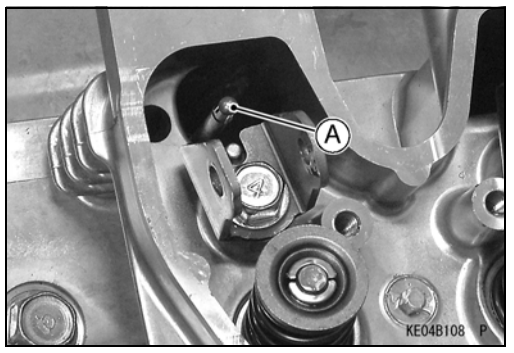



### *Push Rod Removal*

● Set each piston at the T.D.C of the compression stroke.
● Remove the rocker arm (see Valve Mechanism Removal/Installation).
● Pull out the push rods [A]

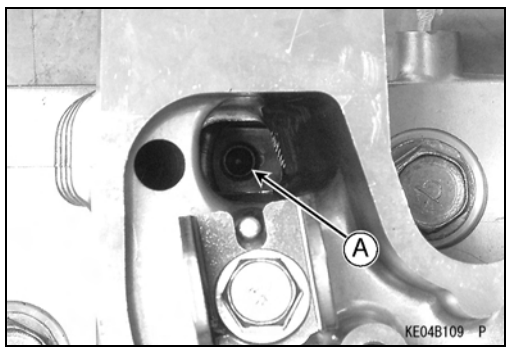
**NOTE**

○*Mark the push rods to reinstall in their original position during assembly.*



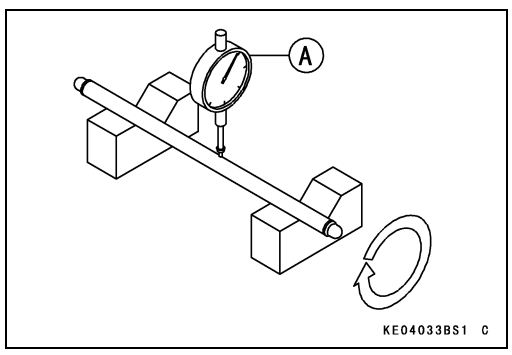
## Cylinder Head

### *Push Rod Installation*




- Set each piston at the T.D.C of the compression stroke.
- Apply engine oil to the both ends and shaft of the push rod.
- Install the push rods in their original positions of the tappet hollow [A]
- Check that both inlet and exhaust push rods on each cylinder are at lowest position on the cam lobes. If the piston is not at the T.D.C of the compression stroke, turn the flywheel clockwise one turn (360°) and reset each piston at the T.D.C of the compression stroke.
- Be sure the end of the push rods are correctly seated on the tappets.
- Install the rocker arm (see Valve Mechanism Removal/Installation).
- Check and adjust the valve clearance.

### *Push Rod Inspection*




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

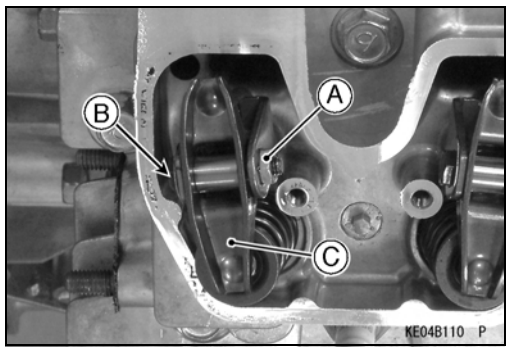
★If the runout exceeds the service limit, replace the rod with a new one.

**Rocker Arm Push Rod Runout**
**Service Limit: 0.2 mm (0.08 in.)**

### *Valve Mechanism Removal/Installation*

**NOTE**

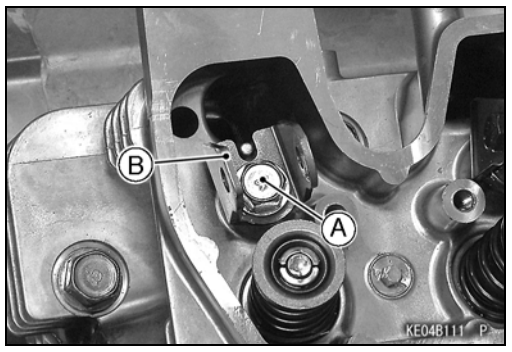
○*When removing the valve mechanism parts, record their position to reinstall in their original position during assembly.*



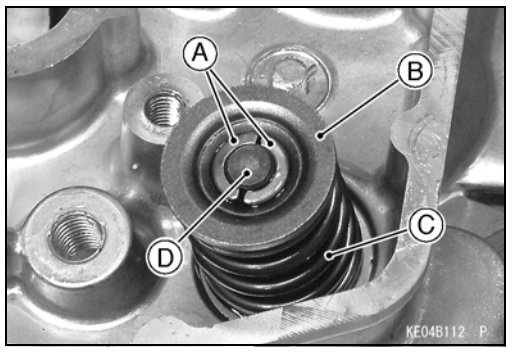

- Remove:
  Valve Clearance Adjusting Locknuts [A]
  Valve Clearance Adjusting Bolts [B] and Washer
  Collar
  Rocker Arm [C]

## Cylinder Head

● Remove:
Rocker Arm Bracket Bolts [A]
Rocker Arm Bracket [B]



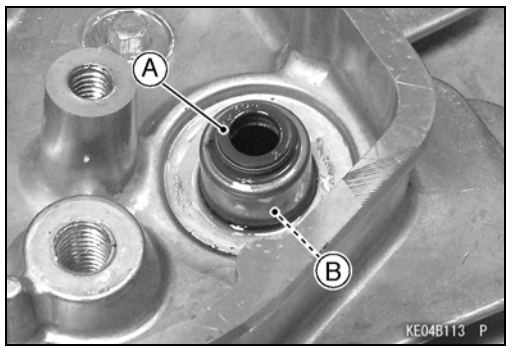

● Remove the cylinder head assembly. (see Cylinder Head Assembly Removal)
● Support the valve head in the combustion chamber with a suitable block.
● To remove the collets [A], push down the valve retainer [B] with suitable tool and remove the collets.
● Remove the spring [C] and valve [D] .



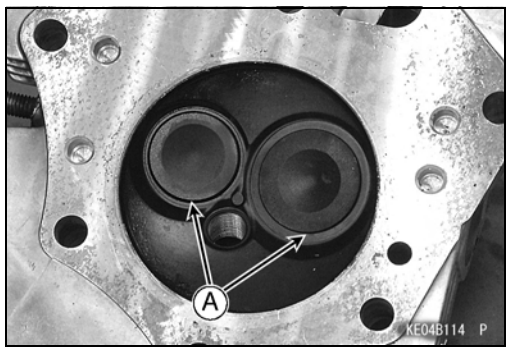

● Remove the stem seals [A].

**NOTE**

○*It is not necessary to remove the stem seal unless it is being replaced.*
○*Valve guide [B] is not replaceable, do no remove it.*



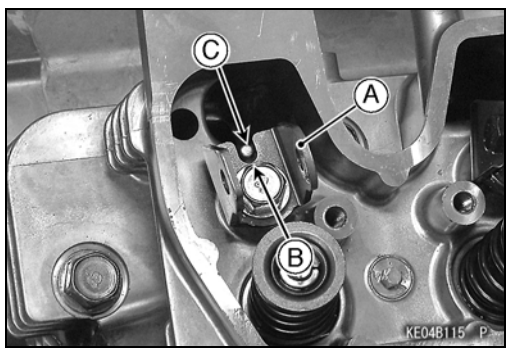

● Apply engine oil to the valve stem to avoid damaging the stem seal.
● Check to see that the valve moves smoothly up and down in the guide.
● Check to see that the valve seats properly in the valve seat [A]. If it does not, repair the valve seat.
● Valve installation is the reverse of removal.
● Install the cylinder head assembly. (see Cylinder Head Assembly Installation)
● Set the each piston at T.D.C of the compression stroke. (see Cylinder Head Assembly Installation)




● Install the rocker arm brackets [A] so that bracket hollows [B] fit to the cylinder head projections [C].
● Apply a non-permanent locking agent to the rocker arm bracket bolts, and tighten them.

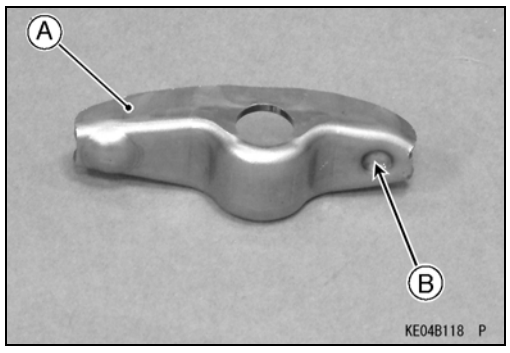
**Torque - Rocker Arm Bracket Bolts: 21 N·m (2.1 kgf·m, 15 ft·lb)**

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



## Cylinder Head

- Position the rocker arm [A] so that the hollow side [B] faces push rod.

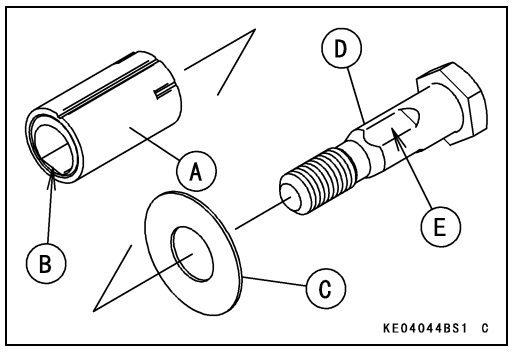



- Apply engine oil to the collars [A].
- For #1 cylinder, insert the collars in to the rocker arm hole so that the flatten side [B] faces PTO side.
- Insert the washers [C] onto the valve clearance adjusting bolts [D], and install them from the flywheel side hole of the rocker arms.

○Align the flatten surface of the collars with the flatten surface [E] of the valve clearance adjusting bolts.

- For #2 cylinder, insert the collars in to the rocker arm hole so that the flatten side faces flywheel side.
- Insert the washers onto the valve clearance adjusting bolts, and install them from the PTO side hole of the rocker arms.

○Align the flatten surface of the collars with the flatten surface of the valve clearance adjusting bolts.




- Tighten the valve clearance adjusting locknuts temporarily.
- Position the push rod end on to the rocker arm hollow.
- Adjust the valve clearance (see Valve Clearance Adjustment in the Periodic Maintenance chapter).

### *Cylinder Head Cleaning*

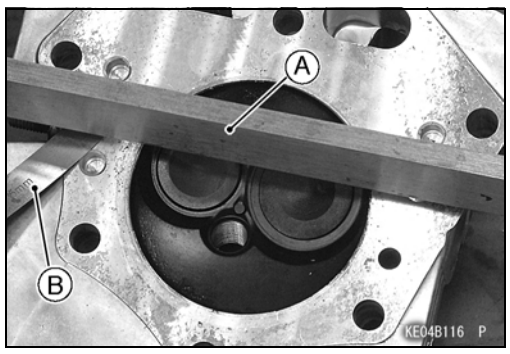
- Refer to the Cylinder Head Cleaning in the Periodic Maintenance chapter.

### *Cylinder Head Inspection*

- Lay a straightedge [A] across the mating surface of the head at several different points, and measure warp by inserting a thickness gauge [B] between the straightedge and head.

★If warp exceeds the service limit, repair the mating surface. Replace the cylinder head if the mating surface is badly damaged.

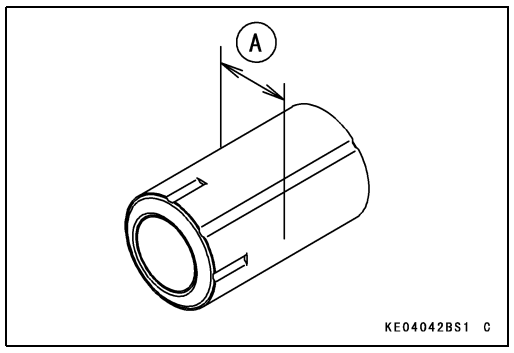
**Cylinder Head Warp**
**Service Limit: 0.03 mm (0.001 in.)**




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

## Cylinder Head

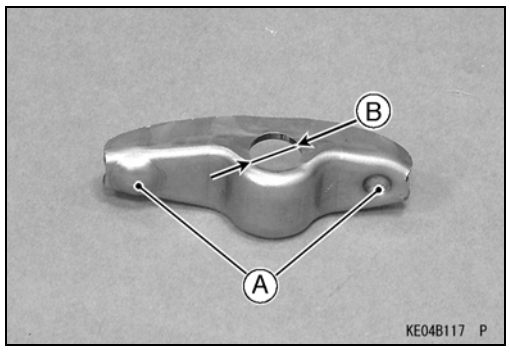
### *Rocker Arm Inspection*




- Measure the diameter [A] of the rocker shafts with a micrometer at several points of bearing the rocker arm.

★If the outside diameter is less than the service limit, replace the rocker shaft.

**Rocker Shafts Outside Diameter**
**Service Limit (Inlet, Exhaust): 10.91 mm (0.4295 in.)**




- Clean and inspect the rocker arm where it touches the push rod and valve stem.

★If the contact points [A] are worn or damaged, replace the rocker arm.

- Measure the inside diameter [B] of the rocker arm at several points using a dial bore gauge or inside micrometer.

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

**Rocker Arm Inside Diameter**
**Service Limit (Inlet, Exhaust): 11.13 mm (0.4382 in.)**

## Valves

### *Valve Clearance Inspection*

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

### *Valve Clearance Adjustment*

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

### *Valve Seat Inspection*

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

### *Valve Seat Repair*

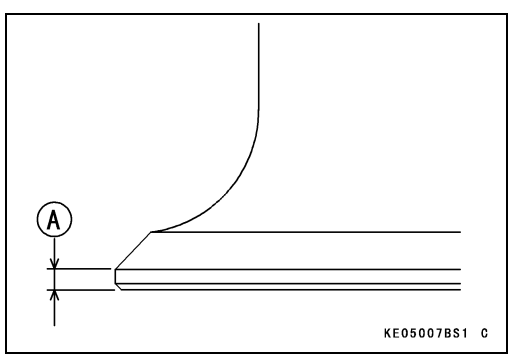
- Refer to the Valve Seat Repair in the Periodic Maintenance chapter.

### *Valve Head Thickness*

- Remove the valve (see Valve Mechanism Removal/Installation).
- Measure the valve head thickness.

★If the valve head thickness (valve margin) [A] is less than the service limit, replace the valve with a new one.

**Valve Head Thickness**
**Service Limit (Inlet, Exhaust): 0.4 mm (0.016 in)**

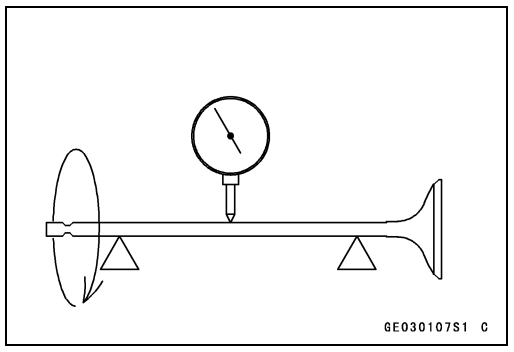



### *Valve Stem Runout*

- Support the valve on 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): 0.05 mm (0.002 in.)**

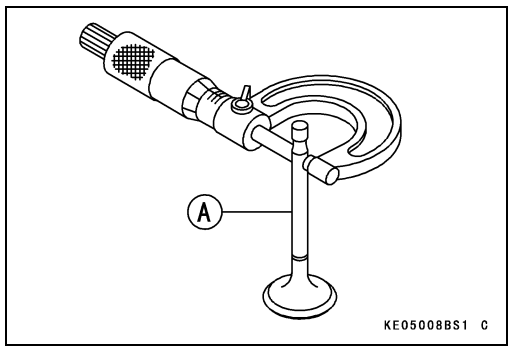



### *Valve Stem Diameter*

- Measure the diameter of the valve stem [A] in two directions at proper angles, at four different positions on the stem.

★If any single measured valve stem diameter is less than the service limit, replace the valve with a new one.

**Valve Stem Diameter**
**Service Limit:**
**Inlet: 6.94 mm (0.2732 in.)**
**Exhaust: 6.93 mm (0.2738 in.)**



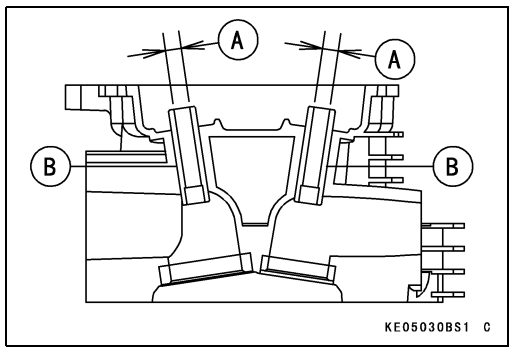
## Valves

### *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 positions down the guide length.

★If the measured valve diameter is greater 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.)**

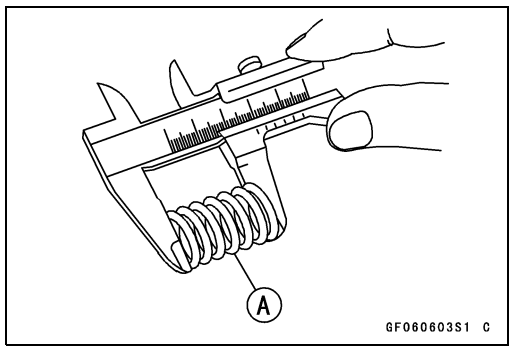



### *Valve Spring Inspection*

- Inspect the valve spring for pitting, cracks, rusting, and burns. Replace the spring with a new one if necessary.
- Measure the free length [A] of the spring.

★If the measured free length is less than the service limit, replace the spring with a new one.

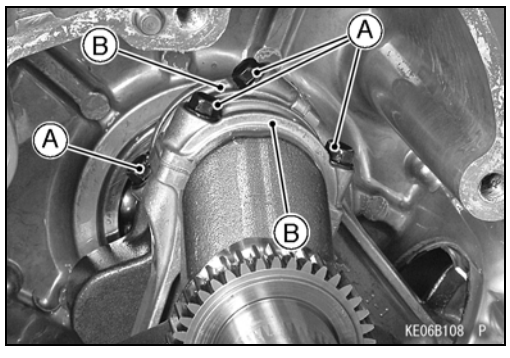
**Valve Spring Free Length**
**Service Limit:**
**Inlet, Exhaust 38.3 mm (1.51 in.)**



## Cylinder, Piston

### *Piston Removal*

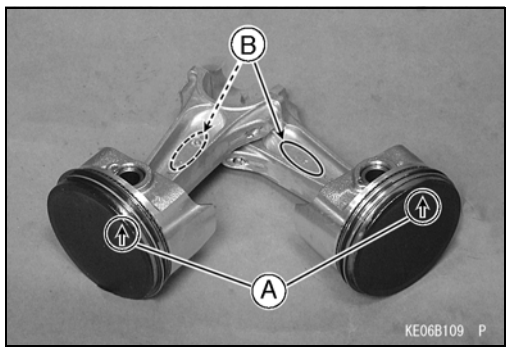
- Split the crankcase (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter).
- Remove the camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter).
- Turn the crankshaft to expose the connecting rod cap bolts [A].
- Remove the bolts and take off the connecting rod caps [B].




**NOTE**

○*Record the positions of the connecting rod caps for re-installing the caps.*

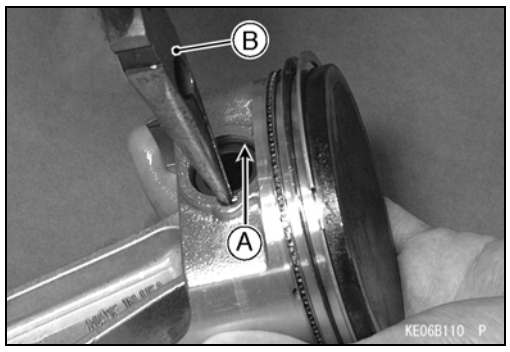
- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.



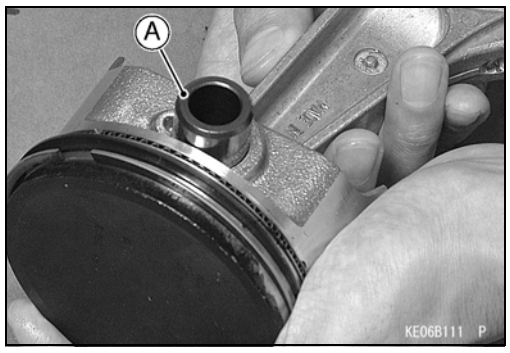

**CAUTION**

**Note a location of the arrow match mark [A] on the piston head in relation to K Mark [B] on the connecting rod.**
**No.1 cylinder K Mark on the connecting rod is face to face with No.2 cylinder K Mark on the connecting rod.**
**Keep parts together as a set.**

- Remove the piston pin snap ring [A] with needle nose pliers [B].

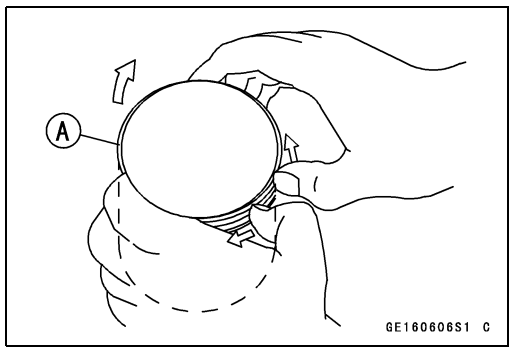



- Remove the piston by pushing the piston pin [A] to the direction from which the snap ring was removed.



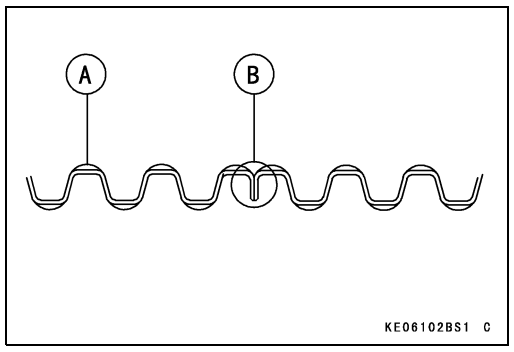
## Cylinder, Piston

- Remove the top and second rings with piston ring pliers.
  **Special Tool - Piston Ring Pliers: 57001-115**
- If the special tool is not available, carefully spread the ring opening with your thumbs, then push up to the opposite side of the ring [A] to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.

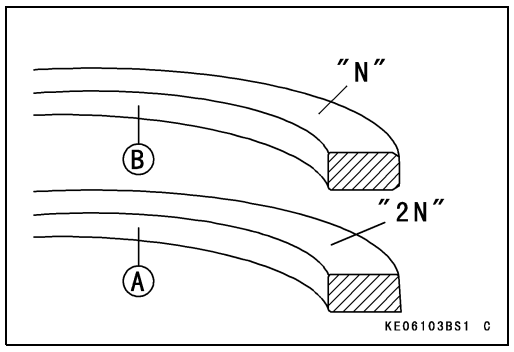



### *Piston Installation*

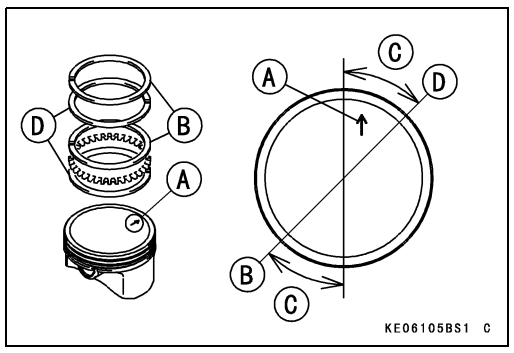
- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap them.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



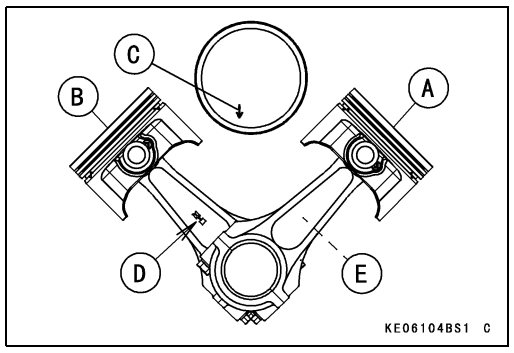

- Do not mix up the top and second rings.
- With the marked side facing up, install the second ring [A] and top ring [B] in that order.
- The rings should turn freely in the grooves.




- 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]

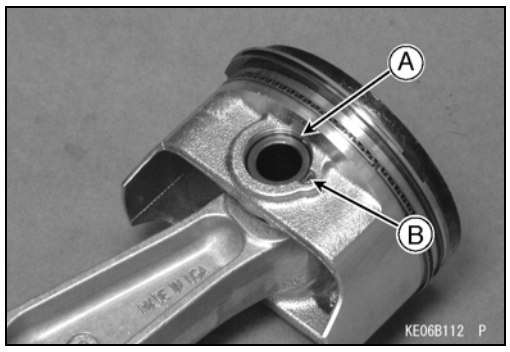



- Apply engine oil to the piston pins.
- Assemble the pistons onto the connecting rods.
  No.1 cylinder piston; align the arrow match mark on the piston head with opposite K Mark on the connecting rod to face the flywheel side.
  No.2 cylinder piston; align the arrow match mark on the piston crown with the K mark on the connecting rod. Both marks must face the flywheel side.
  No.1 cylinder Piston [A]
  No.2 cylinder Piston [B]
  Arrow Match Marks [C]
  K Mark [D]
  Opposite K Mark [E]



## Cylinder, Piston

● When installing a piston pin snap ring, compress it only enough to install it. Do not compress the piston pin snap ring too hard.
● 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] on the edge of the piston pin hole.

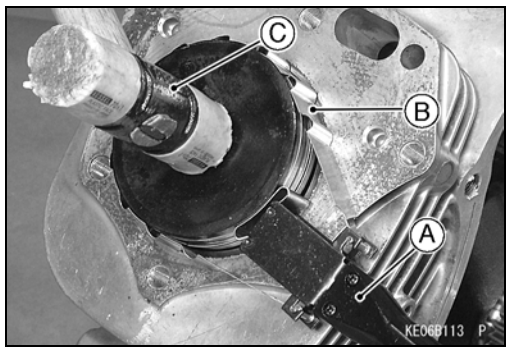



**CAUTION**

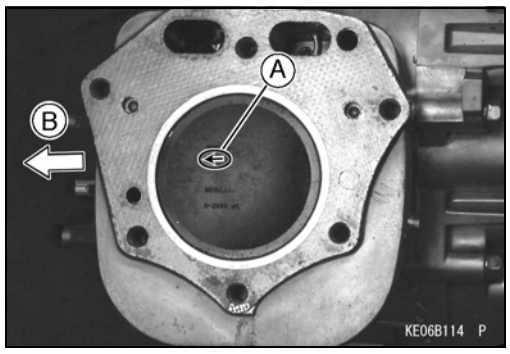
**Do not reuse the snap rings, as removal weakens and deforms them. They could fall out and score the cylinder wall.**

● 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, $\phi$80 ~ $\phi$91: 57001-1320**



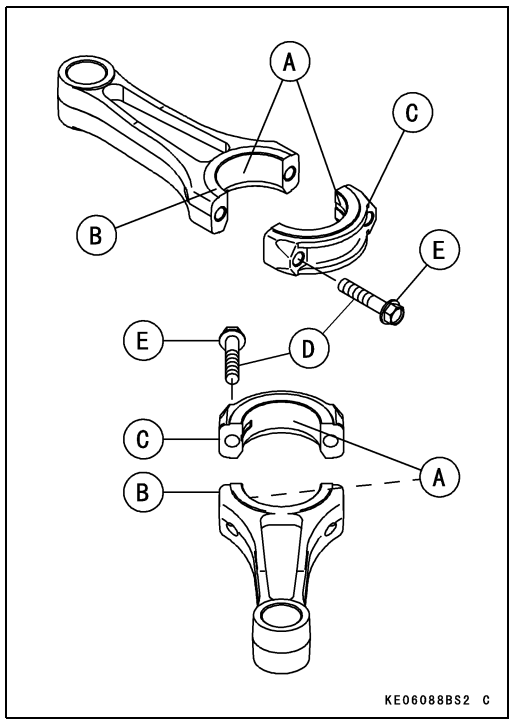

● Insert the piston and the connecting rod so that the arrow match mark [A] on the piston crown faces the flywheel side [B].



## Cylinder, Piston

**CAUTION**

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




- Apply molybdenum disulfide oil solution oil to the inner surface [A] of the connecting rod big end [B] and caps [C].

○The molybdenum disulfide oil solution is a mixture of engine oil and molybdenum disulfide grease with a weight ratio (10 : 1).

- Install the connecting rod big end caps on their original position on each connecting rod big ends.
- Apply a thin layer of engine oil to the thread [D] and seating surface [E] of the cap bolts.
- Tighten:

**Torque - Connecting Rod Big End Cap Bolts: 20.6 N·m (2.10 kgf·m, 15.2 ft·lb)**

- Install:

Camshaft (see Camshaft, Tappet Installation in the Camshaft/Crankshaft chapter)
Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter)

### *Piston/Cylinder Seizure*

- In case of seizure, remove the pistons.
- Visually inspect the cylinder and pistons for damage.

★If there is only light damage, repair the damaged piston surface with #400 emery cloth. Remove the small aluminum deposits from the cylinder with #400 emery cloth or light honing.

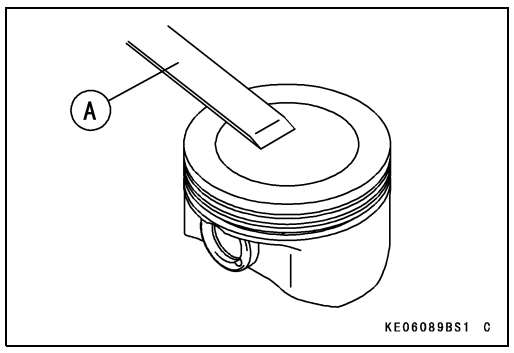
★If the damage is severe, replace the crankcase and pistons.

### *Piston Cleaning*

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

**CAUTION**

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



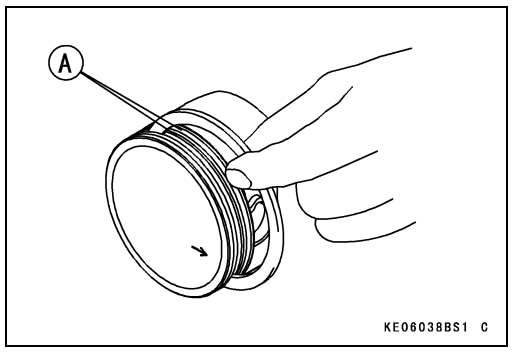

- Scrape the carbon off [A] the piston head.
- Use the scraping tools carefully. Do not gouge the piston head. To avoid gouging, use scrapers that material will not damage the piston head.

## Cylinder, Piston

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

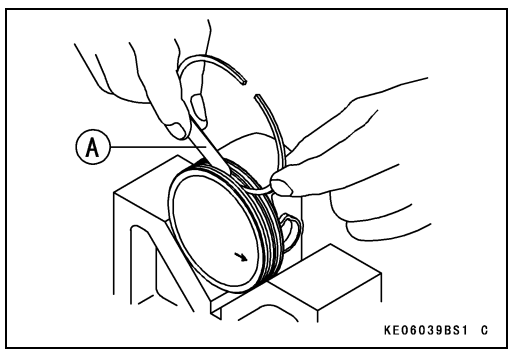
**CAUTION**

**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).
● Visually inspect the piston rings and ring grooves.
★If the piston rings are worn unevenly or damaged, replace them with new ones.
★If the ring grooves are worn unevenly or damaged, replace both the piston and the piston rings with new ones.
● Check ring grooves for wear by inserting a new ring in the proper groove at several points around the piston.
● Measure the clearance between the top and second rings and their grooves using a thickness gauge [A] as shown.
★If the piston ring/groove clearance is greater than the service limit, replace the piston with a new one.



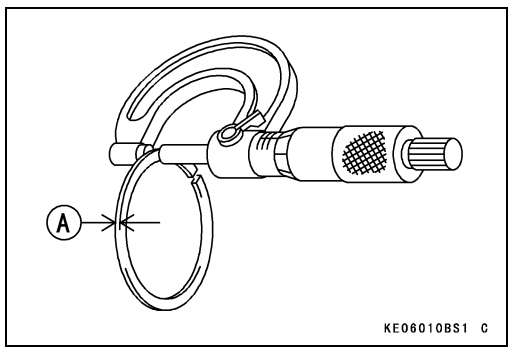

**Piston Ring/Groove Clearance**
**Service Limit:**

| | |
|---|---|
| **Top** | **0.15 mm (0.0059 in.)** |
| **Second** | **0.18 mm (0.0071 in.)** |

**NOTE**

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

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




**Piston Ring Thickness**
**Service Limit**

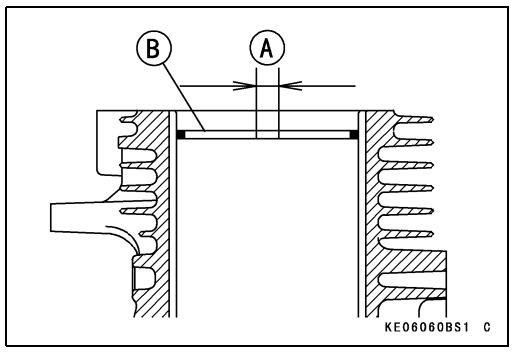
| | |
|---|---|
| **Top** | **1.13 mm (0.0445 in.)** |
| **Second** | **1.08 mm (0.0425 in.)** |

**NOTE**

○*When using new rings in a used piston, check if the groove wear is even. The rings should fit perfectly parallel to the groove sides. If not, replace the piston with a new one.*

## 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.

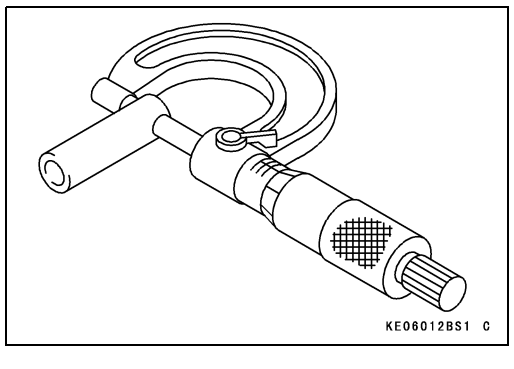
- Measure the gap [A] between the ends of the ring [B] with a thickness gauge.

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

**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.)** |

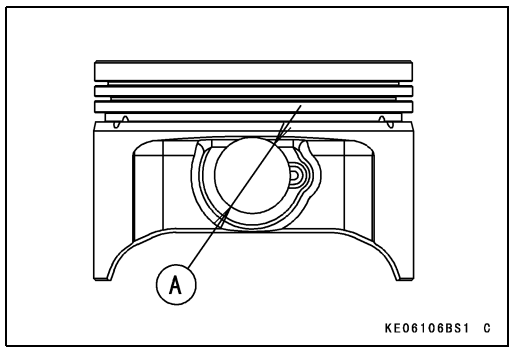
### *Piston Pin, Piston Pin Hole, and Connecting Rod Wear*




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

★If the outside diameter is less than service limit, replace the piston pin with a new one.

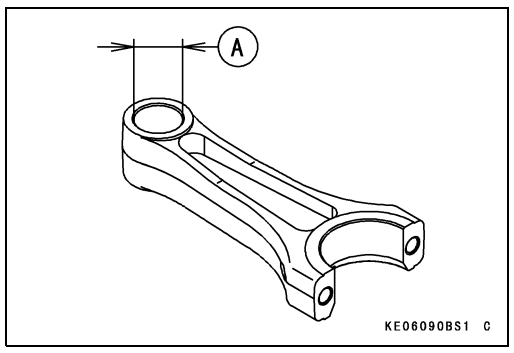
**Piston Pin Outside Diameter**
**Service Limit: 19.96 mm (0.7858 in.)**




- 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 greater than the service limit, replace the piston with a new one.

**Piston Pin Hole Inside Diameter**
**Service Limit: 20.57 mm (0.8098 in.)**




- Measure the inside diameter [A] of the connecting rod small end at several points. Use a dial bore gauge.

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

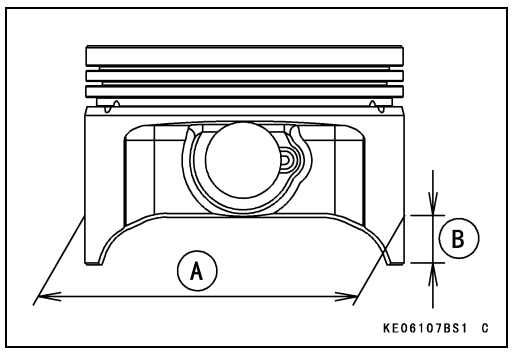
**Connecting Rod Small End Inside Diameter**
**Service Limit: 20.06 mm (0.7898 in.)**

## Cylinder, Piston

### *Piston Diameter*

● Measure the outside diameter [A] of the piston 12.5 mm (0.492 in.) [B] up from the bottom of the piston at a right angle to the direction of the piston pin hole.

★If the measured outside diameter is less than the service limit, replace the piston with a new one.




**Piston Diameter**

**Service Limit: 84.24 mm (3.316 in.)**

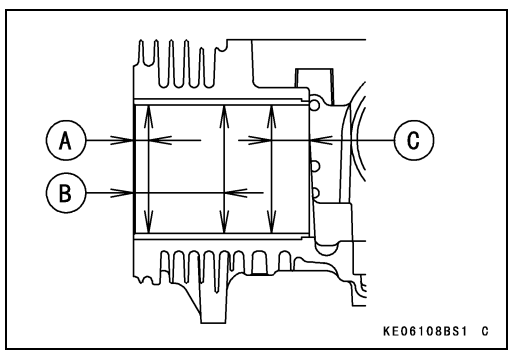
### *Cylinder Inside Diameter*

● Clean and measure the cylinder inside diameter.

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

★If any of the cylinder inside diameter measured value is greater than the service limit, replace the crankcase with a new one.

[A] 10 mm (0.39 in.)
[B] 60 mm (2.4 in.)
[C] 25 mm (0.98 in.)




**Cylinder Inside Diameter**

**Standard: 84.48 ~ 84.50 mm (3.326 ~ 3.327 in.)**

**Service Limit: 84.55 mm (3.329 in.)**

**Cylinder Inside Diameter Out Round**

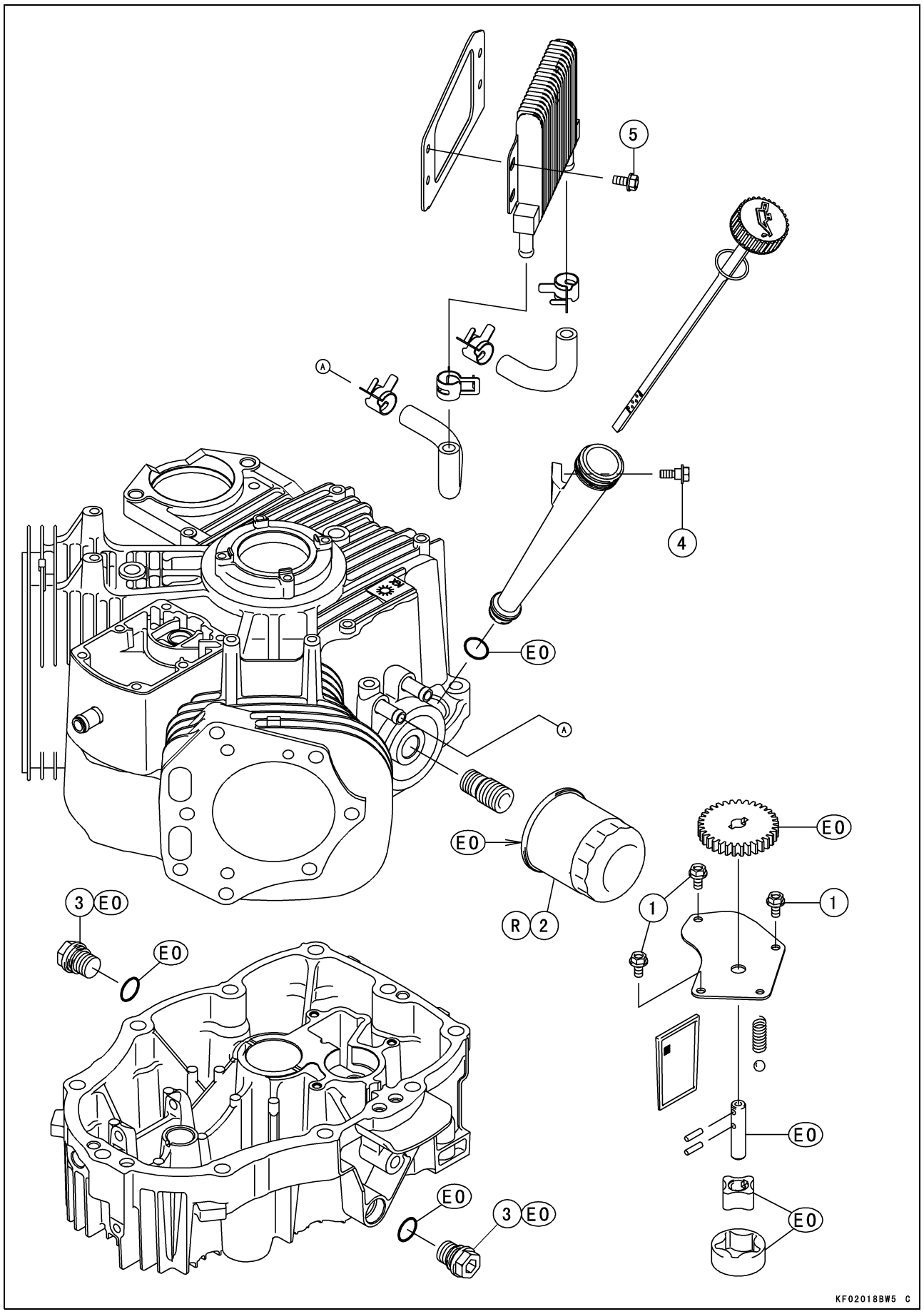
**Service Limit: 0.05 mm (0.002 in.)**

# Lubrication System

## Table of Contents

## 6-2 LUBRICATION SYSTEM

### Exploded View



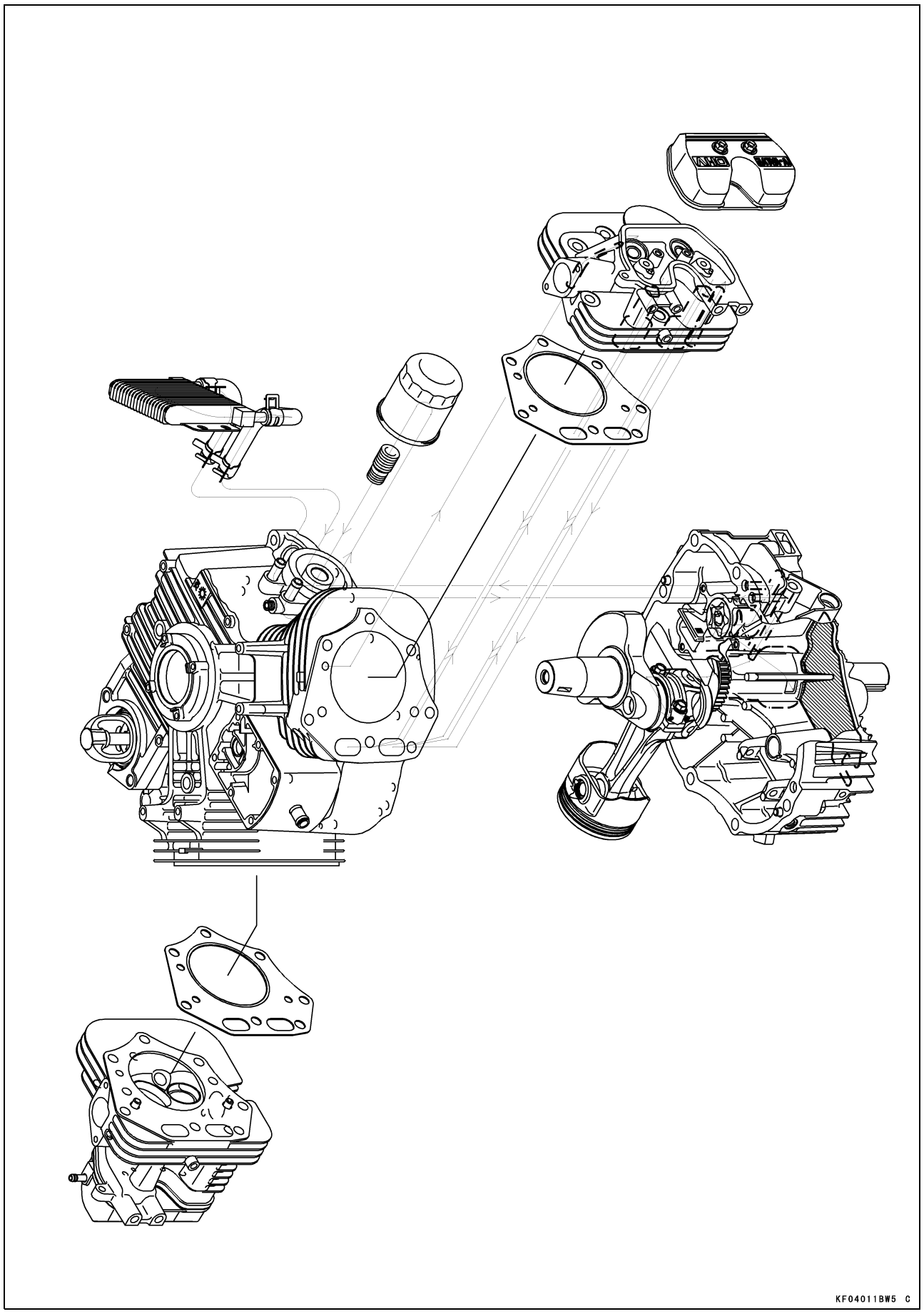
## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Oil Pump Cover Plate Bolts | 5.9 | 0.60 | 52 in·lb | |
| 2 | Oil Filter | 11.8 | 1.20 | 104 in·lb | R |
| 3 | Engine Oil Drain Plugs | 6.9 | 0.70 | 34 in·lb | EO |
| 4 | Oil Filler Mounting Bolt | 5.9 | 0.60 | 52 in·lb | |
| 5 | Oil Cooler Bolts | 5.9 | 0.60 | 52 in·lb | |

EO: Apply engine oil.
R: Replacement Parts

## 6-4 LUBRICATION SYSTEM

### Engine Oil Flow Chart



## Specifications

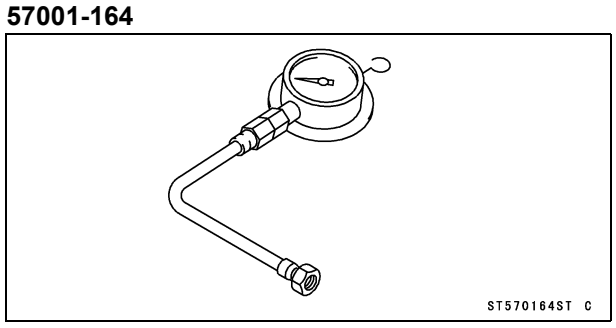
| Item | Standard |
|---|---|
| **Engine Oil:** | |
| Grade | SF, SG, SH, SJ or SL class |
| Viscosity | SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20 |
| Capacity: | |
| When the oil filter is not removed | 2.1 L (2.2 US qt) |
| When the oil filter is removed | 2.3 L (2.4 US qt) |
| Level | Operating range (patterned area) on dipstick |
| **Oil Pressure** | 294 to 588 kPa (43 to 85 psi): Engine oil temperature 50°C to 60°C (122 ~ 144°F) @3 200 r/min (rpm) |

| Item | Service Limit |
|---|---|
| **Oil Pump:** | |
| Inner and Outer Rotor Clearance | 0.2 mm (0.008 in.) |
| Outer Rotor Outside Diameter | 40.47 mm (1.593 in.) |
| Outer Rotor Thickness | 14.91 mm (0.5870 in.) |
| Pump Housing Inside Diameter | 40.901 mm (1.6103 in.) |
| Pump Housing Depth | 15.16 mm (0.5968 in.) |
| Pump Shaft Outside Diameter | 10.923 mm (0.43004 in.) |
| Pump Shaft Bearing Inside Diameter | 11.068 mm (0.43575 in.) |
| Relief Valve Spring Free Length | 20.4 mm (0.803 in.) |

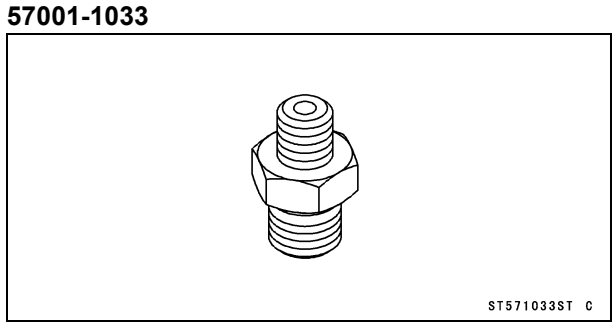
# 6-6 LUBRICATION SYSTEM

## Special Tools

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




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



## Engine Oil, Oil Filter and Oil Cooler

**CAUTION**

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

### *Engine Oil Level Inspection*

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

### *Engine Oil Change*

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

### *Oil Filter Removal*

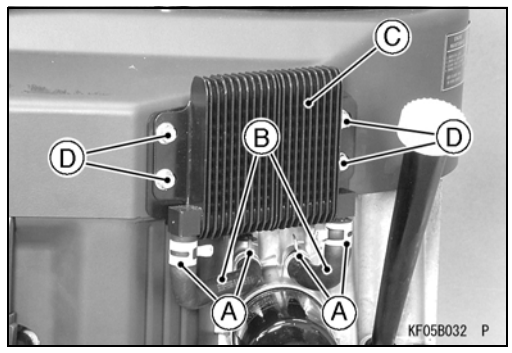
- Refer to the Oil Filter Replacement in the Periodic Maintenance chapter.

### *Oil Filter Installation*

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

### *Oil Cooler Removal*

- Drain the engine oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove the oil hose clamps [A], and take off the oil hoses [B] from the oil cooler [C].
- Remove the oil cooler bolts [D] and oil cooler.




### *Oil Cooler Installation*

- Install the oil cooler.

  **Torque - Oil Cooler Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**

- Connect the oil hoses with the clamps.

### *Oil Cooler Fin Cleaning*

- Refer to the Oil Cooler Fin Cleaning in the Periodic Maintenance chapter.

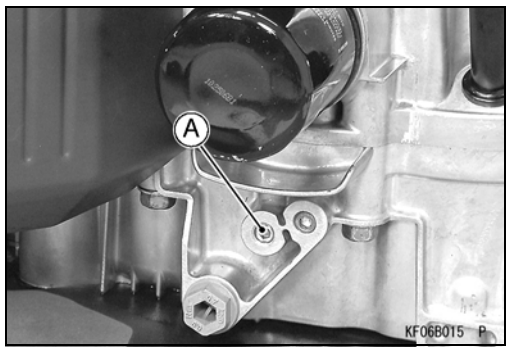
# 6-8 LUBRICATION SYSTEM

## Pressurized Lubrication System

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

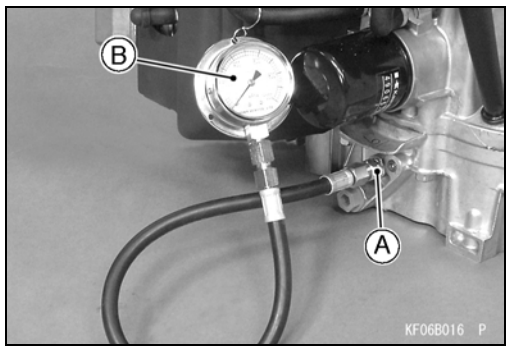
### *Oil Pressure Measurement*

● Remove the oil passage plug [A] from the crankcase.




● Install the oil pressure gauge adapter [A] and oil pressure gauge [B].

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




● Run the engine and warm up thoroughly.
● Run the engine at 3 200 r/min (rpm) and read the oil pressure gauge.

**Oil Pressure**
**294 to 588 kPa (43 to 85 psi)**

**Measurement Condition**
**Engine Oil Temperature: 50 ~ 60°C (122 ~ 144°F)**
**Engine Speed: 3 200 r/min (rpm)**

● Stop the engine.
● Remove the oil pressure gauge and the adapter.
● Apply a non-parmanent locking agent to the oil passage plug, and tighten it.

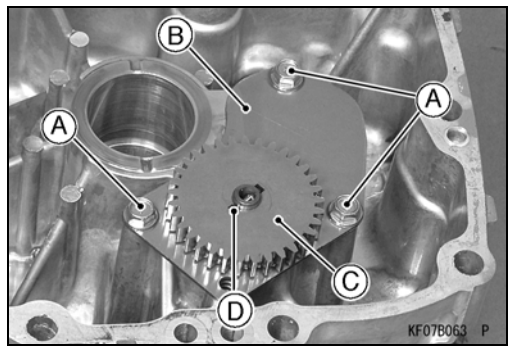
**Torque - Oil Passage Plug: 3.9 N·m (0.40 kgf·m, 34 in·lb)**

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

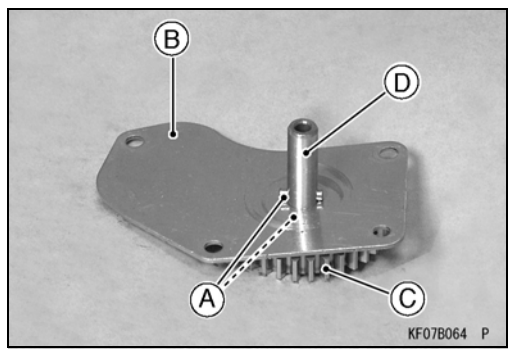
## Oil Pump, Relief Valve

### *Oil Pump, Relief Valve Removal*

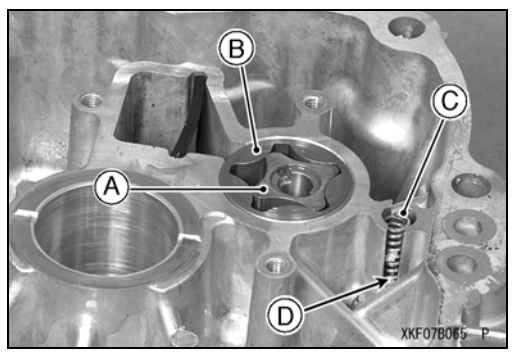
- Remove:
  Crankshaft (see Crankshaft Removal in the Camshaft/Crankshaft chapter)
  Bolts [A]
- Take out the pump cover plate [B] , pump gear [C] and pump shaft [D] as a set.




- Remove the pins [A], oil pump cover plate [B] and oil pump gear [C] from the pump shaft [D].

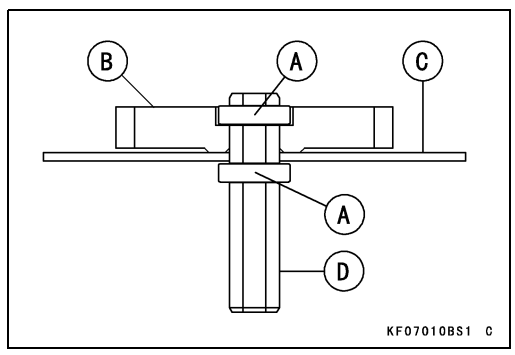



- Remove:
  Inner Rotor [A]
  Outer Rotor [B]
  Spring [C]
  Relief Valve Ball [D]




### *Oil Pump , Relief Valve Installation*

- Install the oil screen (see Oil Screen Installation).
- Assemble the following parts as shown.
  Pins [A]
  Oil Pump Gear [B]
  Oil Pump Cover Plate [C]
  Pump Shaft [D]



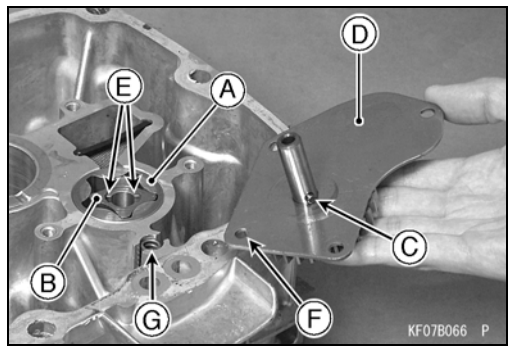

- Fill the rotor housing with engine oil for initial lubrication.
- Install the outer [A] and Inner rotor [B].
- Install the relief valve ball and spring in position.
- Fit the pin [C] of the pump parts assembly [D] into the slots [E] in the inner rotor.

**NOTE**

○*When installing the pump parts assembly align the $\phi$6 mm ($\phi$0.2 in.) hole [F] on the cover plate with center of the relief valve [G].*

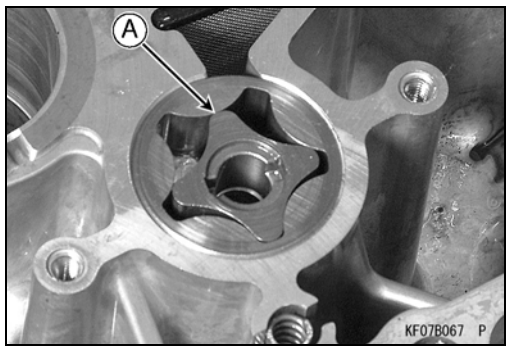
- Tighten:

**Torque - Oil Pump Cover Plate Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**



## Oil Pump, Relief Valve

### *Oil Pump, Relief Valve Inspection*



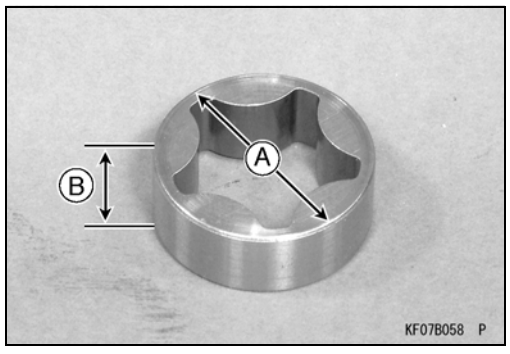

- Remove the oil pump (see Oil Pump, Relief Valve Removal).
- Visually inspect the pump gear, outer and inner rotor, and cover plate.

★If there is any damage or uneven wear, replace them with new ones.

○Check the clearance [A] between the inner and outer rotor with a feeler gauge. Measure the clearance between the highest point of the inner rotor and the highest point of the outer rotor.

★If the measured valve exceeds the service limit, replace the rotors as a set with new ones.

**Inner and Outer Rotor Clearance**
**Service Limit: 0.2 mm (0.008 in.)**




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

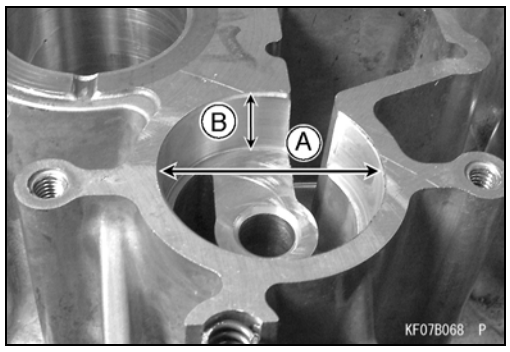
★If the rotor diameter is less than the service limit, replace both the inner and outer rotor with new ones.

**Outer Rotor Outside Diameter**
**Service Limit: 40.47 mm (1.593 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 with new ones.

**Outer Rotor Thickness**
**Service Limit: 14.91 mm (0.5870 in.)**




- Measure the inside diameter [A] of the pump housing with a inside micrometer at several points.

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

**Pump Housing Inside Diameter**
**Service Limit: 40.901 mm (1.6103 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 with a new one.

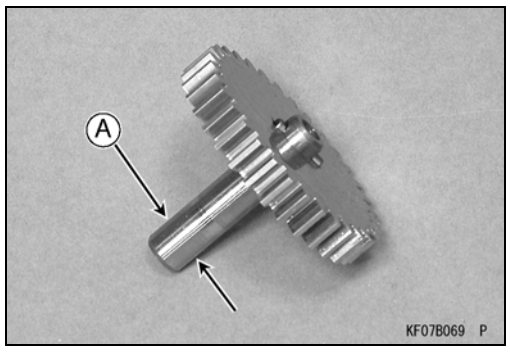
**Pump Housing Depth**
**Service Limit: 15.16 mm (0.5968 in.)**

## Oil Pump, Relief Valve

- 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 with a new one.

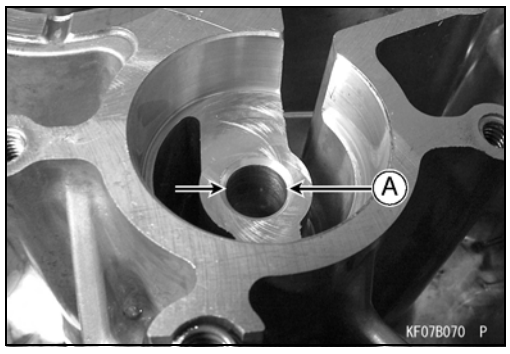
**Pump Shaft Outside Diameter**
**Service Limit: 10.923 mm (0.43004 in.)**




- Measure the inside diameter [A] of the pump shaft bearing in the crankcase with an inside micrometer at several points.

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

**Pump Shaft Bearing Inside Diameter**
**Service Limit: 11.068 mm (0.43575 in.)**




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

★If any rough spot is found during above inspection, wash the valve clean with a high-flash point solvent and blow out any foreign particles on 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.**

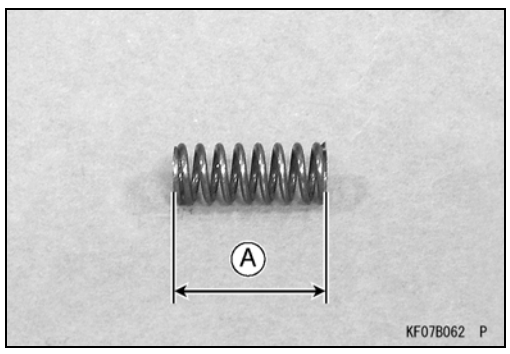
★If cleaning does not solve the problem, replace the relief valve parts with new ones.

★If necessary, put the ball in position and lightly tap the ball with a suitable tool to form a perfect seat.

- Measure the 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 with a new one.

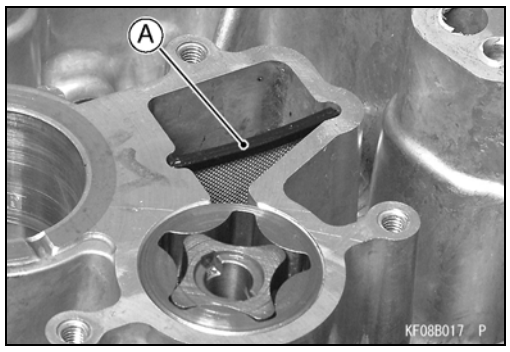
**Relief Valve Spring Free Length**
**Service Limit: 20.4 mm (0.803 in.)**



## Oil Screen

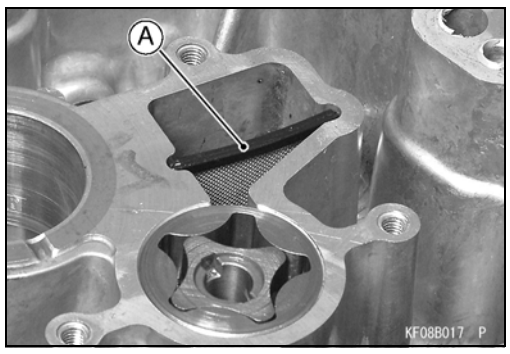
### *Oil Screen Removal*

- Remove the oil pump cover plate (see Oil Pump, Relief Valve Removal).
- Remove the oil screen [A].




### *Oil Screen Installation*

- Clean the oil screen thoroughly whenever it is removed for any reason.
- Insert the oil screen [A] in position and install the oil pump parts assembly (see Oil Pump, Relief Valve Installation).

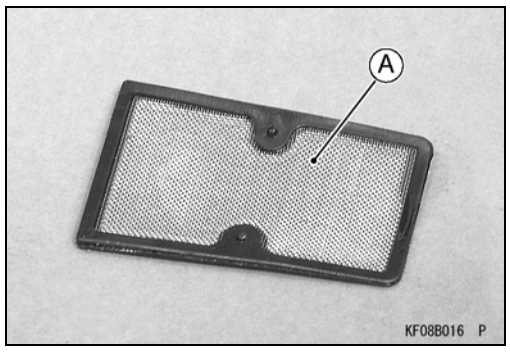



### *Cleaning and Inspection*

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

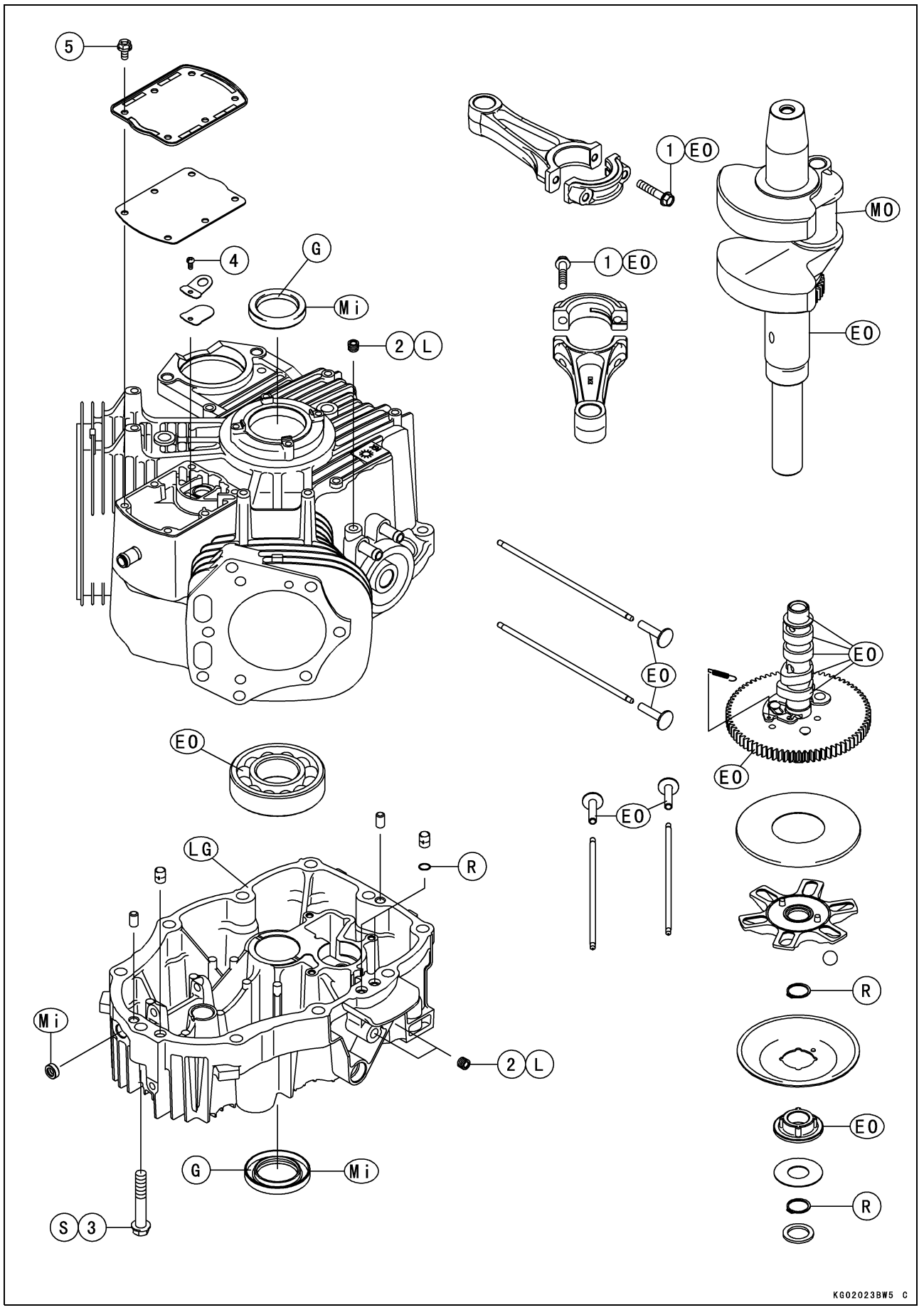
★If the screen is damaged, replace it with a new one.

# Camshaft/Crankshaft

## Table of Contents

## 7-2 CAMSHAFT/CRANKSHAFT

### Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Connecting Rod Big End Cap Bolts | 20.6 | 2.10 | 15.2 | EO |
| 2 | Oil Passage Plugs | 3.9 | 0.40 | 34 in·lb | L |
| 3 | Crankcase Cover Bolts | 46 | 4.7 | 34 | S |
| 4 | Breather Valve Mounting Screw | 2.0 | 0.20 | 18 in·lb | |
| 5 | Breather Chamber Cover Bolts | 5.9 | 0.60 | 52 in·lb | |

EO: Apply engine oil.
G: Apply grease.
L: Apply a non-parmanent locking agent.
Mi: Apply mineral oil.
MO: Apply molybdenum disulfide oil.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

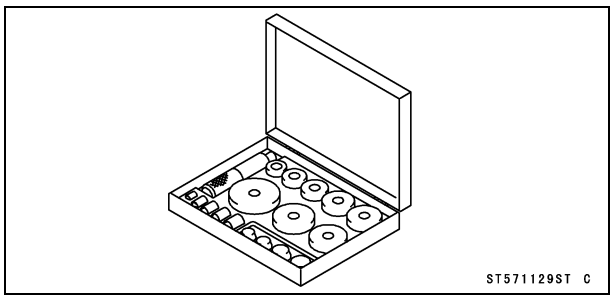
## 7-4 CAMSHAFT/CRANKSHAFT

### Specifications

| Item | Service Limit |
|---|---|
| **Camshaft, Tappet:** | |
| Cam Lobe Height: | |
| Inlet | 34.30 mm (1.350 in.) |
| Exhaust | 35.13 mm (1.383 in.) |
| Camshaft Journal Diameter | |
| PTO Side | 19.98 mm (0.7866 in.) |
| Flywheel Side | 19.98 mm (0.7866 in.) |
| Camshaft Bearing Inside Diameter | |
| Crankcase | 20.14 mm (0.7929 in.) |
| Crankcase Cover | 20.14 mm (0.7929 in.) |
| **Crankshaft, Connecting Rod:** | |
| Connecting Rod Bend | 0.15/100 mm (0.006/3.94 in.) |
| Connecting Rod Twist | 0.15/100 mm (0.006/3.94 in.) |
| Connecting Rod Big End Width | 22.70 mm (0.8937 in.) |
| Crankpin Width | 49.0 mm (1.93 in.) |
| Connecting Rod Big End Inside Diameter | 40.04 mm (1.576 in.) |
| Crankpin Outside Diameter | 39.94 mm (1.572 in.) |
| Crankshaft Runout | TIR 0.05 mm (0.002 in.) |
| Crankshaft Journal Diameter | |
| PTO Side | 41.90 mm (1.650 in.) |
| **Crankcase:** | |
| PTO Shaft Bearing Inside Diameter | 42.15 mm (1.659 in.) |

## Special Tool

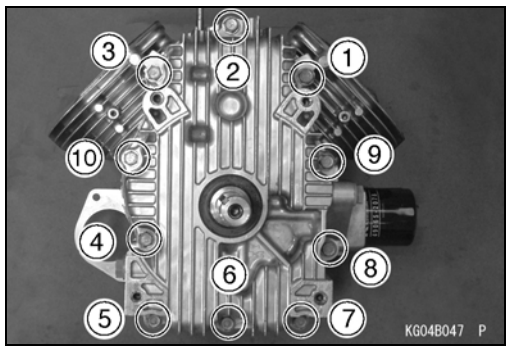
**Bearing Driver Set:**
**57001-1129**



# 7-6 CAMSHAFT/CRANKSHAFT

## Crankcase

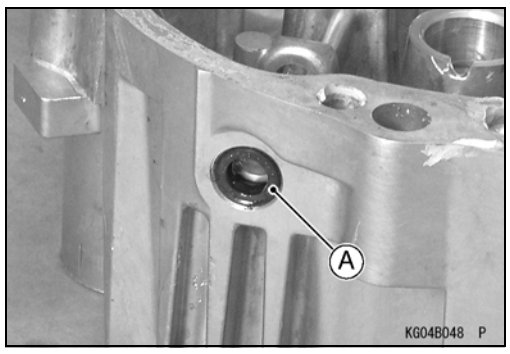
### *Crankcase Cover Removal*



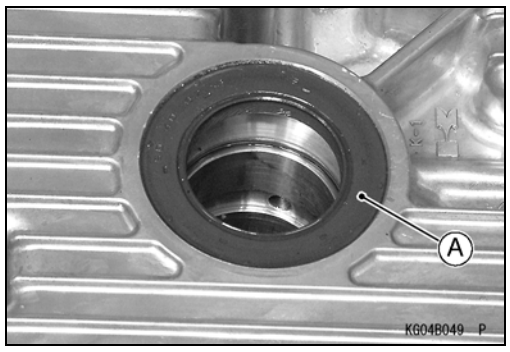

- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove:
  Ignition Coils (see Ignition Coil Removal in the Electrical System chapter)
  Flywheel and Stator Coil (see Flywheel and Stator Coil Removal in the Electrical System chapter)
  Starter Motor (see Starter Motor Removal in the Starter System chapter)
  Carburetor (see Carburetor Removal in the Fuel System chapter)
  Governor Arm (see Governor Arm Removal in the Fuel System chapter)
- Unscrew the mounting bolts in the order shown [1 to 10] and remove the crankcase cover [A] from the crankcase.

○There are two knock pins on the crankcase mating surface. Using a wooden or plastic mallet, gently tap crankcase to loosen the crankcase cover.

### *Crankcase Cover Disassembly*




- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
  Governor Shaft (see Governor Shaft Removal in the Fuel System chapter)
- Pry the governor shaft oil seal with the suitable tool, and remove it.




- Pry the crankshaft oil seal [A] with the suitable tool, and remove it.
- Remove the PTO shaft bearing, if necessary.

**Special Tool - Bearing Driver Set: 57001-1129**

## Crankcase

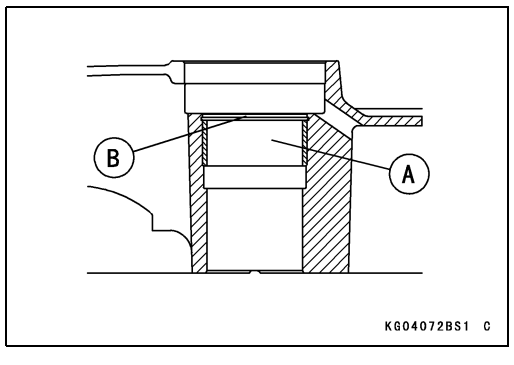
### *Crankcase Cover Assembly*

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

**⚠ WARNING**

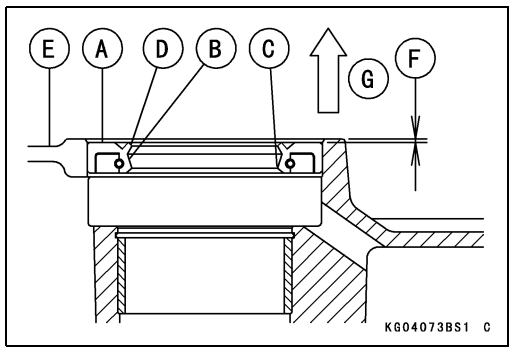
**Clean the crankcase and cover in a well ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean parts. A fire or explosion could result.**

- Replace the PTO shaft bearing [A] and snap ring [B] with new ones if removed.




- Be sure to replace the oil seal with a new one if removed.
- Apply mineral oil to the crankshaft oil seal outside.
- Install the oil seal so that the marks [A] face out.
- Pack some amount of high temperature grease [B] into the space between the seal lip [C] and the dust lip [D].
- Press in the new oil seal using a press or suitable tools until it is flush or below the flange surface [E] as shown.
- Do not damage the seal lips.

[F]: 0 ~ 1 mm (0 ~ 0.04 in.)
[G]: PTO Side



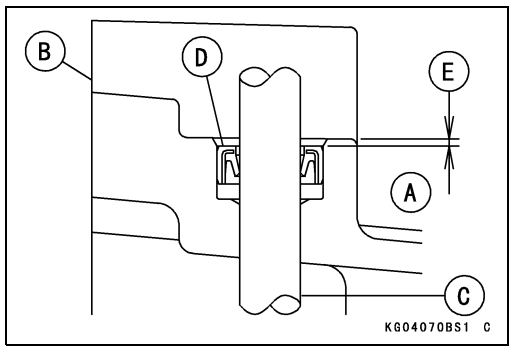

- Apply a non-permanent locking agent to the oil passage plugs, and tighten them.

**Torque - Oil Passage Plugs: 3.9 N·m (0.40 kgf·m, 34 in·lb)**

- When replacing the oil seal [A] of the governor shaft, note the following.

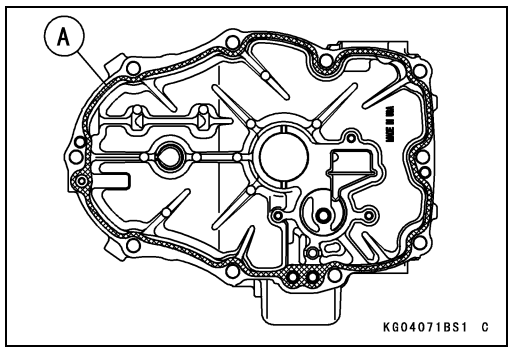
○Install the oil seal into the crankcase cover [B] after inserted the governor shaft [C] in the crankcase cover, and so that the marks [D] face out.
○The depth [E] is 0 to 2 mm (0 to 0.08 in.).

- Install the governor shaft and plate (see Governor Shaft Installation in the Fuel System chapter).



## Crankcase

### *Crankcase Cover Installation*

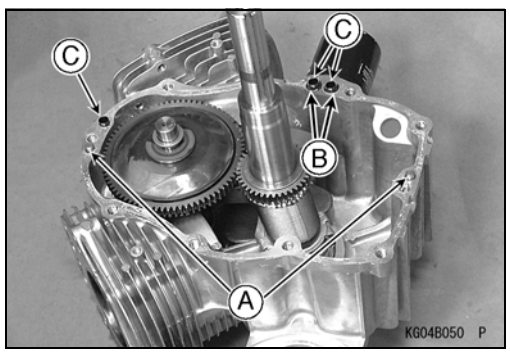



- Install the following parts into the crankcase or crankcase cover.
  Oil Pump and Relief Valve (see Oil Pump, Relief Valve Installation in the Lubrication System chapter)
  Crankshaft (see Crankshaft Installation)
  Tappets and Camshaft (see Camshaft, Tappet Installation)
- Apply liquid gasket (THREE BOND: #1217H) to the mating surface [A] of the crankcase cover.

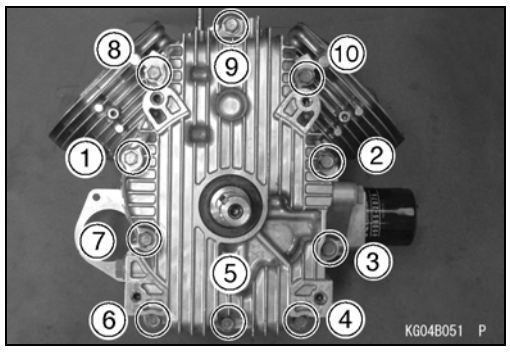
**NOTE**

○*Make the application finish within 5 minutes when the liquid gasket to the mating surface of the crankcase cover is applied.*

○*Moreover fit the case and tighten the cover bolts just after finishing the application of the liquid gasket.*




- Check to see that the dowel pins [A], O-rings [B] and plastic pipe [C] are in place on the crankcase.

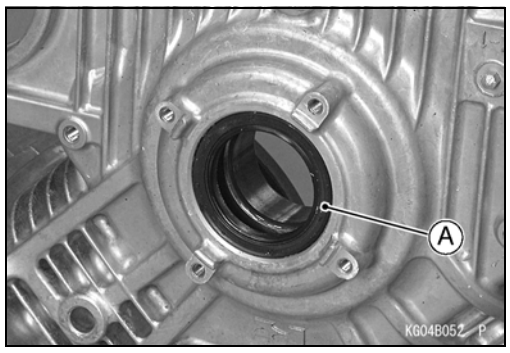



- Install the crankcase cover and tighten the crankcase cover bolts following the tightening sequence as shown.

**Torque - Crankcase Cover Bolts: 46 N·m (4.7 kgf·m, 34 ft·lb)**

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

### *Crankcase Disassembly*




- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
- Pry the crankshaft oil seal with the suitable tool, and remove it.
- Remove the ball bearing.

**Special Tool - Bearing Driver Set: 57001-1129**

## Crankcase

### *Crankcase Assembly*

- Remove the old gasket from the mating surfaces of the crankcase and cover.
- Using compressed air, blow out the oil passage in the crankcase.
- With a high-flash point solvent, clean off the mating surfaces of the crankcase and the cover, and wipe them dry.

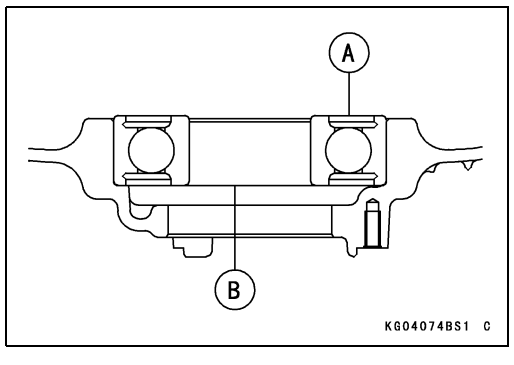
**⚠ WARNING**

**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.**

- Be sure to replace the ball bearing with a new one if removed.
- Press the ball bearing [A] to the bottom surface [B] of the crankcase cover.

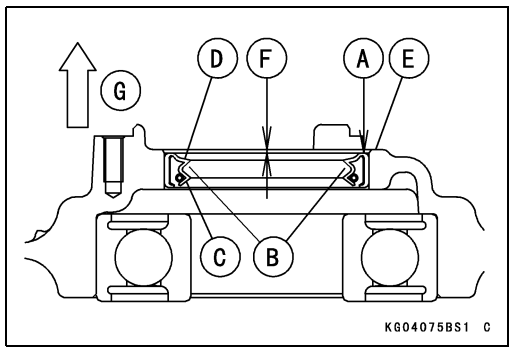
**Special Tool - Bearing Driver Set: 57001-1129**

- Apply engine oil to the ball bearing.




- Be sure to replace any oil seal with a new one if removed.
- Apply mineral oil to the crankshaft oil seal outside.
- Install the oil seal so that the marks [A] face out.
- Pack some amount of high temperature grease [B] into the space between the seal lip [C] and the dust lip [D].
- Press in the new oil seal using a press or suitable tools until it is flush or below the flange surface [E] as shown.
- Do not damage the seal lips.

[F]: 0 ~ 1 mm (0 ~ 0.04 in.)
[G]: Flywheel Side

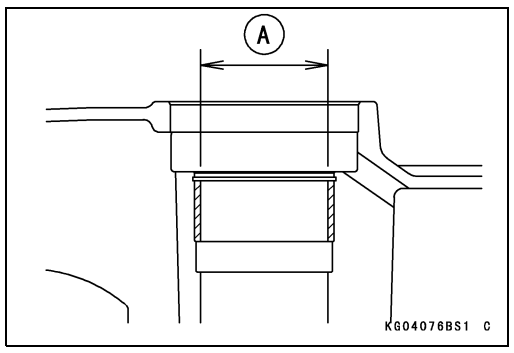



### *Crankcase Cover Inspection*

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

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

**PTO Shaft Bearing Inside Diameter**
**Service Limit: 42.15 mm (1.659 in.)**



## Crankcase

### *Crankcase and Crankcase Cover Cleaning*

- Remove:
  Oil Pump and Relief Valve (see Oil Pump, Relief Valve Removal in the Lubrication System chapter)
  Camshaft and Tappets (see Camshaft, Tappet Removal)
  Crankshaft (see Crankshaft Removal)
  Breather Valve and Cover (see Breather Valve Removal)
- 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.

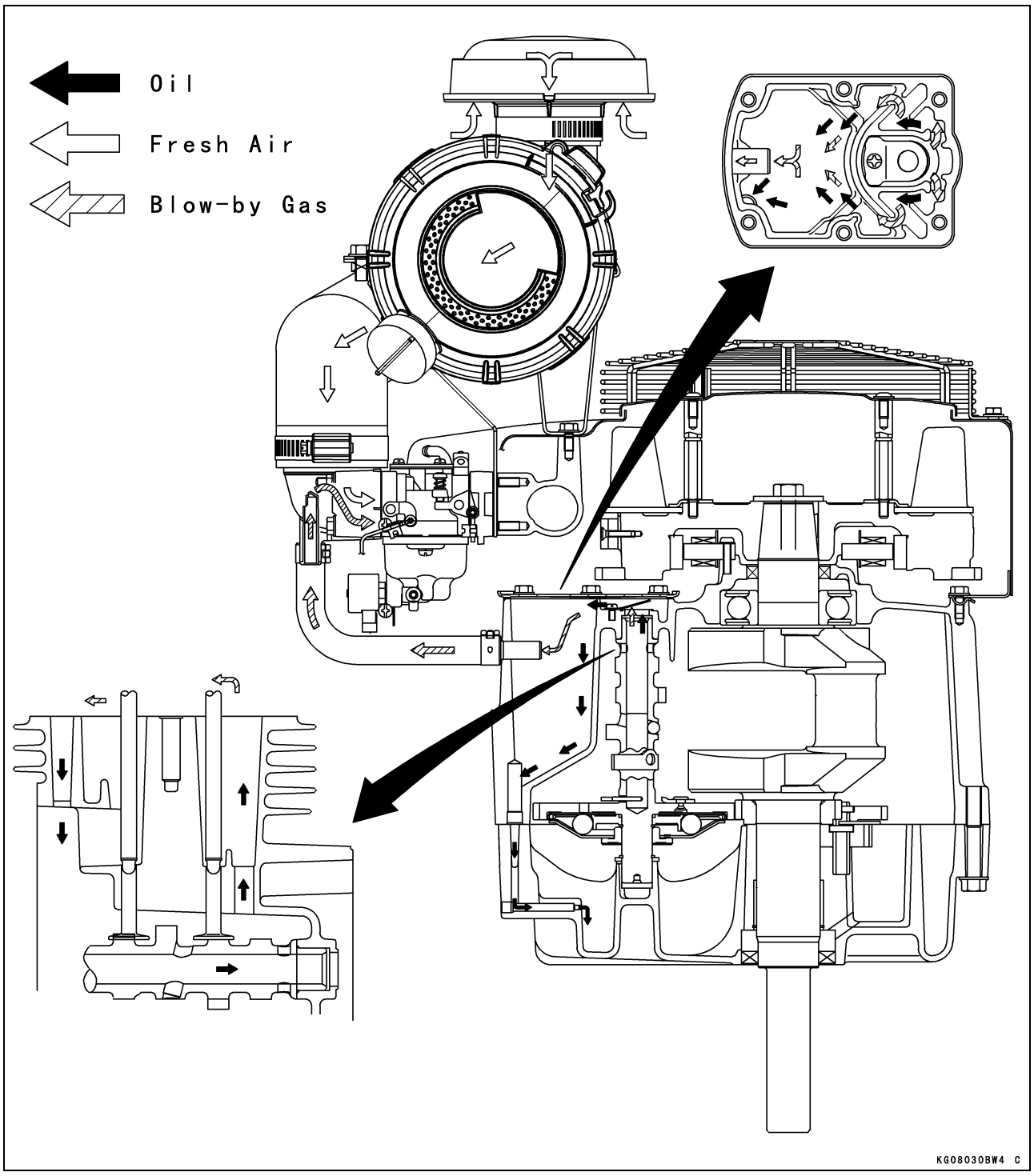
**⚠ WARNING**

**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 solvents.**

## Breather

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. 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 and the camshaft. Then, it is drawn into the clean side of the air cleaner through the cylinder head and the hose and mixed with the clean air flow, and subsequently coming into the combustion chamber through the carburetor and the inlet manifold.

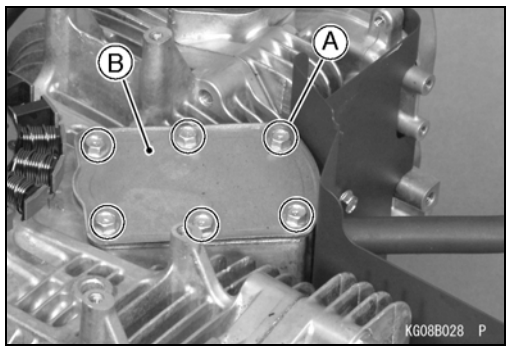
The oil is primarily separated from the gases while passing through the inside of the rocker chamber from the crankcase, and secondly separated from the gases in the breather chamber, then returned back to the crankcase cover.



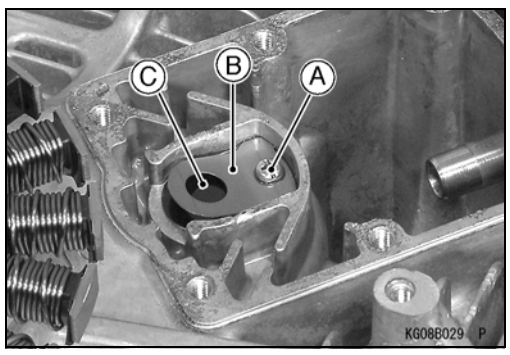
## Breather

### *Breather Valve Removal*

- Remove:
  Inlet Manifold (see Inlet Manifold Removal in the Fuel System chapter)
  Flywheel (see Flywheel and Stator Coil Removal in the Electrical System chapter)
  Bolts [A]
  Breather Chamber Cover [B]




- Remove:
  Screws [A]
  Back Plate [B]
  Reed Valve [C]




### *Breather Valve Installation*

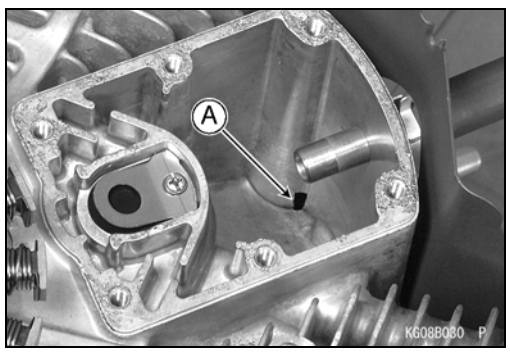
- Be sure the drain hole [A] on the breather chamber does not accumulate with slugs.
- Align center of the valve seat with center of the reed valve and back plate.
- Tighten:

**Torque - Breather Valve Mounting Screws: 2.0 N·m (0.20 kgf·m, 18 in·lb)**

- Replace the breather chamber cover gasket with a new one.
- Install the breather chamber cover so that the bended side faces upward.
- Tighten:

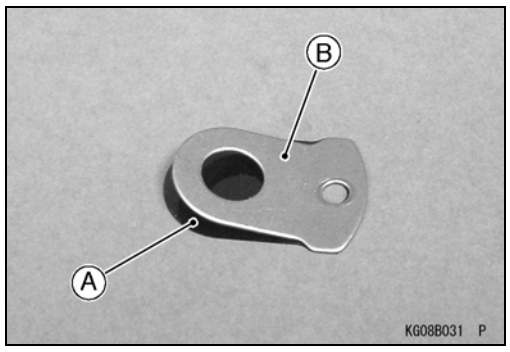
**Torque - Breather Chamber Cover Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**

- Install the removed parts (see appropriate chapters).




### *Breather Valve Inspection*

- Inspect the reed valve [A] for breakage, crack or distortion, replace it with a new one if necessary.
- Inspect the plate [B] for damage or rough contact surface, replace it with a new one if necessary.
- Inspect the valve seating surface. The surface should be no nicks or burrs.

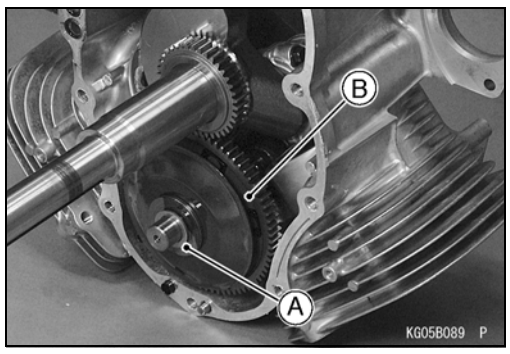


## Camshaft, Tappet

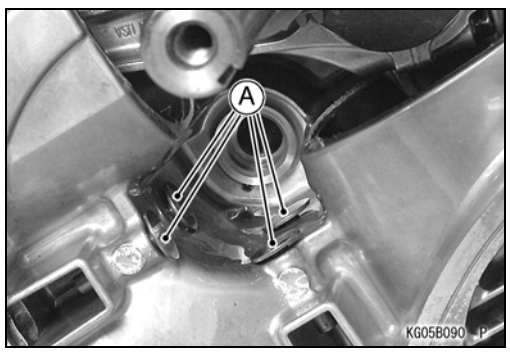
### *Camshaft, Tappet Removal*

- Set the engine on a clean surface while parts are removed.
- Drain the oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
  Rocker Covers (see Cylinder Head Assembly Removal in the Engine Top End chapter)
  Push Rods (see Push Rod Removal in the Engine Top End chapter)

- Turn the crankcase upside down so that the tappets will fall away from the cam lobes.
- Remove the washer [A].
- Pull the camshaft [B] out of the crankcase.

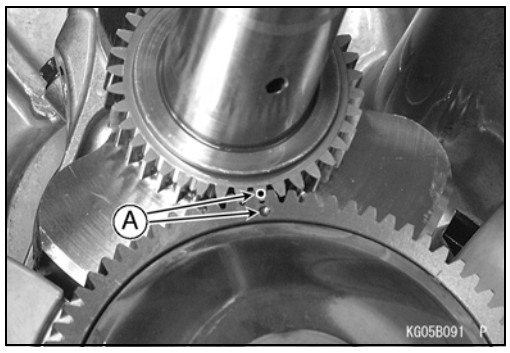



- Remove the tappets [A] and mark them to reinstall in their original positions during assembly.

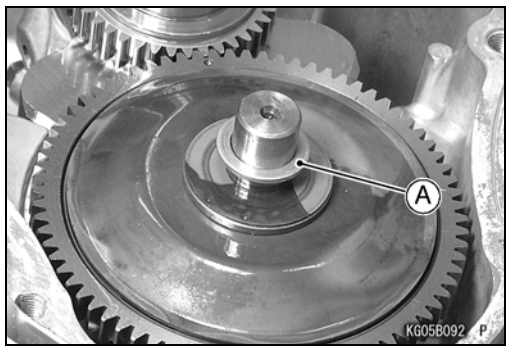



### *Camshaft, Tappet Installation*

- Apply engine oil to the followings.
  Tappet Journal
  Camshaft Journal
  Cam Lobe Surface
  Camshaft Gear
  Camshaft Bearing
- Align the punch marks [A] on the crankshaft gear and camshaft gear.

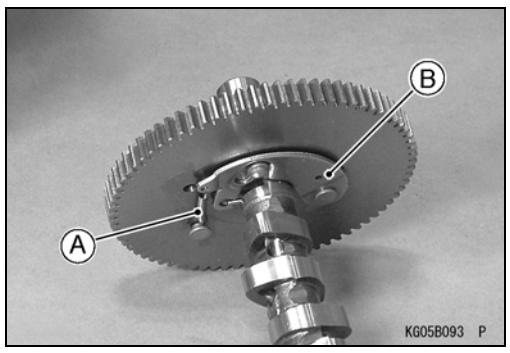



- Install the washer [A] on the camshaft.



## Camshaft, Tappet

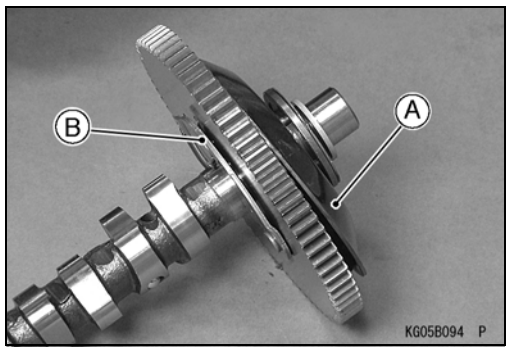
### *Camshaft Disassembly*




● Remove:
  Governor Assembly (see Governor Assembly Removal in the Fuel System chapter)
  Spring [A]

○Do not remove the ACR (automatic compression release) weight [B].

### *Camshaft Assembly*



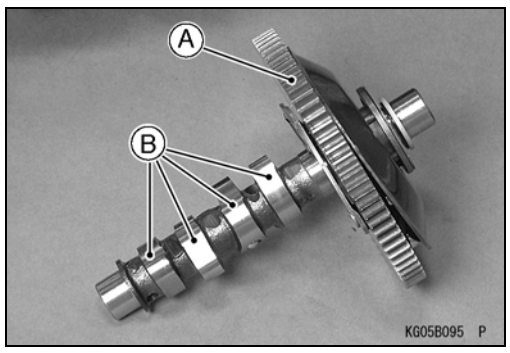

● Install the governor assembly (see Governor Assembly Installation in the Fuel System chapter).

● After assembling the camshaft, check the following items.

○The governor plate [A] must move freely.

○While shaking the camshaft, check if the ACR weight [B] swings smoothly.

### *Camshaft Inspection*



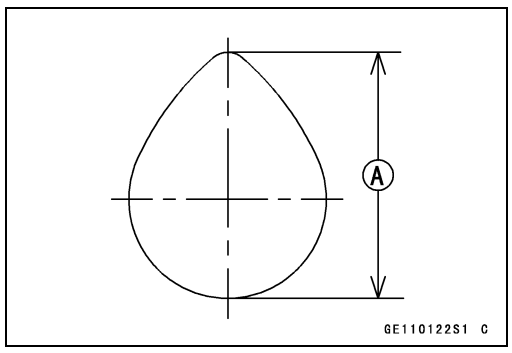

● Check the camshaft gear [A] for pitting, fatigue cracks, burrs or any evidence of improper tooth contact.

★Replace the camshaft with a new one if necessary.

● Check the top of the cam lobes [B] for wear, burrs or uneven contact.

★Replace the camshaft with a new one if necessary.

### *Camshaft Bearing/Journal Wear*



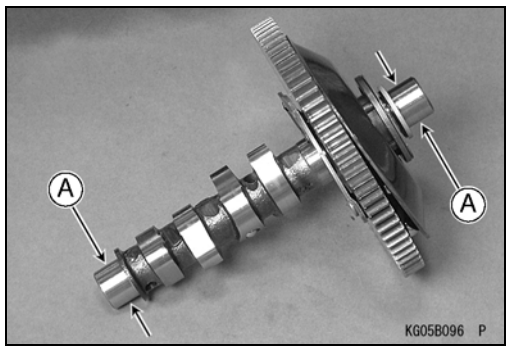

● Measure the height [A] of each cam lobe.

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

**Cam Lobe Height**

**Service Limit:**

| | |
|---|---|
| **Inlet** | **34.30 mm (1.350 in.)** |
| **Exhaust** | **35.13 mm (1.383 in.)** |




● Measure both camshaft journal diameter [A] at several points around the journal circumference.

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

**Camshaft Journal Diameter**

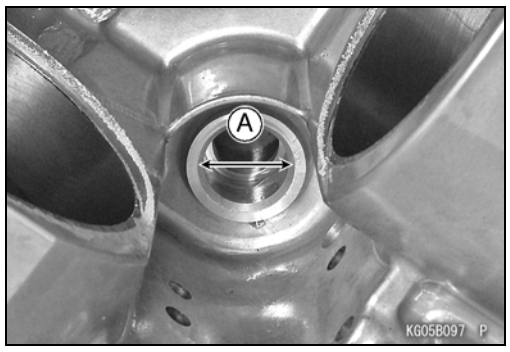
**Service Limit: 19.98 mm (0.7866 in.)**

## Camshaft, Tappet

- Measure the inside diameter [A] of the camshaft bearing on the crankcase at several points. This bearing is not replaceable.

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

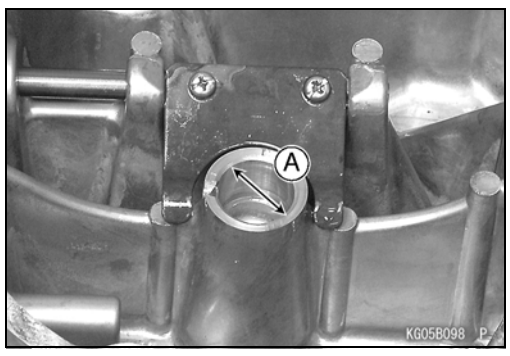
**Camshaft Bearing Inside Diameter (Crankcase)**
**Service Limit: 20.14 mm (0.7929 in.)**




- Measure the inside diameter [A] of the camshaft bearing on the crankcase cover at several points. This bearing is not replaceable.

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

**Camshaft Bearing Inside Diameter (Crankcase Cover)**
**Service Limit: 20.14 mm (0.7929 in.)**



## Crankshaft, Connecting Rod

### *Connecting Rod Removal*

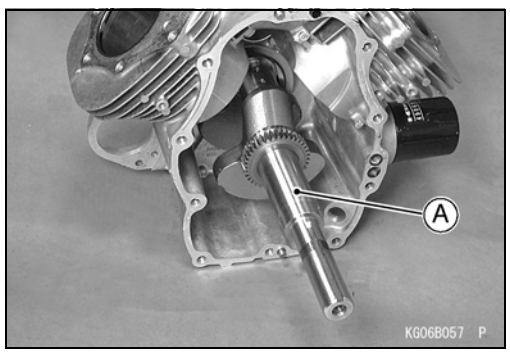
● Refer to the Piston Removal in the Engine Top End chapter.

### *Connecting Rod Installation*

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

### *Crankshaft Removal*

● Remove:
Camshaft (see Camshaft, Tappet Removal)
Connecting Rod and Piston Assembly (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*

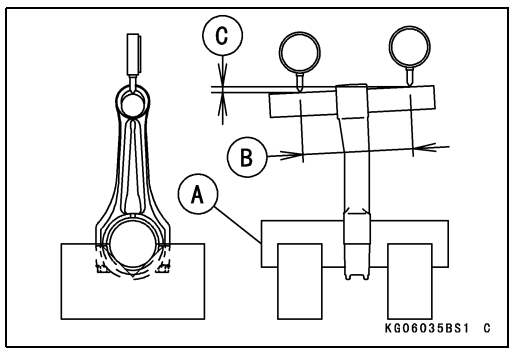
● Clean up the crankshaft and crankcase thoroughly, especially at the bearing contact surfaces.
● Pack some amount of high temperature grease into the oil seals on the crankcase and crankcase cover.
● Apply engine oil to the crankshaft journal and ball bearing.
● Apply molybdenum disulfide oil solution to the crankpin.
○The molybdenum disulfide oil solution is a mixture of engine oil and molybdenum disulfide grease with a weight ratio (10:1).
● Carefully insert the crankshaft end into the main bearing and the oil seal in the crankcase.

### *Cleaning/Inspection*

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

## Crankshaft, Connecting Rod

### *Connecting Rod Bend/Twist*




● Measure the connecting rod bend.

○Select an arbor [A] of the same diameter of the connecting rod big end, and insert the arbor through the connecting rod big end.

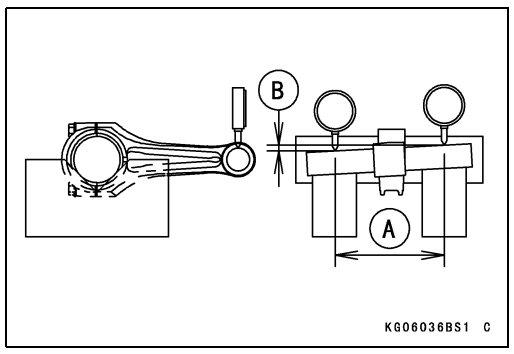
○Select an arbor of the same diameter of the piston pin and at least 100 mm (3.94 in.) long, and insert the arbor through the connecting rod small end.

○On a surface plate, set the big end arbor on V blocks.

○With the connecting rod held vertically, use a height gauge to measure the height difference of the small end arbor on the surface plate. Using a dial gauge, measure the height at two different positions and the distance of the two positions is 100 mm (3.94 in.) [B]. Then determine the connecting rod bent from the measured height differences [C].

★If connecting rod bend exceeds the service limit, replace the connecting rod with a new one.

**Connecting Rod Bend**
**Service Limit: 0.15/100 mm (0.006/3.94 in.)**



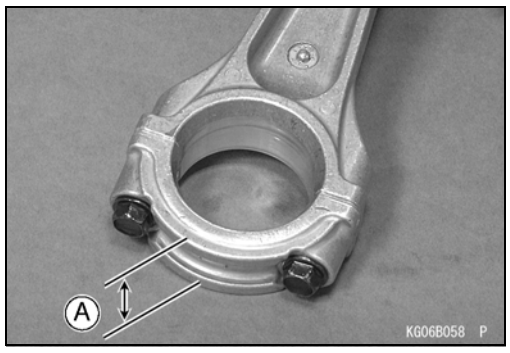

● Measure the connecting rod twist.

○With the big end arbor still on the V blocks, hold the connection rod horizontally and measure the amount that the small end arbor difference. Using a dial gauge, measure the height at tow different positions and the distance of the two positions is 100 mm (3.94 in.) [A]. Then determine the connecting rod twist from the measured height differences [B].

★If connection rod twist exceeds the service limit, replace the connecting rod with a new one.

**Connecting Rod Twist**
**Service Limit: 0.15/100 mm (0.006/3.94 in.)**

### *Connecting Rod Big End/Crankpin Width Wear*




● Measure the connecting rod big end width [A] with a micrometer or a dial caliper.

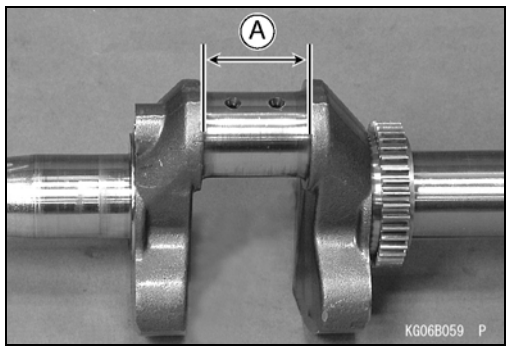
★If the measurement is less than the service limit, replace the connecting rod with a new one.

**Connecting Rod Big End Width**
**Service Limit: 22.070 mm (0.8937 in.)**

## Crankshaft, Connecting Rod

● Measure the crankpin width [A] with a dial caliper.
★If the crankpin width is greater than the service limit, replace the crankshaft with a new one.

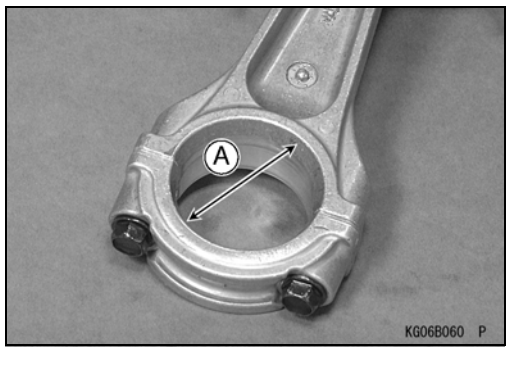
**Crankpin Width**
**Service Limit: 49.0 mm (1.93 in.)**




### *Connecting Rod Big End Bearing/Crankpin Wear*

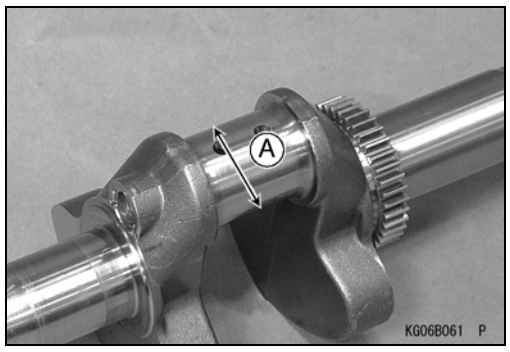
● Apply a light film of engine oil on the threads of the cap bolts.
● Install the cap bolts and tighten the bolts to the specified torque (see Piston Installation in Engine Top End chapter).
● Measure the big end inside diameter [A] at several points with a telescoping gauge or inside micrometer.
★If the inside diameter is greater than the service limit, replace the connecting rod with a new one.

**Connecting Rod Big End Inside Diameter**
**Service Limit: 40.04 mm (1.576 in.)**




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

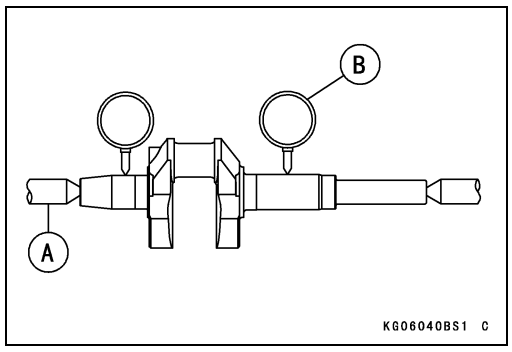
**Crankpin Outside Diameter**
**Service Limit: 39.94 mm (1.572 in.)**




### *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 the lowest dial gauge readings (TIR) is the amount of runout.
★If the measurement exceeds the service limit, replace the crankshaft with a new one.

**Crankshaft Runout**
**Service Limit: TIR 0.05 mm (0.002 in.)**



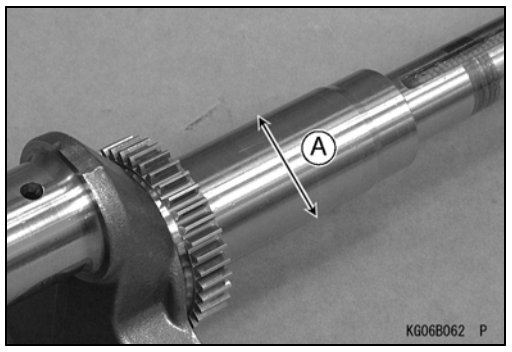
## Crankshaft, Connecting Rod

### *Crankshaft Journal/Wear*

- Measure PTO side crankshaft journal at several points around the journal circumference.

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

**PTO Side Crankshaft Journal Diameter [A]**
**Service Limit: 41.90 mm (1.650 in.)**



# Starter System

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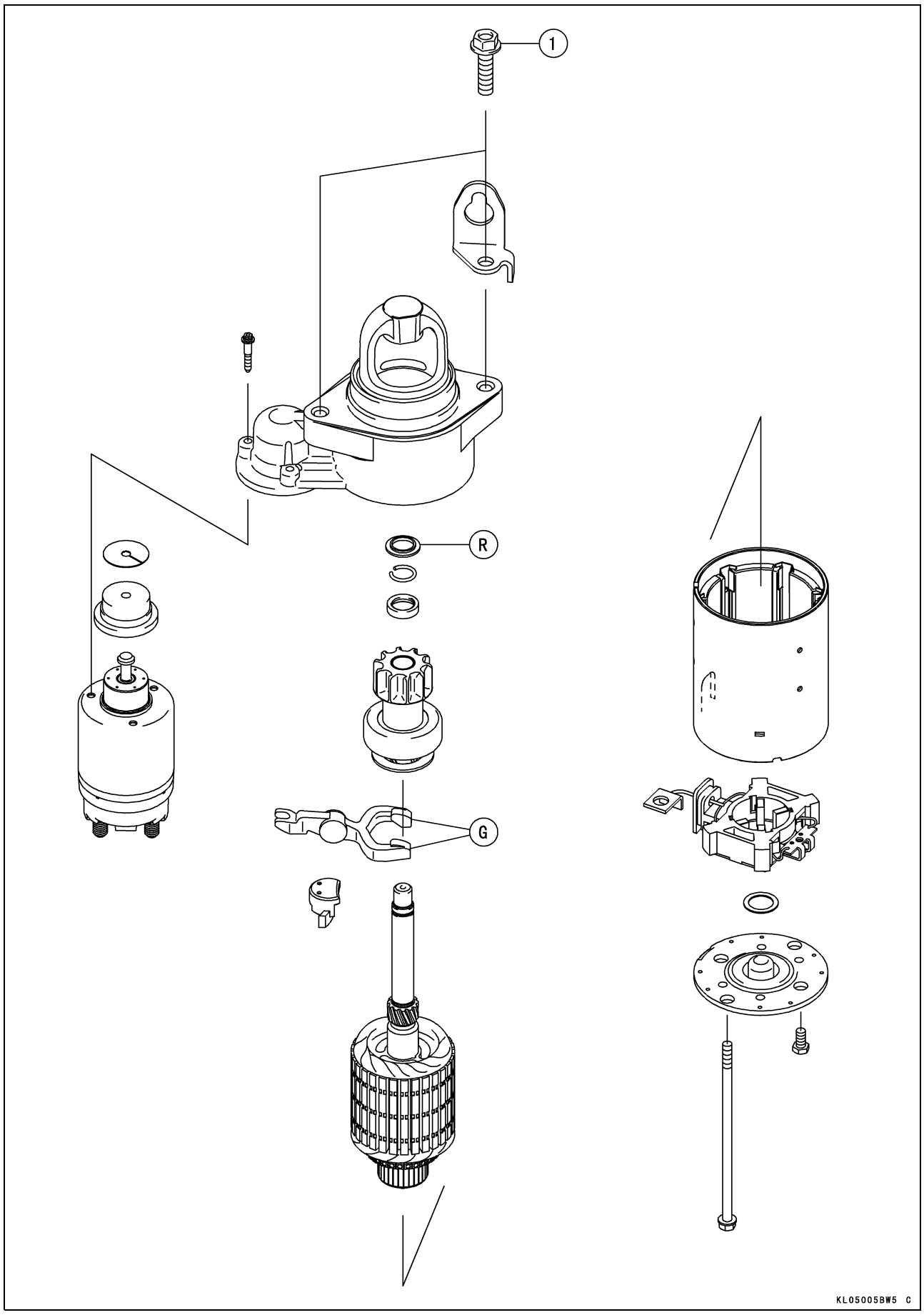
## 8-2 STARTER SYSTEM

### Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Starter Motor Mounting Bolts | 19.6 | 2.00 | 14.4 | |

G: Apply grease.
R: Replacement Parts

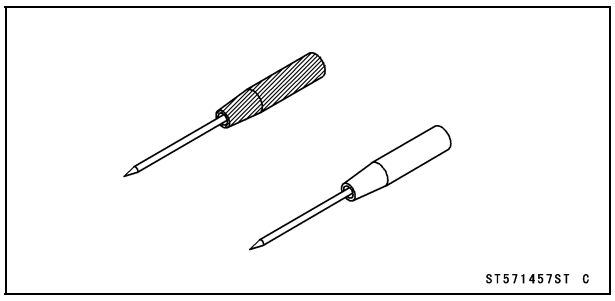
## 8-4 STARTER SYSTEM

### Specifications

| Item | Standard | Service Limit |
|---|---|---|
| **Electric Starter System** | | |
| Starter Motor: | | |
| Carbon Brush Length (with spring boss) | 7.125 mm (0.2805 in.) | 4.0 mm (0.16 in.) |
| Commutator Groove Depth (approx.) | 0.8 mm (0.03 in.) | 0.4 mm (0.016 in.) |
| Commutator Diameter | 29.5 mm (1.16 in.) | 29.0 mm (1.14 in.) |
| Commutator Runout | – – – | 0.4 mm (0.016 in.) |

## Special Tool

**Needle Adapter Set:**
**57001-1457**

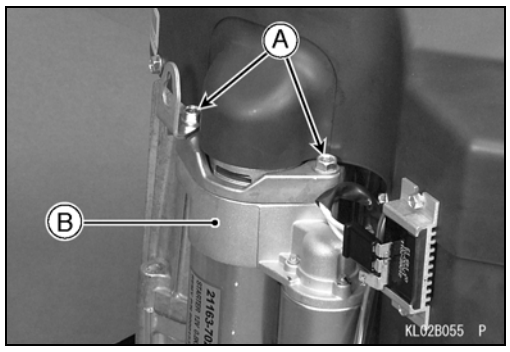


# 8-6 STARTER SYSTEM

## Electric Starter System

### *Starter Motor Removal*

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

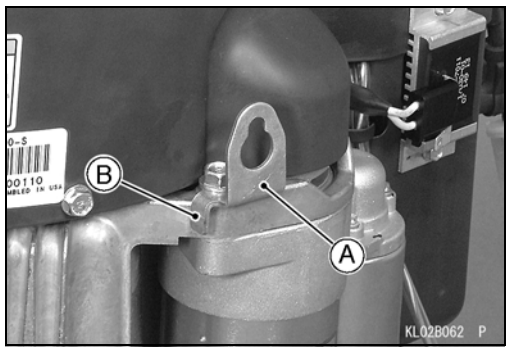



### *Starter Motor Installation*

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

○Install the hook [A] so that the stopper [B] of the hook contacts the crankcase.

**Torque - Starter Motor Mounting Bolts: 19.6 N·m (2.00 kgf·m, 14.4 ft·lb)**

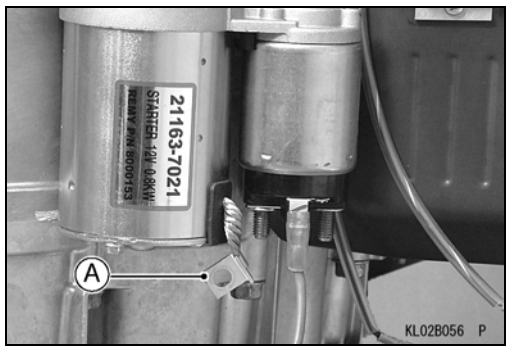



### *Starter Solenoid and Circuit Test*

**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.

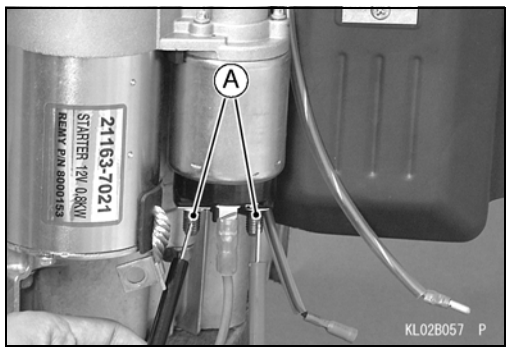
★If the solenoid does not click or if the tester reads more than 0 Ω the solenoid is faulty. Replace it.

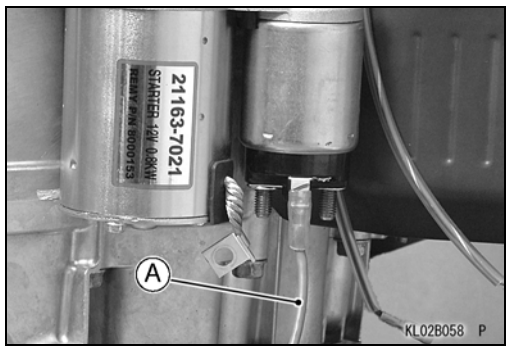
★If the solenoid makes a single clicking sound, the tester reads 0 Ω and the rest of the starter circuit is good.

★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.

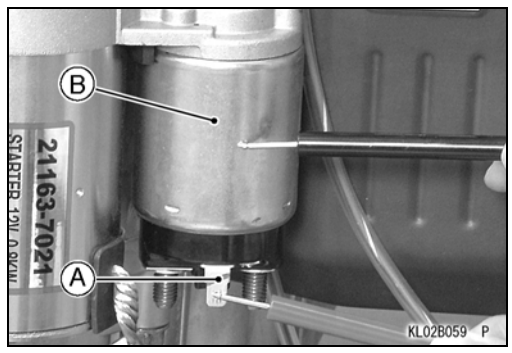
- Disconnect the switch lead [A].



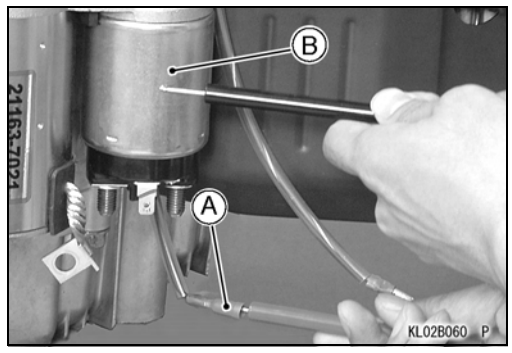



## Electric Starter System

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




### *Starter Motor Test*

**NOTE**

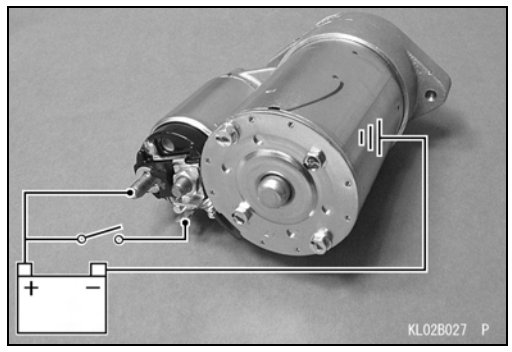
○*Always inspect the Starter Solenoid and Circuit Test section before starting following procedures.*

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

**CAUTION**

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

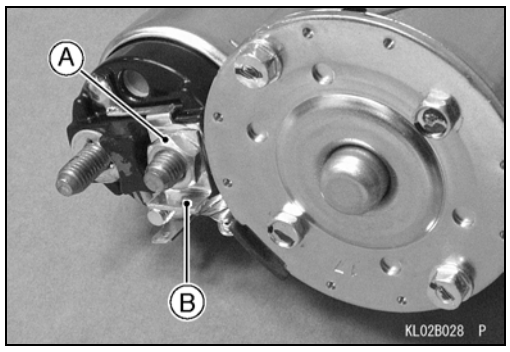
● Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal on the solenoid as shown.
● Connect the second jumper cable to the battery (–) terminal.
● Touch the switch intermittently for one second intervals.
● The pinion should rotate freely.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



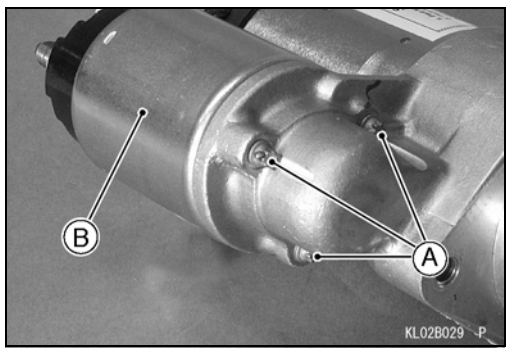
## Electric Starter System

### *Starter Motor Disassembly*

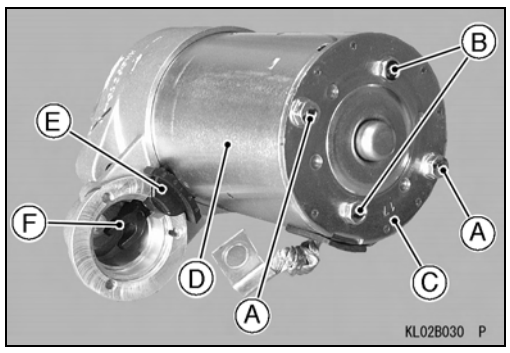
- Loosen the terminal nut [A].
- Remove the lead [B] from the starter motor to the solenoid.



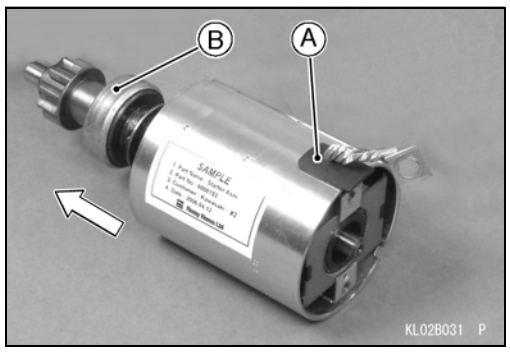

- Unscrew the mounting nuts [A] and remove the solenoid assembly [B].



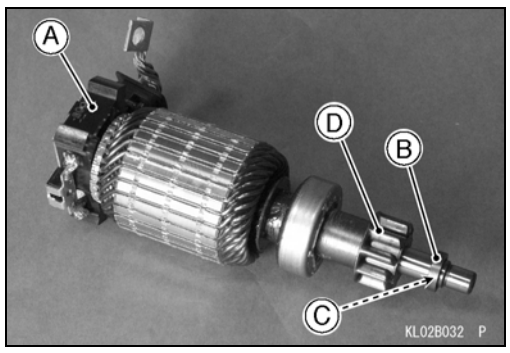

- Remove the through bolts [A] and end cover bolts [B].
- Remove the end cover [C].
- Move the yoke [D] with the armature.
- Pull the rubber insert [E] from the pinion gear cover and remove the pinion gear fork [F].




- Slide the (–) lead grommet [A] to outside.
- Pull the yoke assembly [B] toward the pinion clutch.



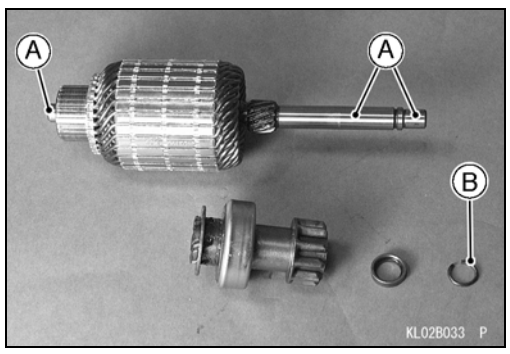

- Remove:
  Brush Assembly [A]
- Push the stopper [B] downward and remove the snap ring [C].
- Pull the rear stopper and pinion clutch [D] from the armature shaft.



## Electric Starter System

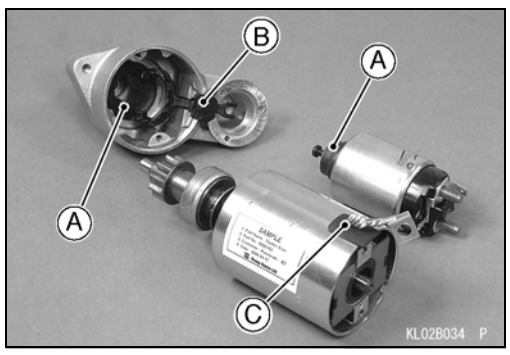
### *Starter Motor Assembly*

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

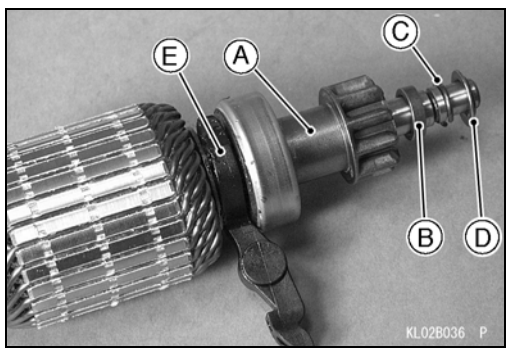



- Inspect the boots [A], rubber insert [B] and grommet [C] for visible damage.

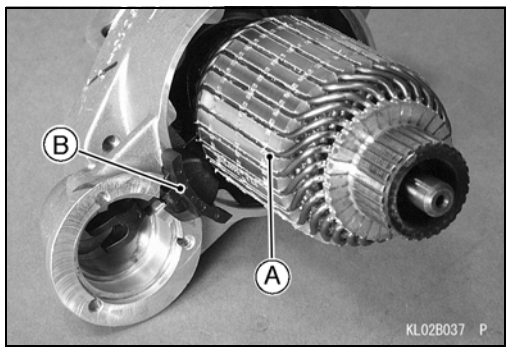
★If it is damaged, replace it.



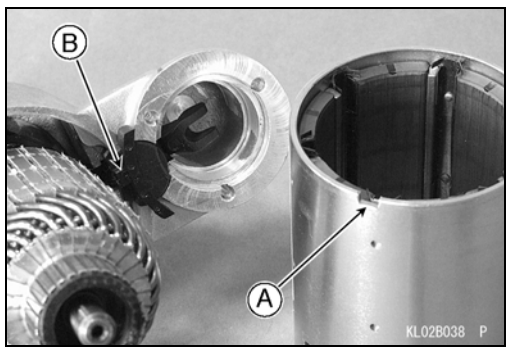

- Install the pinion clutch [A].
- Install the stopper [B] so that the hollow side face the outside.
- Install the snap ring [C] to the groove of the shaft.
- Slide the stopper until the stopping with the snap ring.
- Install the collar [D] so that the smaller diameter face the outside.
- Apply grease to the pinion gear fork fingers.
- Assemble the pinion gear fork [E] as shown.




- Install the armature assembly [A] to the pinion gear cover.
- Install the rubber insert [B] as shown.

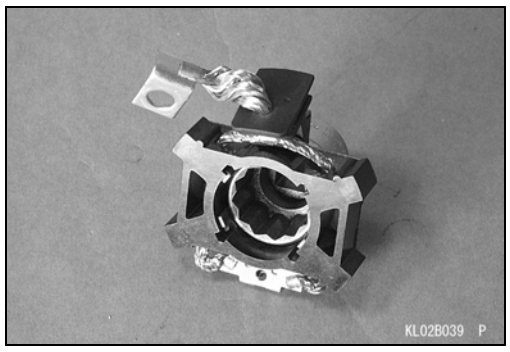



- Install the yoke so that the slit [A] fit the projection [B] of the rubber insert.

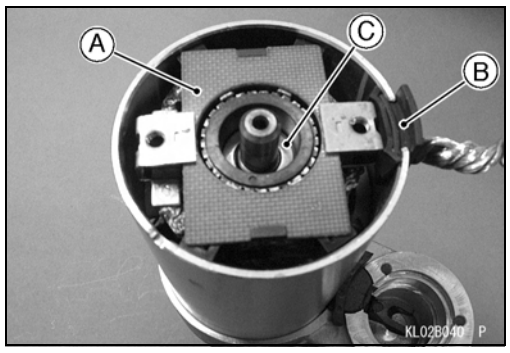


## Electric Starter System

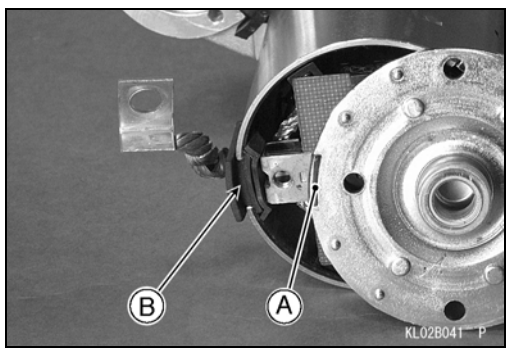
- Using the suitable tool (for instance, socket wrench of 22 mm), expand the brushes as shown.



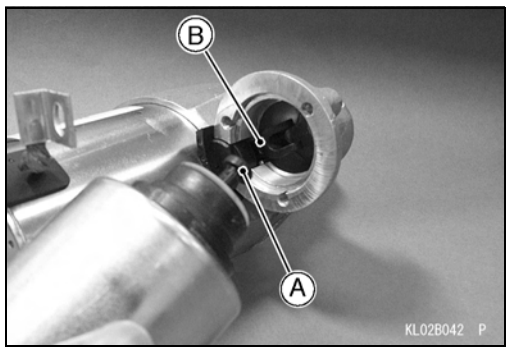

- Install the brush assembly [A] with the suitable tool installed.
- Pull out the suitable tool.
- Fit the notch on the (–) lead grommet [B] and slit on the yoke.
- Install the washer [C].




- Install the end cover so that the projection [A] fit the groove [B] of the grommet.
- Tighten the through bolts and end cover bolts.




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




### *Starter Motor Brush Inspection*

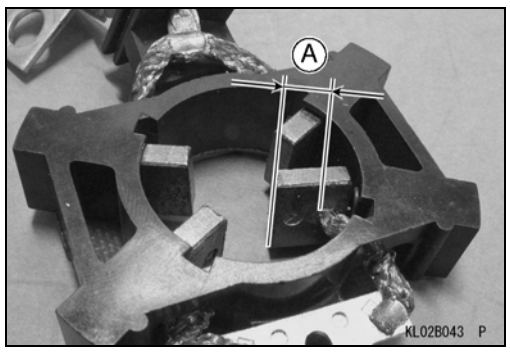
- Measure the overall length [A] of each brush.

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

**Brush Length**

**Standard:** **7.125 mm (0.2805 in.)**

**Service Limit:** **4.0 mm (0.16 in.)**



## Electric Starter System

### *Brush Spring Inspection*

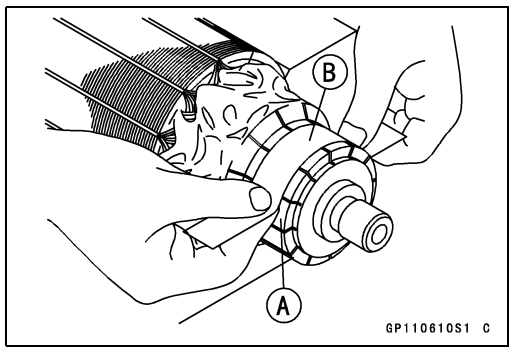
- Inspection the brush springs for pitting, cracks, rusting and burrs. Replace the brush assembly if necessary.
- Inspect the springs for weakened conditions and distortion. Replace the brush assembly if necessary.

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

### *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.

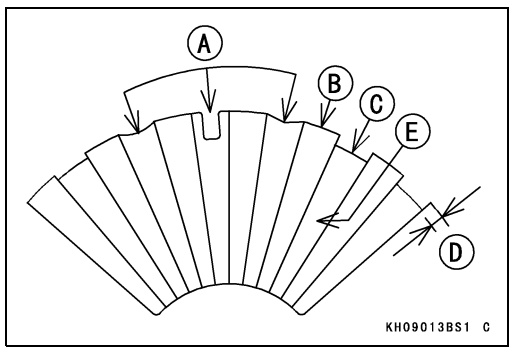



- Measure the depth of the grooves between the commutator segments.

★If the grooves are shallower than the specified limit, undercut the insulating material to the standard depth 0.5 ~ 0.8 mm (0.012 ~ 0.031 in.) using a thin file.

★If the grooves are only dirty, clean them carefully.

**Commutator Groove Depth (approx.)**
**Standard: 0.8 mm (0.03 in.)**
**Service Limit: 0.4 mm (0.016 in.)**

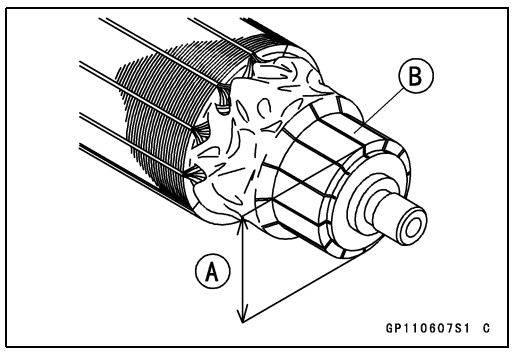



Bad [A]
Segment [B]
Good [C]
0.4 mm (0.016 in.) limit [D]
Mica [E]

- Measure the commutator [B] outside diameter [A] at several points.

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

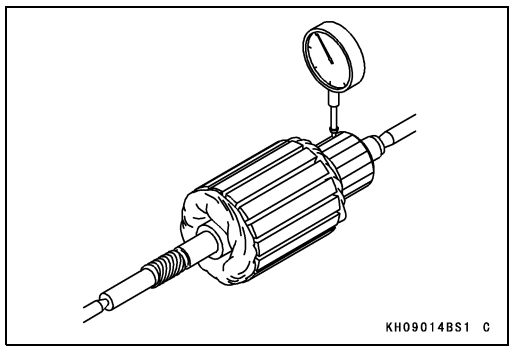
**Commutator Outside Diameter**
**Standard: 29.5 mm (1.16 in.)**
**Service Limit: 29.0 mm (1.14 in.)**




- 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.

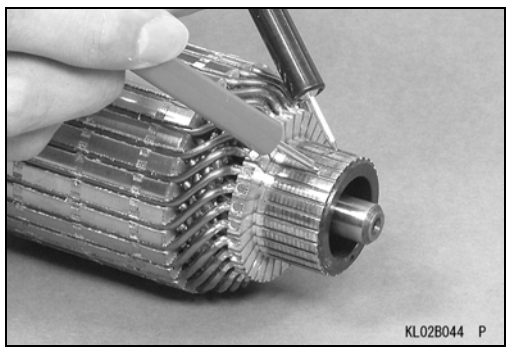
**Commutator Runout**
**Service Limit: 0.4 mm (0.016 in.)**



## Electric Starter System

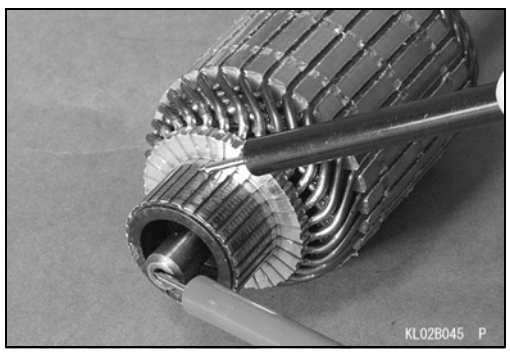
● Measure the armature winding resistance.
○Set the multimeter selector switch to the R × 1 Ω position and check the resistance between each segment and all the others.
★If the resistance it too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

**Armature Winding Resistance**
**Close ~ 0 Ω**

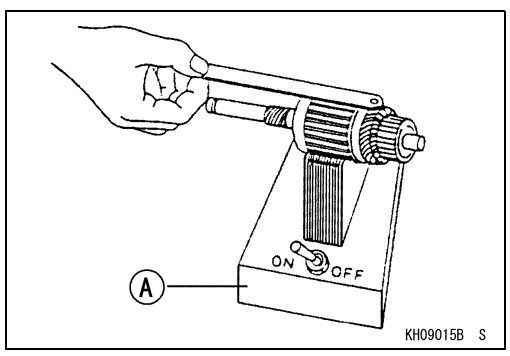



● Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the commutator and the armature shaft.
★If the resistance is less than infinite, the armature is shorted.

**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.



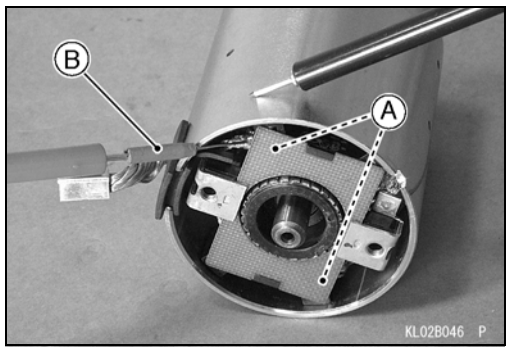

### *Yoke Assembly Inspection*

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

**Special Tool - Needle Adapter Set [B]: 57001-1457**

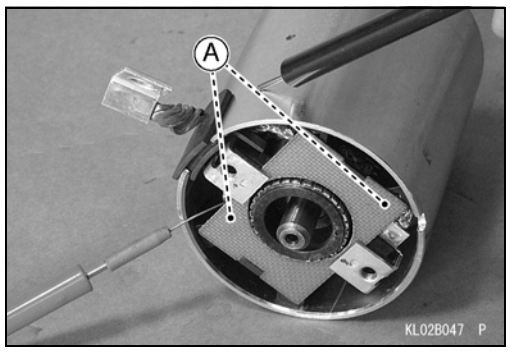
★If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

**Positive Brush to Ground Resistance**
**(∞)**




● Set the multimeter selector switch to the R × 1 Ω position and measure the resistance between the negative brushes [A] and starter motor yoke.
★If the meter dose not read close ~ 0 Ω, the yoke assembly is faulty. Replace it.

**Negative Brush to Ground Resistance**
**Close ~ 0 Ω**

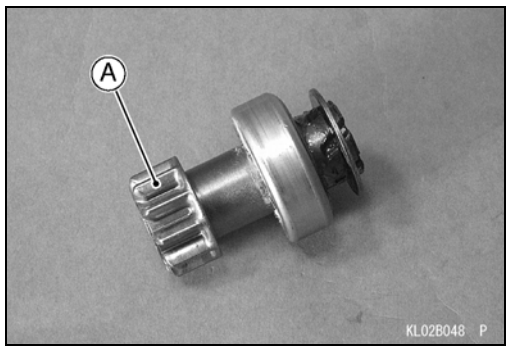


## Electric Starter System

### *Pinion Clutch Inspection*

- Remove the pinion clutch.
- Turn the pinion gear [A] by hand. The pinion gear should turn counterclockwise 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.



# Electrical System

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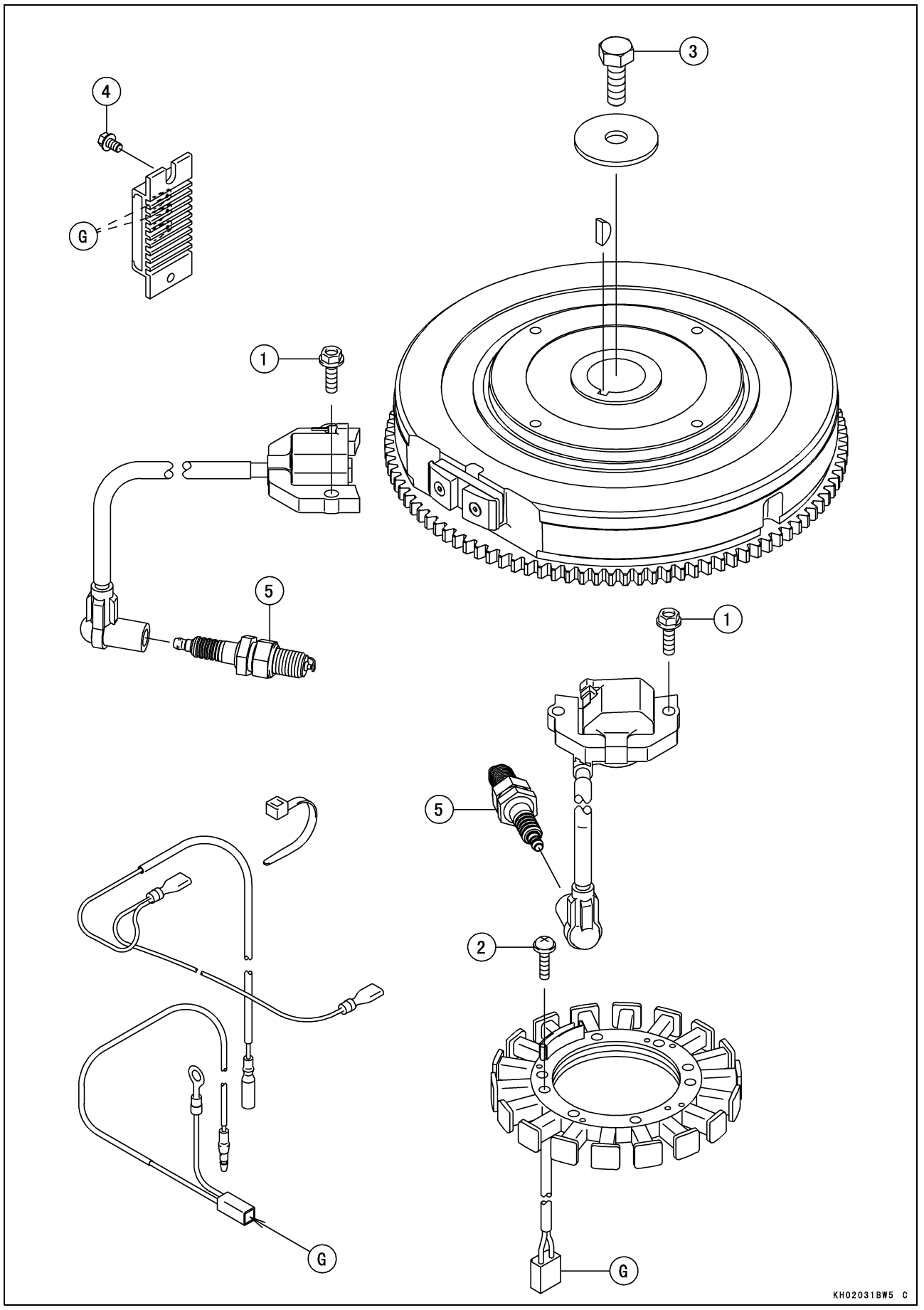
## Exploded View



## Exploded View

| No. | Fastener | Torque | | | Remarks |
|---|---|---|---|---|---|
| | | N·m | kgf·m | ft·lb | |
| 1 | Ignition Coil Bolts | 5.9 | 0.60 | 52 in·lb | |
| 2 | Stator Coil Screws | 3.4 | 0.35 | 30 in·lb | |
| 3 | Flywheel Bolt | 56 | 5.7 | 41 | |
| 4 | Regulator Bolts | 1.8 | 0.18 | 16 in·lb | |
| 5 | Spark Plugs | 22 | 2.2 | 16 | |

G: Apply grease (Three Bond: TB2585G or equivalent).

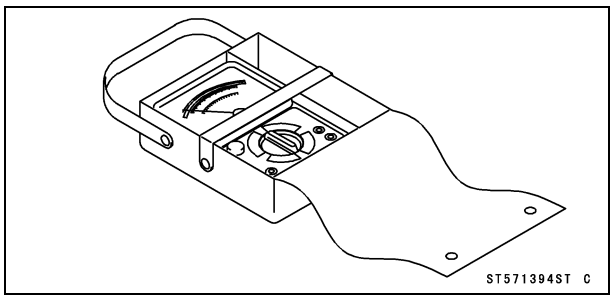
# 9-4 ELECTRICAL SYSTEM

## Specifications

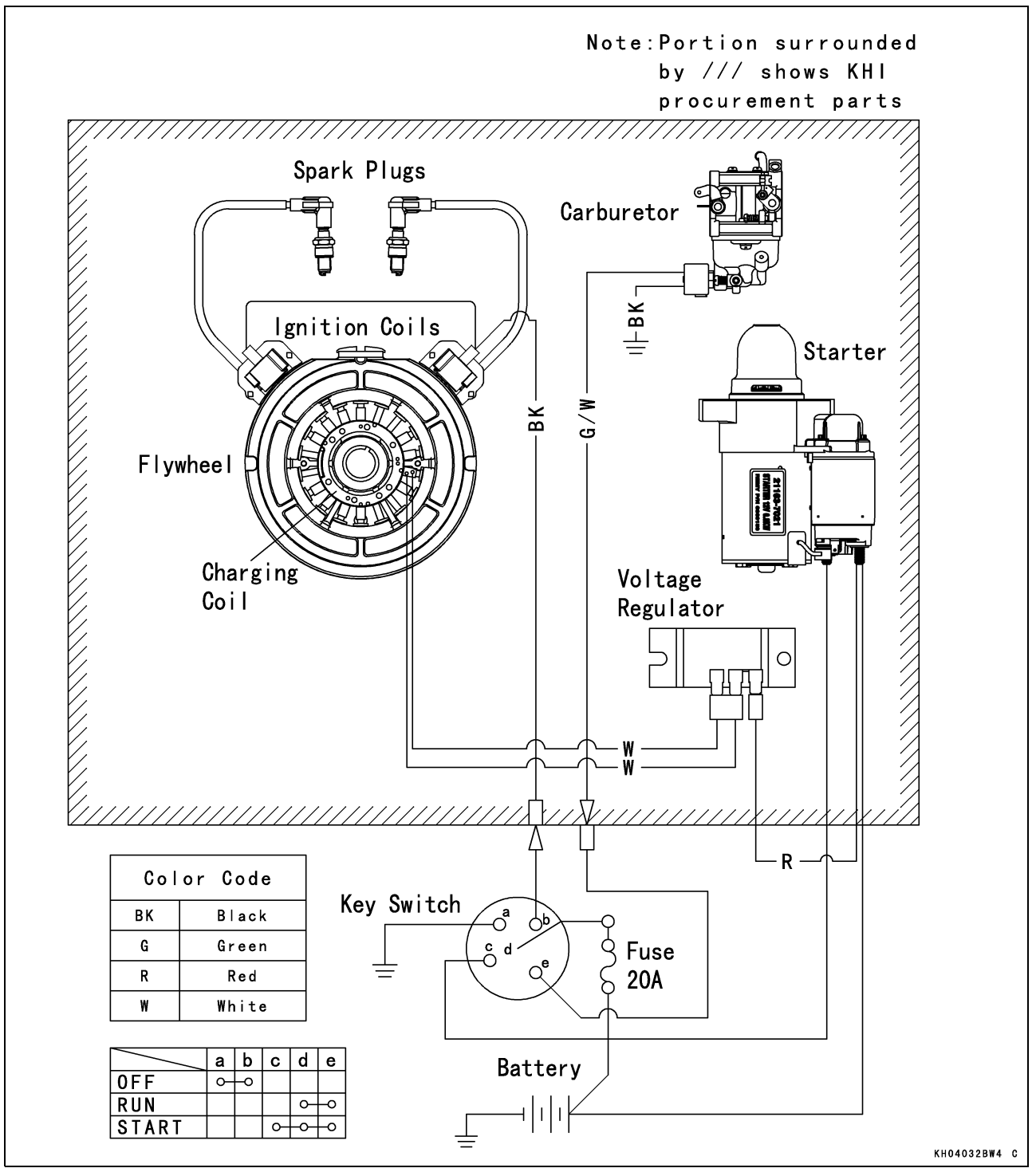
| Item | Standard | Service Limit |
|---|---|---|
| **Charging System** | | |
| Regulated Output Voltage | 14.1 V DC | 15 V DC |
| Stator Coil Resistance | 0.01 ~ 0.1 Ω | – – – |
| Unregulated Stator Output | 28.4 V AC/3 000 rpm | 26 V AC/3 000 rpm |
| Regulator Resistance | in the text | |
| **Ignition System** | | |
| Ignition Coil: | | |
| Air Gap | 0.2 ~ 0.4 mm (0.008 ~ 0.016 in.) | |
| Primary Winding Resistance | in the text | – – – |
| Secondary Winding Resistance | in the text | – – – |
| Spark Plug | NGK BPR4ES | – – – |
| Plug Gap | 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.) | – – – |

## Special Tool

**Hand Tester:**
**57001-1394**



## Wiring Dagram

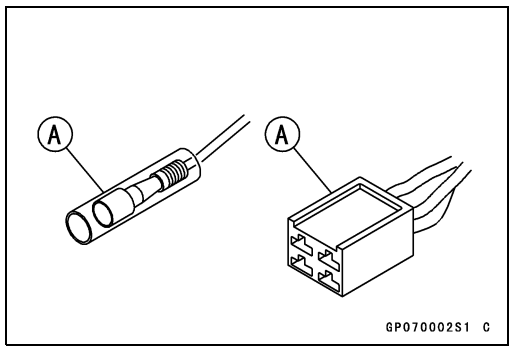


## Precautions

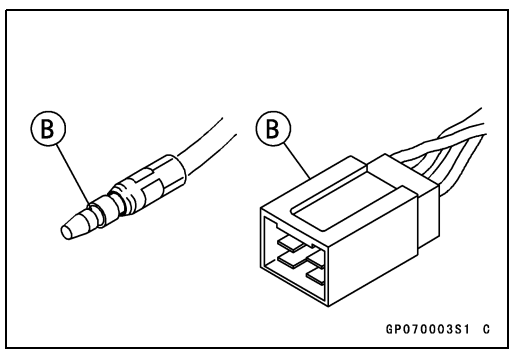
There are a number of important precautions that you must follow when servicing electrical systems. Learn and observe all the rules below.

- ○Do not reverse the battery cable connections. This will burn out the diodes in the electrical parts.
- ○Always check the battery condition before judging other parts of the electrical system. A fully charged battery is necessary for conducting accurate electrical system tests.
- ○Do not hit the electric parts with a hammer or do not drop the electric parts. These may result in the electric parts damage or breakage.
- ○To prevent damage to electrical parts, do not disconnect the battery cables or any other electrical connections when the engine switch is on, or while the engine is running.
- ○Because of the large amount of current, never keep the engine switch turned to the start position when the starter motor will not start, or the current may burn out the starter motor windings.
- ○Take care not to short the leads that are directly connected to the battery positive (+) terminal to the chassis ground.
- ○Troubles may involve one or all items in some cases. Never replace a defective part without determining what CAUSED the failure. If the failure was occurred by another item or some other items, repair and/or replace the item(s). Or the failure may happen again.
- ○Make sure all connectors in the circuit are clean and tight, and examine the leads for signs of burning, fraying, etc. Poor leads and bad connections will affect electrical system operation.
- ○Measure the coil and the winding resistance when the parts are cold (at room temperature).
- ○Electrical connectors:

Connectors [A]



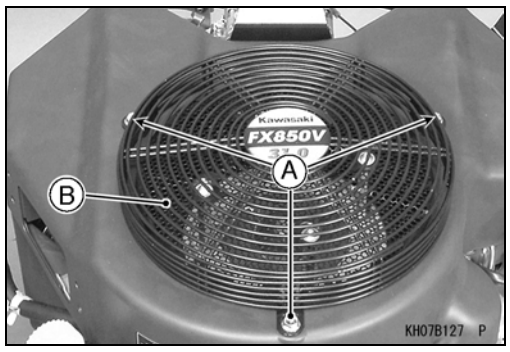

Connectors [B]



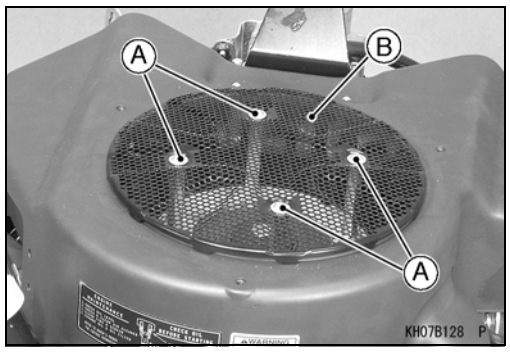
## Charging System

### *Flywheel and Stator Coil Removal*

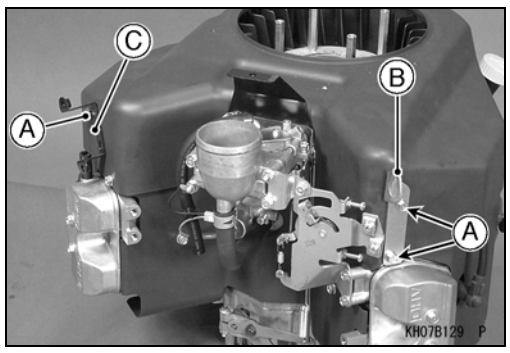
● Remove:
Air Cleaner (see Air Cleaner Body and Bracket Removal in the Fuel System chapter)
Oil Cooler (see Oil Cooler Removal in the Lubrication System chapter)
Regulator (see Regulator Removal)
Fuel Pump (see Fuel Pump Removal in the Fuel System chapter)
Bolts [A] and Guard [B]



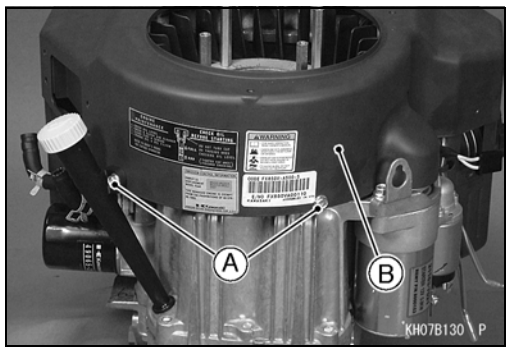

● Remove:
Bolts [A] and Screen [B]



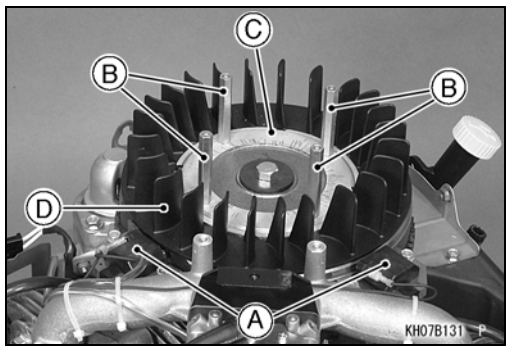

● Remove:
Bolts [A]
Bracket [B]
Fuel Pump Bracket [C]




● Remove:
Bolts [A]
Fan Housing [C]

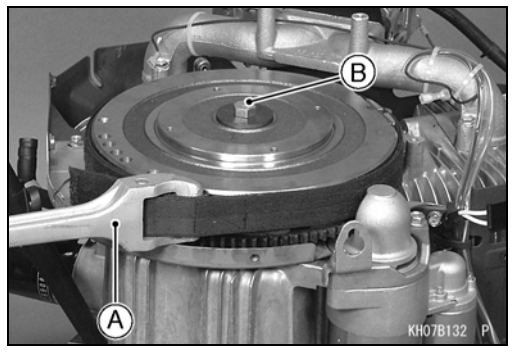



● Remove:
Ignition Coils [A] (see Ignition Coil Removal)
Stud Bolts [B]
Plate [C]
Cooling Fan [D]



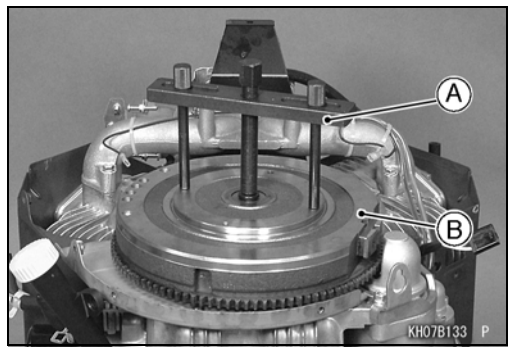
## Charging System

● Hold the flywheel with a suitable tool [A], remove the flywheel bolt [B] and the washer.

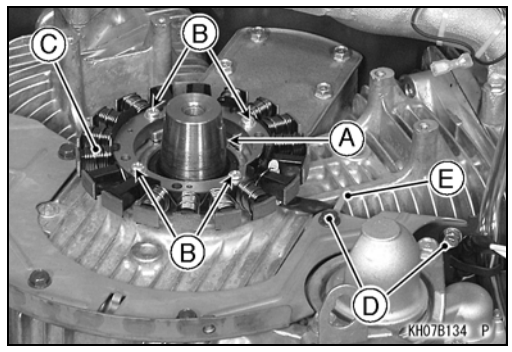



● Using a suitable flywheel puller [A], remove the flywheel [B].

| CAUTION |
| --- |
| **Always use flywheel puller.** |




● Remove:
Woodruff Key [A]
Stator Coil Screw [B]
Stator Coil [C]
○Remove the two shroud bolts [D] to clear the stator coil harness from the holder [E], if necessary.




### *Flywheel and Stator Coil Installation*

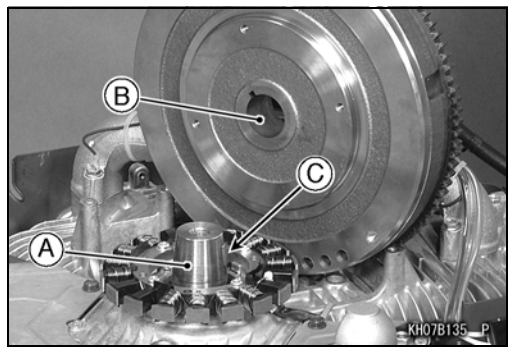
● Install the stator coil and tighten the screws.

**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]

● Fit the Woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.

● Install the flywheel.

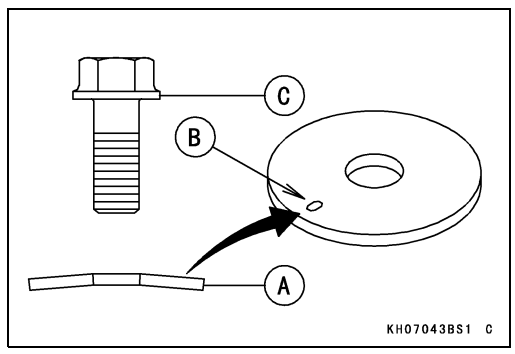



● Put the washer [A] as shown so that the “0” mark [B] faces up.

● Tighten:

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

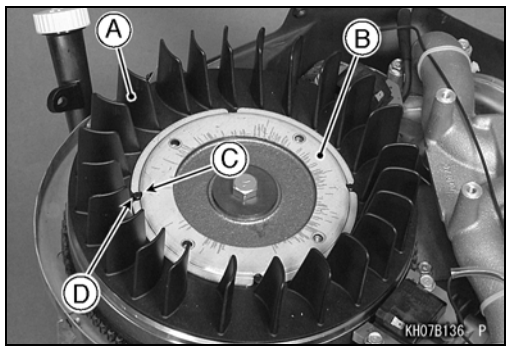
● Install the ignition coils (see Ignition Coil Installation).



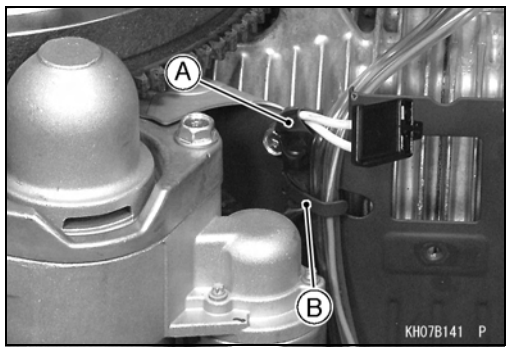
## Charging System

- Install the cooling fan [A].
- Install the plate [B] so that the slits [C] fit to the bosses [D] on the fan.
- Tighten:

**Torque - Cooling Fan Plate Mounting Stud Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**




- Run the stator coil lead [A] into the engine shroud clamp [B] as shown.




- Install the fan housing.
- Tighten:

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

- Install the screen and guard.
- Tighten:

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

### *Charging System Operational Inspection*

- Check the battery condition.

**NOTE**

○*Always check the battery condition before judging other parts of the charging system. The battery must be fully charged for accurate charging system tests.*

- Warm up the engine to bring the components up to their normal operating temperatures.
- Measure regulated output voltage at various engine speeds.

○Connect a voltmeter across the battery terminals.

★The readings should show nearly battery voltage when the engine speed is low, and as the engine speed rises, the readings should also rise. But they must stay within the specified range.

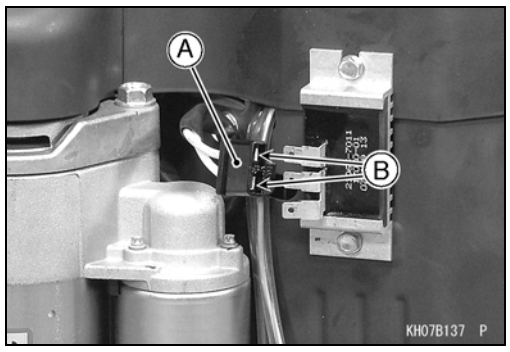
★If the output voltage is much higher than the specification, the regulator is defective, or the regulator leads are loose or open.

★If the output voltage dose not rise as the engine speed increase, the regulator is defective or the alternator output is insufficient for the loads.

**Regulated Output Voltage**
**Battery Voltage to 15 V DC**

## Charging System

### *Stator Coil Resistance*




- Disconnect the connector [A].
- Measure the stator coil resistance.

(Electric Starter Model)

○Connect an ohmmeter between stator pins [B].

**Stator Coil Resistance**
**0.01 to 0.1 Ω**

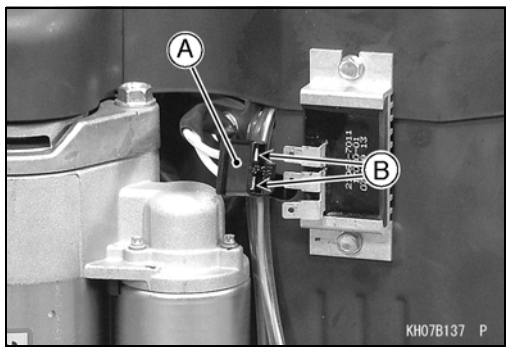
★If the measured value is not within the specification, replace the stator coil with a new one.

★If the coil has normal resistance, but the voltage inspection shows the alternator to be defective; the flywheel magnets have probably weakened, and the flywheel must be replaced.

- 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.

### *Unregulated Stator Output*

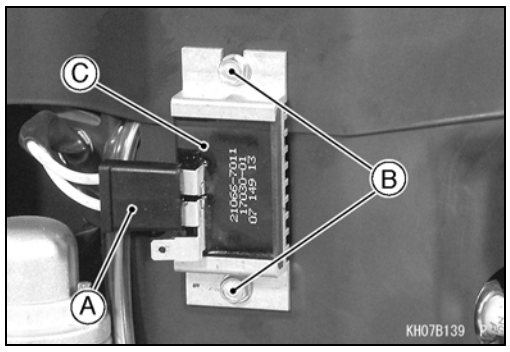



- Disconnect the connector [A].
- Connect AC voltmeter to the stator pins [B].
- Start the engine. Run the engine at the 3 000 rpm speed.
- Voltage reading should be minimum 26 V AC/3 000 rpm.

★If the AC voltage reading is less than the specification, replace the stator with a new one.

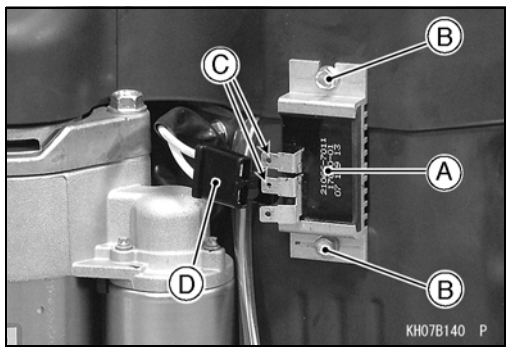
**Unregulated Stator Output (MIN)**
**26 V AC/3 000 rpm**

### *Regulator Removal*




- Remove:
  Stator Coil Lead Connector [A]
  Regulator Bolts [B]
  Regulator [C]

### *Regulator Installation*




- Install the regulator [A].
- Tighten:

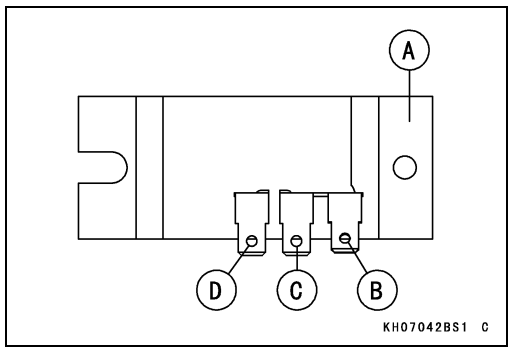
**Torque - Regulator Bolts [B]: 1.8 N·m (0.18 kgf·m, 16 in·lb)**

- Apply grease (Three Bond: TB2585G) to the regulator terminals [C].
- Connect the stator coil lead connector [D].

## Charging System

### *Regulator Resistance*

- Remove the regulator (see Regulator Removal).
- Set the KAWASAKI Hand Tester selector switch to the R × 100 Ω position.
- Connect the test leads to the points shown on the chart and read the resistance.




**(Without Charging Monitor Type …3 Blades)**

| + / – | A | B | C | D |
|---|---|---|---|---|
| A | – | ∞ | ∞ | ∞ |
| B | ∞ | – | 0 | ∞ |
| C | ∞ | 0 | – | ∞ |
| D | over than 1 MΩ | over than 1 MΩ | over than 1 MΩ | – |

**NOTE**

○*Resistance value may vary with individual meters.*

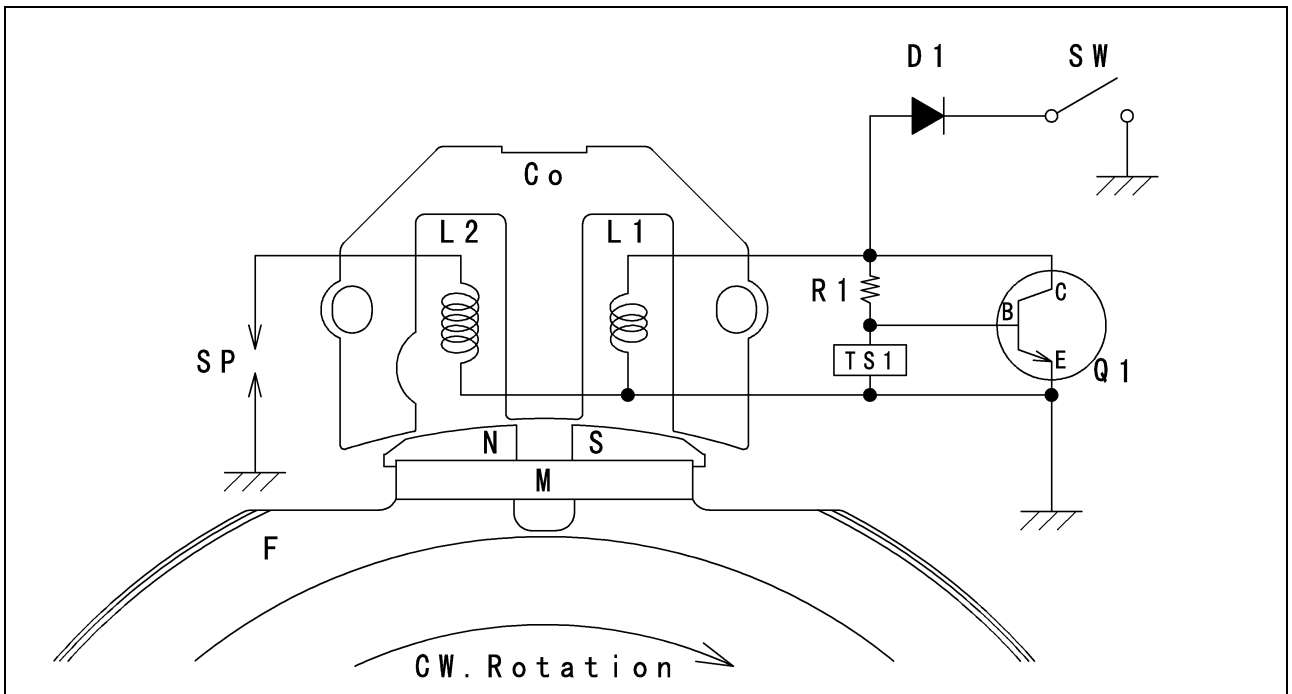
★If the resistance is not as specified, replace the regulator with a new one.

## Ignition System

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

The system consists of the following:

Inductive Ignition Assemblies
Permanent Magnet Flywheel
Spark Plugs
Stop Switch




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

**Ignition System Operation Theory**

Permanent magnets are mounted around the edge area of a flywheel. As the flywheel (magnetic pole) rotates clockwise and passes the ignition module on a laminated core group, voltage is produced at the primary winding (L1), allowing a small bias current to flow from the control resister (R1) to the transistor (Q1) base and thereby exciting the transistor base. Thus the transistor forms (turns ON) the primary circuit. This circuit current flows from the plus (+) side of the primary winding to ground through the transistor [Collector (C) to Emitter (E)].

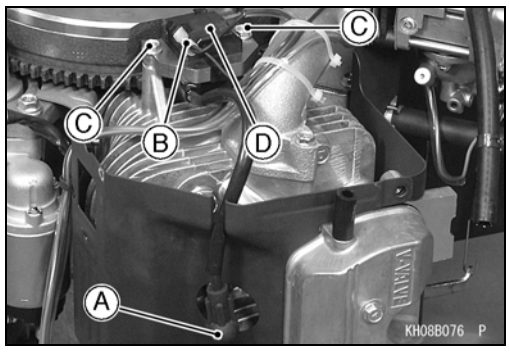
When the base current is flowing, the trigger sensor (TS1) detects optimum time (peak current) to shut off the transistor base current. With the transistor rapidly shutting off the current at the primary coil, counter-electromotive force is generated and voltage in hundreds-volts is induced through the primary winding (L1), thereby producing extremely high voltage at the secondary winding (L2). When this secondary voltage steps up to k-volts, “ionization” meaning “ignition” occurs across the electrodes at the spark plug (SP).

The trigger sensor located internally in the ignition system is set to give constant ignition timing according to engine speed and temperature.

The diode (D1) located at the ignition shut-off circuit prevents misconnection of battery voltage, protecting the internal components of the ignition system. When the stop switch (SW) is set at the closed position, primary voltage is routed to ground, not allowing igniting operation.

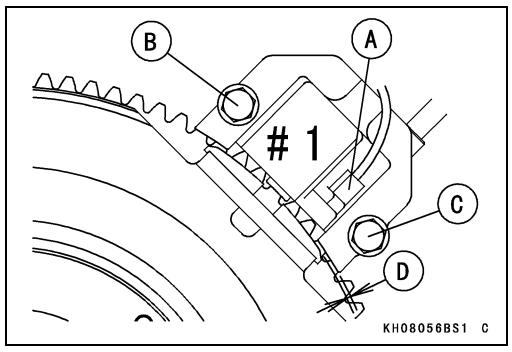
## Ignition System

### *Ignition Coil Removal*




- Remove:
  Fan Housing (see Flywheel and Stator Coil Removal)
  Spark Plug Cap [A]
  Stop Switch Lead Connector [B]
  Bolts [C]
  Ignition Coil [D]

### *Ignition Coil Installation*



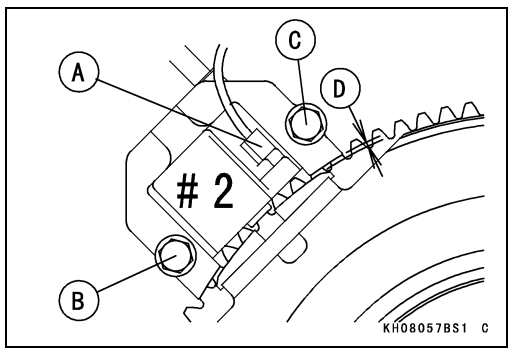

- Install the ignition coil on the crankcase so that the stop switch lead connector [A] face the upward, and tighten the bolt [B] first, then tighten the another bolt [C]. While tightening bolts, adjust the air gap [D] between the three legs of ignition coil and the two pole-plates of magnet to the specified gap value as shown.

**Ignition Coil Air Gap**
**Standard: 0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)**

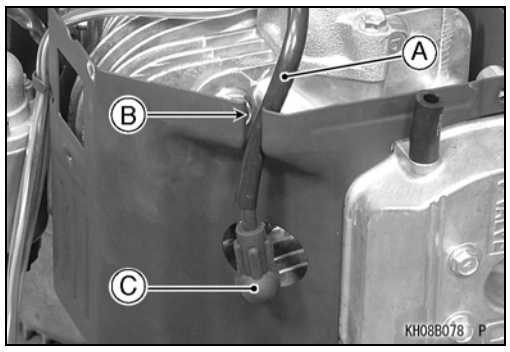
**Torque - Ignition Coil Bolts: 6.9 N·m (0.70 kgf·m, 61 in·lb)**

**NOTE**

○*Use the above procedure to insure proper coil air gap.*

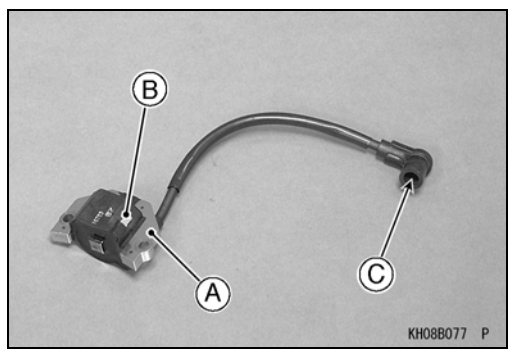



- Fit the ignition coil leads [A] to the each engine shroud groove [B].
- Install the spark plug cap [C].



## Ignition System

### *Ignition Coil Inspection*




- Remove the ignition coils (see Ignition Coil Removal).
- Measure the winding resistance as follows:

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

**Special Tool - Hand Tester: 57001-1394**

○Measure the ignition coil winding resistance as shown in the table.

**Ignition Coil Winding Resistance**

| + / – | A | B | C |
|---|---|---|---|
| A | – | 3 ~ 13 kΩ | 10 ~ 20 kΩ |
| B | ∞ | – | ∞ |
| C | 10 ~ 20 kΩ | 18 ~ 28 kΩ | – |

**CAUTION**

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

★If the tester does not read as specified, replace the coil with a new one.

### *Spark Plug Cleaning and Inspection*

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

### *Spark Plug Gap Inspection*

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

# Troubleshooting

## Table of Contents

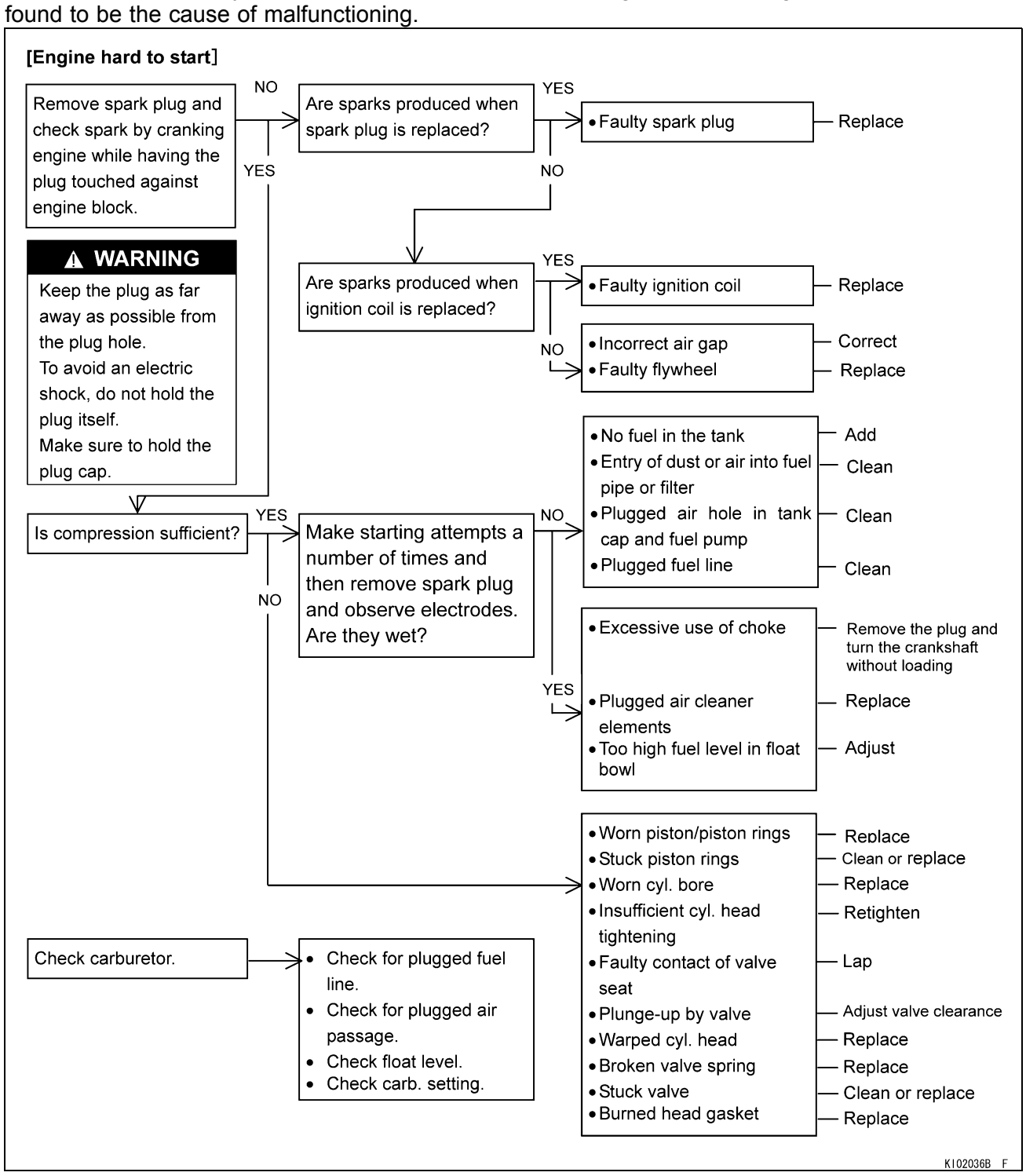
# 10-2 TROUBLESHOOTING

## Engine Troubleshooting Guide

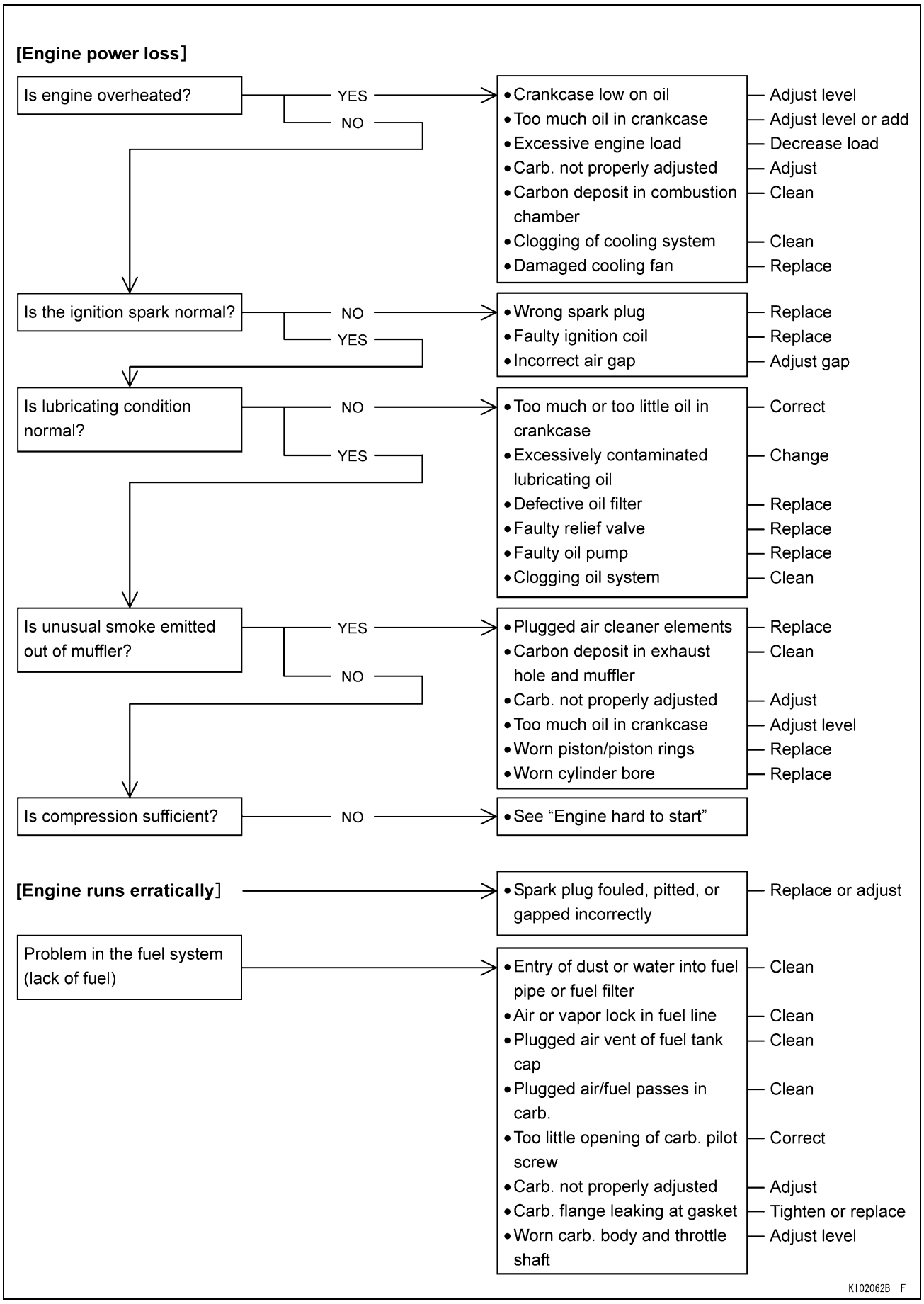
If the engine malfunctions, check if the way the engine is used is correct. If the engine malfunctions even if the engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

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

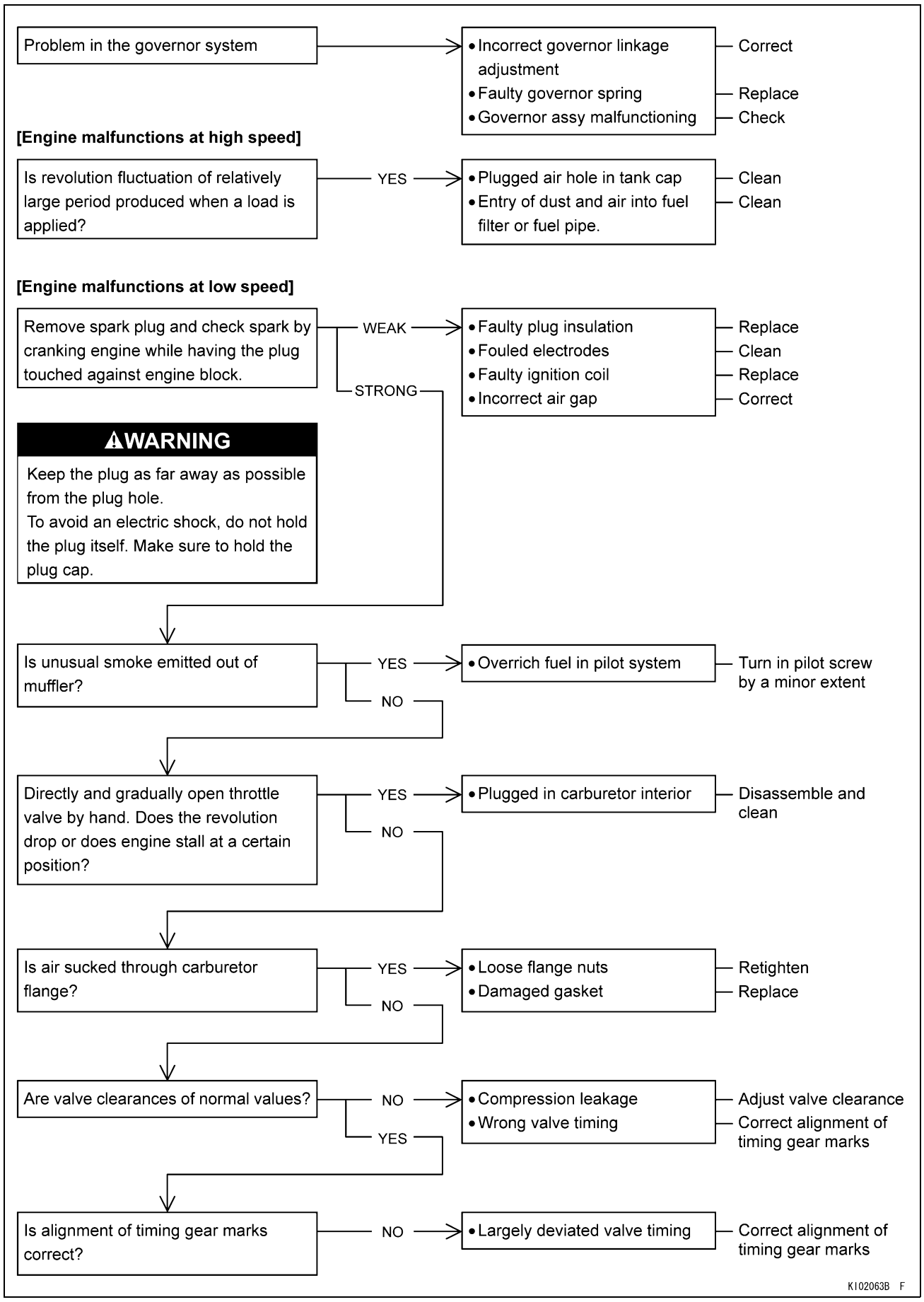


## Engine Troubleshooting Guide

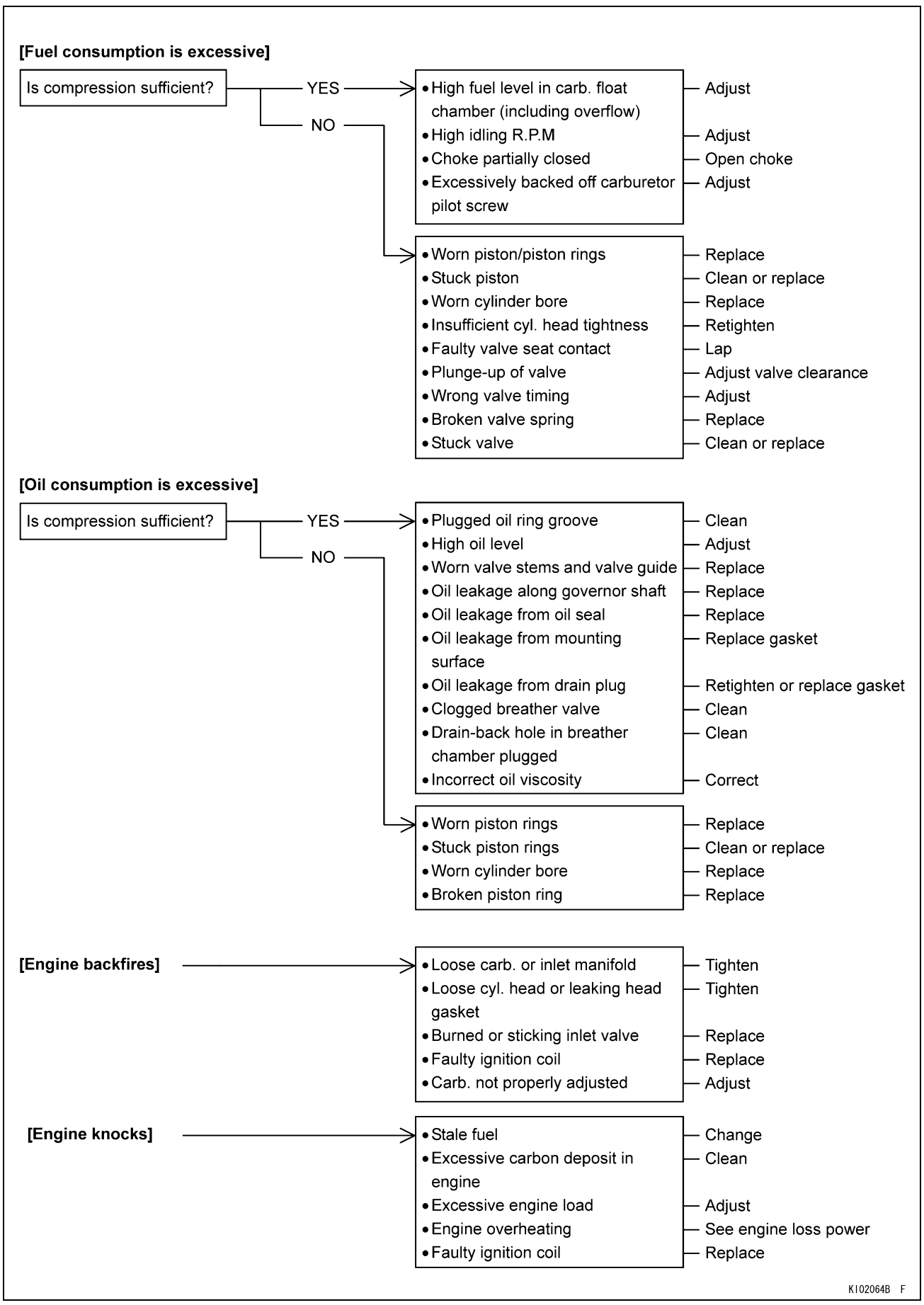


# 10-4 TROUBLESHOOTING

## Engine Troubleshooting Guide



## Engine Troubleshooting Guide



# 10-6 TROUBLESHOOTING

## Starter Motor Troubleshooting Guide

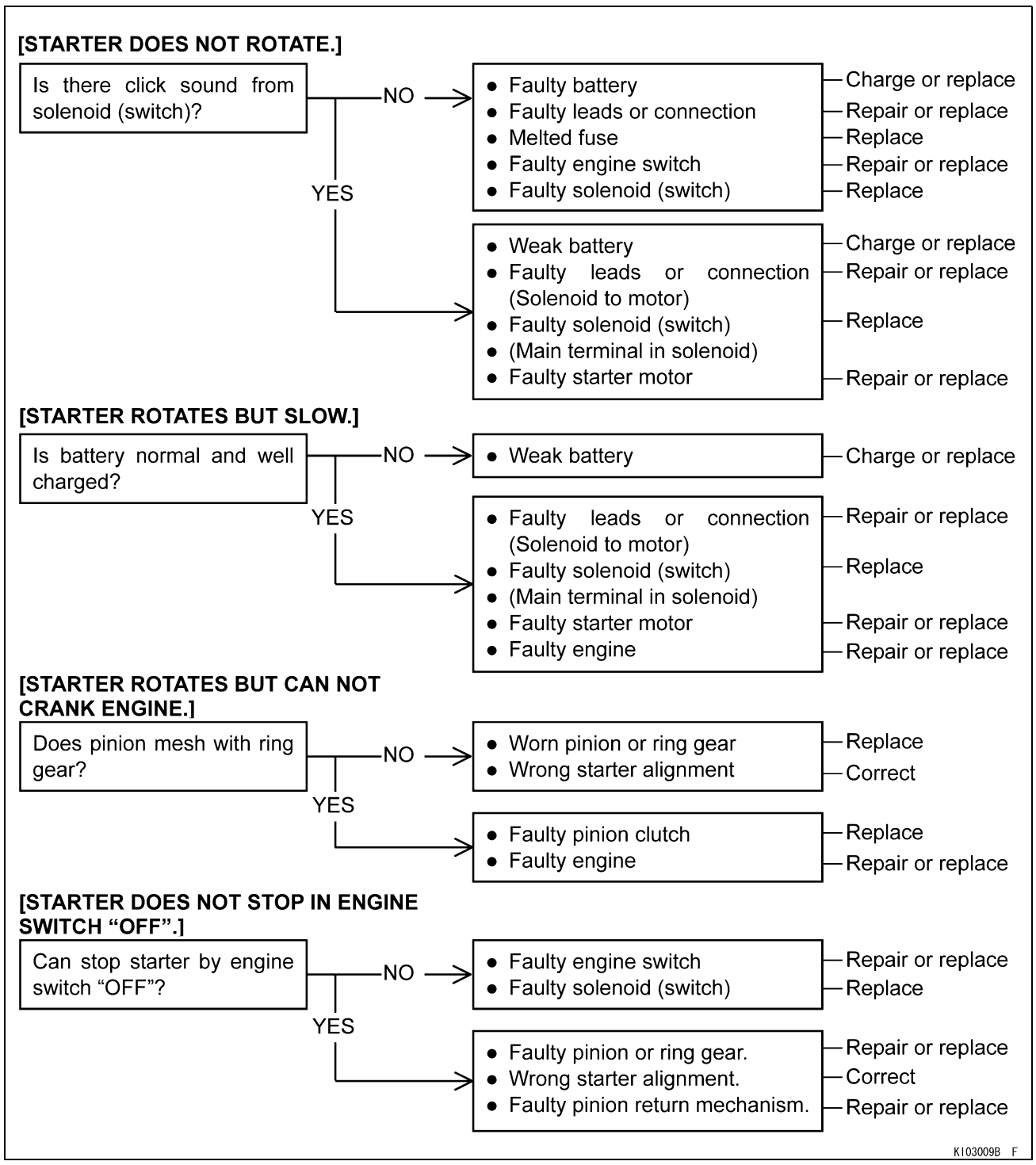
1. Disconnect the spark plug caps from the spark plugs.
2. Turn engine switch to “start” position and check condition.

**⚠ 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 (–) cable from battery as soon as possible.**



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