Kawasaki

ENGINES

SERVICE MANUAL

4-STROKE AIR-COOLED V-TWIN GASOLINE ENGINE

FT651V
FT691V
FT730V

P/N 99830-0035-03

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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4-Stroke Air-Cooled V-Twin Gasoline Engine

Service Manual

3rd Edition (0):Nov. 15, 2019

LIST OF ABBREVIATIONS

A	ampere(s)	HTIS	hand throttle input sensor
ABDC	after bottom dead center	in.	inch(es)
AC	alternating current	L	liter(s)
ATDC	after top dead center	lb	pound(s)
BBDC	before bottom dead center	m	meter(s)
BDC	bottom dead center	MIL	malfunction indicator light
BTDC	before top dead center	min	minute(s)
°C	degree(s) Celsius	N	newton(s)
CAN	controller area network	Pa	pascal(s)
CHTS	cylinder head temperature sensor	PS	horsepower
CPS	crankshaft position sensor	psi	pound(s) per square inch
DC	direct current	PTO	power take-off
DTC	diagnostic trouble code	r	revolution
EFI	electric fuel injection	rpm	revolution(s) per minute
ECU	electronic control unit	SPN	suspect parameter number
F	farad(s)	TDC	top dead center
°F	degree(s) Fahrenheit	TIR	total indicator reading
FMI	failure mode identifier	TPS	throttle position sensor
ft	foot, feet	V	volt(s)
g	gram(s)	W	watt(s)
h	hour(s)	Ω	ohm(s)

Color Codes:

BK:	Black	O:	Orange
BL:	Blue	P:	Pink
BR:	Brown	PU:	Purple
CH:	Chocolate	R:	Red
DG:	Dark Green	V:	Violet
G:	Green	W:	White
GY:	Gray	Y:	Yellow
LB:	Light Blue		
LG:	Light Green		

EMISSION CONTROL INFORMATION

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

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 fuel injection system and an ignition system having optimum ignition timing characteristics.

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

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

Federal law prohibit the following acts or the causing there of: (1) the removal or rendering inoperative by any person other than for purpose 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, do not tamper with the original emission related parts below:

- 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
- Intake pipe and tube

Foreword

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

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

To get the longest life out of your engine:

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

How to Use This Manual

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

For, example, if you want ignition coil information, use the Quick Reference Guide to locate the Electrical System chapter. Then, use the Table of Contents on the first page of the chapter to find the Ignition Coil section.

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

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

NOTICE

NOTICE is used to address practices not related to personal injury.

This manual contains four more symbols which will help you distinguish different types of information.

NOTE

○*NOTE indicates information that may help or guide you in the operation or service of the vehicle.*

- 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 NOTE.

★Indicates a conditional step or what action to take based on the results of the test or inspection in the procedural step or sub-step it follows.

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

General Information

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1-2 GENERAL INFORMATION

Before Servicing

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

Especially note the following

(1) Dirt

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

(2) Battery Ground

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

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

(3) Tightening Sequence

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

(4) Torque

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

(5) Force

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

(6) Edges

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

(7) High-Flash Point Solvent

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

(8) Gasket, O-ring

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

(9) Liquid Gasket, Non-Permanent Locking Agent

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

(10) Press

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

(11) Ball Bearing, Needle Bearing

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

Before Servicing

(12)Oil Seal and Grease Seal

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

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

(13)Seal Guide

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

(14)Circlip, Retaining Ring and Cotter Pin

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

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

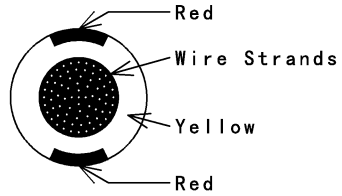
(15)Lubrication

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

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

(16)Electrical Wires

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

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

GBO20601W1 C

(17)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.

(18)Inspection

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

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

(19)Service Data

Service Data terms are defined as follows:

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

Before Servicing

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

Model Identification

Cylinder Number Designation:

No.1 Cylinder is the left-hand cylinder viewed from the intake pipe.

No.2 Cylinder is the right-hand cylinder viewed from the intake pipe.

General Specifications

Item	FT730V
Type of Engine	Forced air-cooled, vertical shaft, OHV, 4-stroke gasoline engine
Cylinder Layout	90 V-Twin
Bore × Stroke	78 mm × 76 mm (3.1 in. × 3.0 in.)
Piston Displacement	726 cm³ (44.3 cu in.)
Direction of Rotation	Counterclockwise facing the PTO shaft
Compression Release	Automatic compression release
Low Idle Speed	1 550 r/min (rpm)
High Idle Speed	3 600 r/min (rpm)
Ignition System	Solid-state ignition
RFI	Per Canada and U.S.A. requirements
Starting System:	Electric starter
Charging System:	12 V - 15 amps with regulator
Spark Plug	NGK BPR4ES
Carburetor:	Float type, fixed main jet, single barrel
Fuel Pump	Diaphragm type pulse pump
Air Cleaner:	Single stage element, dry type
Governor	Flyweight all speed governor
Lubrication System	Pressure feed by positive displacement
Oil Filter	Cartridge type full flow filter
Oil Capacity:	
(when engine is completely dry)	2.2 L (2.3 US qt)
(when the oil filter is not removed)	1.8 L (1.9 US qt)
(when the oil filter is removed)	2.1 L (2.2 US qt)
Cooling System	Forced air cooling by fan
Dimensions (L × W × H):	505 mm × 457 mm × 418 mm (19.9 in. × 18.0 in. × 16.5 in.)
Dry Weight (without muffler):	43.8 kg (96.6 lbs)

Specifications are subject to change without notice.

Unit Conversion Table

Prefixes for Units:

Prefix	Symbol	Power
mega	M	× 1 000 000
kilo	k	× 1 000
centi	c	× 0.01
milli	m	× 0.001
micro	μ	× 0.000001

Units of Mass:

kg	×	2.205	=	lb
g	×	0.03527	=	oz

Units of Volume:

L	×	0.2642	=	gal (US)
L	×	0.2200	=	gal (IMP)
L	×	1.057	=	qt (US)
L	×	0.8799	=	qt (IMP)
L	×	2.113	=	pint (US)
L	×	1.816	=	pint (IMP)
mL	×	0.03381	=	oz (US)
mL	×	0.02816	=	oz (IMP)
mL	×	0.06102	=	cu in.

Units of Force:

N	×	0.1020	=	kg
N	×	0.2248	=	lb
kg	×	9.807	=	N
kg	×	2.205	=	lb

Units of Length:

km	×	0.6214	=	mile
m	×	3.281	=	ft
mm	×	0.03937	=	in.

Units of Torque:

N·m	×	0.1020	=	kgf·m
N·m	×	0.7376	=	ft·lb
N·m	×	8.851	=	in·lb
kgf·m	×	9.807	=	N·m
kgf·m	×	7.233	=	ft·lb
kgf·m	×	86.80	=	in·lb

Units of Pressure:

kPa	×	0.01020	=	kgf/cm²
kPa	×	0.1450	=	psi
kPa	×	0.7501	=	cmHg
kgf/cm²	×	98.07	=	kPa
kgf/cm²	×	14.22	=	psi
cmHg	×	1.333	=	kPa

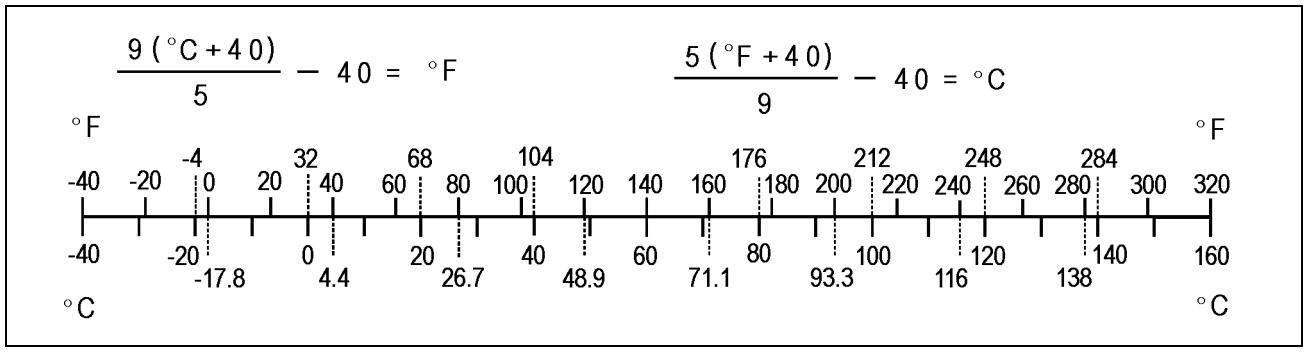
Units of Speed:

km/h	×	0.6214	=	mph

Units of Power:

kW	×	1.360	=	PS
kW	×	1.341	=	HP
PS	×	0.7355	=	kW
PS	×	0.9863	=	HP

Units of Temperature:



Periodic Maintenance

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2-2 PERIODIC MAINTENANCE

Periodic Maintenance Chart

⚠ WARNING

Prevent accidental starting during engine service by removing the spark plug caps.

NOTE

○*The service intervals can be used as a guide. Service more frequently as necessary by operating conditions.*

MAINTENANCE	INTERVAL					
	Daily	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 250 hr.	Every 300 hr.
Check and add engine oil.	●					
Check for loose or lost nuts and screws.	●					
Check for fuel and oil leakage.	●					
Check battery electrolyte level.	●					
♦ Check or clean air intake screen.	●					
♦ Check inspection ports and clean.		●				
♦ Clean air cleaner element.			●			
♦ ◊ Clean dust and dirt from cylinder and cylinder head fins.			●			
Tighten nuts and screws.			●			
Change engine oil.	Every 100 hours or 1 year whichever comes first					
Clean and regap spark plugs.			●			
Change oil filter.				●		
♦ Replace air cleaner element					●	
◊ Clean combustion chamber.						●
◊ Check and adjust valve clearance.						●
◊ Clean and lap valve seating surface.						●

♦: Service more frequently under dusty or dirty conditions.

◊: Service to be performed by an authorized Kawasaki engine dealer or equally qualified service facility

Torque and Locking Agent

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

Letters used in the “Remarks” column mean:

EO: Apply oil to the threads.

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

L1: Apply non-permanent locking agent (LOCTITE: VIBRASEAL 516 or equivalent)

Lh: Left-hand threads.

S: Tighten the fasteners following the specified sequence.

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Fuel System				
Caburetor and Intake Pipe Mounting Nuts	6.9	0.70	61 in·lb	
Intake Manifold Bolts	6.9	0.70	61 in·lb	S
Governor Shaft Plate Screws	2.2	0.22	19 in·lb	
Control Panel Mounting Bolts	6.9	0.70	61 in·lb	
Governor Arm Clamp Nut	9.9	1.01	88 in·lb	
Governor Arm Joint Bolt	6.9	0.70	61 in·lb	Lh
Main Jet	1.7	0.17	15 in·lb	
Solenoid Valve	4.4	0.45	39 in·lb	
Throttle Valve Screws	0.68	0.069	6 in·lb	L
Control Panel and Intake Pipe Mounting Bolt	6.9	0.70	61 in·lb	
Cooling System				
Fan Screen Bolts	6.9	0.70	61 in·lb	
Engine Shroud Bolts	9.8	1.0	87 in·lb	
Fan Housing Bolts	9.8	1.0	87 in·lb	
Cooling Fan Bolts	6.9	0.70	61 in·lb	
Oil Filler Mounting Bolt	9.8	1.0	87 in·lb	
Engine Top End				
Rocker Cover Bolts	9.0	0.92	80 in·lb	S
Cylinder Head Bolts (L = 65 mm)	44	4.5	32	S
Cylinder Head Bolts (L = 50 mm)	44	4.5	32	S
Rocker Arm Bracket Bolts	21	2.1	15	L
Valve Clearance Adjusting LockNuts	9.5	0.97	84 in·lb	
Spark Plugs	23	2.3	17	
Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	EO
Lubrication System				
Oil Filter Pipe	27	2.8	20	
Oil Pump Cover Plate Bolts	6.9	0.70	61 in·lb	
Oil Filter	5.8	0.59	51 in·lb	R
Engine Oil Drain Plug	7.9	0.81	70 in·lb	G
Oil Filler Mounting Bolt	9.8	1.0	87 in·lb	
Camshaft/Crankshaft				
Crankcase Cover Bolts	25	2.5	18	S
Crankcase Cover Oil Passage Plug (PT 1/8)	3.9	0.40	35 in·lb	L1
Breather Chamber Cover Bolts	6.9	0.70	61 in·lb	
Breather Valve Mounting Screw	2.2	0.22	19 in·lb	

Torque and Locking Agent

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Crankcase Oil Passage Plug (PT 1/8)	3.9	0.40	35 in·lb	L1
Crankcase Cover Oil Passage Plug (PT 1/16)	3.9	0.40	35 in·lb	L1
Crankcase Cover Oil Passage Plug (PT 1/8)	3.9	0.40	35 in·lb	L1
Crankcase Cover Oil Passage Plug (PT 1/4)	5.2	0.53	46 in·lb	L
Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	EO
Starter System				
Starter Motor Mounting Bolts	19.6	2.00	14.5	
Starter Motor Through Bolts	4.0	0.41	35 in·lb	
Electrical System				
Ignition Coil Bolts	6.9	0.70	61 in·lb	
Stator Coil Screws	3.7	0.38	33 in·lb	S
Flywheel Bolt	57	5.8	42	
Spark Plugs	23	2.3	17	

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

Basic Torque for General Fasteners

Threads Diameter (mm)	Torque		
	N·m	kgf·m	ft·lb
4	2.0	0.20	17 in·lb
5	3.4	0.35	30 in·lb
6	5.9	0.60	52 in·lb
8	15	1.5	11
10	20	2.0	15

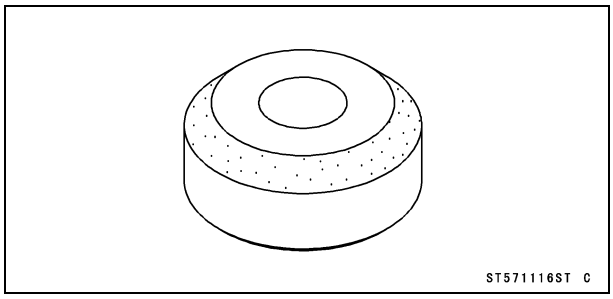
Specifications

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:	Single stage element, dry type
Engine Top End	
Valve Clearance:	
Intake, Exhaust	0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake	1.2 ~ 1.8 mm (0.047 ~ 0.071 in.)
Exhaust	0.8 ~ 1.6 mm (0.031 ~ 0.063 in.)
Lubrication System	
Engine Oil:	
Type	API SJ or SL class
Viscosity	SAE 40, SAE 30, SAE 20W-50, SAE 10W-30/SAE 10W-40, or SAE 5W-20
Capacity	1.8 L (1.9 US qt) (When the oil filter is not removed)
	2.1 L (2.2 US qt) (When the oil filter is removed)
Level	Operating range (dimpled area (ADD and FULL)) on dipstick
Electrical System	
Spark Plug	NGK BPR4ES
Spark Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

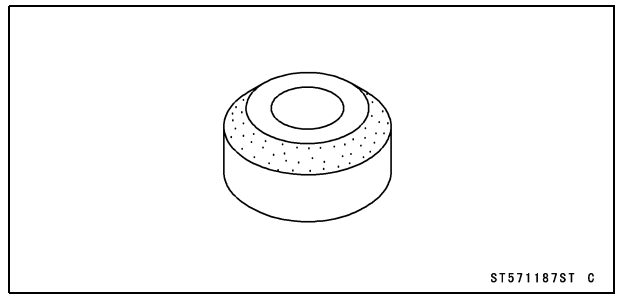
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

Special Tools

Valve Seat Cutter, 45° - ϕ35:
57001-1116



Valve Seat Cutter, 45° - ϕ30:
57001-1187



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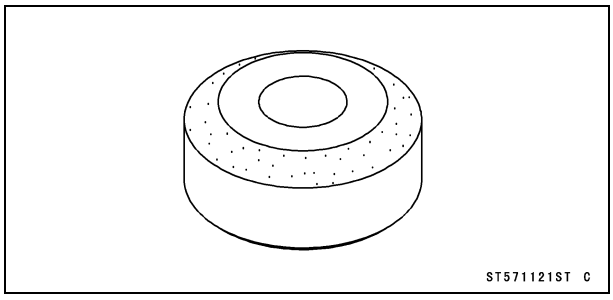
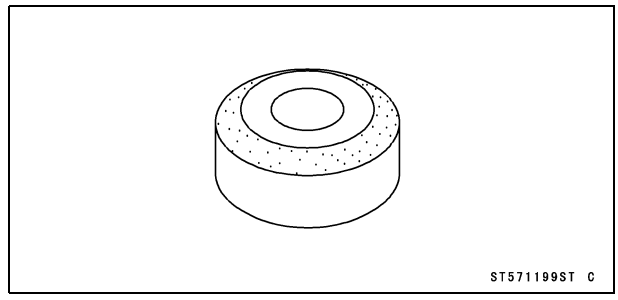
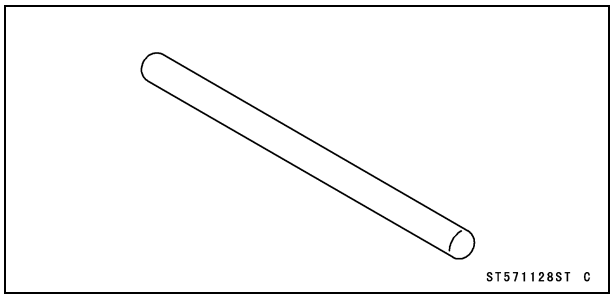
57001-1121



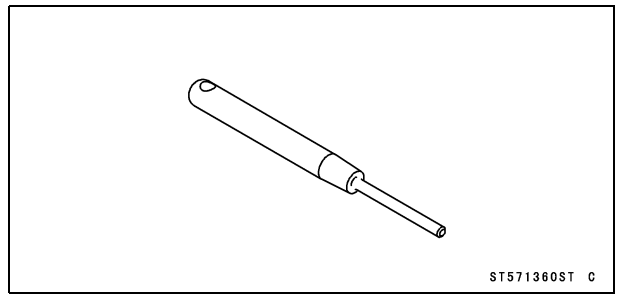
Valve Seat Cutter, 32° - ϕ33:
57001-1199



Valve Seat Cutter Holder Bar:
57001-1128



Valve Seat Cutter Holder, ϕ6:
57001-1360



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

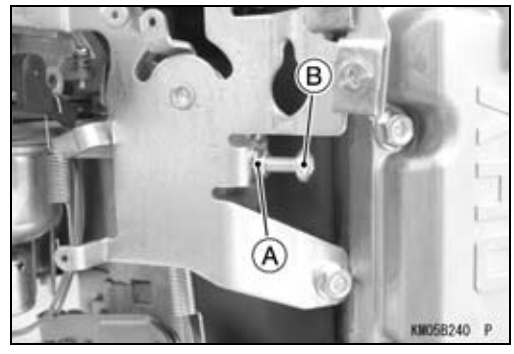
- Disconnect all possible external loads from the engine.
- Start the engine and warm it up thoroughly.

⚠ WARNING

Moving parts can cause severe injury. 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 r/min (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 r/min (rpm)

- Tighten the locknut.

High Idle Speed Adjustment

NOTE

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

NOTICE

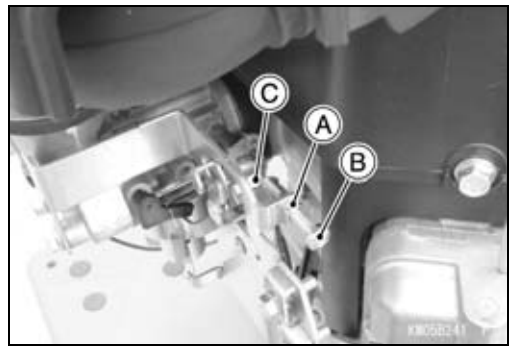
Do not adjust high idle speed with the air cleaner removed.

- Start and warm up the engine thoroughly.

Periodic Maintenance Procedures

⚠ WARNING

Moving parts can cause severe injury. 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 r/min (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.

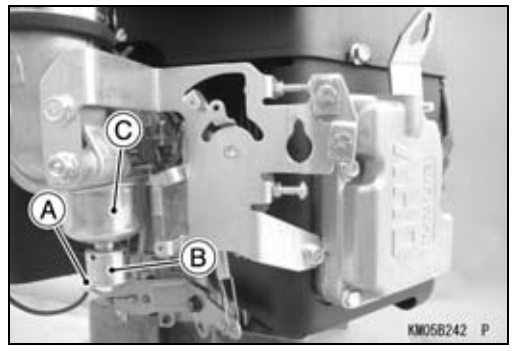
NOTICE

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.

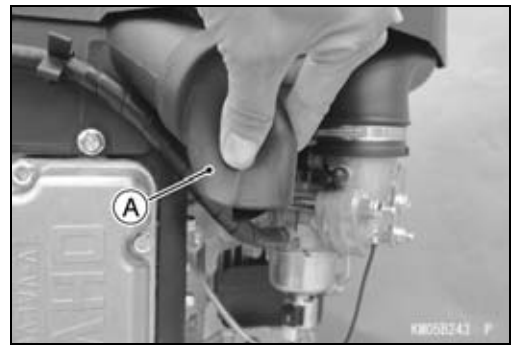


- Place a suitable container under the carburetor.
- Remove:
  Solenoid Valve Connector [A]
  Solenoid Valve [B]
  Float Chamber [C] and Gasket
- Check if water or dirt has accumulated in the carburetor.
- Install the removed parts.

★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 (see Fuel Filter Inspection in the Fuel System chapter).

Periodic Maintenance Procedures

Air Cleaner Draining



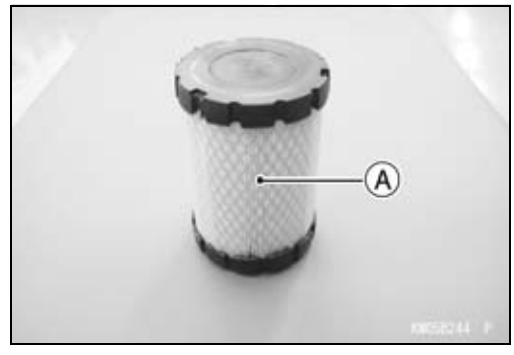
- Push the cap [A] to drain any water or oil accumulates inside the cap.

Element Cleaning and Inspection

Air cleaner element is not recommended to be cleaned, and air cleaner element should be replaced with a new one at the maintenance time as shown in the maintenance chart.

NOTE

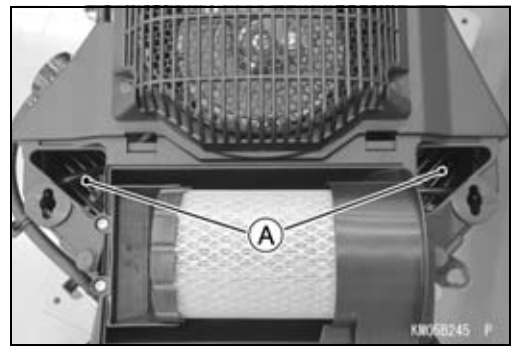
○*Operating in dusty condition may require more frequent maintenance than above.*



- Remove the element (see Air Cleaner Element Removal in the Fuel System chapter).
- Clean the paper element [A] by tapping it gently on a flat surface to remove dust. If the element is very dirty, replace it with a new one.

NOTICE
Do not wash air cleaner element. Do not apply oil to the air cleaner element. Do not use pressurized air to clean air cleaner element.

Engine Cooling System Cleaning

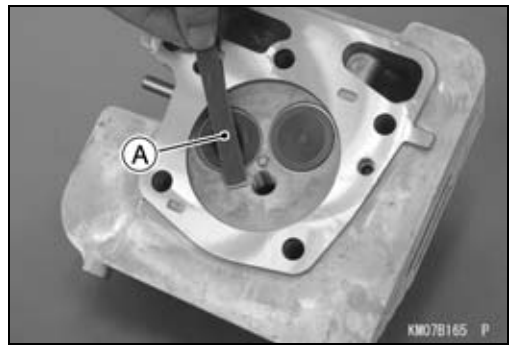


- Remove the air cleaner cover (see Air Cleaner Element Removal in the Fuel System chapter).
- Viewed from the openings [A], check to see if a dust or debris has accumulated on the cylinders or cylinder heads.
- Clean dirt off the outside fins with a compressed air from the opening.
- Install the air cleaner cover (see Air Cleaner Element Installation in the Fuel System chapter).

Periodic Maintenance Procedures

Engine Top End

Cylinder Head Cleaning



- Remove the cylinder head assembly (see Cylinder Head Assembly Removal in the Engine Top End chapter).
- Scrape the carbon deposits from the cylinder head and the exhaust port with a suitable tool [A].

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

- Clean the head in a bath of high flash-point solvent and dry it with compressed air.

⚠ WARNING

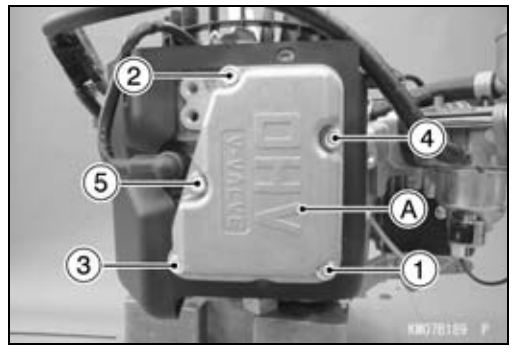
Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the cylinder head in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low flash-point solvent to clean the cylinder head.

Valve Clearance Inspection

NOTE

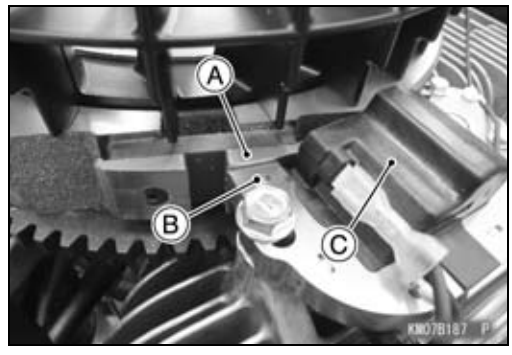
○*Valve clearance must be checked when the engine is cold (at room temperature).*

- Remove:
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)



- Unscrew the rocker cover bolts in the order shown [1 ~ 5].
- Remove the rocker cover [A] and the gasket.
- Place the piston at the top dead center (TDC) of the compression stroke by turning the flywheel clockwise.

#1 Cylinder



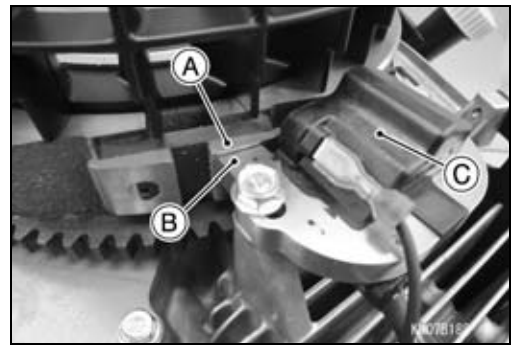
○The left projection [A] on the flywheel is faced with the right leg [B] on the #1 ignition coil [C] as shown in the figure.

○Check the intake and exhaust valves are closed completely, if not, turn the flywheel one turn (360°) clockwise and face the left projection with the right leg again.

Periodic Maintenance Procedures

#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.

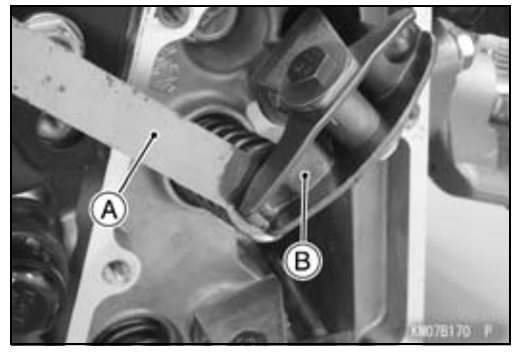


● Then check the valve clearance.

○Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.

★If the valve clearance is incorrect, adjust it.

Valve Clearance
Intake, Exhaust: 0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)



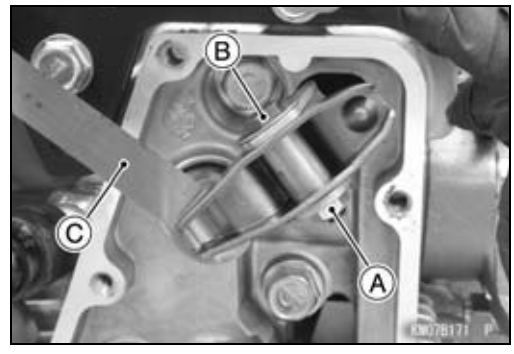
Valve Clearance Adjustment

● 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 0.12 mm (0.005 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
Intake, Exhaust: 0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)

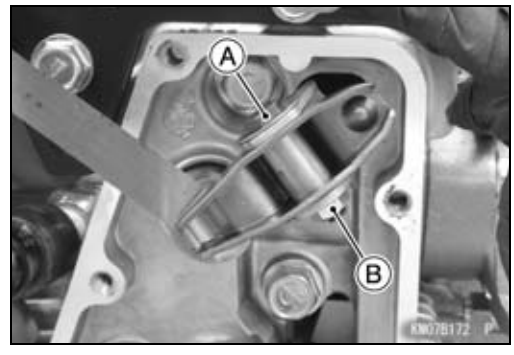


● Holding the adjusting bolt [A] with a suitable tool, tighten the adjusting locknut [B] to the specified torque.

Torque - Valve Clearance Adjusting Locknuts: 9.5 N·m (0.97 kgf·m, 84 in·lb)

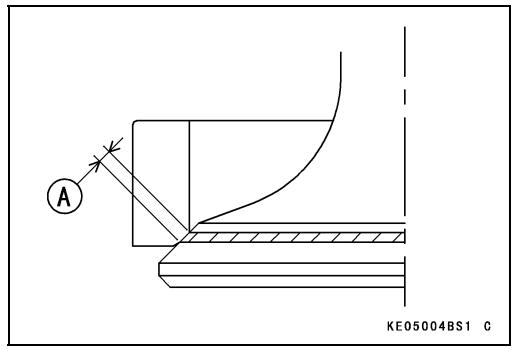
● Do not overtighten the valve clearance adjusting locknuts.

● After the valve clearance adjustment, measure the valve clearance again. Readjust the valve clearance if necessary.



Periodic Maintenance Procedures

Valve Seat Inspection



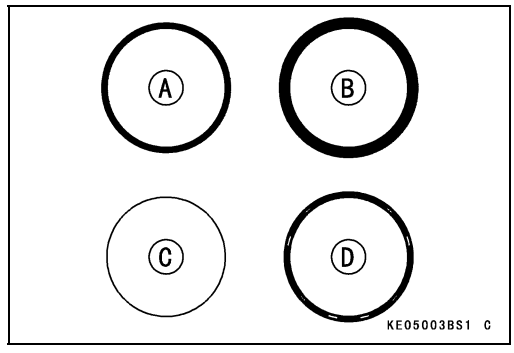
- Remove the valve (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
- Inspect the valve seats for damage.

★If the seats are warped or distorted beyond reconditioning, replace the cylinder head 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 (Standard)

Intake	**1.2 ~ 1.8 mm (0.047 ~ 0.071 in.)**
Exhaust	**0.8 ~ 1.6 mm (0.031 ~ 0.063 in.)**

Valve Seat Repair

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

Special Tools - Valve Seat Cutter Holder Bar: 57001-1128
Valve Seat Cutter Holder, ϕ6: 57001-1360

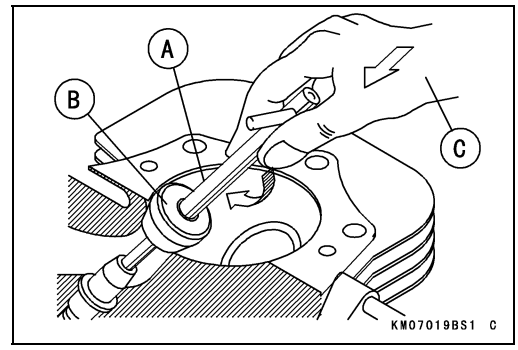
Intake Valve
Valve Seat Cutter, 45° - ϕ35: 57001-1116
Valve Seat Cutter, 32° - ϕ35: 57001-1121

Exhaust Valve
Valve Seat Cutter, 45° - ϕ30: 57001-1187
Valve Seat Cutter, 32° - ϕ33: 57001-1199

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

Periodic Maintenance Procedures

Seat Cutter Operating Cares



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

NOTE

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

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

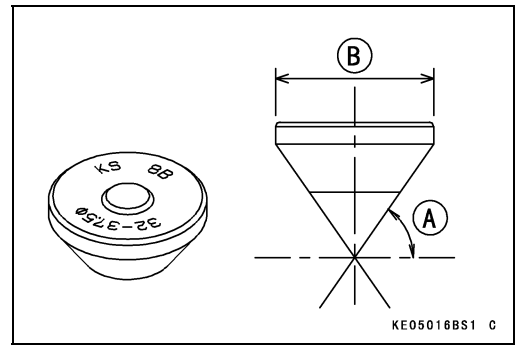
NOTE

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

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

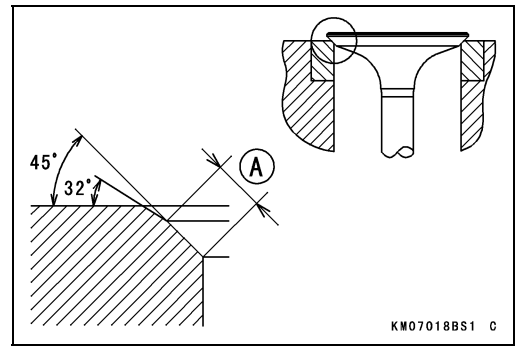
Marks Stamped on the Cutter

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



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

Operating Procedures



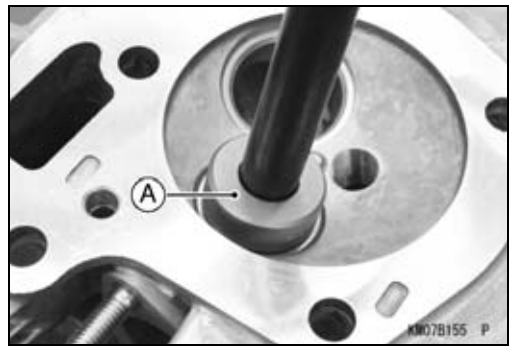
- Clean the seat area carefully.
- Recondition the valve seats with the valve seat cutters (45°, 32°) and lap the valves.
- Check the seats for good contact all the way around with machinist's dye.
- Measure the seat width [A]. If it is more than the standard width, the seating surface should be refaced.

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

Periodic Maintenance Procedures

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

○Resurface the valve seat with a 45° cutter, removing only enough material to produce a smooth and concentric seat.

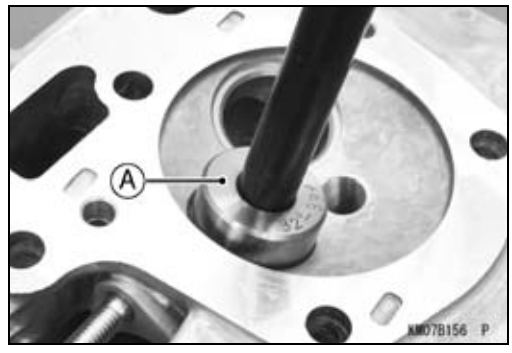


NOTICE

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 standard width.

○Turn the seat cutter one turn at a time while pressing down very lightly. Check the seat width after each turn.



NOTICE

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

NOTE

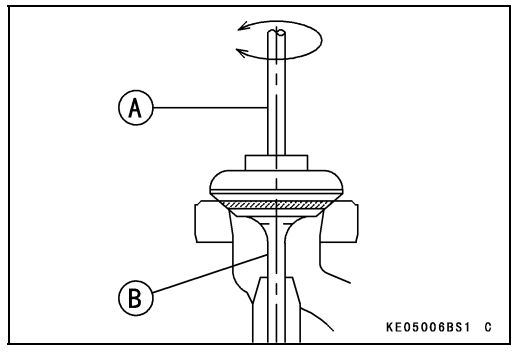
○*Keep the seat width as close as possible to the standard width.*

- 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.

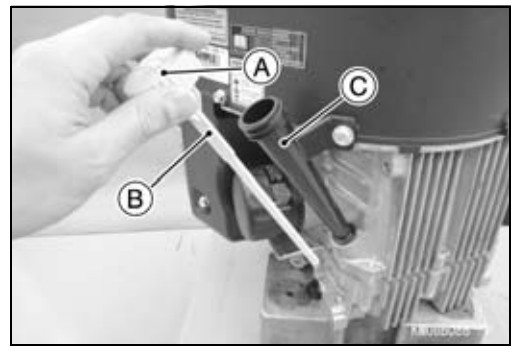
- Coat the face of valve sparingly with a fine lapping compound.
- Use the lapping tool [A], to grip top of the valve [B]. Rotate the valve in a circular motion to lap the valve to the seat.
- Lift the valve slightly from the seat every 8 to 10 strokes, continue lapping operation until a uniform ring appears around entire surface of the valve face.



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

Lubrication System

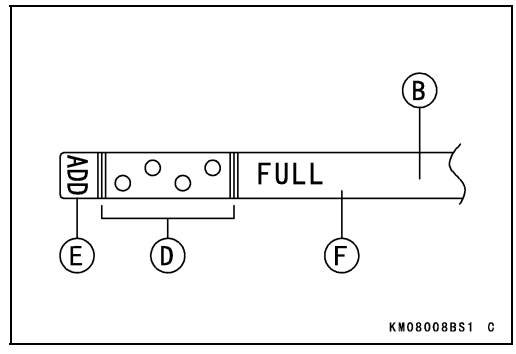
Engine Oil Level Inspection



- 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 screw it in, then check the oil level.
- The oil level should be the operating range (dimpled area) [D] on the dipstick.

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

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



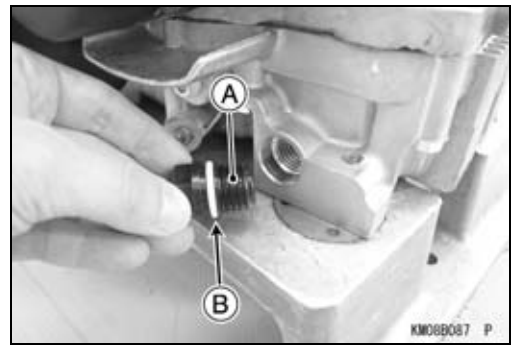
○Use the same type and make of oil that is already in the engine.

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 [F], drain the excess oil by loosening the drain plug.

Engine Oil Change



- 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
Hot oil can cause severe burns. Use caution when draining oil from a hot engine.

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

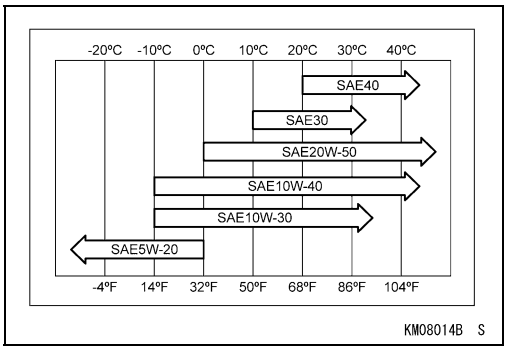
Torque - Engine Oil Drain Plug: 7.9 N·m (0.81 kgf·m, 70 in·lb)

Periodic Maintenance Procedures

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

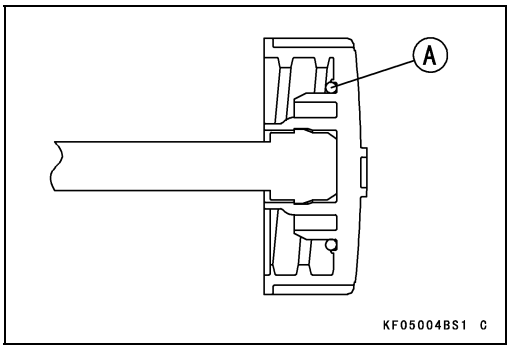
Engine Oil:

Grade:	**API SJ or SL Class**
Viscosity:	**SAE40, SAE30, SAE20W-50, SAE10W-30/SAE10W-40, or SAE5W-20**
Capacity:	**[When the oil filter is not removed]**
	1.8 L (1.9 US qt)
	[When the oil filter is removed]
	2.1 L (2.2 US qt)



● Check the O-ring [A] on the oil filler cap for damage. Replace the oil filler cap assembly 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).

● Using a suitable tool, remove the oil filter.

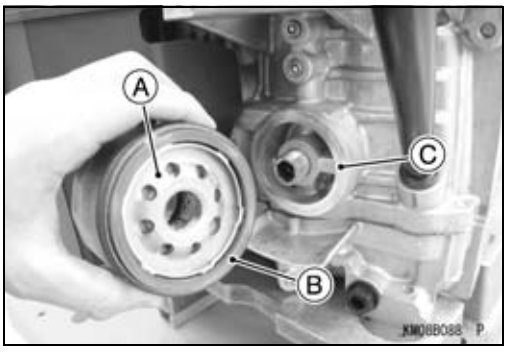
○When unscrew the oil filter, place a suitable container beneath the oil drip tray to receive oil from the oil filter and oil passages in the engine.

● 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 Filter: 5.8 N·m (0.59 kgf·m, 51 in·lb)



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

● Fill the engine oil.

● Run the engine at slow idle speed 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).

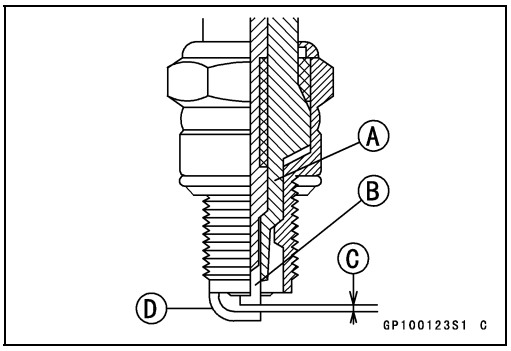
Electrical System

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 nonmetal brush (nylon etc.).

★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]

Periodic Maintenance Procedures

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.

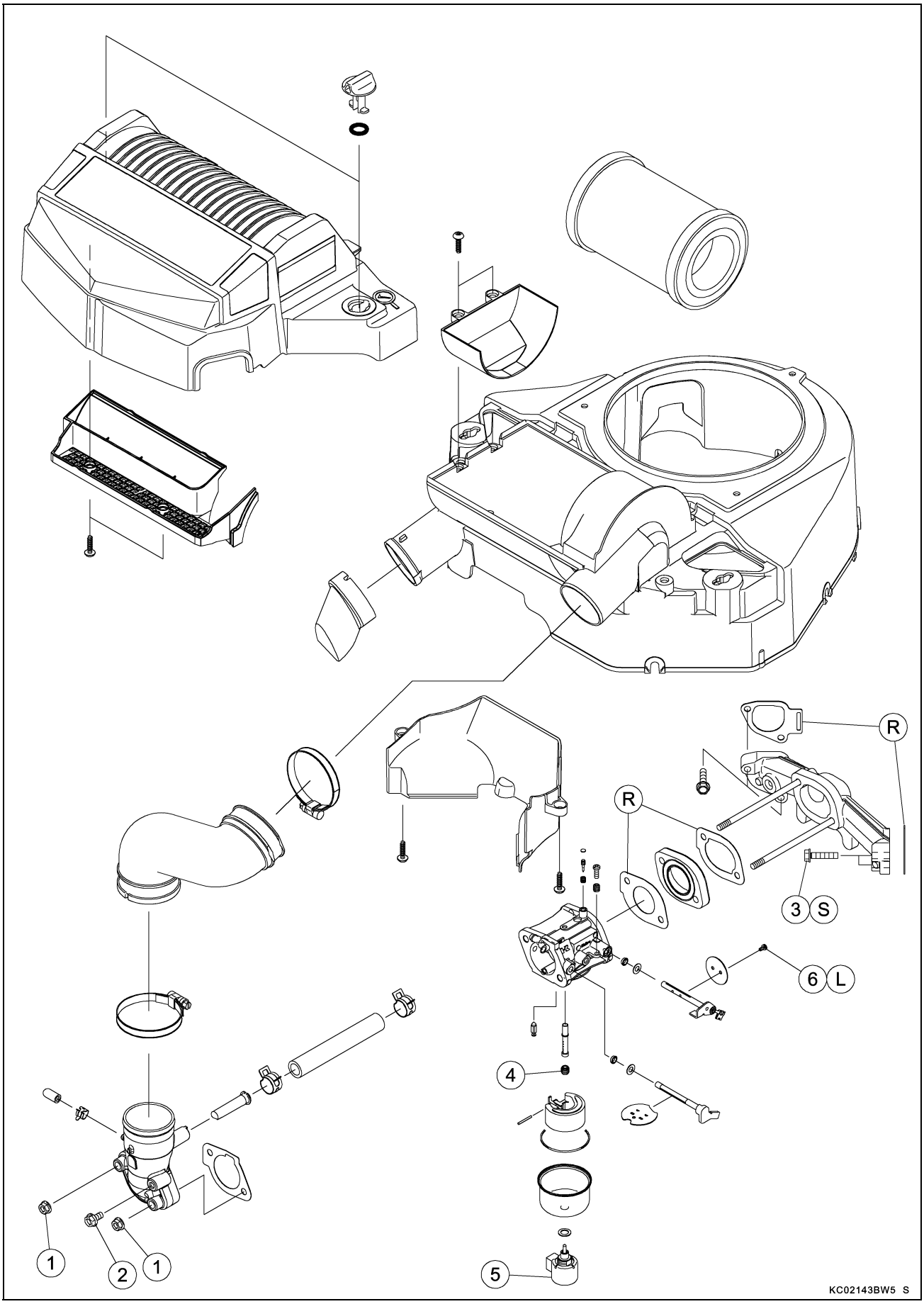
Spark Plug Gap

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

Fuel System

Table of Contents

Exploded View

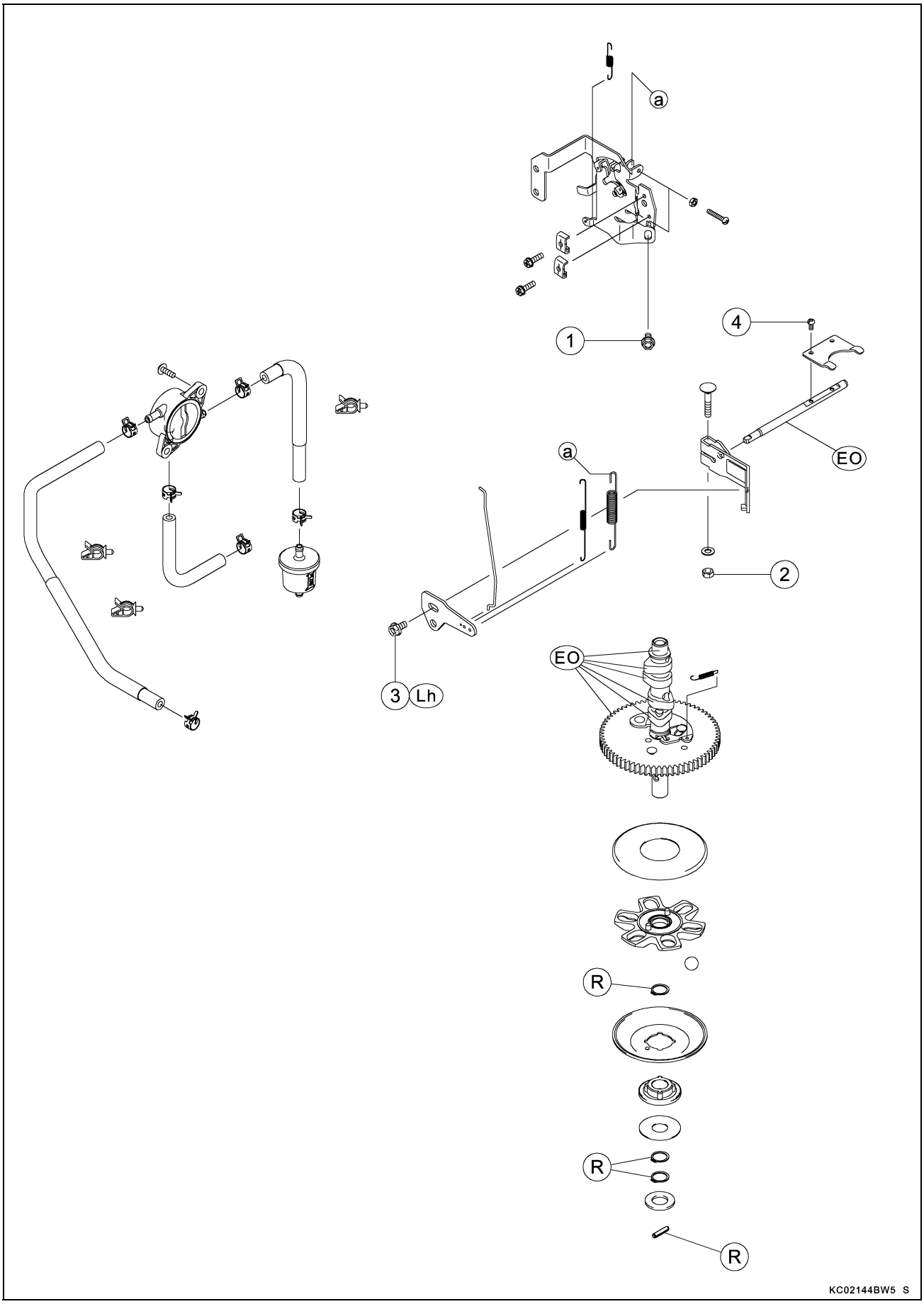


Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Carburetor and Intake Pipe Mounting Nut	6.9	0.70	61 in·lb	
2	Control Panel and Intake Pipe Mounting Bolt	6.9	0.70	61 in·lb	
3	Intake Manifold Bolts	6.9	0.70	61 in·lb	S
4	Main Jet	1.7	0.17	15 in·lb	
5	Solenoid Valve	4.4	0.45	39 in·lb	
6	Throttle Valve Screws	0.68	0.069	6.0 in·lb	L

L: Apply a non-permanent locking agent.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Control Panel Mounting Bolt	6.9	0.70	61 in·lb	
2	Governor Arm Clamp Nut	9.9	1.01	88 in·lb	
3	Governor Arm Joint Bolt	6.9	0.70	61 in·lb	Lh
4	Governor Shaft Plate Screws	2.2	0.22	19 in·lb	

EO: Apply engine oil.
Lh: Left-hand threads.
R: Replacement Parts

3-6 FUEL SYSTEM

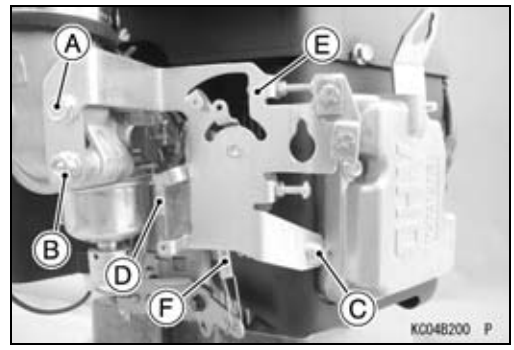
Specifications

Item	Standard
Carburetor Specifications	
Make/Type:	
FT651V	Walbro LMF-44
FT691V	Walbro LMF-43
FT730V	Walbro LMF-42
Throttle Bore Diameter	30 mm (1.2 in.)
Venturi Diameter	22 mm (0.87 in.)
Main Jet (MJ):	
FT651V	#124
FT691V	#124
FT730V	#128
Pilot Jet (PJ)	#56
Pilot Air Screw Turns out (PS) (Idle Mixture Screw Turns Out)	1 1/2 ±1/2
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	Single stage element, dry type
Fuel (2)	
Fuel Requirement	Unleaded regular grade gasoline
US, Canada	Using a minimum of 87 octane by antiknock index is recommended. Antiknock Index: (RON + MON)/2 RON = Research Octane Number MON = Motor Octane Number
Other Countries	Using a minimum of 91 octane by RON is recommended.
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.
(2) Other fuel requirements:
See Fuel and oil recommendations in Owner's Manual.

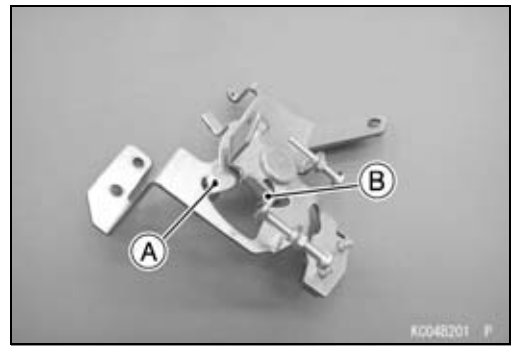
Governor Link Mechanism

Control Panel Assembly Removal



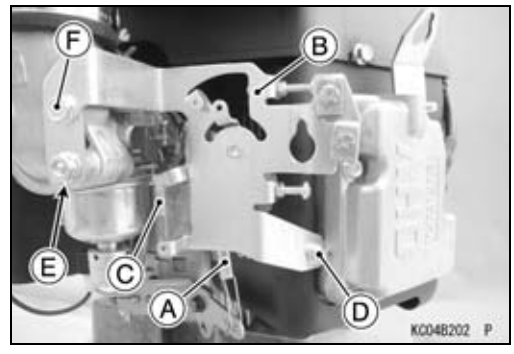
- Remove:
  Control Panel and Intake Pipe Mounting Bolt [A]
  Carburetor and Intake Pipe Mounting Nut [B]
  Control Panel Mounting Bolt [C]
  Choke Spring [D]
  Control Panel Assembly [E]
  Governor Spring [F]

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.

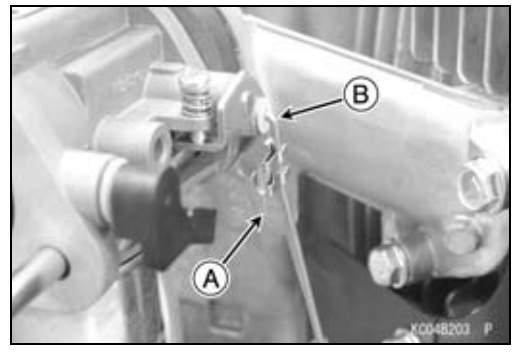


- Install the governor spring [A], control panel assembly [B] and choke spring [C].
- Tighten:

Torque - Control Panel Mounting Bolt [D]: 6.9 N·m (0.70 kgf·m, 61 in·lb)
Carburetor and Intake Pipe Mounting Nut [E]: 6.9 N·m (0.70 kgf·m, 61 in·lb)
Control Panel and Intake Pipe Mounting Bolt [F]: 6.9 N·m (0.70 kgf·m, 61 in·lb)

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

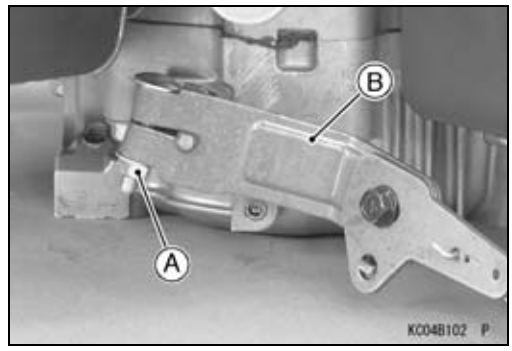
Governor Arm Removal



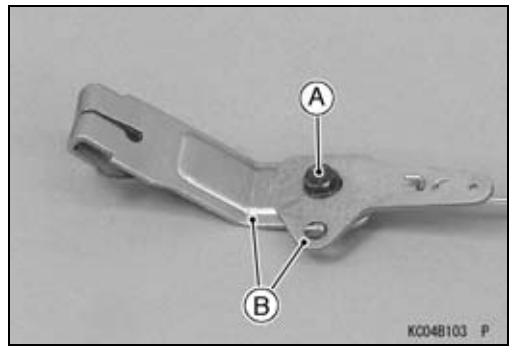
- Remove the control panel assembly (see Control Panel Assembly Removal)
- Unhook the throttle link rod spring [A] end loop and clear the throttle link rod lower end [B].

Governor Link Mechanism

- 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].
- Be sure the link spring [C] around the throttle link rod [D] is in place and that it pulls the outside governor arm [E] and throttle lever [F] each other.
- Tighten:

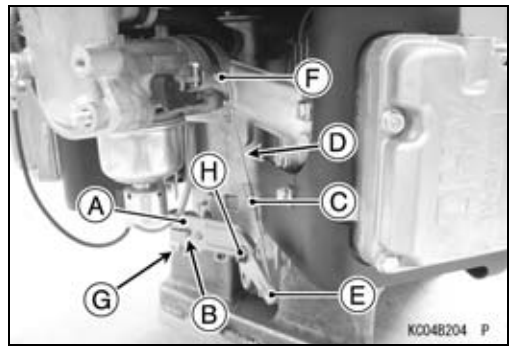
Torque - Governor Arm Clamp Nut [G]: 9.9 N·m (1.01 kgf·m, 88 in·lb)

- Turn the top end of the governor arm counterclockwise to fully open the carburetor throttle valve and hold it there.
- Turn the inside governor arm counterclockwise fully to the end of its travel.
- Tighten:

Torque - Governor Arm Joint Bolt [H]: 6.9 N·m (0.70 kgf·m, 61 in·lb)

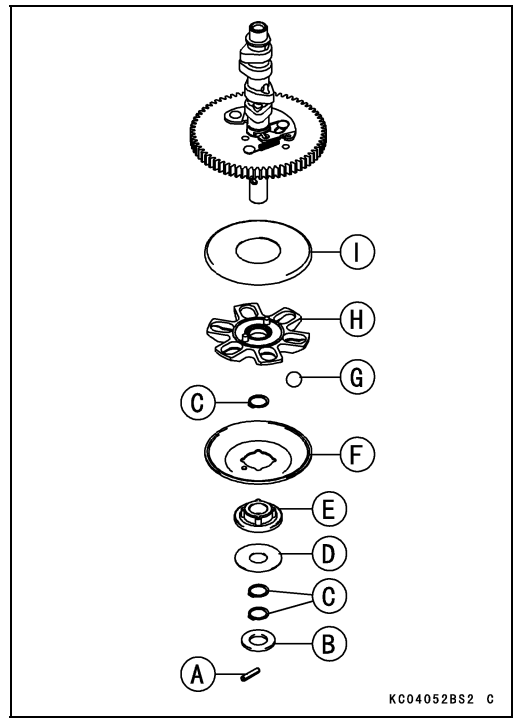
○Governor arm joint bolt is left-hand threads.

- Install the control panel assembly (see Control Panel Assembly Installation).



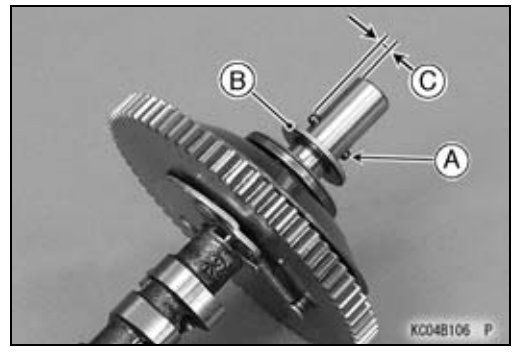
Governor Link Mechanism

Governor Assembly Removal



- Remove:
  Camshaft (see Camshaft, Tappet Removal in the Camshaft/Crankshaft chapter)
  Pin [A]
  Washer (ϕ30) [B]
  Snap Rings [C]
  Washer (ϕ42) [D]
  Sleeve [E]
  Governor Plate [F]
  Steel Balls [G]
  Ball Guide [H]
  Ball Plate [I]

Governor Assembly Installation



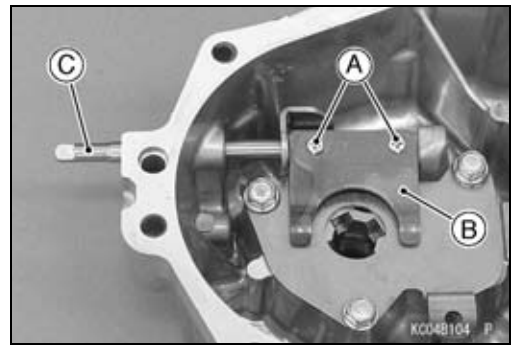
- Fit the snap ring into the groove securely.
- Turn the governor plate by hand and check that the steel balls and governor plate operate freely.
- Replace the spring pin [A] with a new one.
- Be sure to install the washer [B] and pin.
  2.0 ~ 2.3 mm (0.079 ~ 0.091 in.) [C]

Governor Assembly Inspection

- Visually check all governor parts for wear or damage.

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

Governor Shaft Removal



- Remove the crankcase cover (see Crankcase Cover Removal in the Camshaft/Crankcase chapter).
- Remove the governor shaft plate screws [A], and remove the governor shaft plate [B].
- Pull out the governor shaft [C] outside.

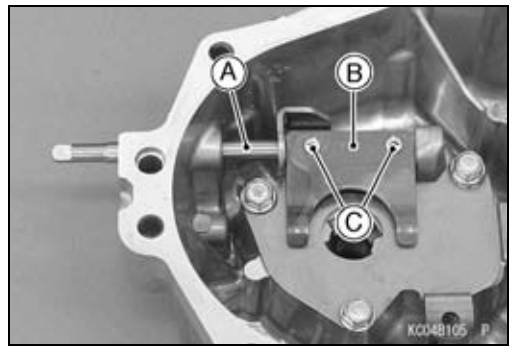
NOTE

○*Remove the governor shaft only if the replacement of the governor shaft is necessary.*

- 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.
- Tighten:

Torque - Governor Shaft Plate Screws [C]: 2.2 N·m (0.22 kgf·m, 19 in·lb)

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

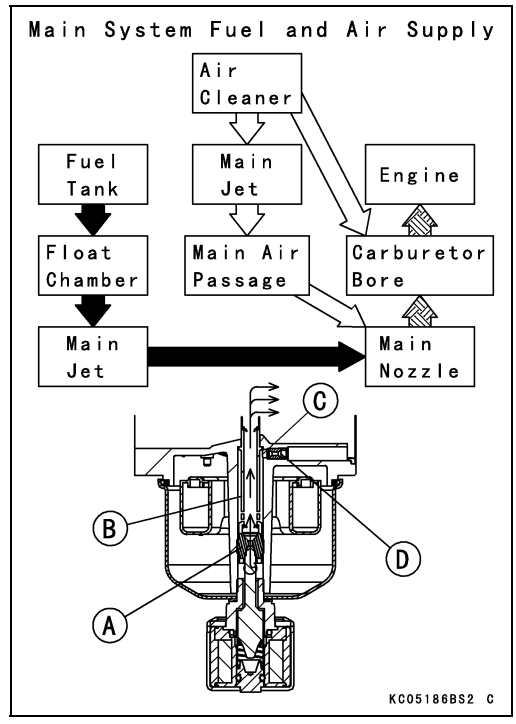
NOTE

○*If the oil seal is removed, oil seal is put on after shaft is installed (see Crankcase Cover Installation in the Camshaft/Crankshaft chapter).*

Carburetor

Fuel and Air Flow

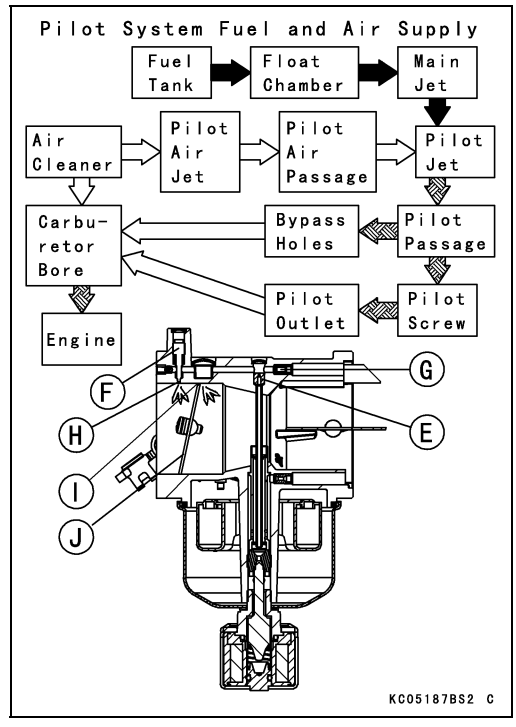
The main system of the carburetor consists of the main jet [A], main nozzle [B], and the main air passage [C] (main air jet [D]). The main system meters fuel to the engine during moderate to heavy load conditions. Fuel flows through the main jet and into the main nozzle, where it is joined by air from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



The pilot system includes the pilot jet [E], pilot screw [F] (idle mixture screw), pilot air jet [G], pilot outlet [H], and the bypass holes [I]. 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 [J] 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 idle, so adjusting the pilot screw changes the fuel/air ratio. Turning the pilot screw (idle mixture screw) out (counterclockwise) enriches the mixture; turning it in (clockwise) leans the mixture.

Main Fuel Flow →
Pilot Fuel Flow ⇒

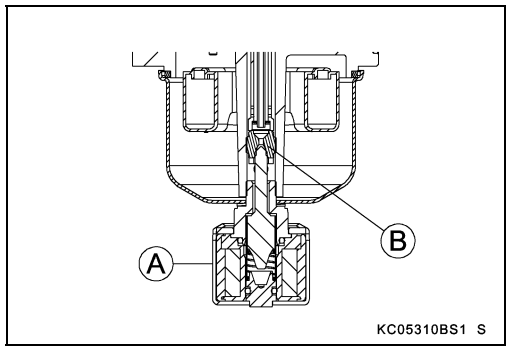


Carburetor

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.

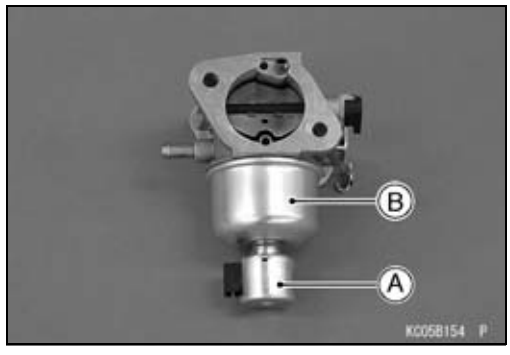
NOTE

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

- Refer to Part Catalog for correct part number.

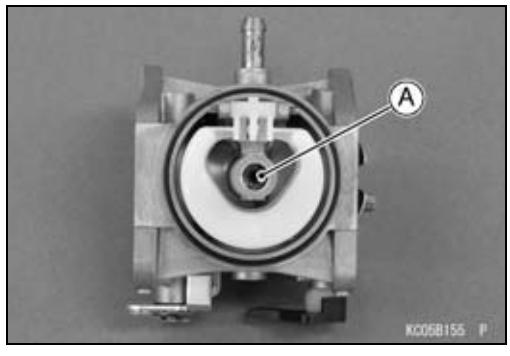
Main Jet Replacement

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



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

Torque - Main Jet: 1.7 N·m (17 kgf·m, 15 in·lb)



- Replace the float chamber gasket with a new one.
- Install the new gasket and float chamber.
- Tighten:

Torque - Solenoid Valve: 4.4 N·m (0.45 kgf·m, 39 in·lb)

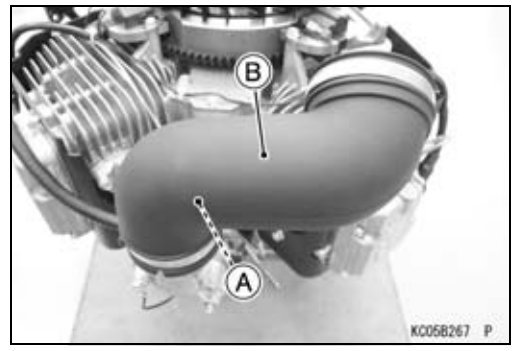
Carburetor

Fuel System Cleanliness Inspection

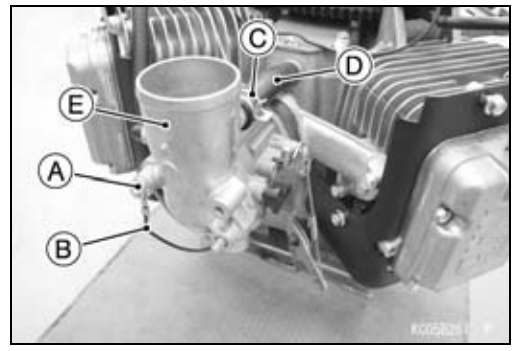
- Refer to the Fuel System Cleanliness Inspection in the Periodic Maintenance chapter.

Intake Pipe Removal

- Remove:
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)
- Loosen the hose band screw [A] and remove the intake hose [B] from the intake pipe.



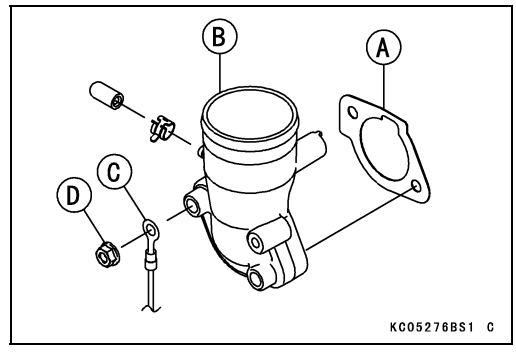
- Remove:
  Control Panel Assembly (see Control Panel Assembly Removal)
  Intake Pipe Mounting Nut [A]
  Ground Lead [B]
  Clamp [C]
  Breather Hose [D]
  Intake Pipe [E]



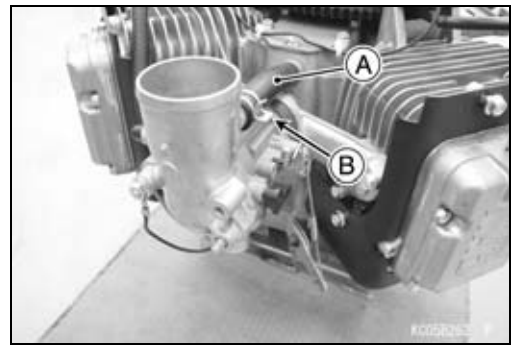
Intake Pipe Installation

- Replace the gasket [A] with a new one.
- Install:
  Gasket
  Intake Pipe [B]
  Ground Lead [C]
- Tighten:

Torque - Carburetor and Intake Pipe Mounting Nut [D]: 6.9 N·m (0.70 kgf·m, 61 in·lb)



- Connect the breather hose [A] so that the clamp knob [B] faces the downward.
- Install the removed parts.



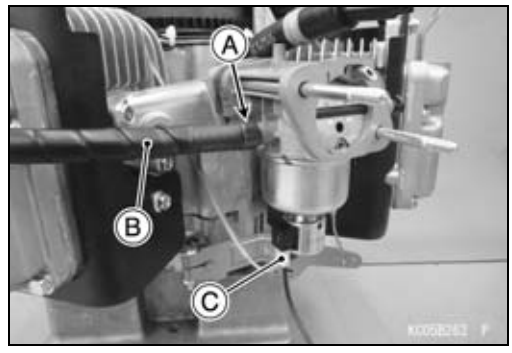
Carburetor Removal

⚠ WARNING

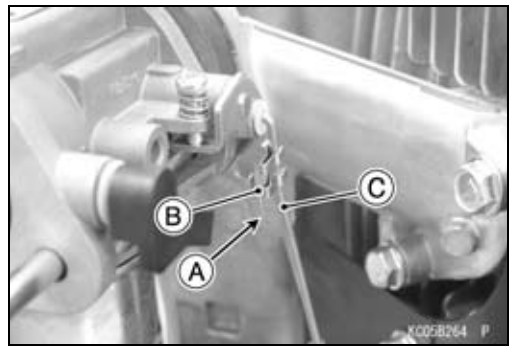
Gasoline is extremely flammable and can be explosive under certain conditions. Turn the engine switch off. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

Carburetor

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

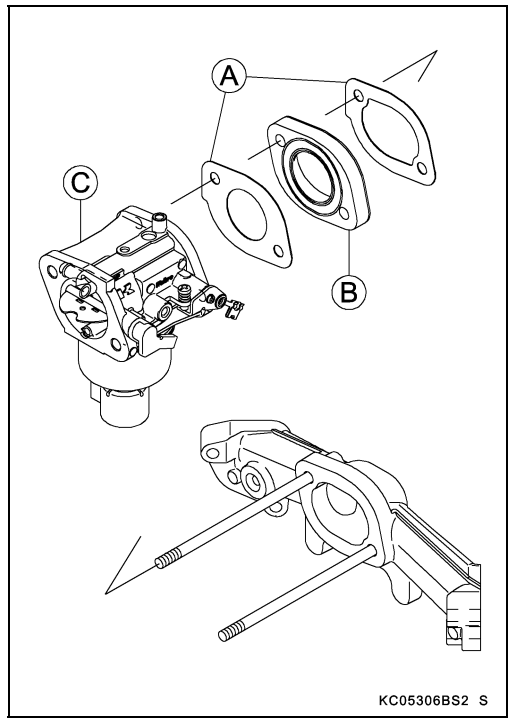


- Unhook the throttle link spring [A] at the throttle shaft lever clip end [B] with a long nose plier.
- Unhook the throttle link rod [C] from the throttle shaft lever clip end.
- Remove the carburetor.



Carburetor Installation

- Clean the mating surface of the carburetor and intake manifold.
- Replace the gaskets [A] with new ones.
- Install the insulator [B], carburetor [C] and gaskets sequence as shown in the figure.
- Apply dielectric grease to the solenoid valve connector.
- Connect the solenoid valve connector.

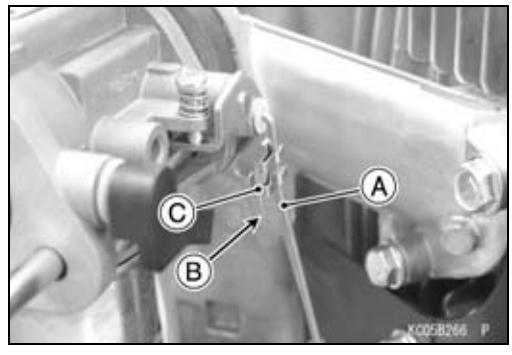


- Install the throttle link rod [A] and spring [B] to the throttle shaft lever clip [C].

NOTE

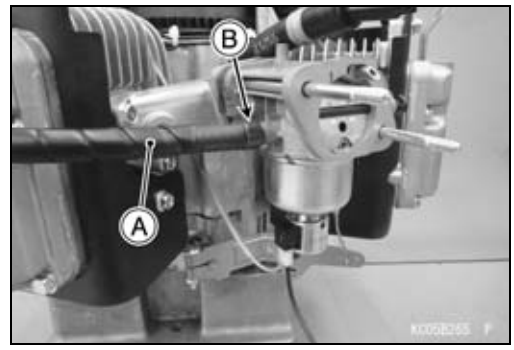
○ *Take care not to bend the throttle link rod during installation.*

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



Carburetor

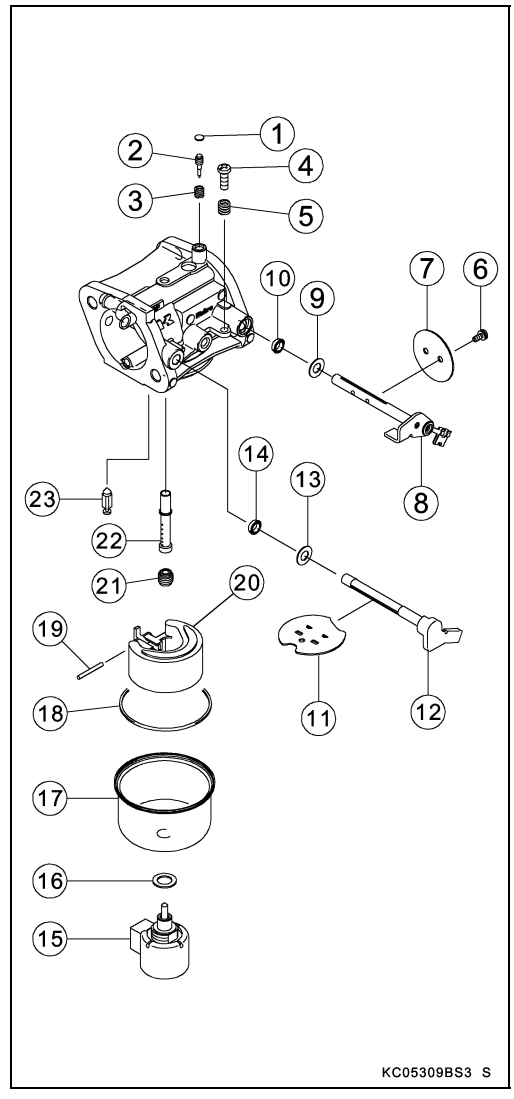
- Install the fuel tube [A] fully so that the clamp knob [B] faces the downward.
- Install the removed parts.
- After installation, adjust the idle speed (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter).



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

1. Pilot Screw Plug
2. Pilot Screw
3. Spring
4. Low Idle Speed Screw
5. Spring
6. Screws
7. Throttle Valve
8. Throttle Shaft
9. Washer
10. Dust Seal
11. Choke Valve
12. Choke Shaft
13. Washer
14. Dust Seal
15. Solenoid Valve
16. Gasket
17. Float Chamber
18. Gasket
19. Float Pin
20. Float
21. Main Jet
22. Main Nozzle
23. Float Valve



Carburetor

Carburetor Cleaning

⚠ WARNING

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the carburetor 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 carburetor.

NOTICE

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 carburetor metal parts in a carburetor cleaning solution and clean them.
- Rinse the parts in water and dry them with compressed air.
- Do not use rags or paper to dry parts. Lint may plug the holes or passages.
- Blow air through the holes and fuel passages with the compressed air. All holes must be open.
- Assemble the carburetor (see Carburetor Disassembly/Assembly).

Carburetor

Carburetor Inspection

⚠ WARNING

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

- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burns and nicks.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.

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

- Check the gasket on the carburetor body.

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

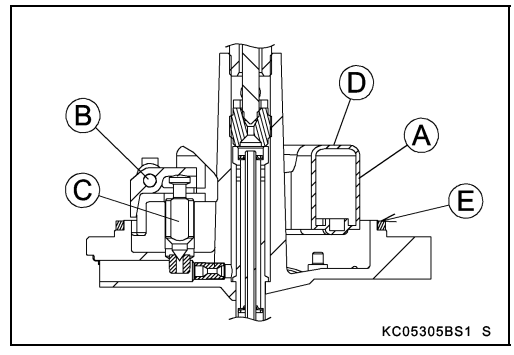
- Check the other parts of the carburetor for any wear or damage. Replace the part with a new one if necessary.
- Clean and check the float level as follows.

NOTICE

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

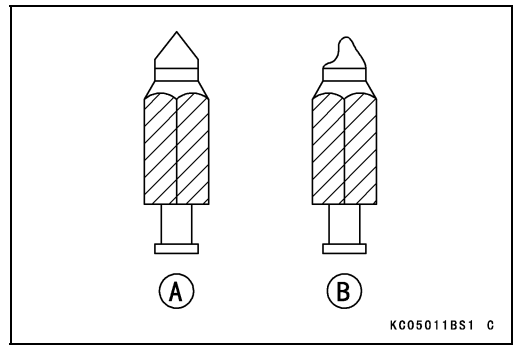
- With the float [A] assembly installed onto the carburetor body, hold the carburetor upside down at eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab [B] just touches the float valve [C]. The float lower surface [D] should be parallel with the carburetor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

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



- Inspect the float valve for excessive wear or damage. The tip should be smooth, without any grooves, scratches, or tears. The rod at the other end of the needle should move smoothly when push in and released.
  Good [A]
  Not Good [B]

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

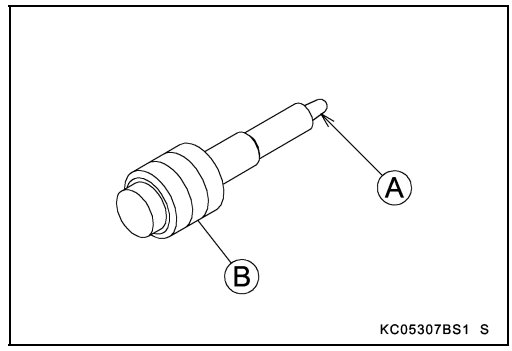


Carburetor

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

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

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



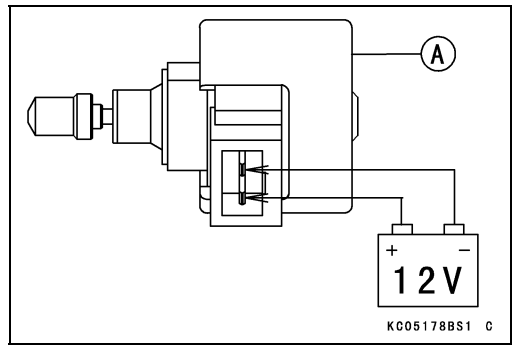
Fuel Shut Off Solenoid Valve Test

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

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

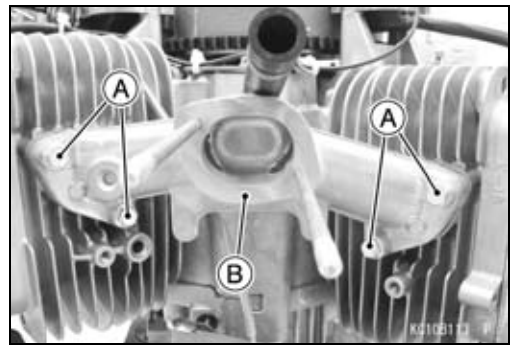
NOTE

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



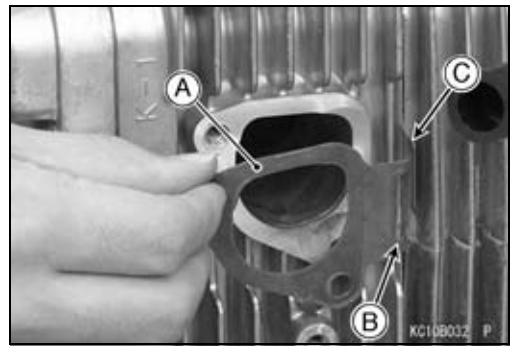
Intake Manifold

Intake Manifold Removal

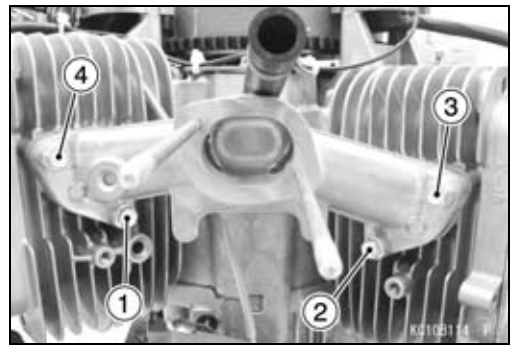


- Remove the engine shroud (see Engine Shroud Removal in the Cooling System chapter)
- Unscrew the intake manifold mounting bolts [A].
- Remove the intake manifold [B] and gaskets.

Intake Manifold Installation



- Replace the intake manifold gaskets [A] with new ones.
- Clean the mating surfaces of the cylinders and intake manifolds.
- Install the intake manifold gaskets so that the hole [B] of the gaskets fit the projection [C] of the cylinder head.
- Install the intake manifold.



- Tighten the intake manifold mounting bolts following the tightening sequence.

Torque - Intake Manifold Mounting Bolts: 6.9 N·m (0.70 kgf·m, 61 in·lb)

- Install the removed parts.

Intake 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 burrs and nicks.

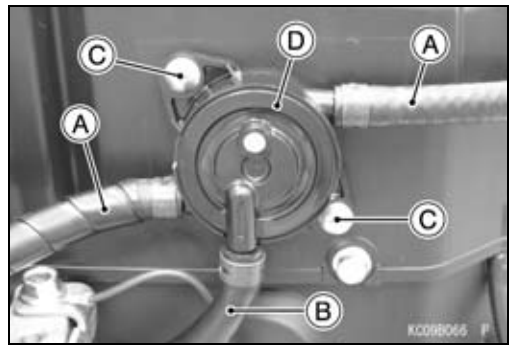
Fuel Pump, Fuel Filter

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

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

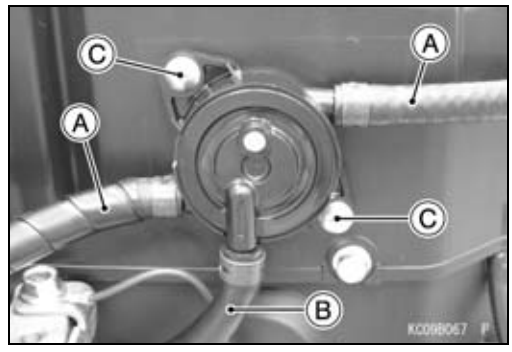
Fuel Pump Removal

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



Fuel Pump Installation

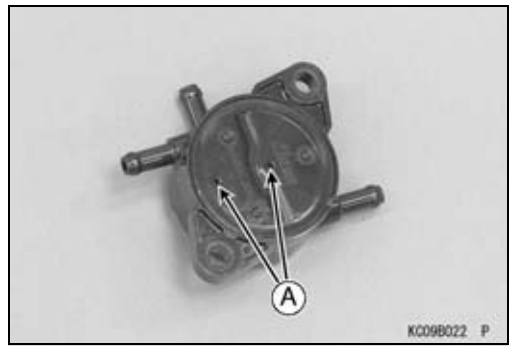
- Connect the fuel tubes [A] and pulse tube [B] fully.
- Tighten the fuel pump mounting screws [C].

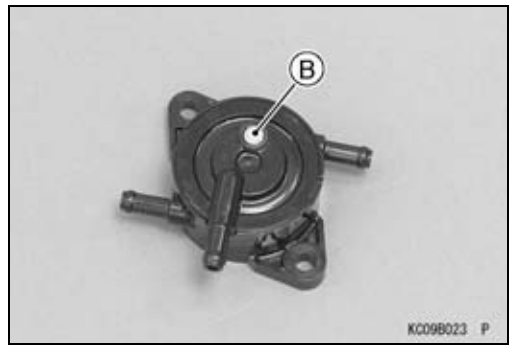


Fuel Pump Inspection

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

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



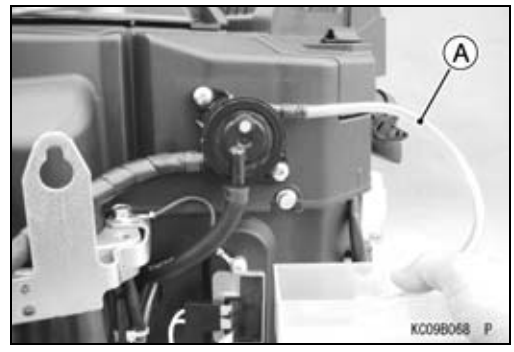


Fuel Pump, Fuel Filter

Fuel Flow Test

⚠ WARNING

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



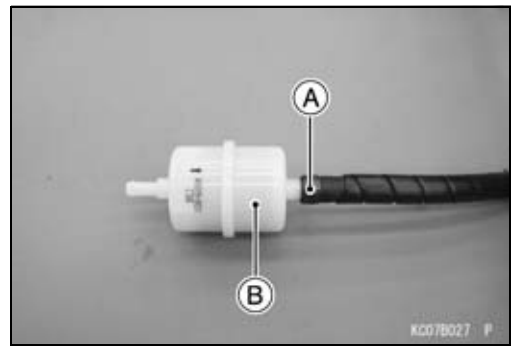
- Disconnect the fuel pump outlet nozzle from the tube.
- Connect a suitable hose [A] to the outlet nozzle.
- Run the lower end of the hose into a container.
- Start the engine, check the fuel flow.

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

★Check for clogged or damaged tubes and fuel filter. Replace the faulty parts.

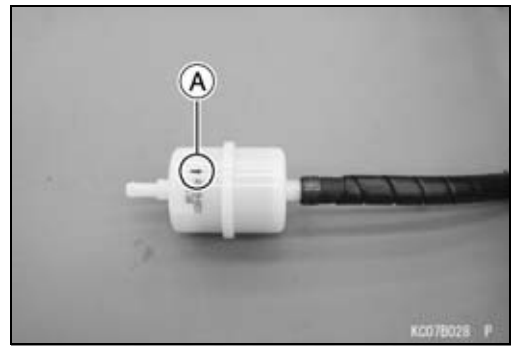
Fuel Filter Removal

- Remove:
  Clamp [A]
  Fuel Filter [B]



Fuel Filter Installation

- When installing the fuel filter, the point of arrow mark [A] faces fuel pump side.



Fuel Filter Inspection

- Visually inspect the fuel filter [A].

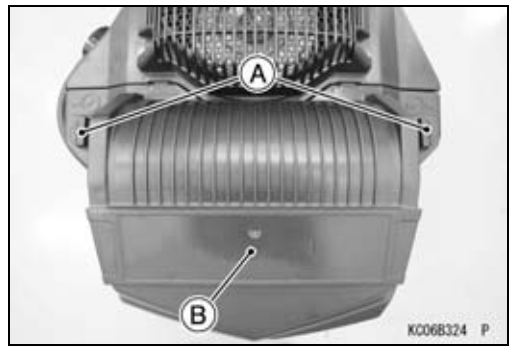
★If the filter is clear with no signs of dirt or other contamination, replacement of the fuel filter is not necessary.

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

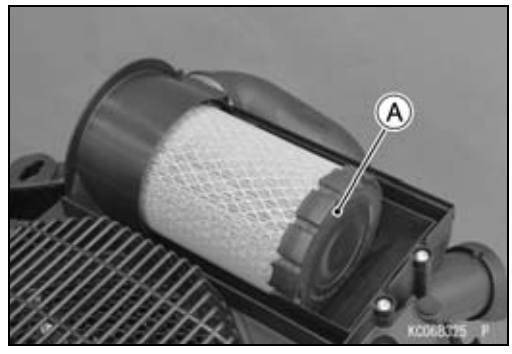
Air Cleaner

Air Cleaner Element Removal

- Turn the stopper knobs [A] counterclockwise.
- Remove the air cleaner cover [B] from the fan housing.

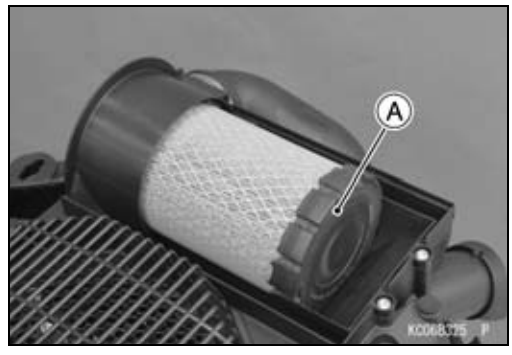


- Remove the element assembly [A].

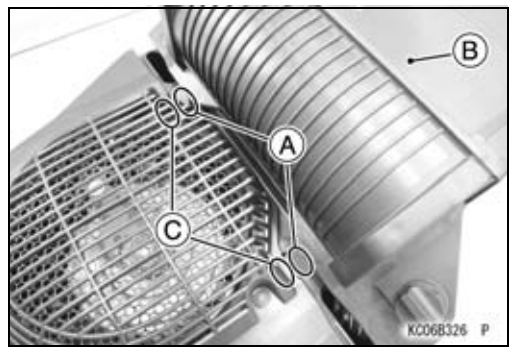


Air Cleaner Element Installation

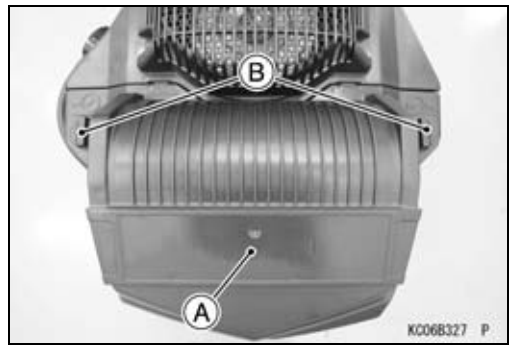
- Install the element assembly [A].



- Insert the tabs [A] of the air cleaner cover [B] to the slots [C] of fan housing.



- Install the air cleaner cover [A] and turn the stopper knobs [B] clockwise.



Air Cleaner

Air Cleaner 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.

Cooling System

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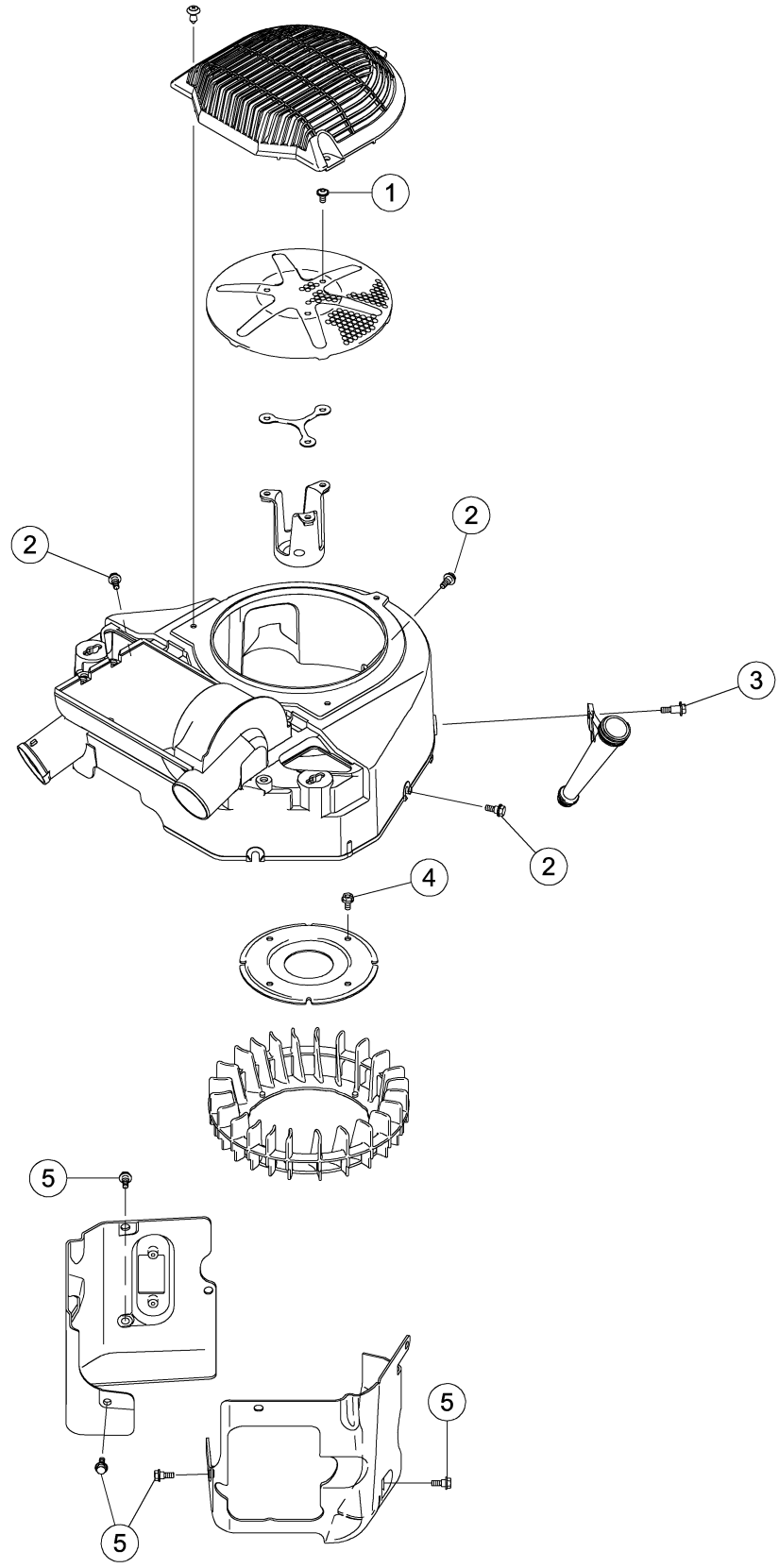
Exploded View



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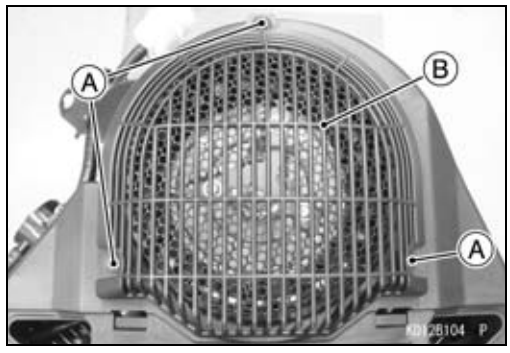
Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Fan Screen Bolts	6.9	0.70	61 in·lb	
2	Fan Housing Bolts	9.8	1.0	87 in·lb	
3	Oil Filler Mounting Bolt	9.8	1.0	87 in·lb	
4	Cooling Fan Bolts	6.9	0.70	61 in·lb	
5	Engine Shroud Bolts	9.8	1.0	87 in·lb	

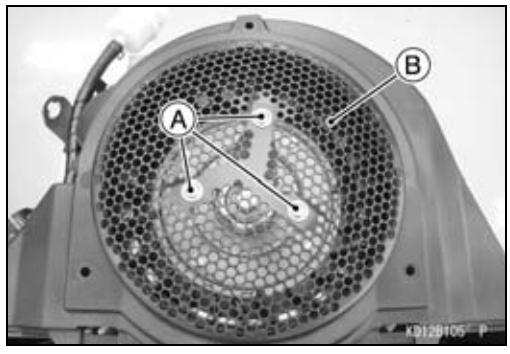
Fan Housing

Fan Housing Removal

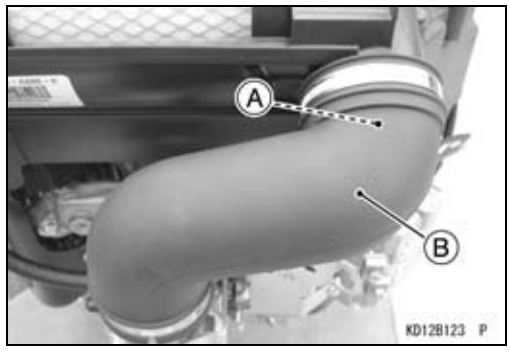
- Remove:
  Air Cleaner Cover (see Air Cleaner Element Removal in the Fuel System chapter)
  Regulator (see Regulator Removal in the Electrical System chapter)
- Remove:
  Quick Rivets [A]
  Fan Guard [B]



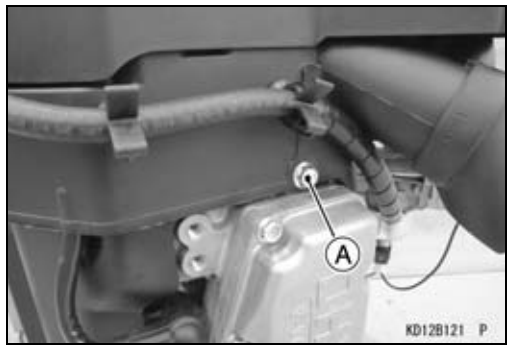
- Remove:
  Fan Screen Bolts [A]
  Fan Screen [B]
  Plates



- Loosen the hose band screw [A] and disconnect the intake hose [B] from the air cleaner.

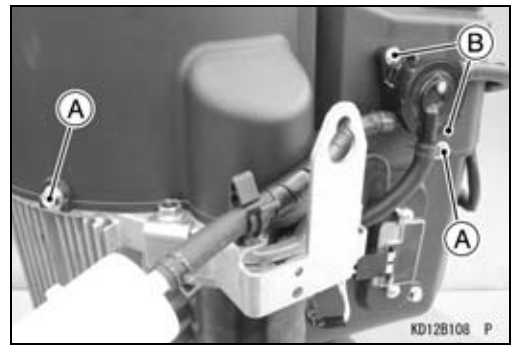


- Loosen the fan housing bolts [A] (not necessary to remove).



Fan Housing

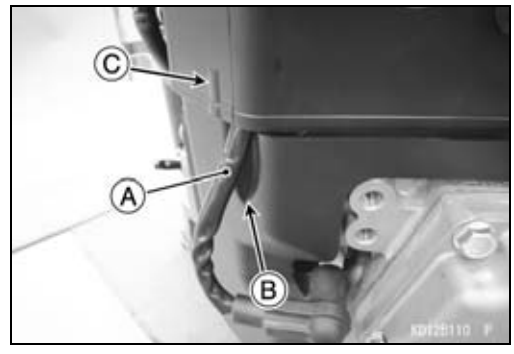
- Remove:
  Fan Housing Bolts [A]
  Fuel Pump Mounting Bolts [B]



- Remove:
  Oil Filler Mounting Bolt [A]
  Fan Housing Bolt [B]
  Fan Housing [C]

Fan Housing Installation

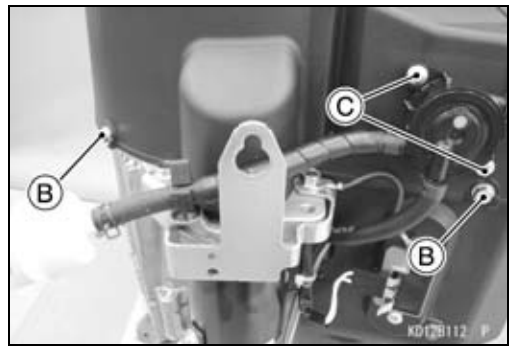
- Fit the ignition coil lead [A] to the each engine shroud groove [B] and the fan housing [C].

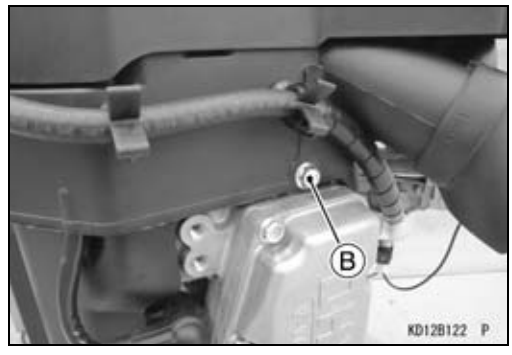


Fan Housing

- Install the fan housing [A] with the fan housing bolts [B], the fuel pump mounting bolts [C] and oil filler mounting bolt [D] which has been removed.
- Tighten:

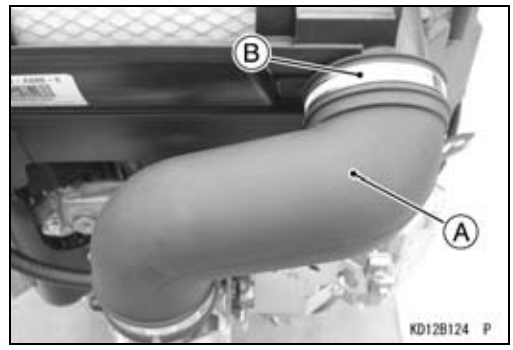
Torque - Fan Housing Bolts: 9.8 N·m (1.0 kgf·m, 87 in·lb)
Oil Filler Mounting Bolt: 9.8 N·m (1.0 kgf·m, 87 in·lb)

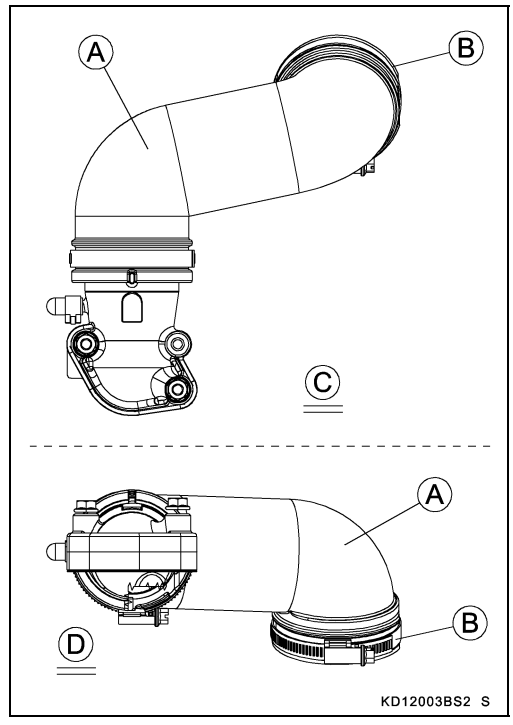




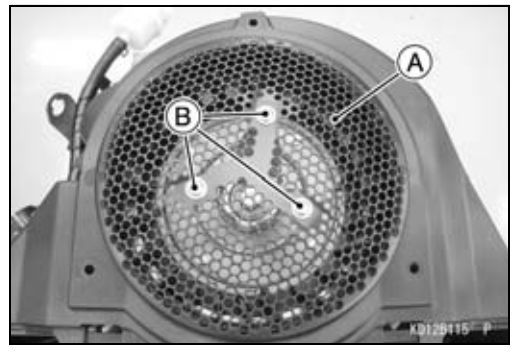
Fan Housing

- Connect the intake hose [A].
- Install the hose band [B] direction as shown.
  Viewed from Side [C]
  Viewed from Bottom [D]

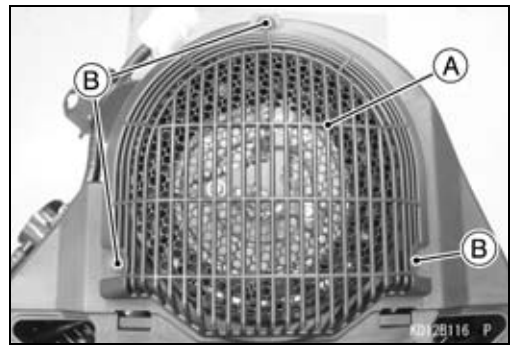




- Install the fan screen [A] and fan screen bolts [B].
  Torque - Fan Screen Bolts: 6.9 N·m (0.70 kgf·m, 61 in·lb)



- Install the fan guard [A] and quick rivets [B].
- Install the removed parts.



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.

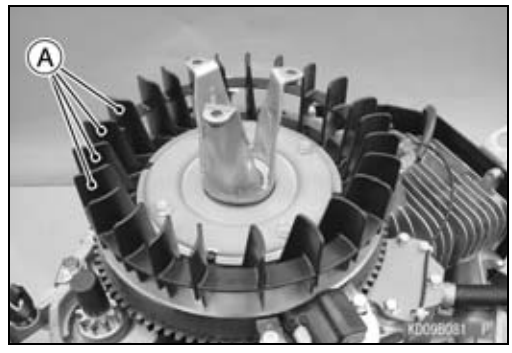
Cooling Fan Inspection

- Remove the fan housing (see Fan Housing Removal).
- 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.



NOTICE
Do not clean the cooling fan in oil solvent. It may be damage by oil solvent.

Engine Shroud

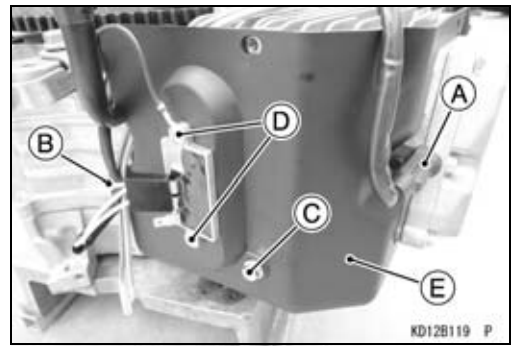
Engine Shroud Removal

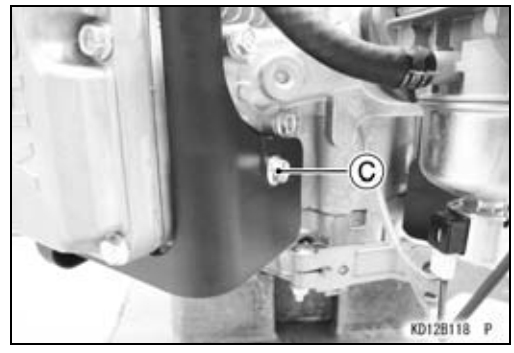
Upper Engine Shroud

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

#1 Cylinder Engine Shroud

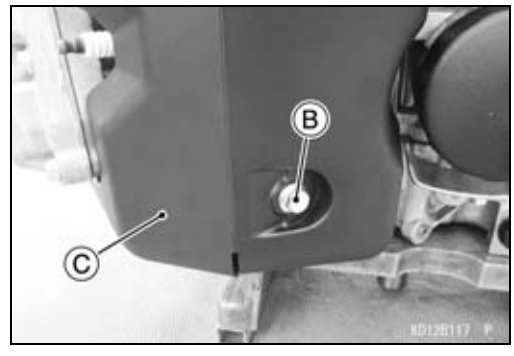
- Carefully pull the plug cap [A] from the spark plug.
- Cut off the band [B].
- Remove:
  Engine Shroud Bolt [C]
  Regulator Mounting Screws [D] and Ground Lead
  Engine Shroud [E]





#2 Cylinder Engine Shroud

- Carefully pull the plug cap [A] from the spark plug.
- Remove:
  Engine Shroud Bolt [B]
  Engine Shroud [C]



Engine Shroud Installation

- Installation is the reverse of removal.
- Tighten:

Torque - Engine Shroud Bolts: 9.8 N·m (1.0 kgf·m, 87 in·lb)

Engine Top End

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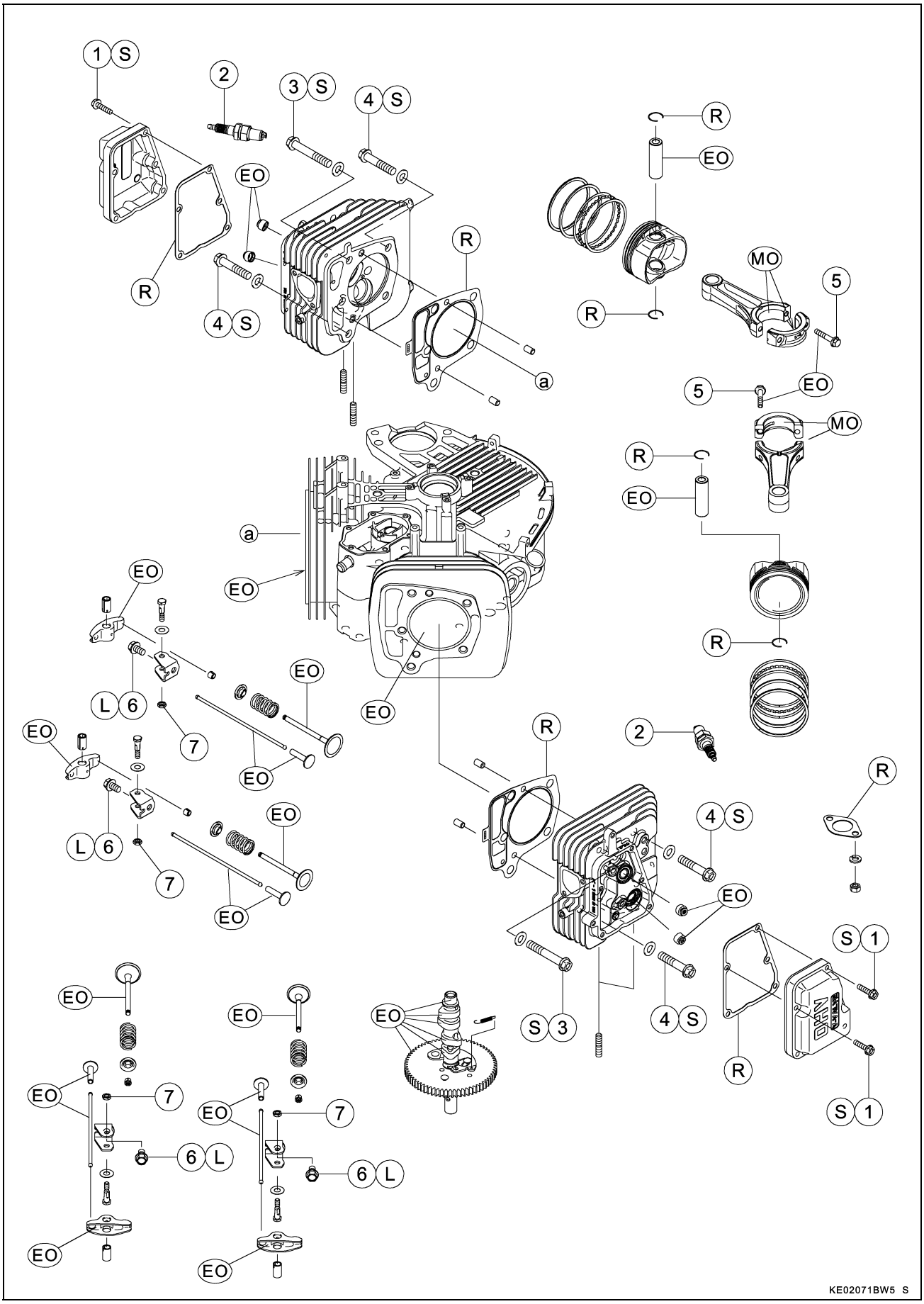
5-2 ENGINE TOP END

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Rocker Cover Bolts	9.0	0.92	80 in·lb	S
2	Spark Plugs	23	2.3	17	
3	Cylinder Head Bolts (L = 65 mm)	44	4.5	32	S
4	Cylinder Head Bolts (L = 50 mm)	44	4.5	32	S
5	Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	EO
6	Rocker Arm Bracket Bolts	21	2.1	15	L
7	Valve Clearance Adjusting Locknuts	9.5	0.97	84 in·lb	

EO: Apply engine oil.
L: Apply a non-permanent locking agent.
MO: Apply molybdenum disulfide oil solution. (mixture of engine oil and molybdenum disulfide grease in a weight ratio 10:1)
R: Replacement Parts
S: Follow the specified tightening sequence.

Specifications

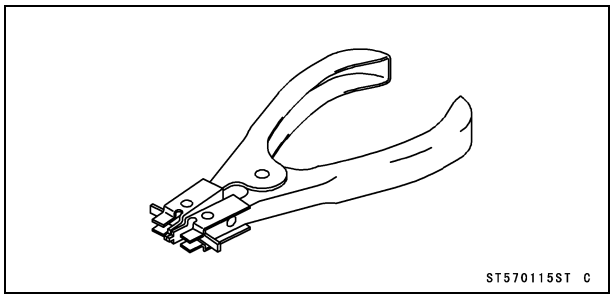
Item	Service Limit
Cylinder Head:	
Cylinder Compression (MIN)	440 kPa (4.5 kg/cm², 64 psi) @Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 450 r/min (rpm)/5 Seconds
Cylinder Head Warp	0.05 mm (0.002 in.)
Valves:	
Valve Head Thickness:	
Intake, Exhaust	0.8 mm (0.03 in.)
Valve Stem Runout:	
Intake, Exhaust	TIR 0.05 mm (0.002 in.)
Valve Stem Diameter:	
Intake	5.95 mm (0.234 in.)
Exhaust	5.93 mm (0.233 in.)
Valve Guide Inside Diameter:	
Intake, Exhaust	6.08 mm (0.239 in.)
Valve Spring Free Length:	
Intake, Exhaust	31.2 mm (1.23 in.)
Rocker Arm Push Rod Runout:	
Intake, Exhaust	TIR 0.5 mm (0.02 in.)
Rocker Shaft Outside Diameter:	
Intake, Exhaust	10.91 mm (0.430 in.)
Rocker Arm Inside Diameter:	
Intake, Exhaust	11.13 mm (0.438 in.)
Cylinder, Piston:	
Piston Diameter	77.79 mm (3.063 in.)
Piston Ring/Groove Clearance:	
Top	0.19 mm (0.0075 in.)
Second	0.20 mm (0.0079 in.)
Piston Ring Thickness:	
Top	1.10 mm (0.0433 in.)
Second	1.10 mm (0.0433 in.)
Piston Ring End Gap:	
Top	0.6 mm (0.024 in.)
Second	0.8 mm (0.031 in.)
Oil	0.9 mm (0.035 in.)
Piston Pin Outside Diameter	16.96 mm (0.6677 in.)
Piston Pin Hole Inside Diameter	17.08 mm (0.6724 in.)
Connecting Rod Small End Inside Diameter	17.06 mm (0.672 in.)
Cylinder Inside Diameter:	
Standard Cylinder	78.08 mm (3.074 in.)
0.50 mm Oversize Cylinder	78.58 mm (3.094 in.)
Cylinder Inside Diameter Out Round	0.05 mm (0.002 in.)

Specifications

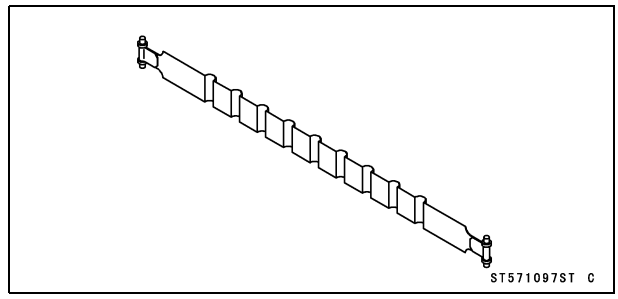
Item	Standard
Valves (Standard):	
Valve Clearance:	
Intake, Exhaust	0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake	1.2 ~ 1.8 mm (0.047 ~ 0.071 in.)
Exhaust	0.8 ~ 1.6 mm (0.031 ~ 0.063 in.)
Valves Guide Inside Diameter:	
Intake, Exhaust	6.000 ~ 6.012 mm (0.2362 ~ 0.2367 in.)
Cylinder Inside Diameter:	
Standard Cylinder	77.98 ~ 78.00 mm (3.070 ~ 3.071 in.)
0.50 mm Oversize Cylinder	78.48 ~ 78.50 mm (3.090 ~ 3.091 in.)

Special Tools

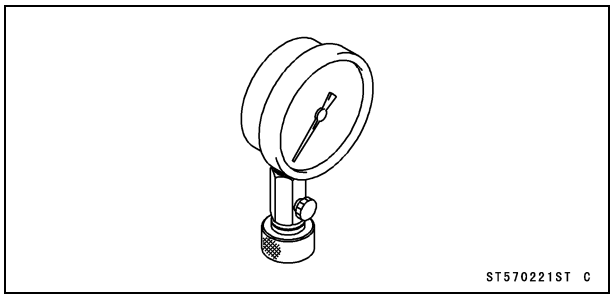
Piston Ring Pliers:
57001-115



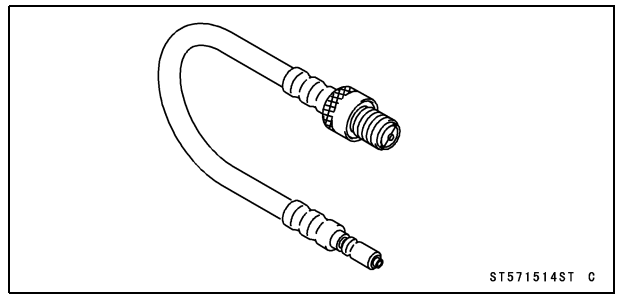
Piston Ring Compressor Belt, ϕ67 ~ ϕ79:
57001-1097



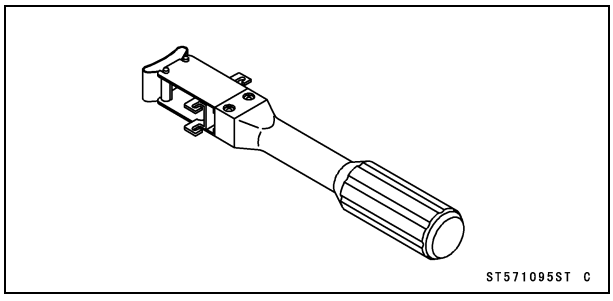
Compression Gauge, 20 kgf/cm²:
57001-221



Compression Gauge Adapter, M14 × 1.25:
57001-1514

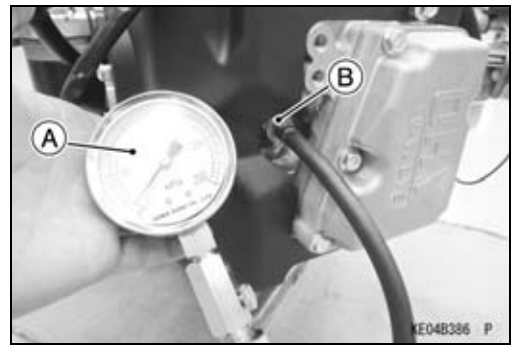


Piston Ring Compressor Grip:
57001-1095



Cylinder Head

Compression Measurement



● Before measuring compression, do the following.
○Be sure the battery is fully charged.
○Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help 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 [A]: 57001 -221
Compression Gauge Adapter, M14 × 1.25 [B]: 57001-1514

● 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 (4.5 kg/cm², 64 psi) @Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 450 r/min(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 - rapid carbon accumulation in the combustion chamber may be caused by worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.

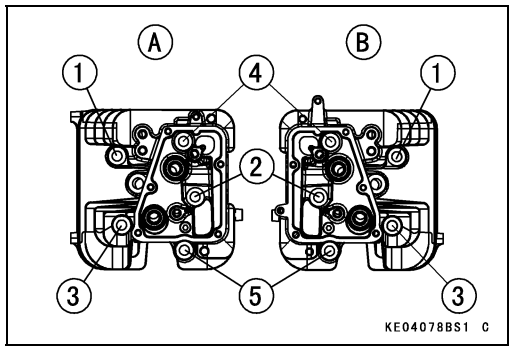
★If the cylinder compression is lower than the (MIN), check the following.
1. Gas leakage around the cylinder head - replace the damaged gasket with a new one and check the cylinder head warp.
2. Condition of the valve seating.
3. Valve clearance.
4. Piston/cylinder wear, piston seizure.
5. Piston ring,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

Cylinder Head

Cylinder Head Assembly Removal

- Remove:
  Spark Plugs (see Spark Plug Removal in the Electrical System chapter)
  Engine Shrouds (see Engine Shroud Removal in the Cooling System chapter)
  Rocker Cover and Gasket (see Valve Clearance Inspection in the Periodic Maintenance chapter)
  Intake Manifold (see Intake Manifold Removal in the Fuel System chapter)

- Loosen the cylinder head bolts 1/4 turn in the sequence [1 ~ 5] as shown.
  #1 Cylinder [A]
  #2 Cylinder [B]



NOTICE

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

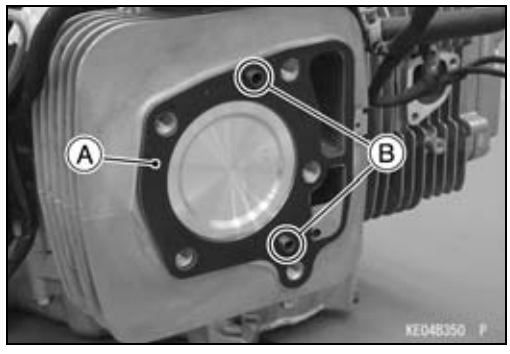
- Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.

NOTE

○*Mark and keep the valve mechanism components including the push rods so that they can be installed in their original position when assembly.*

Cylinder Head Assembly Installation

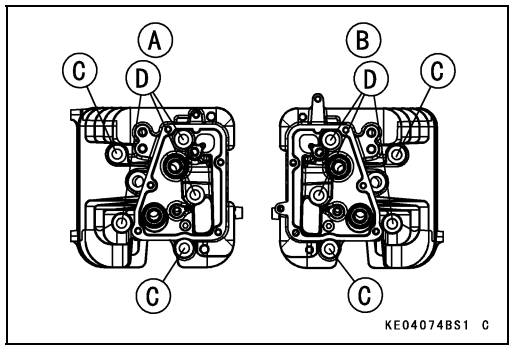
- Set the piston at the TDC of the compression stroke.
- Clean the mating surfaces of the cylinder heads and cylinders.
- Replace the gasket [A] with a new one.
- Install the dowel pins [B] and new gasket.



NOTE

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

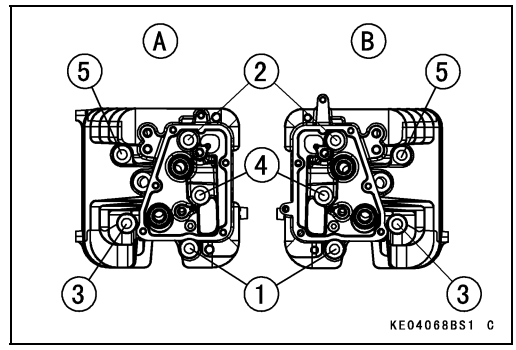
- Install the cylinder head and cylinder head bolts in place as shown.
  #1 Cylinder Head [A]
  #2 Cylinder Head [B]
  Cylinder Head Bolts (L = 50 mm) [C] and Washers
  Cylinder Head Bolts (L = 65 mm) [D] and Washers



Cylinder Head

- Tighten the cylinder head bolts following the tightening sequence [1 ~ 5] as shown.
  #1 Cylinder Head [A]
  #2 Cylinder Head [B]

  Torque - Cylinder Head Bolts: 44 N·m (4.5 kgf·m, 32 ft·lb)



NOTICE

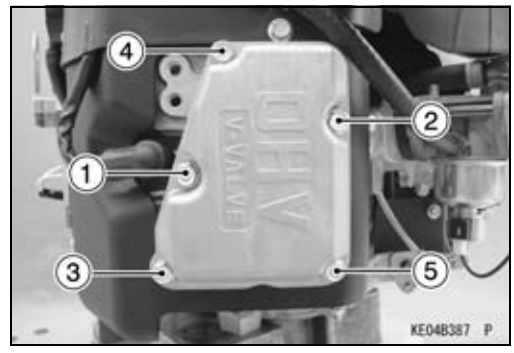
A torque wrench must be used to assure proper torque. Improper tightening of the head bolts may result in warping of the cylinder head.

- Install:
  Rocker Arm Bracket (Exhaust Side) (see Valve Mechanism Removal/Installation)
  Push Rod (see Push Rod Installation)
  Rocker Arm (see Valve Mechanism Removal/Installation)

- Check and adjust the valve clearance (see Valve Clearance Inspection in the Periodic Maintenance chapter).
- Install the new gaskets and the rocker covers.
- Tighten the rocker cover bolts following the tightening sequence [1 ~ 5] as shown.

  Torque - Rocker Cover Bolts: 9.0 N·m (0.92 kgf·m, 80 in·lb)

- Install the other removed parts.

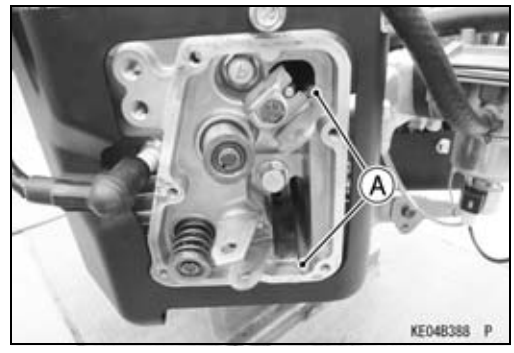


Push Rod Removal

- Set each piston at the TDC of the compression stroke.
- Remove the rocker arm (see Valve Mechanism Removal/Installation).
- Remove the push rods [A].

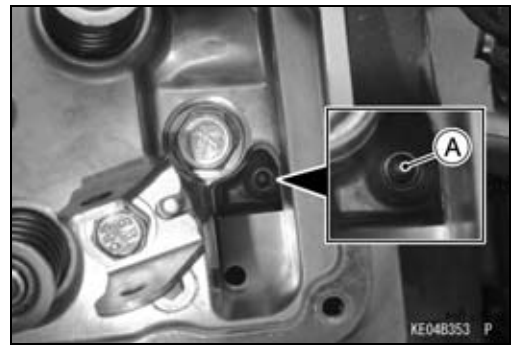
NOTE

○*Mark and keep the valve mechanism components including the push rods so that they can be installed in their original position when assembly.*



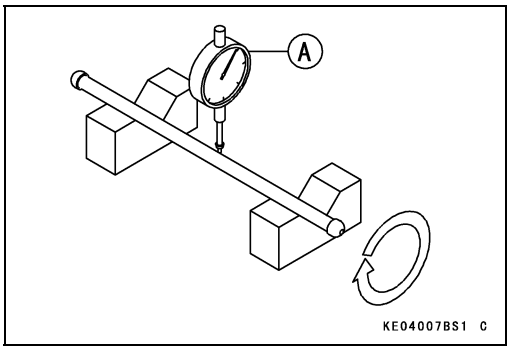
Push Rod Installation

- Set each piston at the TDC 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 intake and exhaust push rods on each cylinder are at lowest position on the cam lobes. If the piston is not at the TDC of the compression stroke, turn the flywheel clockwise one turn (360°) and reset each piston at the TDC of the compression stroke.
- Be sure the end of the push rods are correctly seated on the tappets.
- Install the rocker arms (see Valve Mechanism Removal/Installation).
- Check to see that push rod ends are in the hollow of the rocker arms.



Cylinder Head

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.

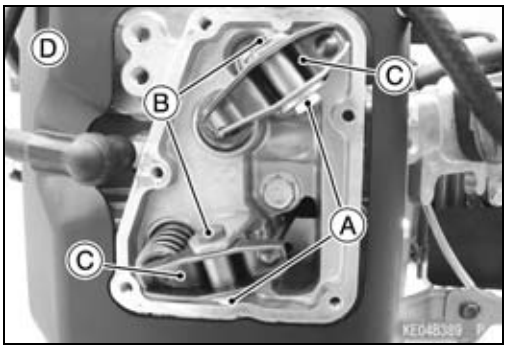
Rocker Arm Push Rod Runout
Service Limit:

Intake, Exhaust	**TIR 0.5 mm (0.02 in.)**

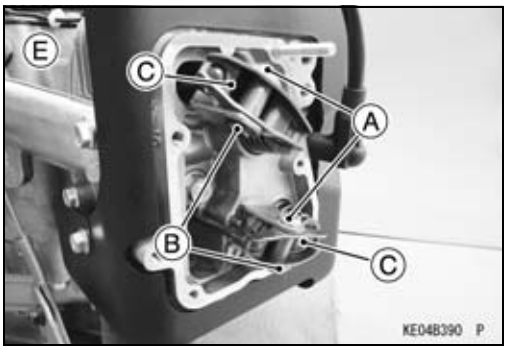
Valve Mechanism Removal/Installation

NOTE

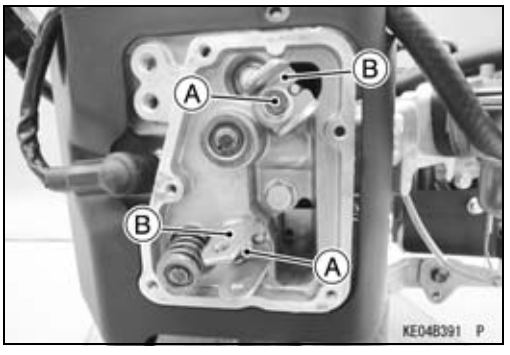
○*When removing the valve mechanism parts, note their position so that they may be reinstalled in their original position during assembly.*



- Remove the rocker cover and set piston at the top dead center (TDC) of #1 or #2 cylinder head to be removed (see Valve Clearance Inspection in the Periodic Maintenance chapter).
- Remove:
  Valve Clearance Adjusting Locknuts [A]
  Valve Clearance Adjusting Bolts [B] and Washer
  Rocker Shafts
  Rocker Arms [C]
  #1 Cylinder Head [D]
  #2 Cylinder Head [E]

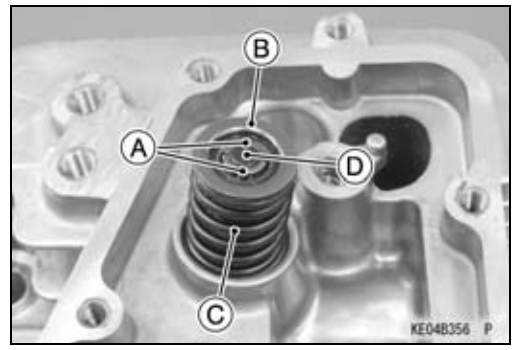


- Remove:
  Push Rods (see Push Rod Removal)
  Rocker Arm Bracket Bolts [A]
  Rocker Arm Brackets [B]



Cylinder Head

- 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 valve retainer, spring [C] and valve [D].

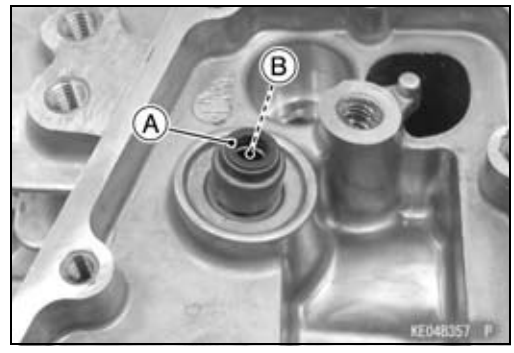


- Remove the stem seals [A].

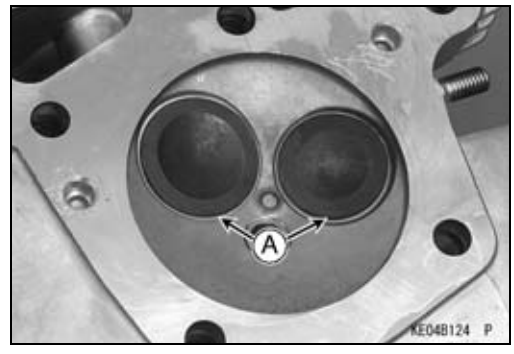
NOTE

○*It is not necessary to remove the stem seal unless it is being replaced.*

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



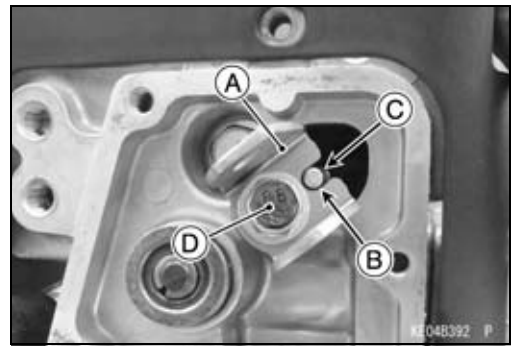
- Apply engine oil to the valve stem to avoid damaging the stem seal.
- Check to see that the valve moves smoothly up and down in the guide.
- Check to see that the valve seats properly in the valve seat [A]. If it does not, repair the valve seat (see Valve Seat Repair in the Periodic Maintenance chapter).
- Valve installation is the reverse of removal.
- Install the cylinder head assembly (see Cylinder Head Assembly Installation).



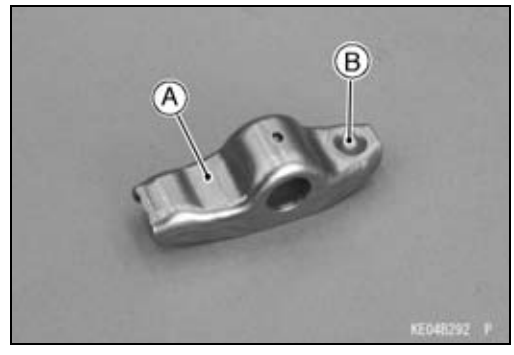
- Install the rocker arm bracket [A] so that bracket hollow [B] fit to the cylinder head projection [C].
- Apply a non-permanent locking agent to the rocker arm bracket bolt [D], and tighten it.

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

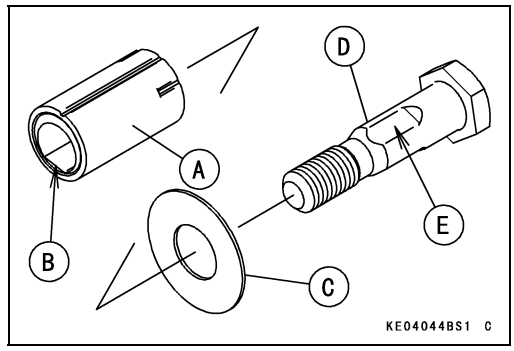
- Install the push rods (see Push Rod Installation).



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



Cylinder Head



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

○Align the flatten surface of the rocker shaft with the flatten surface [E] of the valve clearance adjusting bolt.

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

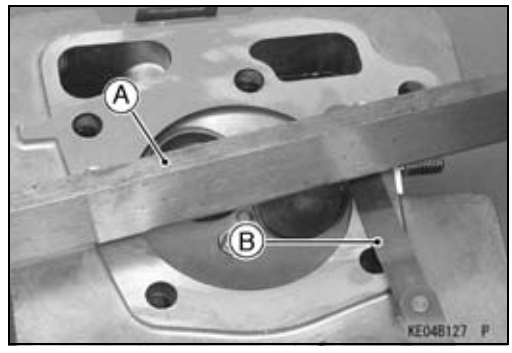
○Align the flatten surface of the rocker shaft with the flatten surface of the valve clearance adjusting bolt.

- Tighten the valve clearance adjusting locknut 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.

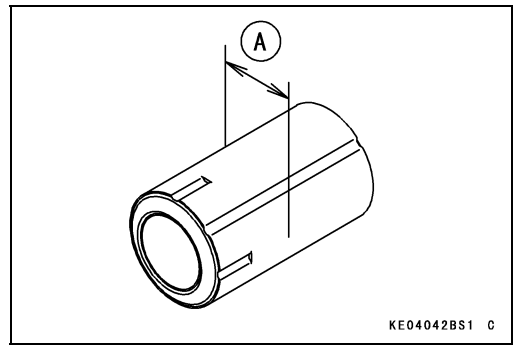
★If warp exceeds the service limit, repair the head by lapping the mating surface with emery paper secured to a surface plate (first No. 200, then No. 400). If the mating surface is badly damaged, replace the cylinder head.

Cylinder Head Warp
Service Limit: 0.05 mm (0.002 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

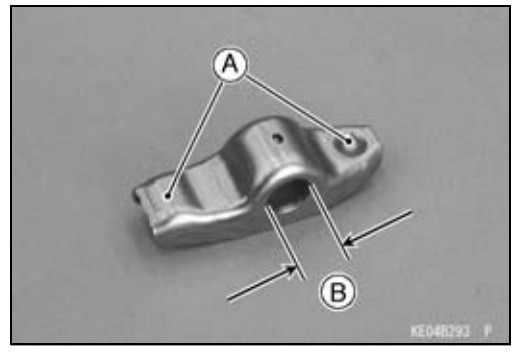


- Measure the diameter [A] of the rocker shaft with a micrometer at several points of bearing the rocker arm.

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

Rocker Shaft Outside Diameter
Service Limit:

Intake, Exhaust	**10.91 mm (0.430 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:

Intake, Exhaust	**11.13 mm (0.438 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.

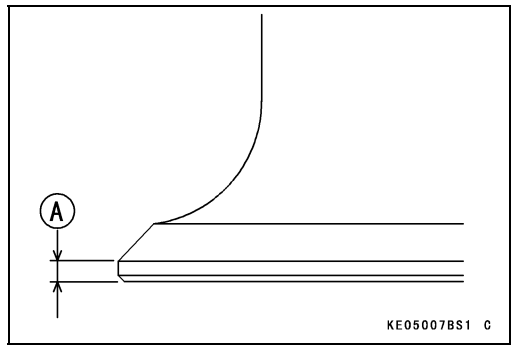
Valve Head Thickness

- 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:

Intake, Exhaust	**0.8 mm (0.03 in.)**



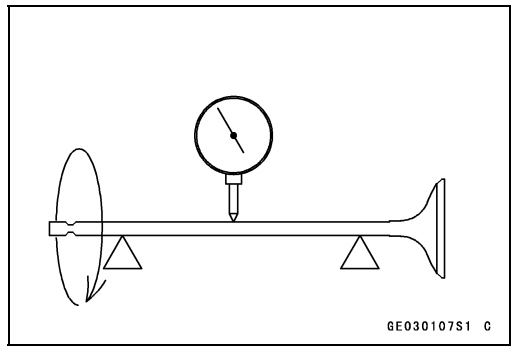
Valve Stem Runout

- 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:

Intake, Exhaust	**TIR 0.05 mm (0.002 in.)**



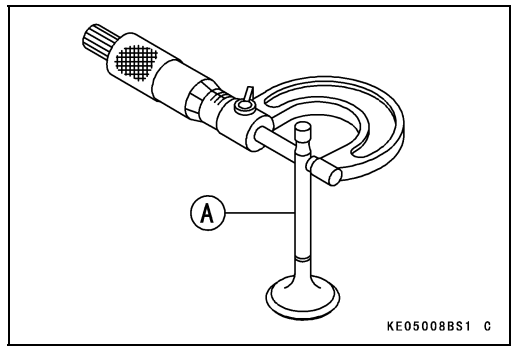
Valve Stem Diameter

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

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

Valve Stem Diameter
Service Limit:

Intake	**5.95 mm (0.234 in.)**
Exhaust	**5.93 mm (0.233 in.)**



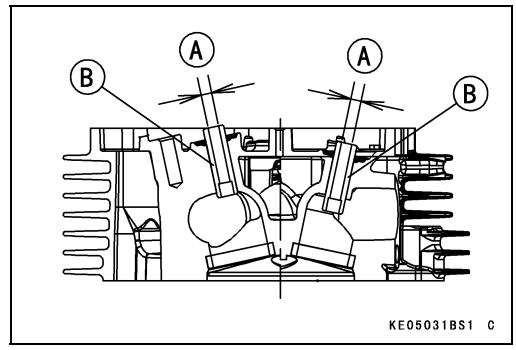
Valves

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 measurement is more than the service limit, replace the cylinder head with a new one.

Valve Guide Inside Diameter
Service Limit:
Intake, Exhaust 6.08 mm (0.239 in.)

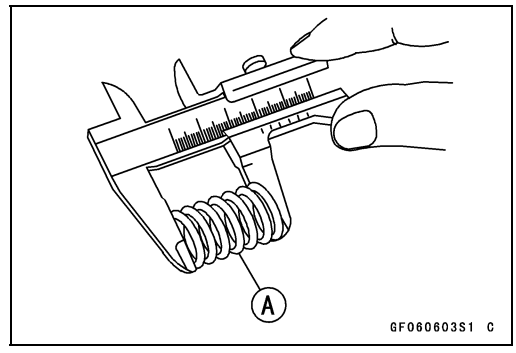


Valve Spring Inspection

- 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 measurement is less than the service limit, replace the spring with a new one.

Valve Spring Free Length
Service Limit:
Intake, Exhaust 31.2 mm (1.23 in.)

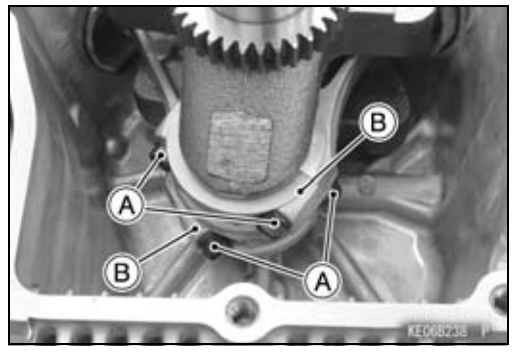


Cylinder, Piston

Piston Removal

- Remove:
  Cylinder Head Assembly (see Cylinder Head Assembly Removal)
  Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter)

- Remove the carbon deposits from top of the cylinder wall with a suitable tool such before the piston and connecting rod assemblies are pushed out.
- Turn the crankshaft to expose the connecting rod cap bolts [A].
- Remove the bolts and connecting rod caps [B].
- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.

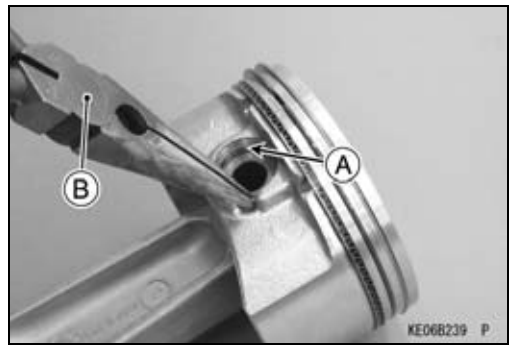


NOTE

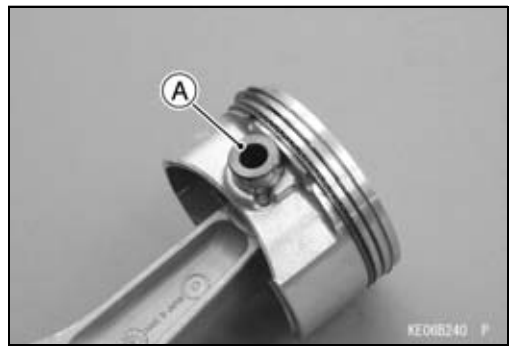
○*Note the positions of the connecting rod caps for reinstalling the caps.*

○*Mark and record the locations of the pistons, connecting rods and their connecting rod caps so that they can be reassembled in their original positions.*

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



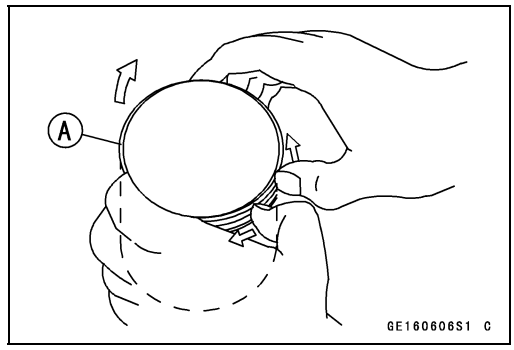
- Remove the piston by pushing the piston pin [A] to the direction from which the snap ring was removed.
- Remove the piston from the connecting rod.



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

Special Tool - Piston Ring Pliers: 57001-115

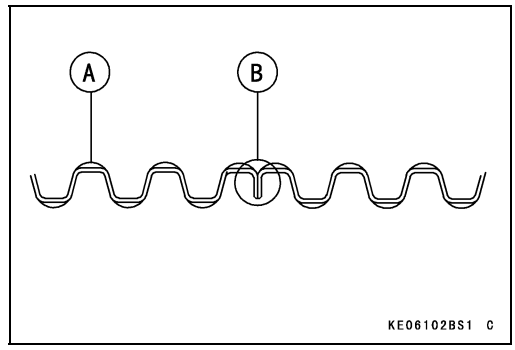
- If the special tool is not available, carefully spread the ring opening with your thumbs, then push up to the opposite side of the ring [A] to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.



Cylinder, Piston

Piston Installation

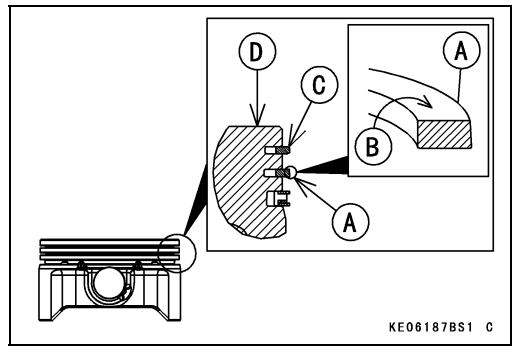
- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap them.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



- Install the second ring [A] so that the "2R" mark [B] faces upward.

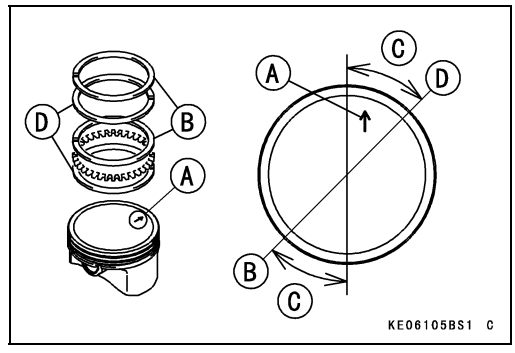
○Do not mix up the top and second rings.

- Install the top ring [C].
- The rings should turn freely in the ring grooves of the piston [D].



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

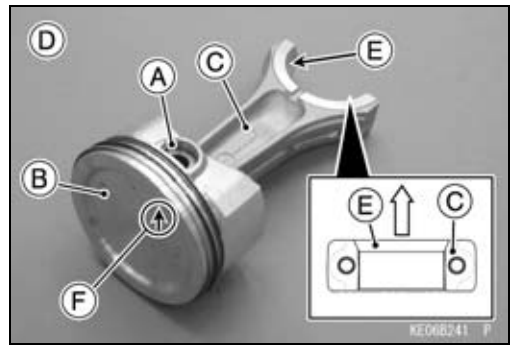
  Arrow Match Marks [A]
  Top Ring End Gap, Upper Steel Rail End Gap [B]
  About 45° [C]
  Second Ring End Gap, Lower Steel Rail End Gap [D]

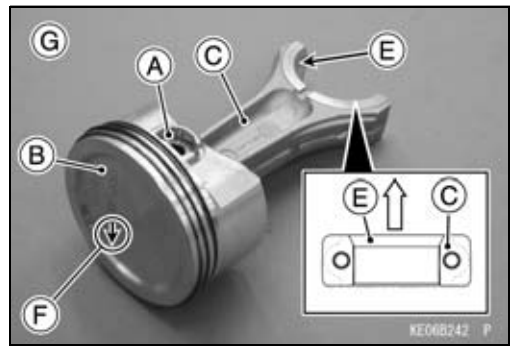


- Apply engine oil to the piston pins [A].
- Assemble the pistons [B] onto the connecting rods [C] as follow.

○For the #1 cylinder [D], when the large chamfer [E] of the connecting rod is faced upward, the arrow mark [F] on the piston head is pointed **upward**.

○For the #2 cylinder [G], when the large chamfer [E] of the connecting rod is faced upward, the arrow mark [F] on the piston head is pointed **downward**.

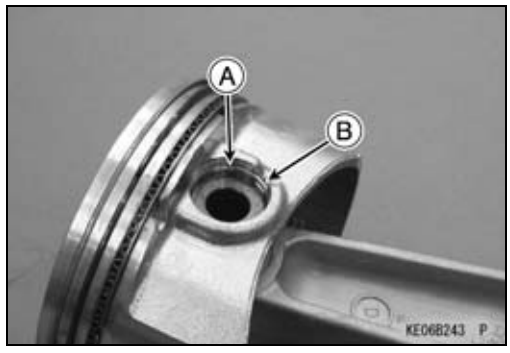




Cylinder, Piston

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

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

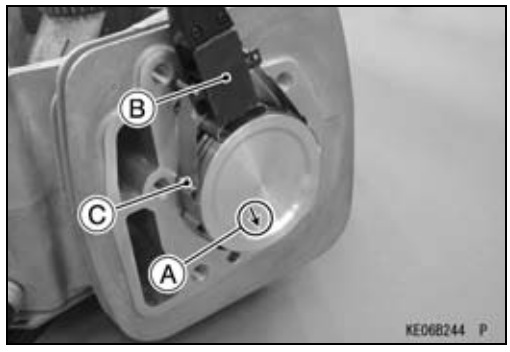


NOTICE

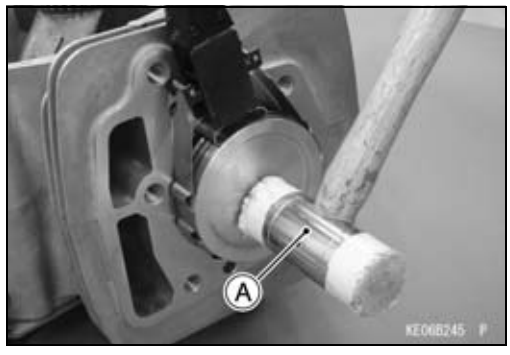
Do not reuse the snap rings, as removal weakens and deforms them. They could fall out and score the cylinder wall.

- Apply engine oil to the piston skirt and the cylinder bore.
- Insert the piston and connecting rod so that the arrow mark [A] on the top of the piston is facing the flywheel side.
- Using the piston ring compressor grip [B] and the belt [C], to compress the piston rings.

Special Tools - Piston Ring Compressor Grip: 57001-1095
Piston Ring Compressor Belt, ϕ67 ~ ϕ79: 57001-1097



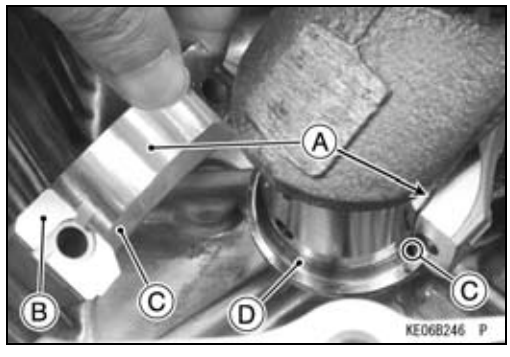
- Lightly tap the top of the piston with a plastic mallet [A] to insert the piston and connecting rod into the cylinder.



- Apply molybdenum disulfide oil solution oil to the sliding surfaces [A] of the connecting rod big end bore.

○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 [B] on their original position on each connecting rod big ends.



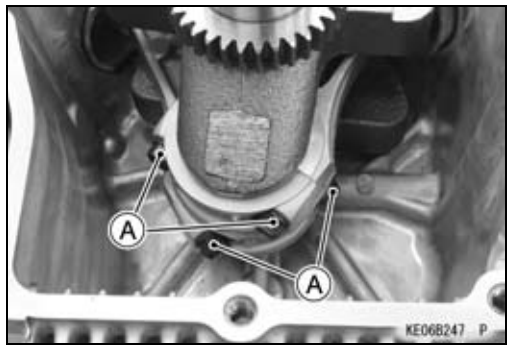
NOTE

○*Make sure that the large chamfers [C] are placed on the rounded area [D] of the crankpin ends.*

- Apply a thin layer of engine oil to the thread and seating surface of the cap bolts [A].
- Tighten:

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

- Install the removed parts.



Cylinder, Piston

Piston/Cylinder Seizure

- In case of seizure, remove the pistons (see Piston Removal).
- 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.

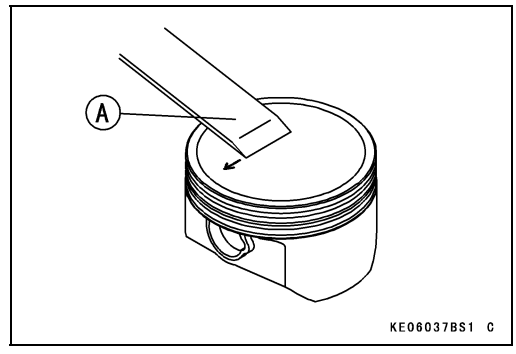
★If the damage is severe, replace the crankcase and pistons.

Piston Cleaning

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

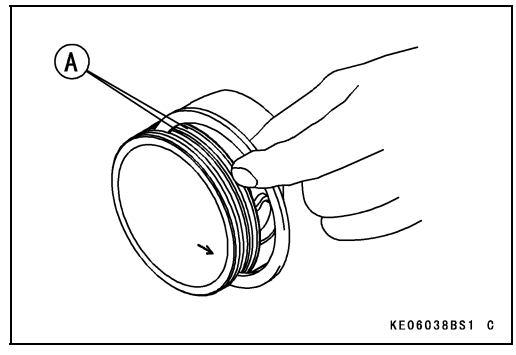
NOTICE
Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.

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



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

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



Piston Ring and Ring Groove Wear

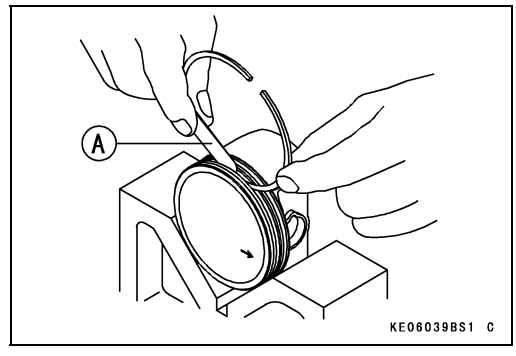
- Clean the piston (see Piston Cleaning).
- Visually inspect the piston rings and ring grooves.

★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.

- 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:

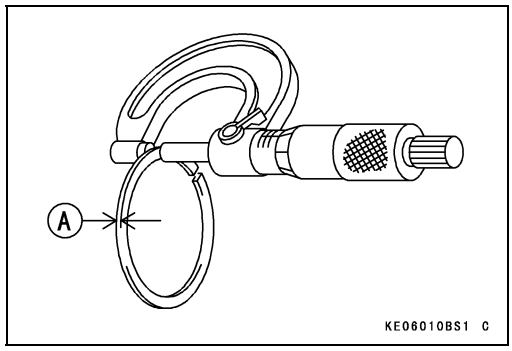
Top	**0.19 mm (0.0075 in.)**
Second	**0.20 mm (0.0079 in.)**

NOTE

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

Cylinder, Piston

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



Piston Ring Thickness
Service Limit:

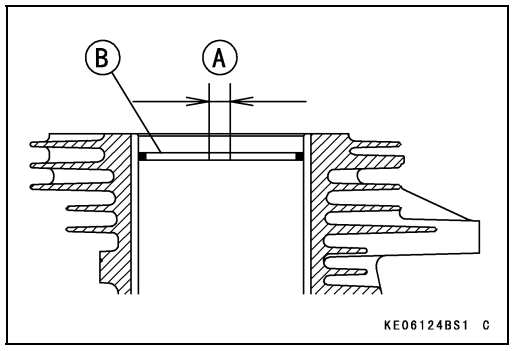
Top	**1.10 mm (0.0433 in.)**
Second	**1.10 mm (0.0433 in.)**

NOTE

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

Piston Ring End Gap

● Remove the piston rings (see Piston Removal).
● 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.

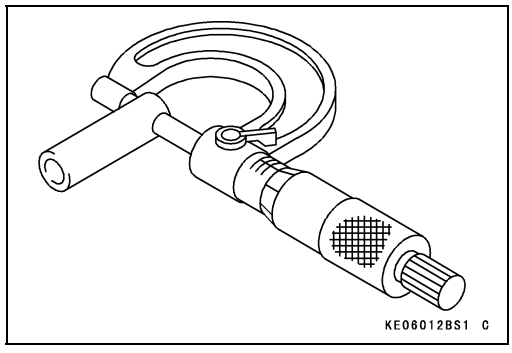


Piston Ring End Gap
Service Limit:

Top	**0.6 mm (0.024 in.)**
Second	**0.8 mm (0.031 in.)**
Oil	**0.9 mm (0.035 in.)**

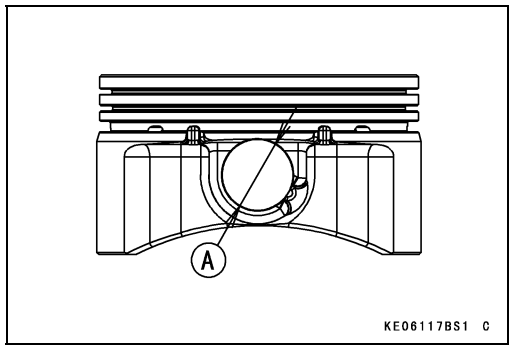
Piston Pin, Piston Pin Hole, and Connecting Rod Wear

● Remove the piston pin (see Piston Removal).
● Measure the outside diameter of the piston pin with a micrometer at several points.
★If the outside diameter is less than service limit, replace the piston pin with a new one.



Piston Pin Outside Diameter
Service Limit: 16.96 mm (0.6677 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.

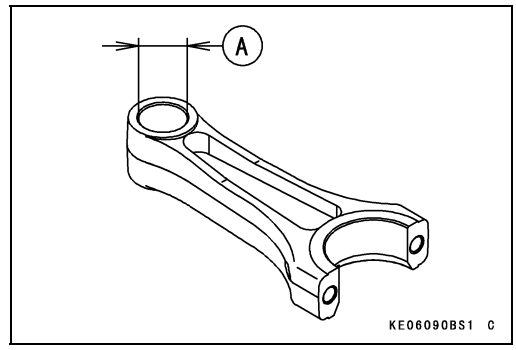


Piston Pin Hole Inside Diameter
Service Limit: 17.08 mm (0.6724 in.)

Cylinder, Piston

● 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.

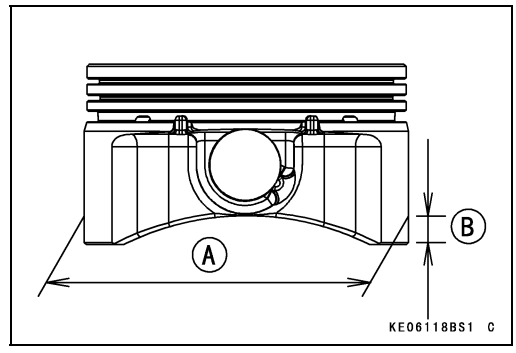
Connecting Rod Small End Inside Diameter
Service Limit: 17.06 mm (0.672 in.)



Piston Diameter

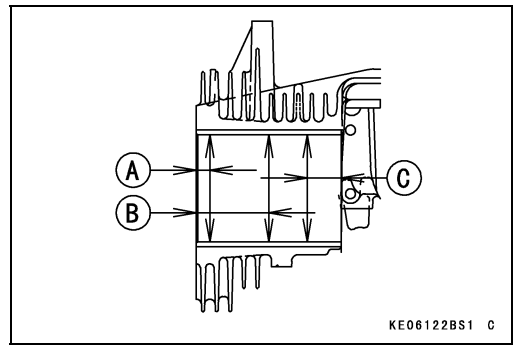
● Measure the outside diameter [A] of the piston 11 mm (0.43 in.) [B] up from the bottom of the piston at a right angle to the direction of the piston pin hole.
★If the measurement is less than the service limit, replace the piston with a new one.

Piston Diameter
Service Limit: 77.79 mm (3.063 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.
★If any of the cylinder inside diameter measured value is greater than the service limit, replace the crankcase with a new one.
10 mm (0.39 in.) [A]
55 mm (2.17 in.) [B]
25 mm (0.98 in.) [C]



Cylinder Inside Diameter
Standard:

Standard Cylinder	**77.98 ~ 78.00 mm (3.070 ~ 3.071 in.)**
0.50 mm Oversize	**78.48 ~ 78.50 mm (3.090 ~ 3.091 in.)**

Service Limit:

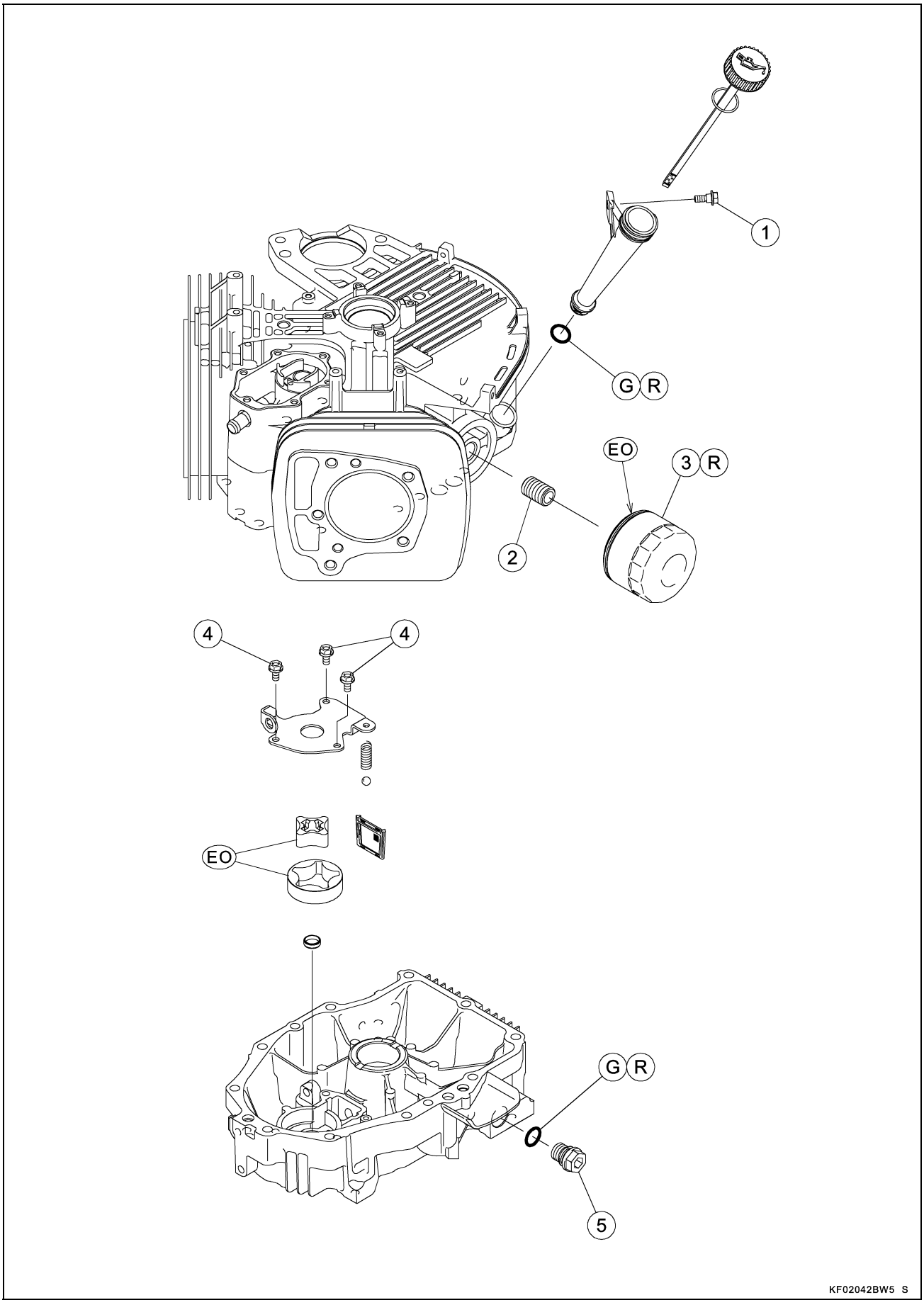
Standard Cylinder	**78.08 mm (3.074 in.)**
0.50 mm Oversize	**78.58 mm (3.094 in.)**

Cylinder Inside Diameter Out Round
Service Limit: 0.05 mm (0.002 in.)

Lubrication System

Table of Contents

Exploded View

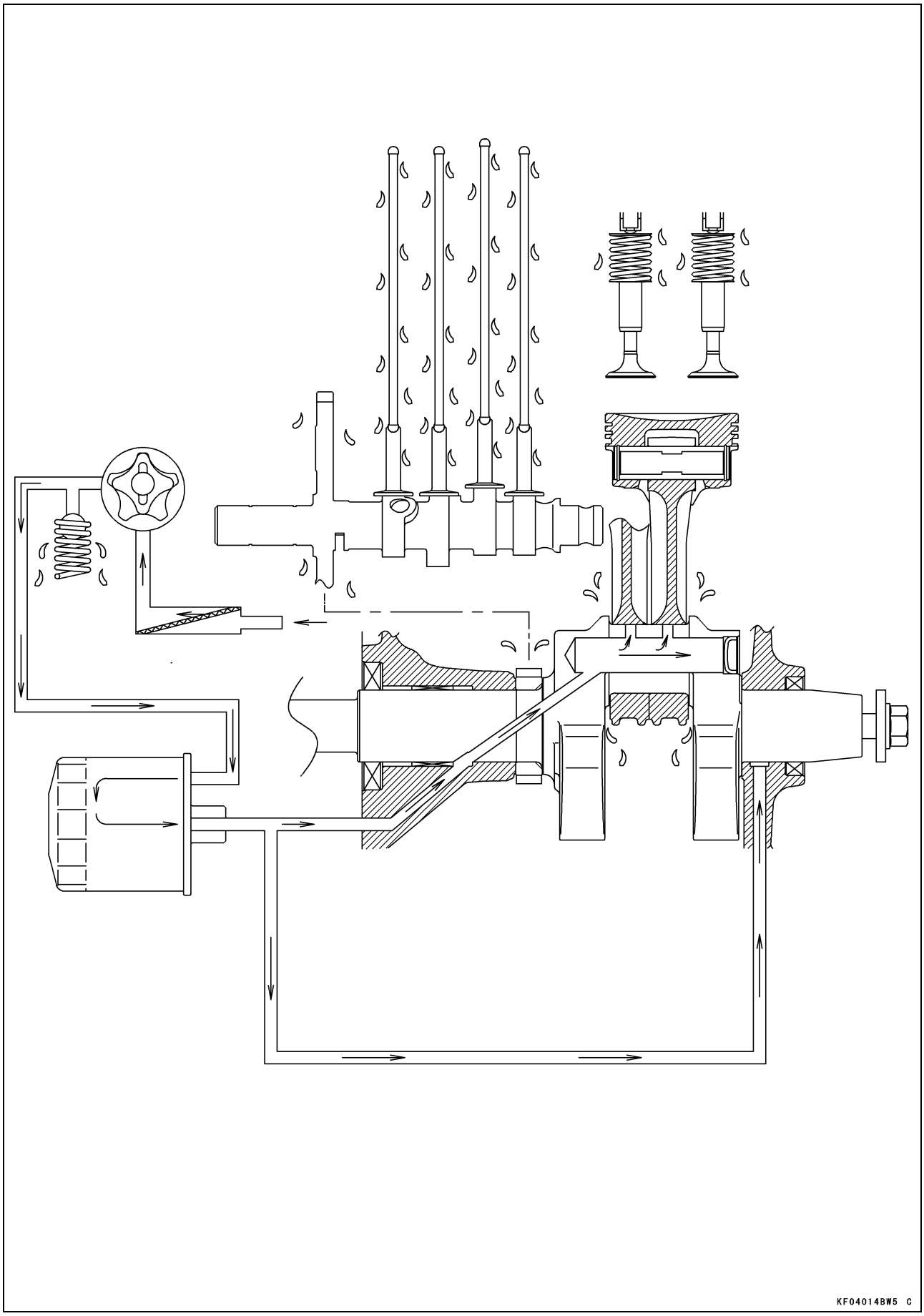


Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Oil Filler Mounting Bolt	9.8	1.0	87 in·lb	
2	Oil Filter Pipe	27	2.8	20	
3	Oil Filter	5.8	0.59	51 in·lb	R
4	Oil Pump Cover Plate Bolts	6.9	0.70	61 in·lb	
5	Engine Oil Drain Plug	7.9	0.81	70 in·lb	G

EO: Apply engine oil.
G: Apply grease.
R: Replacement Parts

Engine Oil Flow Chart



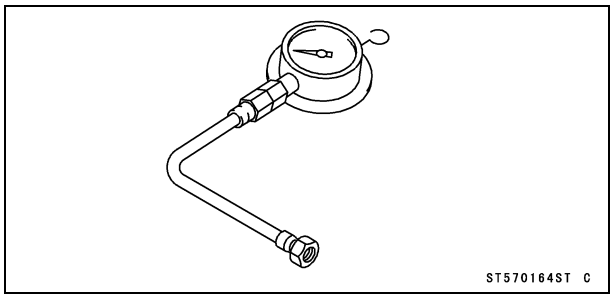
Specifications

Item	Standard
Engine Oil	
Grade	API SJ or SL class
Viscosity	SAE40, SAE30, SAE20W-50, SAE10W-30/SAE10W-40, or SAE5W-20
Capacity:	
When the oil filter is not removed	1.8 L (1.9 US qt)
When the oil filter is removed	2.1 L (2.2 US qt)
Level	Operating range (dimpled area (ADD and FULL)) on dipstick
Oil Pressure	294 ~ 588 kPa (3.0 ~ 6.0 kgf/cm², 43 ~ 85 psi): Engine oil temperature 50 ~ 60°C (122 ~ 140°F) @3 200 r/min (rpm)

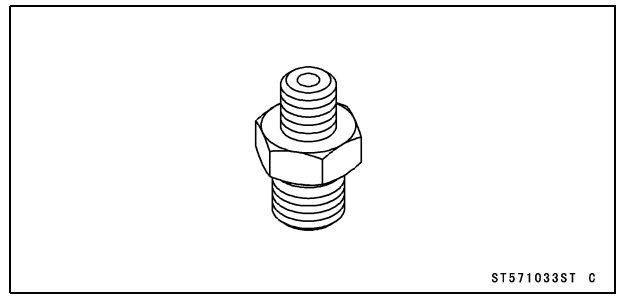
Item	Service Limit
Oil Pump	
Inner and Outer Rotor Clearance	0.2 mm (0.008 in.)
Outer Rotor Outside Diameter	52.31 mm (2.059 in.)
Outer Rotor Thickness	14.96 mm (0.5890 in.)
Pump Housing Inside Diameter	52.72 mm (2.076 in.)
Pump Housing Depth	15.17 mm (0.5972 in.)
Relief Valve Spring Free Length	20.4 mm (0.803 in.)

Special Tools

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



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



Engine Oil and Oil Filter

NOTICE
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.

Pressurized Lubrication System

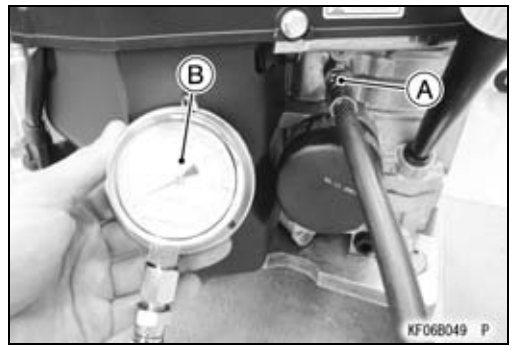
The engine lubrication circuit is a pressurized system consisting of a positive displacement pump which picks up oil through a oil screen from the crankcase. The oil is pumped to a replaceable oil filter cartridge, through the engine's oil passages to lubricate internal components, and return to the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

Oil Pressure Measurement

- Remove the oil passage plug [A].

- 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 ~ 588 kPa (3.0 ~ 6.0 kgf/cm², 43 ~ 85 psi): Engine oil temperature 50 ~ 60°C (122 ~ 140°F) @3 200 r/min (rpm)

- Stop the engine.
★If the oil pressure is below the specification, inspect the oil pump and relief valve (see Oil Pump, Relief Valve Inspection).
★If the oil pump and relief valve are not at fault, inspect the rest of the lubrication system.
- Remove the oil pressure gauge and adapter.

⚠ WARNING

Hot oil can cause severe burns. Beware of hot engine oil that will drain through the oil passage when the gauge adapter is removed.

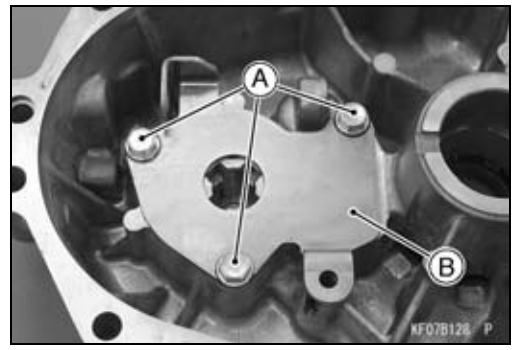
- Apply a non-permanent locking agent (LOCTITE: VIBRASEAL 516 or equivalent) to the threads of the oil passage plug [A], and tighten it.

Torque - Oil Passage Plug (PT 1/8): 3.9 N·m (0.40 kgf·m, 35 in·lb)

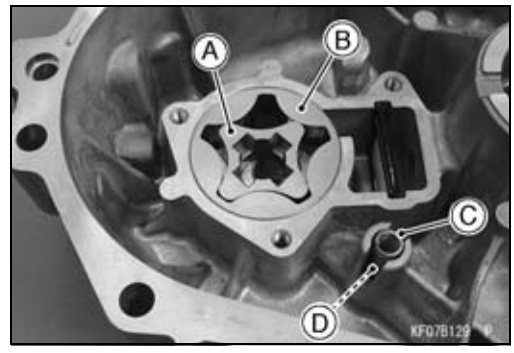
Oil Pump, Relief Valve

Oil Pump, Relief Valve Removal

● Remove:
Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankcase chapter)
Oil Pump Cover Plate Bolts [A]
Oil Pump Cover Plate [B]



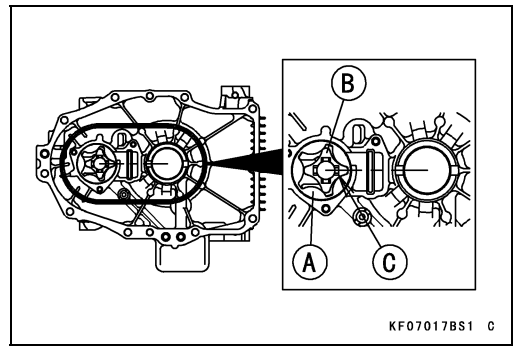
● Remove:
Inner Rotor [A]
Outer Rotor [B]
Spring [C]
Relief Valve Ball [D]



Oil Pump, Relief Valve Installation

● Fill the rotor housing with engine oil for initial lubrication.
● Install the outer rotor [A] and inner rotor [B].
○Align the inner rotor groove [C] to the center of the crankcase cover as shown.
● Install the relief valve ball and relief valve spring in position.
● Install the oil pump cover plate.
● Tighten:

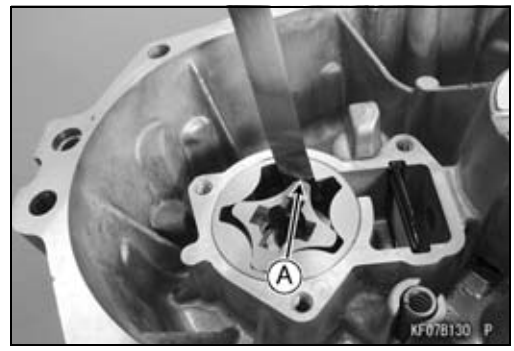
Torque - Oil Pump Cover Plate Bolts: 6.9 N·m (0.70 kgf·m, 61 in·lb)



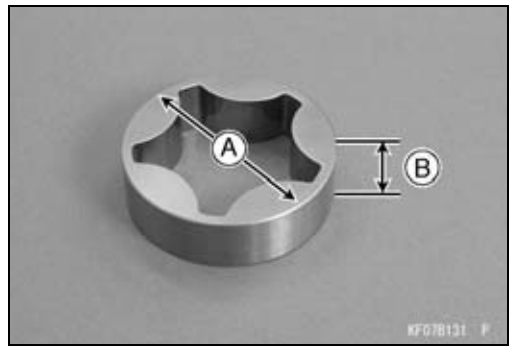
Oil Pump, Relief Valve Inspection

● Remove the oil pump cover plate (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.)



Oil Pump, Relief Valve



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

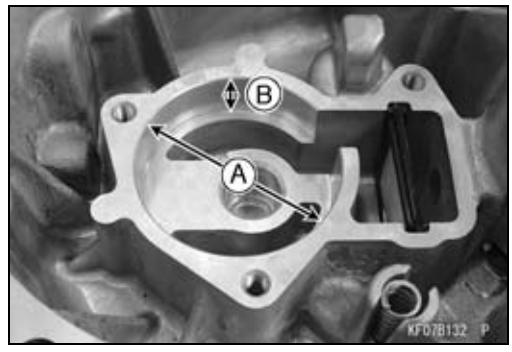
★If the rotor diameter is less than the service limit, replace both the inner and outer rotor with new ones.

Outer Rotor Outside Diameter
Service Limit: 52.31 mm (2.059 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: 14.96 mm (0.5890 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: 52.72 mm (2.076 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: 15.17 mm (0.5972 in.)

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

★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

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the engine parts in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low flash-point solvents to clean parts.

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

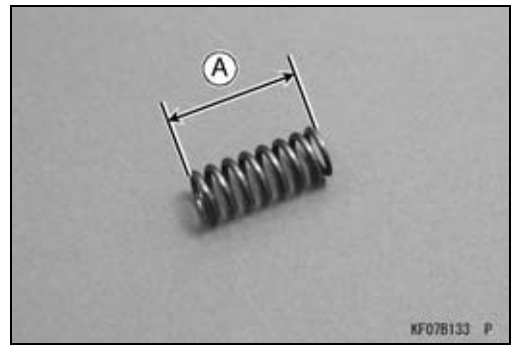
★If necessary, put the ball in position and lightly tap the ball with a suitable tool to form a perfect seat.

Oil Pump, Relief Valve

- 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.

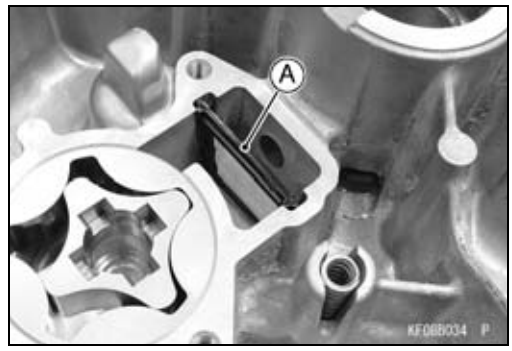
Relief Valve Spring Free Length
Service Limit: 20.4 mm (0.803 in.)



Oil Screen

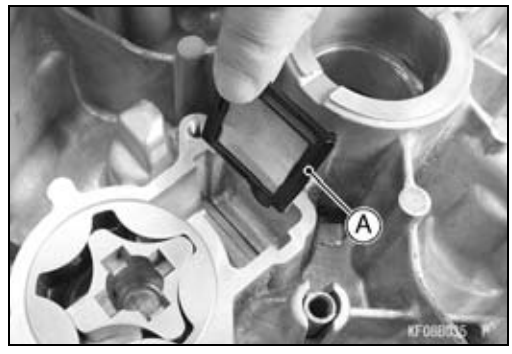
Oil Screen Removal

- 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 cover plate (see Oil Pump, Relief Valve Installation).

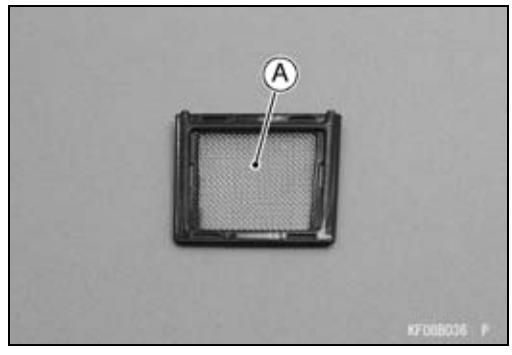


Oil Screen Cleaning and Inspection

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

⚠ WARNING

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the engine parts in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low flash-point solvents to clean parts.



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

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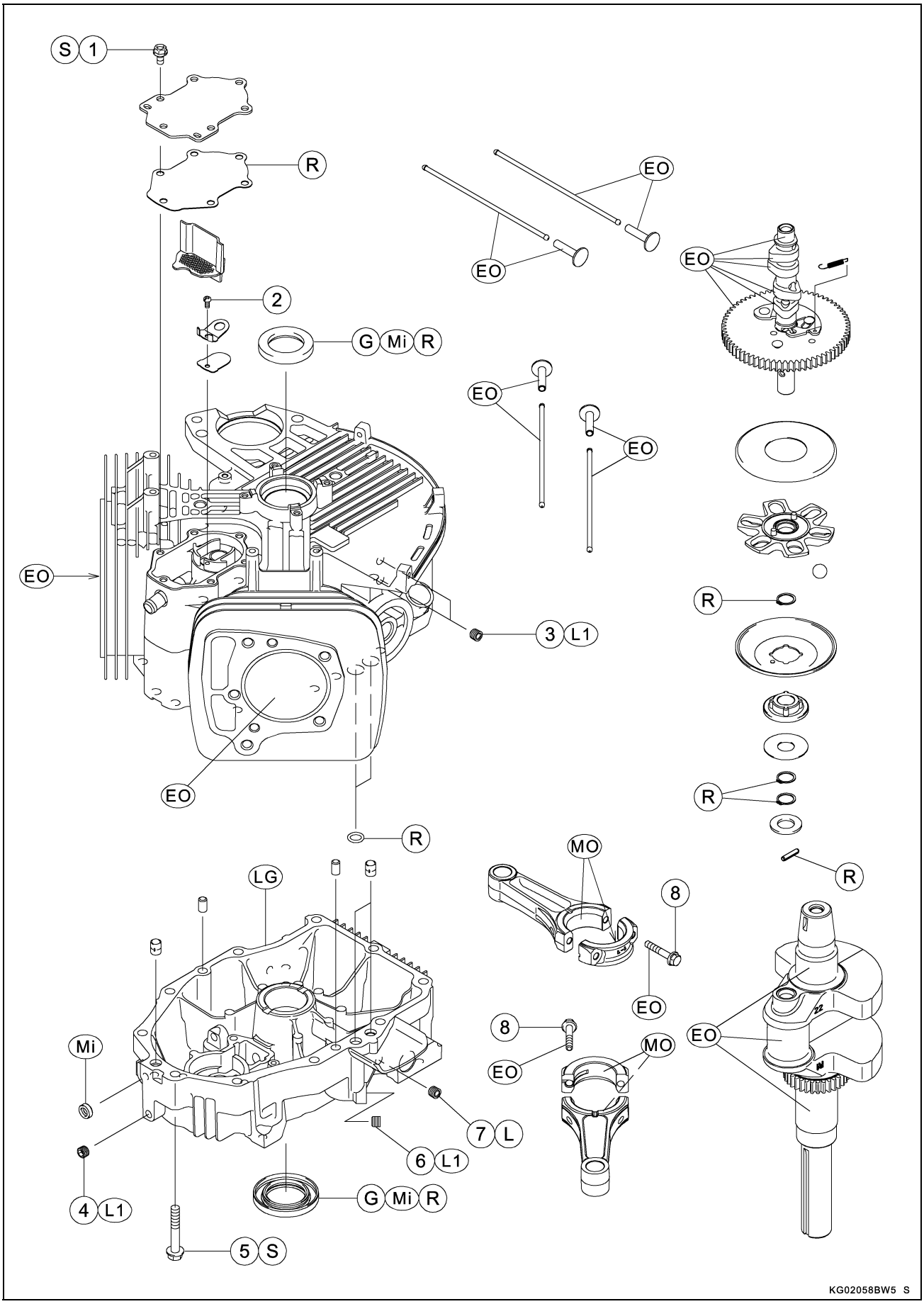
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Breather Chamber Cover Bolts	6.9	0.70	61 in·lb	S
2	Breather Valve Mounting Screw	2.2	0.22	19 in·lb	
3	Crankcase Oil Passage Plug (PT 1/8)	3.9	0.40	35 in·lb	L1
4	Crankcase Cover Oil Passage Plug (PT 1/16)	3.9	0.40	35 in·lb	L1
5	Crankcase Cover Bolts	25	2.5	18	S
6	Crankcase Cover Oil Passage Plug (PT 1/8)	3.9	0.40	35 in·lb	L1
7	Crankcase Cover Oil Passage Plug (PT 1/4)	5.2	0.53	46 in·lb	L
8	Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	EO

EO: Apply engine oil.
G: Apply grease.
L: Apply a non-permanent locking agent.
L1: Apply a non-permanent locking agent (LOCTITE: VIBRASEAL 516 or equivalent).
LG: Apply liquid gasket.
Mi: Apply mineral oil.
MO: Apply molybdenum disulfide oil solution.
(mixture of engine oil and molybdenum disulfide grease in a weight ratio 10:1)
R: Replacement Parts
S: Follow the specified tightening sequence.

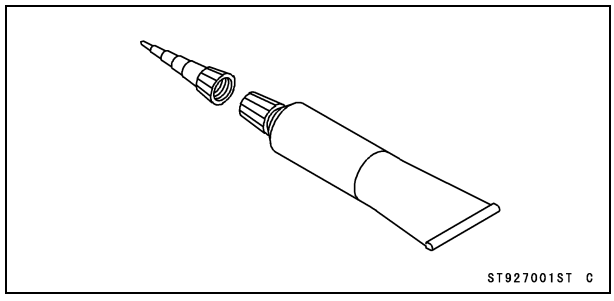
7-4 CAMSHAFT/CRANKSHAFT

Specifications

Item	Service Limit
Camshaft, Tappet	
Cam Lobe Height:	
Intake	29.59 mm (1.165 in.)
Exhaust	29.59 mm (1.165 in.)
Camshaft Journal Diameter:	
PTO Side	15.99 mm (0.630 in.)
Flywheel Side	15.99 mm (0.630 in.)
Camshaft Bearing Inside Diameter:	
Crankcase	16.14 mm (0.6354 in.)
Crankcase Cover	16.14 mm (0.6354 in.)
Crankshaft, Connecting Rod	
Connecting Rod Bend	TIR 0.15/100 mm (0.006/3.94 in.)
Connecting Rod Twist	TIR 0.15/100 mm (0.006/3.94 in.)
Connecting Rod Big End Width	21.85 mm (0.8602 in.)
Crankpin Width	44.7 mm (1.76 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	39.90 mm (1.571 in.)
Flywheel Side	39.88 mm (1.570 in.)
Crankcase	
Crankshaft Bearing Inside Diameter:	
Crankcase	40.035 mm (1.5762 in.)
Crankshaft Journal Bearing Inside Diameter:	
Crankcase Cover	40.065 mm (1.5774 in.)

Sealant

Liquid Gasket, TB1217H:
92104-7001

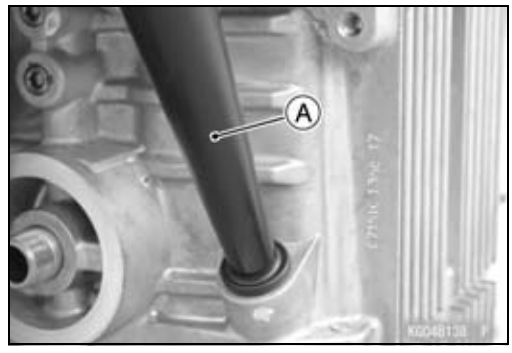


Crankcase

Crankcase Cover Removal

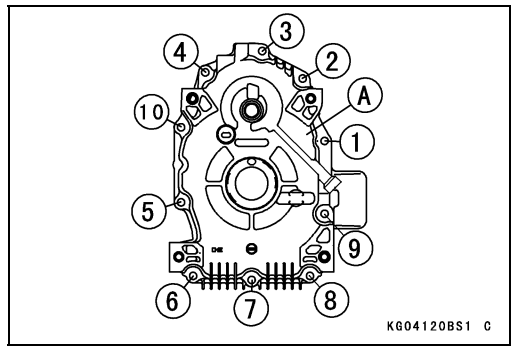
- Set the engine on a clean surface while parts are being removed.
- Drain the engine oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove:
  Intake Manifold (see Intake Manifold Removal in the Fuel System chapter)
  Flywheel and Stator Coil (see Flywheel and Stator Coil Removal in the Electrical System chapter)
  Starter Motor (see Starter Motor Removal in the Starter System chapter)
  Oil Filter (see Oil Filter Replacement in the Periodic Maintenance chapter)
  Governor Arm (see Governor Arm Removal in the Fuel System chapter)

- Remove the dipstick and oil filler tube [A].



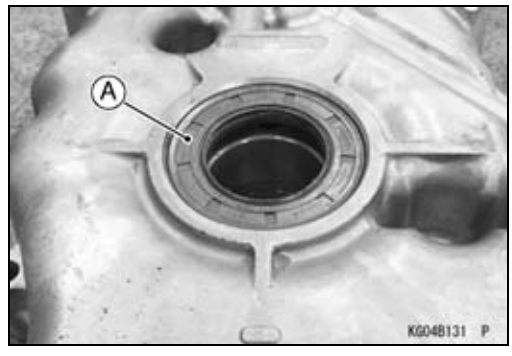
- Turn the engine so that the crankcase cover [A] is facing up.
- Remove the mounting bolts in the order shown [1 ~ 10].
- Tap the crankcase cover gently with a wooden or plastic mallet to remove the crankcase cover from the crankcase.

○There are two dowel pins on the crankcase mating surface.



Crankcase Cover Disassembly

- Remove the crankcase cover (see Crankcase Cover Removal).
- Pry the crankshaft oil seal [A] with the suitable tool, and remove it.



Crankcase

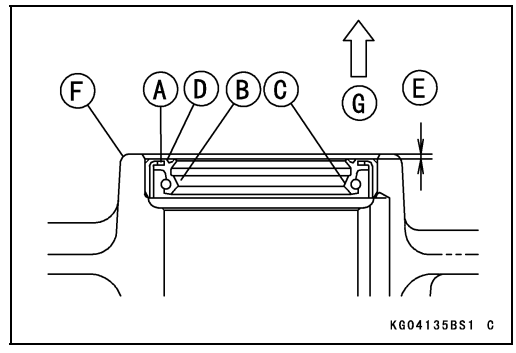
Crankcase Cover Assembly

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

⚠ WARNING

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the crankcase and cover in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low flash-point solvents to clean parts.

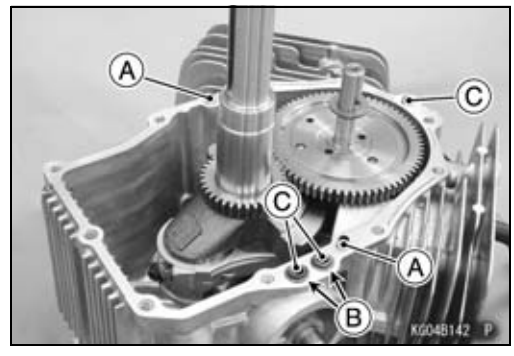
- Be sure to replace the oil seal with a new one if removed.
- Apply mineral oil to the crankshaft oil seal outside.
- Install the oil seal so that the marks [A] face out.
- Thoroughly pack high-temperature grease to 60% volume into the space [B] between the seal lip [C] and the dust lip [D].
- Press in the new oil seal using a press or suitable tools until 1.0 ~ 2.5 mm (0.04 ~ 0.10 in.) [E] below the flange surface [F] as shown.
- Be careful not to damage the seal lips during installation.
  [G]: PTO Side



- Install the crankcase cover (see Crankcase Cover Installation).

Crankcase Cover Installation

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



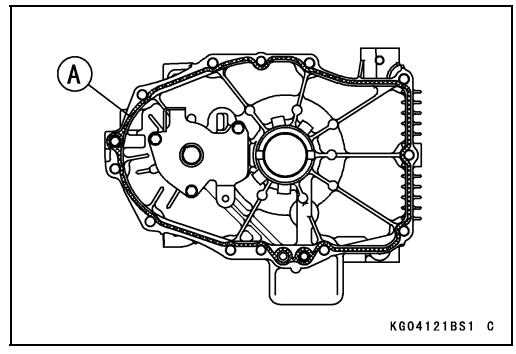
- Align the inner rotor groove to the center of the crankcase cover (see Oil Pump, Relief Valve Installation in the Lubrication System chapter).
- Apply liquid gasket [A] to the mating surface of the crankcase cover.

Sealant - Liquid Gasket, TB1217H: 92104-7001

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.*

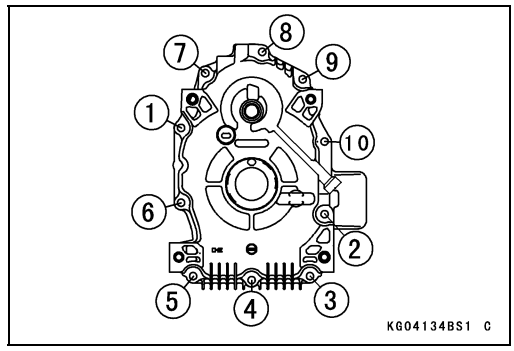


Crankcase

- Install the crankcase cover and tighten the crankcase cover bolts following the tightening sequence [1 ~ 10] as shown.

Torque - Crankcase Cover Bolts: 25 N·m (2.5 kgf·m, 18 ft·lb)

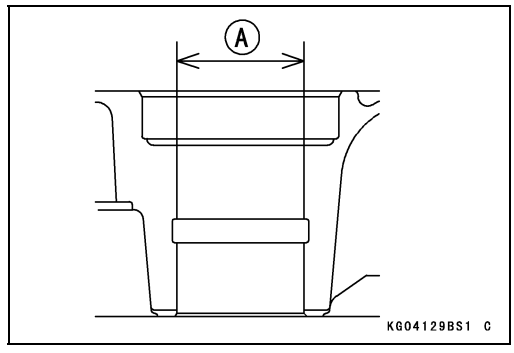
- Install the removed parts.



Crankcase Cover Inspection

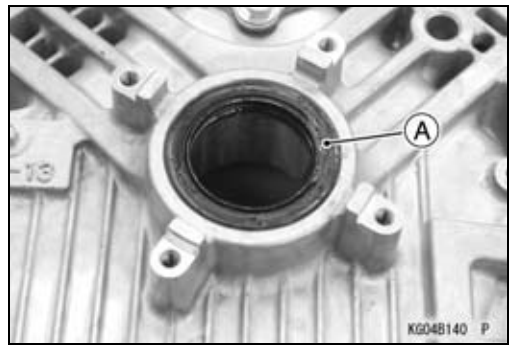
- Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase cover at several points. Replace the crankcase cover if the inside diameter is more than the service limit.

Crankshaft Journal Bearing Inside Diameter
Service Limit: 40.065 mm (1.5774 in.)



Crankcase Disassembly

- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
  Camshaft and Tappets (see Camshaft, Tappet Removal)
  Crankshaft (see Crankshaft Removal)
- Pry the crankshaft oil seal [A] with the suitable tool, and remove it.



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.

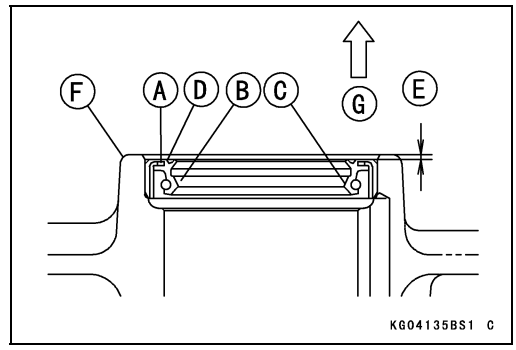
⚠ WARNING

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the crankcase and cover in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low flash-point solvents to clean parts.

Crankcase

- 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.
- Thoroughly pack high-temperature grease to 60% volume into the space [B] 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 1 mm (0.04 in.) [E] below the flange surface [F] as shown.
- Do not damage the seal lips.

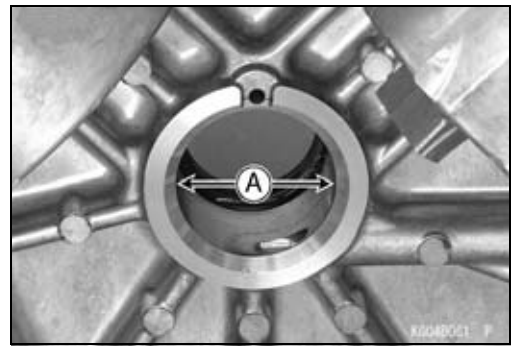
[G]: Flywheel Side



Crankcase Inspection

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

Crankshaft Bearing Inside Diameter
Service Limit: 40.035 mm (1.5762 in.)



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.

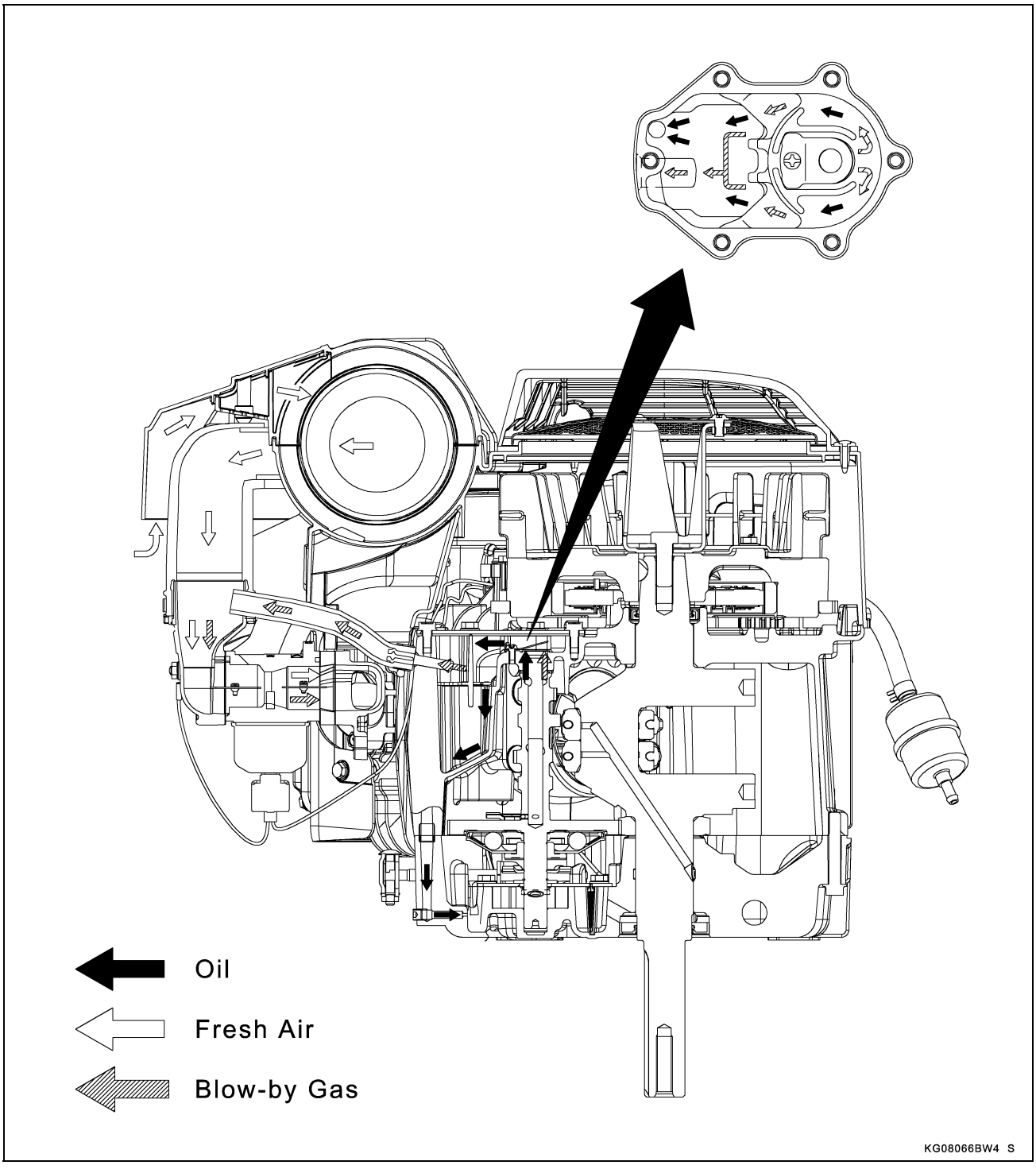
⚠ WARNING

Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the crankcase and cover in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low flash-point solvents to clean parts.

Breather

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

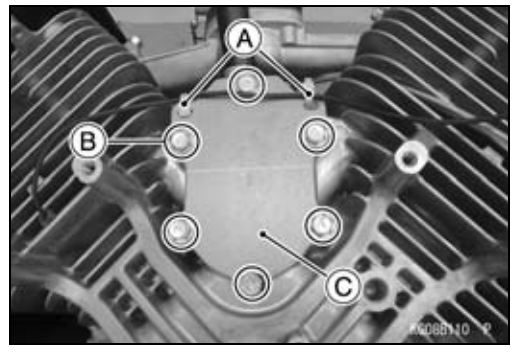
Oil is primarily separated from the gases while passing through the inside of the rocker chamber from the crankcase, and secondly separated from the gases in the breather chamber, and then returned back to the crankcase cover.



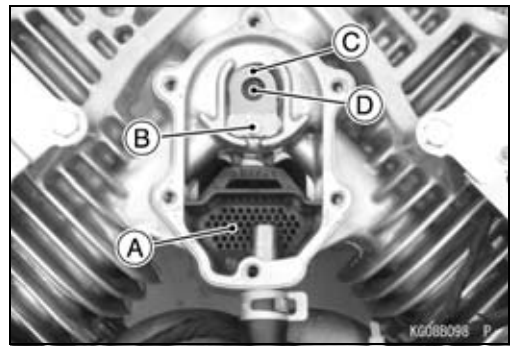
Breather

Breather Valve Removal

- Remove:
  Stator Coil (see Flywheel and Stator Coil Removal in the Electrical System chapter)
- Cut the bands [A].
- Unscrew the bolts [B] and remove the breather chamber cover [C] and the gasket.



- Remove:
  Breather Separator [A]
  Screw [B]
  Back Plate [C]
  Reed Valve [D]

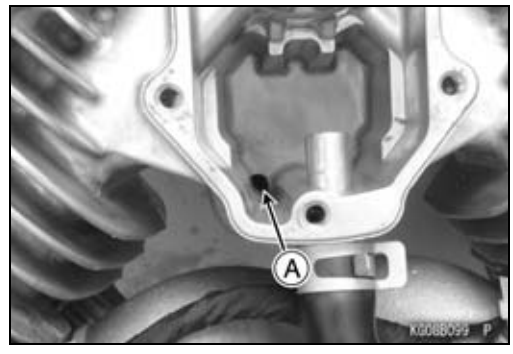


Breather Valve Installation

- Align center of the valve seat with center of the reed valve and back plate.
- Tighten:

Torque - Breather Valve Mounting Screw: 2.2 N·m (0.22 kgf·m, 19 in·lb)

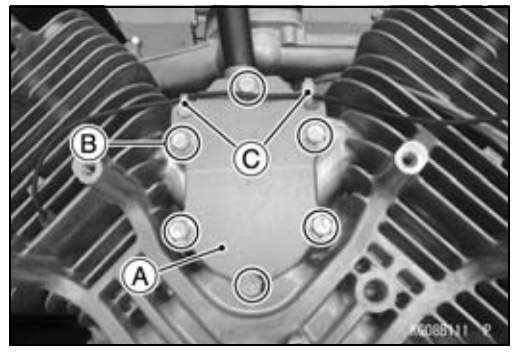
- Be sure the drain hole [A] on the breather chamber does not accumulate with slugs.



- Replace the breather chamber cover gasket with a new one.
- Install:
  Breather Separator
  Gasket
  Breather Chamber Cover [A]
- Tighten:

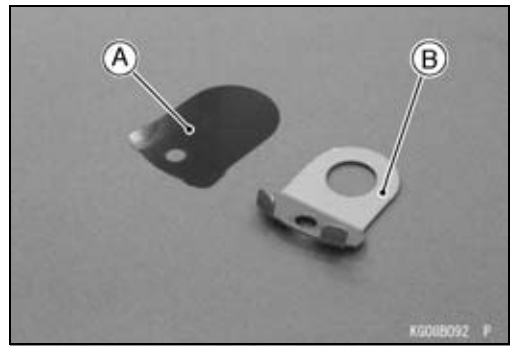
Torque - Breather Chamber Cover Bolts [B]: 6.9 N·m (0.70 kgf·m, 61 in·lb)

- Attach the state coil lead to the breather chamber cover with the bands [C].
- Install the removed parts.



Breather Valve Inspection

- Inspect the reed valve [A] for breakage, crack or distortion, replace it with a new one if necessary.
- Inspect the back 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.

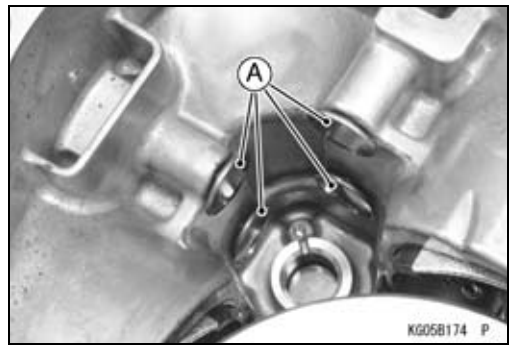


Camshaft, Tappet

Camshaft, Tappet Removal

- Set the engine on a clean surface while parts are removed.
- Drain the engine oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
  Cylinder Head Assembly (see Cylinder Head Assembly Removal in the Engine Top End chapter)
- Turn the crankcase upside down so that the tappets will fall away from the cam lobes.
- Pull the camshaft [A] out of the crankcase.

- Remove the tappets [A] and mark them so they can be installed in their original positions during assembly.

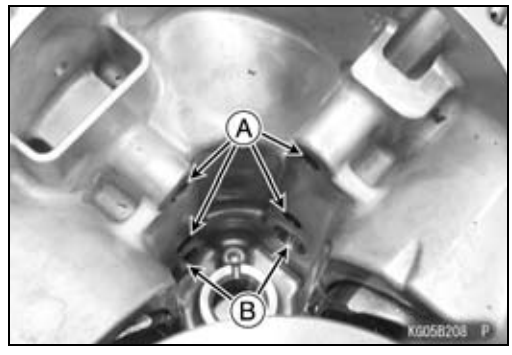


Camshaft, Tappet Installation

- Apply engine oil to the tappet journal.
- Insert the tappets into the tappet holes in the crankcase.

NOTE

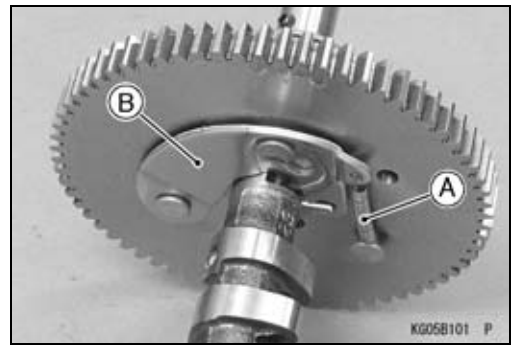
○*Insert the tappets for the intake valve into the correct tappet holes [A]. Be careful not to insert the tappets into the large diameter holes [B] near the tappet holes.*



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

Camshaft, Tappet

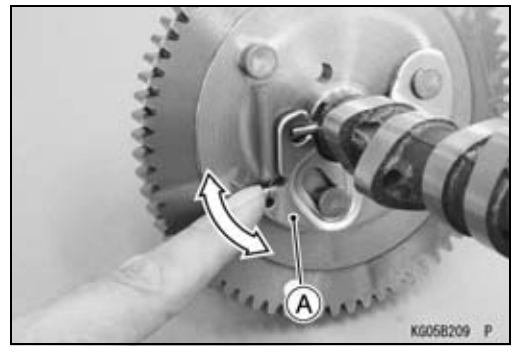
Camshaft Disassembly



- Remove:
  Spring [A]

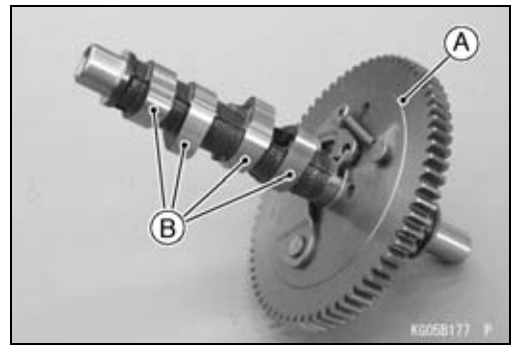
○Do not remove the ACR (automatic compression release) weight [B].

Camshaft Assembly



- After assembling the camshaft, check if the ACR weight [A] swings smoothly.

Camshaft Inspection



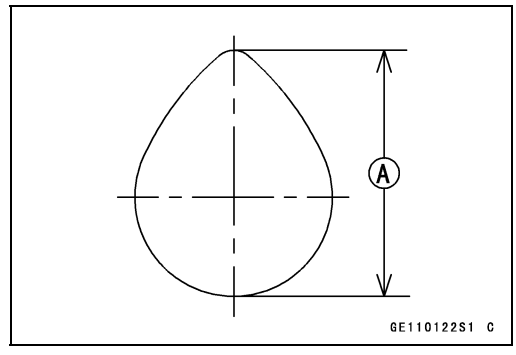
- Check the camshaft gear [A] for pitting, fatigue cracks, burrs or any evidence of improper tooth contact.

★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

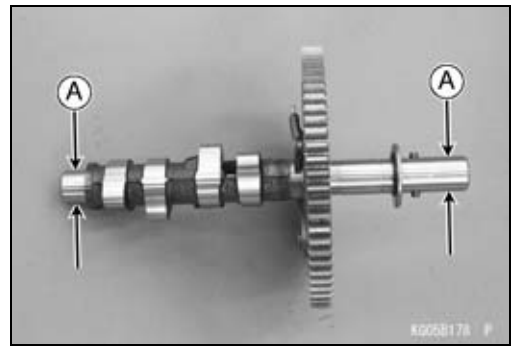


- Measure the height [A] of each cam lobe.

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

Cam Lobe Height
Service Limits:

Intake	**29.59 mm (1.165 in.)**
Exhaust	**29.59 mm (1.165 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 Limits:

PTO Side	**15.99 mm (0.630 in.)**
Flywheel Side	**15.99 mm (0.630 in.)**

Camshaft, Tappet

● Measure the inside diameter [A] of the camshaft insert on the crankcase at several points.

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

Camshaft Bearing Inside Diameter (Crankcase)
Service Limit: 16.14 mm (0.6354 in.)

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

★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: 16.14 mm (0.6354 in.)

Crankshaft, Connecting Rod

Connecting Rod Removal

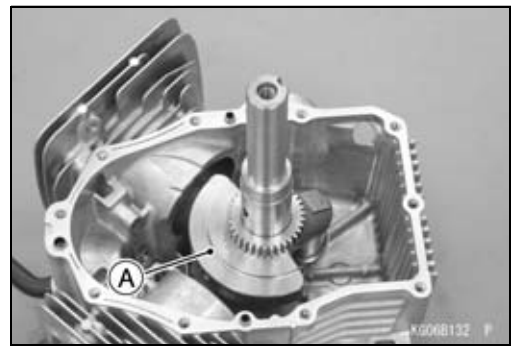
- Remove the pistons (see Piston Removal in the Engine Top End chapter).

Connecting Rod Installation

- Install the pistons (see Piston Installation in the Engine Top End chapter).

Crankshaft Removal

- Remove:
  Camshaft (see Camshaft, Tappet Removal)
  Connecting Rods and Pistons (see Piston Removal in the Engine Top End chapter)
- Pull the crankshaft [A] out of the crankcase. Tap the end of crankshaft 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.
- Apply engine oil to the crankshaft journal.
- Apply molybdenum disulfide oil solution to the crankpin.
- Carefully insert the crankshaft end into the main bearing 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.

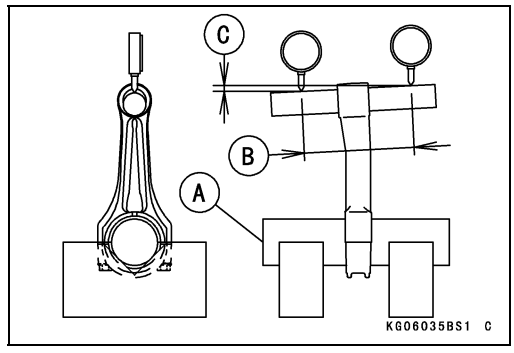
★Replace the crankshaft with a new one if necessary.

- 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 Inspection



● Measure the connecting rod bend.

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

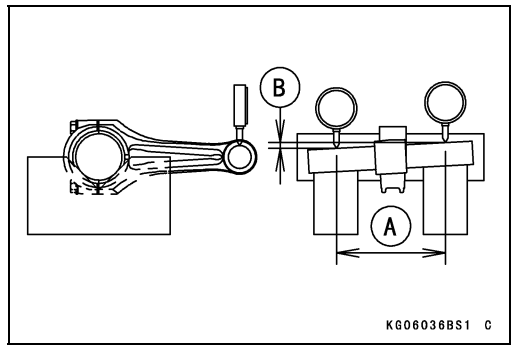
○Select an arbor of the same diameter as the piston pin and at least 100 mm (3.94 in.) [B] long, and insert the arbor through the connecting rod small end.

○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.). Then determine the connecting rod bent from the measured height differences [C].

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

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



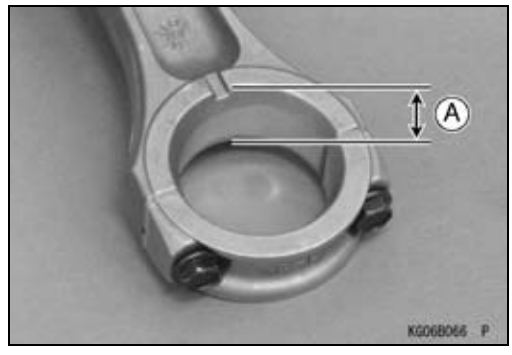
● Measure the connecting rod twist.

○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 two 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 the connecting rod twist exceeds the service limit, replace the connecting rod with a new one.

Connecting Rod Twist
Service Limit: TIR 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.

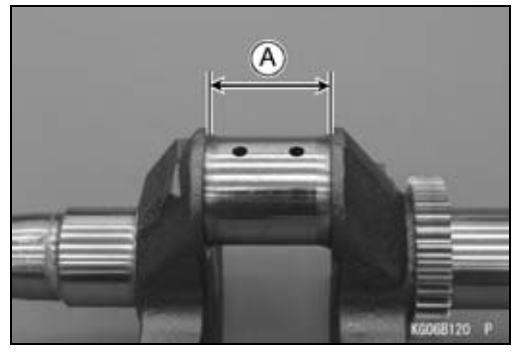
★If the measurement is less than the service limit, replace the connecting rod with a new one.

Connecting Rod Big End Width
Service Limit: 21.85 mm (0.8602 in.)

Crankshaft, Connecting Rod

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

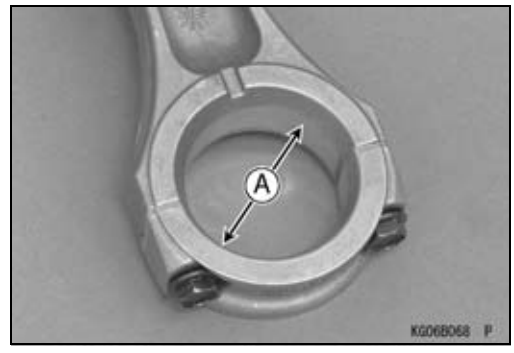
Crankpin Width
Service Limit: 44.7 mm (1.76 in.)



Connecting Rod Big End Bearing/Crankpin Wear Inspection

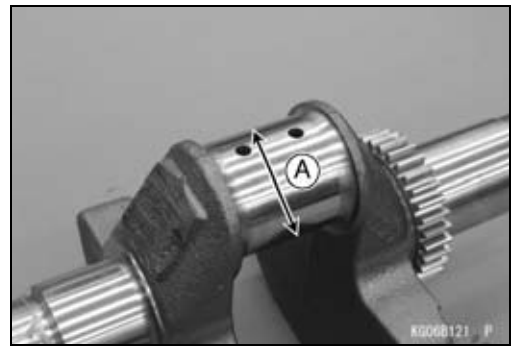
● Apply a light film of engine oil on the threads of the cap bolts.
● Install the cap bolts and tighten the bolts to the specified torque (see Piston Installation in the Engine Top End chapter).
● Measure the inside diameter [A] of big end at several points with a telescoping gauge or inside micrometer.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

Connecting Rod Big End Inside Diameter
Service Limit: 40.04 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.

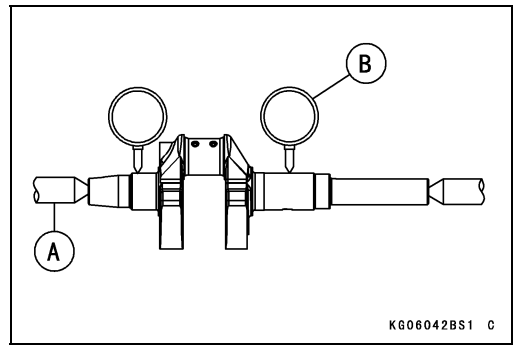
Crankpin Outside Diameter
Service Limit: 39.94 mm (1.572 in.)



Crankshaft Runout Inspection

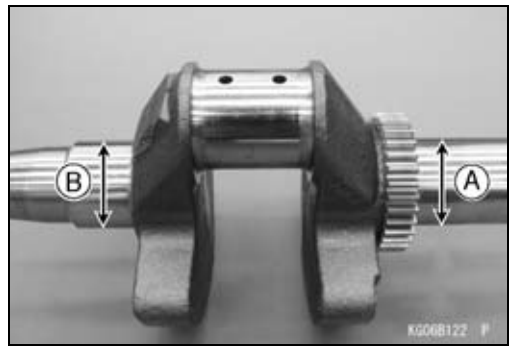
● Measure the crankshaft runout.
○Set the crankshaft in a flywheel alignment jig [A] or on V blocks gauge.
○Set a dial gauge [B] against both bearing journals.
○Turn the crankshaft slowly to measure the runout. The difference between the highest and lowest dial gauge readings (TIR) is the amount of runout.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

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



Crankshaft, Connecting Rod

Crankshaft Main Journal/Wear Inspection



- Measure both main journals at several points around the journal circumference.

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

Crankshaft Journal Diameter
Service Limit:

PTO Side [A]	**39.90 mm (1.571 in.)**
Flywheel Side [B]	**39.88 mm (1.570 in.)**

Starter System

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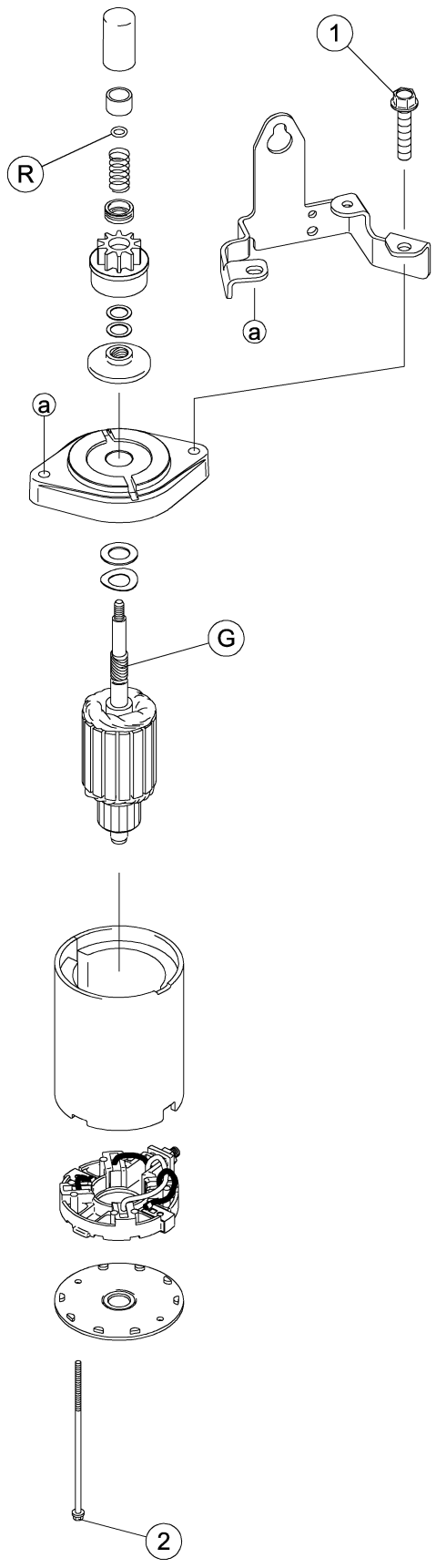
Exploded View



KH02068BW5 S

Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Starter Motor Mounting Bolts	19.6	2.0	14.5	
2	Starter Motor Through Bolts	4.0	0.41	35 in·lb	

G: Apply grease.
R: Replacement Parts

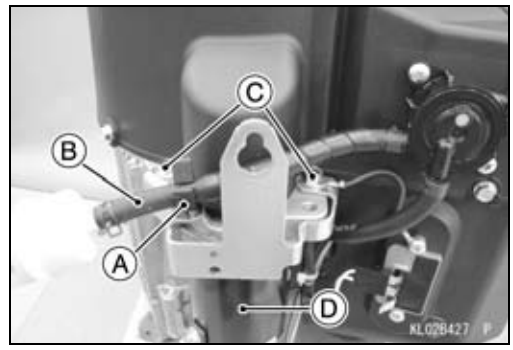
8-4 STARTER SYSTEM

Specifications

Item	Standard	Service Limit
Electric Starter System		
Starter Motor:		
Carbon Brush Length:	11.68 mm (0.4598 in.)	10.16 mm (0.4 in.)
Commutator Groove Depth:	1.78 mm (0.0701 in.)	1.27 mm (0.05 in.)
Commutator Diameter:	31.5 mm (1.24 in.) Min	31.369 mm (1.235 in.)
Commutator Runout:	0.013 mm (0.0005 in.)	0.043 mm (0.002 in.)

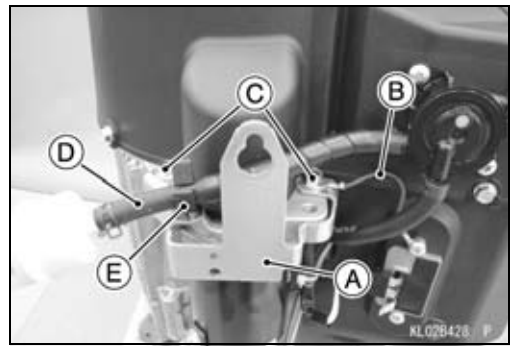
Electric Starter System

Starter Motor Removal



- Disconnect the wire.
- Open the clamp [A] and free the fuel hose [B].
- Remove the starter motor mounting bolts [C] and pull the starter motor [D] from the engine.

Starter Motor Installation

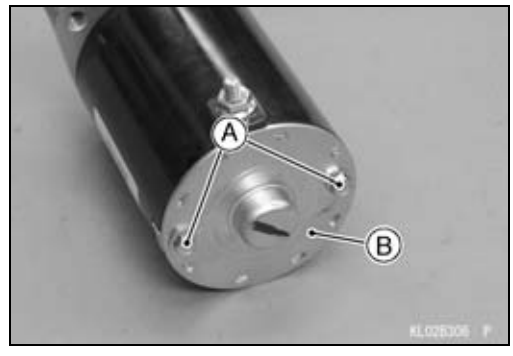


- Clean the starter motor and engine mounting flanges to ensure good electrical contact and tighten the mounting bolts.
- Install:
  Bracket [A]
  Ground lead [B]
- Tighten:

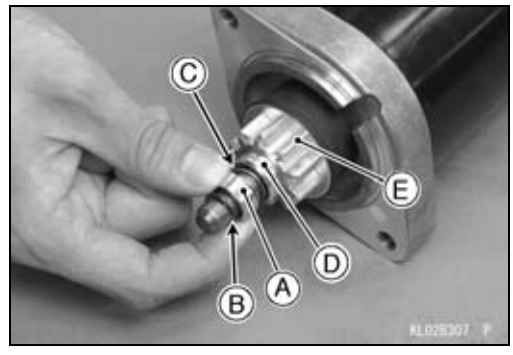
Torque - Starter Motor Mounting Bolts [C]: 19.6 N·m (2.00 kgf·m, 14.5 ft·lb)

- Attach the fuel hose [D] to the clamp [E].

Starter Motor Disassembly



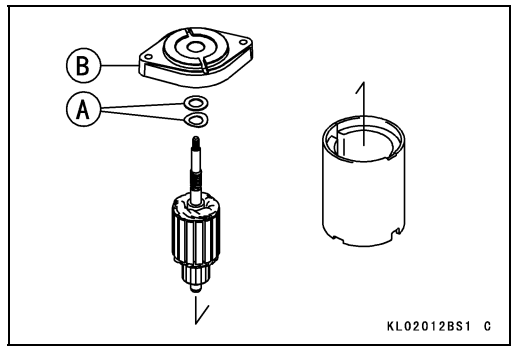
- Remove:
  Through Bolts [A]
  Brush Plate Assembly [B]



- Remove the cap.
- Press the retainer [A] using a suitable tool.
- Remove:
  Snap Ring [B]
  Retainer
  Spring [C]
  Spacer [D]
  Pinion Gear [E]

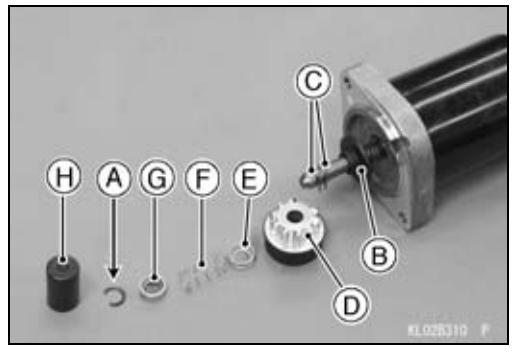
Electric Starter System

Starter Motor Assembly



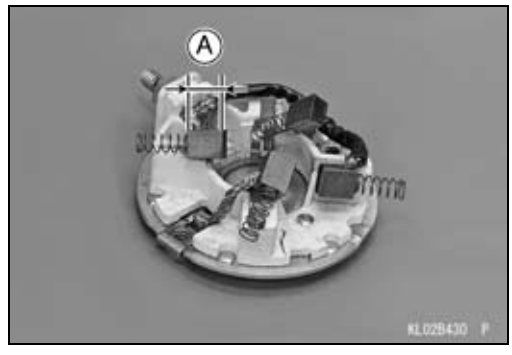
- Apply grease to the armature shaft.
- Install the washers [A].
- Install the end cover [B] so that the slit fit the projection of the yoke.
- Tighten:

Torque - Starter Motor Through Bolts: 4.0 N·m (0.41 kgf·m, 35 in·lb)



- Do not reuse the snap ring [A]. Replace it with a new one.
- Install:
  Collar [B]
  Spacer [C]
  Pinion Gear [D]
  Spacer [E]
  Spring [F]
  Washer [G]
  Snap Ring
- Make sure that grease does not attach to the contact portion between the collar and the rubber damper.
- Push up the retainer using the suitable tool, hold on the snap ring.
- Install the cap [H].

Starter Motor Brush Inspection



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

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

Brush Length

Standard:	**11.68 mm (0.4598 in.)**
Service Limit:	**10.16 mm (0.4 in.)**

Brush Spring Inspection

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

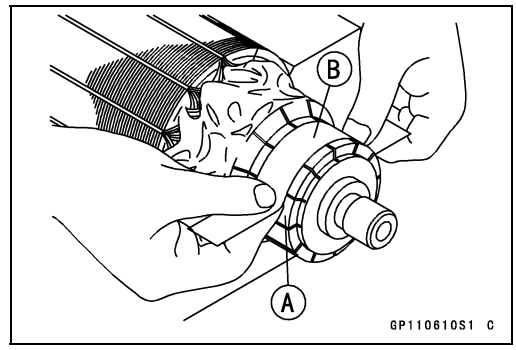
★If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them.

Electric Starter System

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.



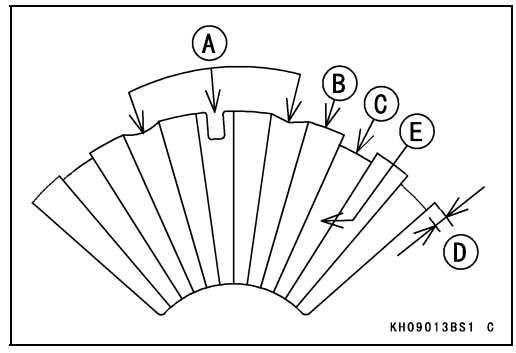
- Measure the depth of the grooves between the commutator segments.

★If the grooves are shallower than the specified limit, replace the armature with a new one.

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

Commutator Groove Depth

Standard:	**1.78 mm (0.0701 in.)**
Service Limit:	**1.27 mm (0.05 in.)**



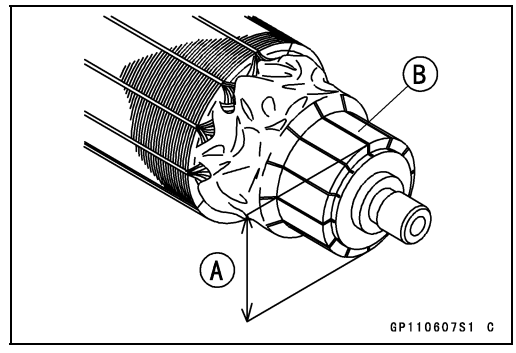
Bad [A]
Segment [B]
Good [C]
1.27 mm (0.05 in.) limit [D]
Mica [E]

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

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

Commutator Diameter

Standard:	**31.5 mm (1.24 in.)**
Service Limit:	**31.369 mm (1.2350 in.)**

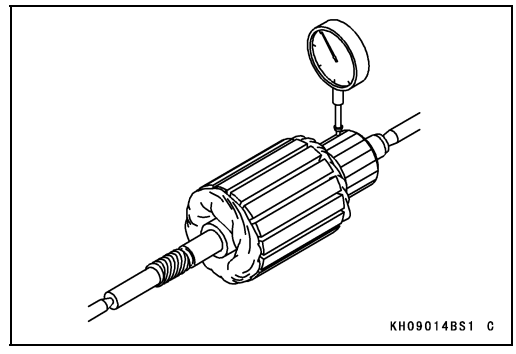


- Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.
- Rotate the armature slowly and read the commutator runout.

★If runout is more than the service limit, replace the armature with a new one.

Commutator Runout

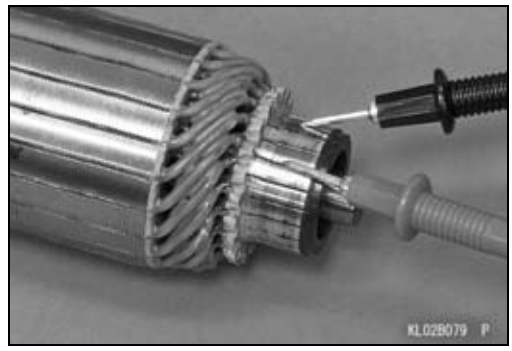
Standard:	**0.013 mm (0.0005 in.)**
Service Limit:	**0.043 mm (0.002 in.)**



Electric Starter System

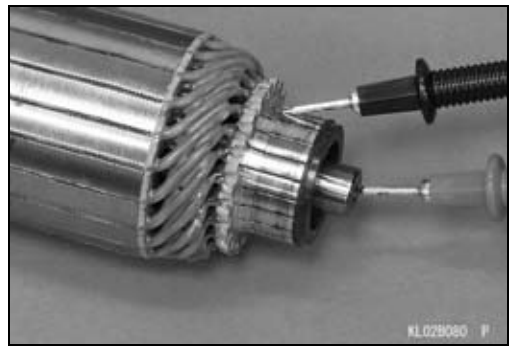
● Measure the armature winding resistance.
○Set the multimeter selector switch to the R × 1 Ω position and check the resistance between each segment and all the others.
★If the resistance it too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

Armature Winding Resistance
Close ~ 0 Ω

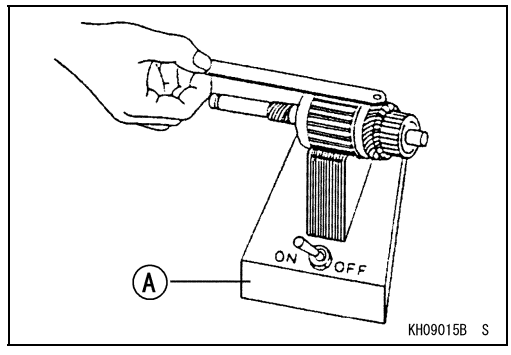


● Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the commutator and the armature shaft.
★If the resistance is less than infinite, the armature is shorted.

Commutator to Shaft Resistance
(∞)



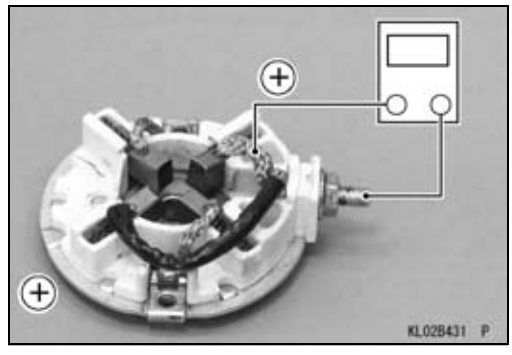
● Test the armature winding for shorts.
○Place the armature on a growler [A].
○Hold a thin metal strip (e.g., hack saw blade) on top of the armature.
○Turn on the growler and rotate the armature one complete turn.
★If the metal strip vibrates, the windings are internally shorted to each other and the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



Yoke Assembly Inspection

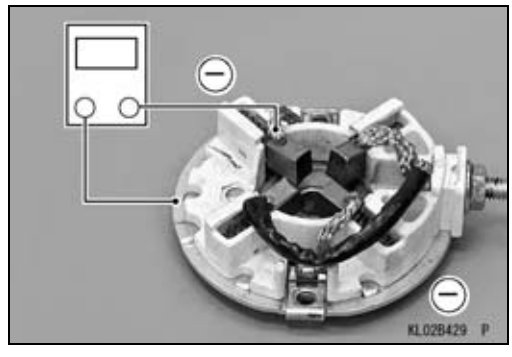
● Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the positive brushes and stator motor yoke.
★If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

Positive Brush to Ground Resistance
(∞)



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

Negative Brush to Ground Resistance
Close ~ 0 Ω



Electrical System

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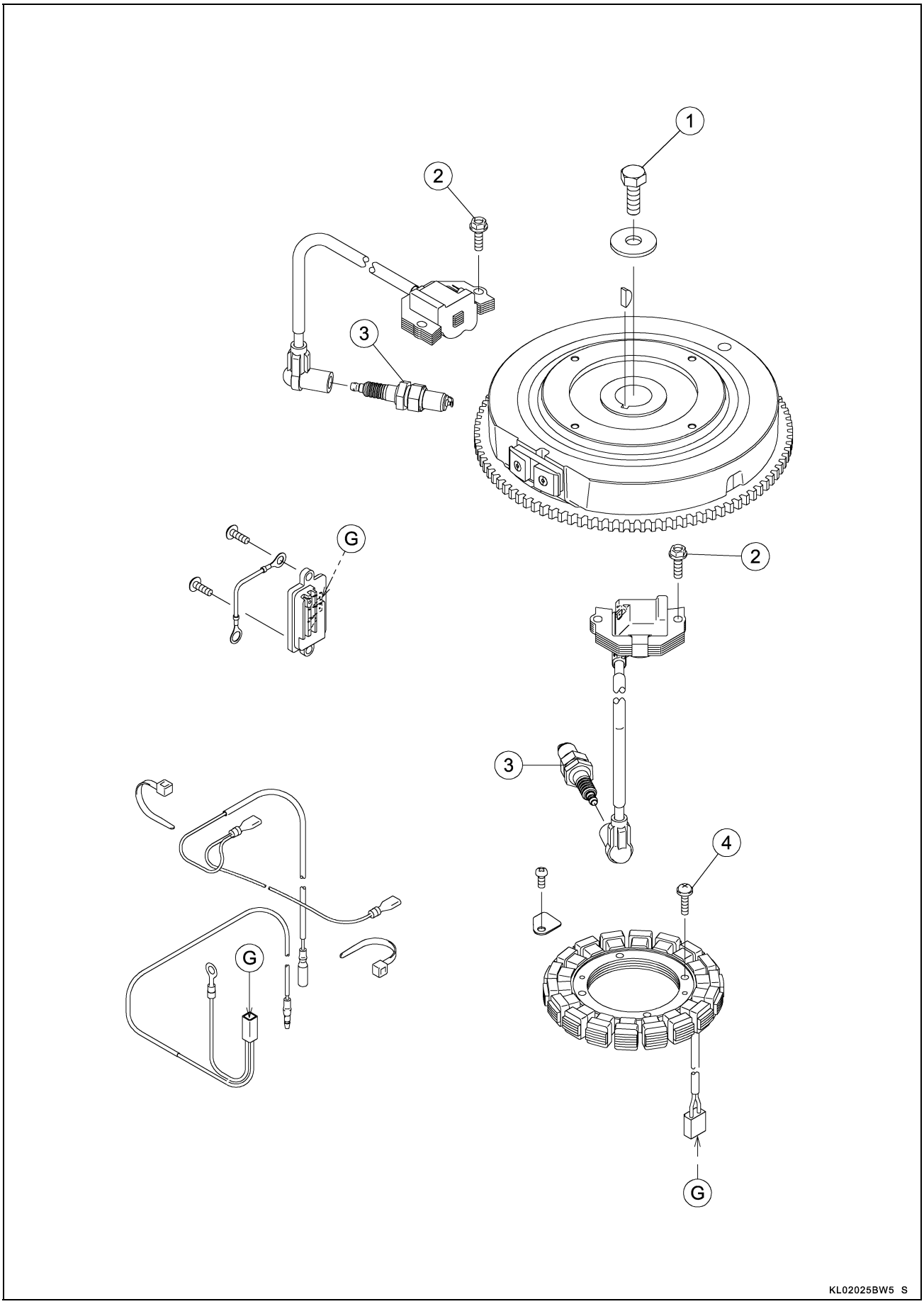
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Flywheel Bolt	57	5.8	42	
2	Ignition Coil Bolts	6.9	0.70	61 in·lb	
3	Spark Plugs	23	2.3	17	
4	Stator Coil Screws	3.7	0.38	33 in·lb	S

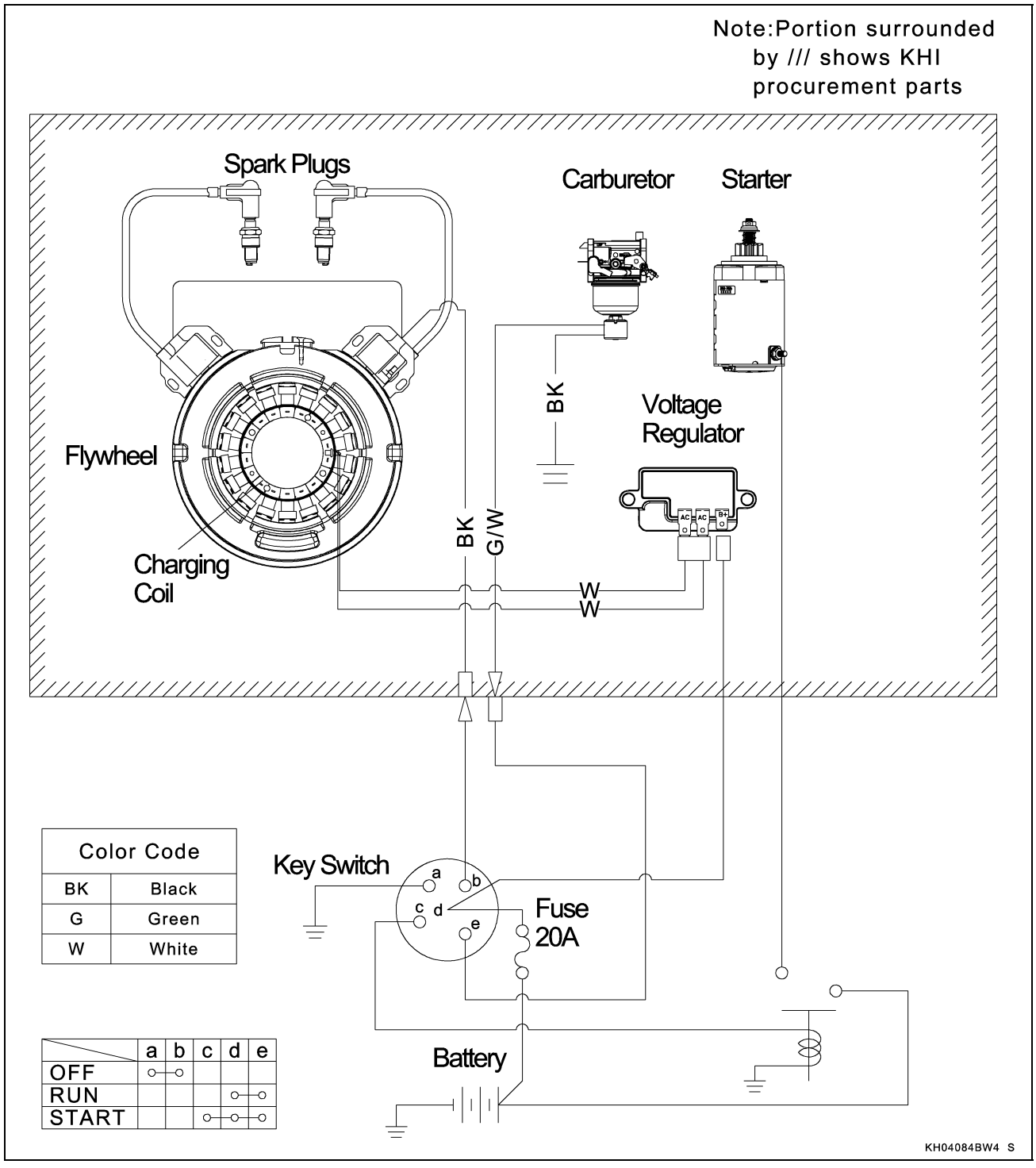
G: Apply dielectric grease.

9-4 ELECTRICAL SYSTEM

Specifications

Item	Standard
Charging System	
Regulated Output Voltage	DC 13.8 ~ 14.4 V @21°C (70 °F)
Stator Coil Resistance	About 0.12 Ω
Unregulated Stator Output	AC 36 V @3 500 r/min (rpm)
Ignition System	
Ignition Coils:	
Air Gap	0.3 ±0.1 mm (0.01 ~ 0.004 in.)
Primary Winding Resistance	3 ~ 13 kΩ
Secondary Winding Resistance	10 ~ 20 kΩ
Spark Plug	NGK BPR4ES
Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

Wiring Diagram

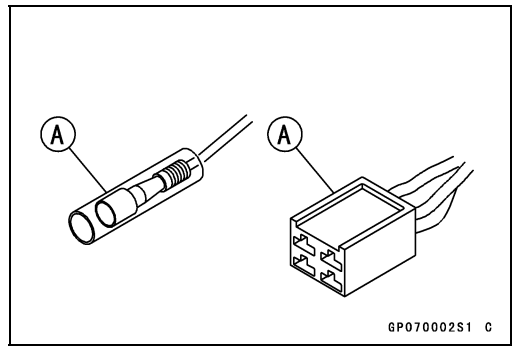


Precautions

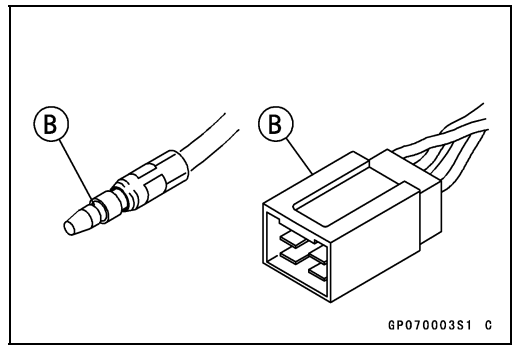
There are a number of important precautions that you must follow when servicing electrical systems. Learn and observe all the rules below.

- ○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]

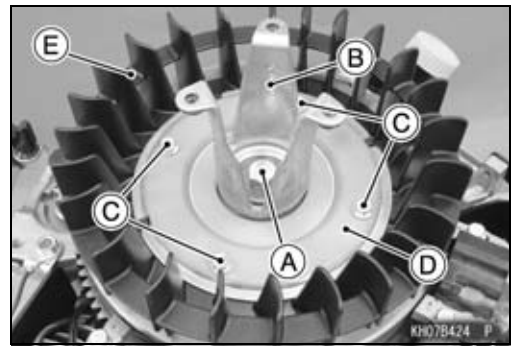


Charging System

Flywheel and Stator Coil Removal

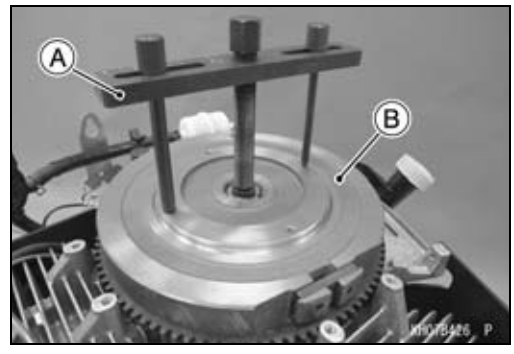
- Remove:
  Paper Element (see Element Removal in the Fuel System chapter)
  Fuel Pump (see Fuel Pump Removal in the Fuel System chapter)
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)

- Remove the ignition coils (see Ignition Coil Removal).
- Hold the flywheel with a suitable tool, remove the flywheel bolt [A] and washer.
- Remove:
  Bracket [B]
  Bolts [C]
  Plate [D]
  Cooling Fan [E]

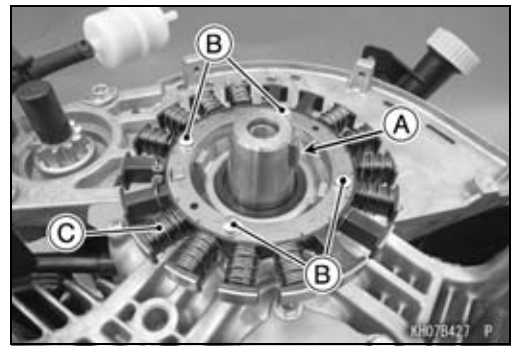


- Using a suitable flywheel puller [A], remove the flywheel [B].

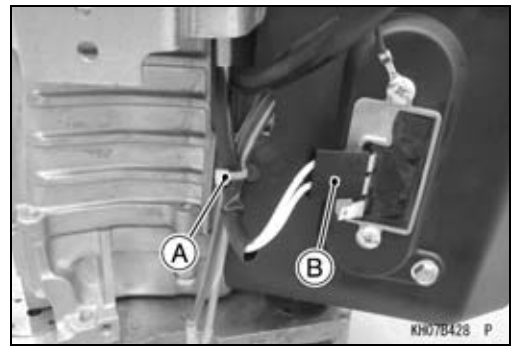
NOTICE
Always use flywheel puller.



- Free the stator coil lead from the clamp.
- Remove:
  Woodruff Key [A]
  Stator Coil Screws [B]
  Stator Coil [C]

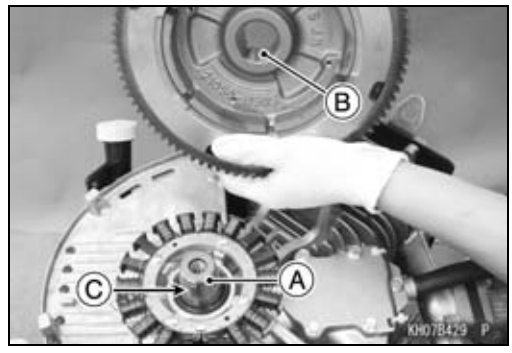


- Cut off the band [A].
- Disconnect the stator coil lead connector [B].



Charging System

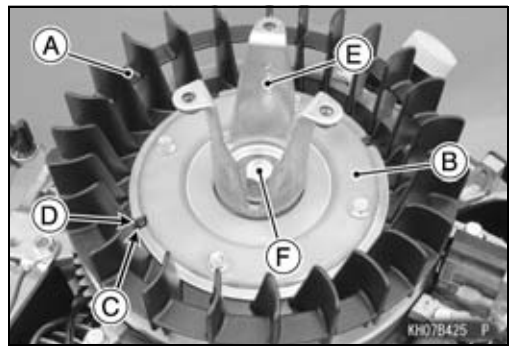
Flywheel and Stator Coil Installation



- Install the stator coil and hold the stator coil lead to the clamp.
- Tighten:

Torque - Stator Coil Screws: 3.7 N·m (0.38 kgf·m, 33 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 onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.



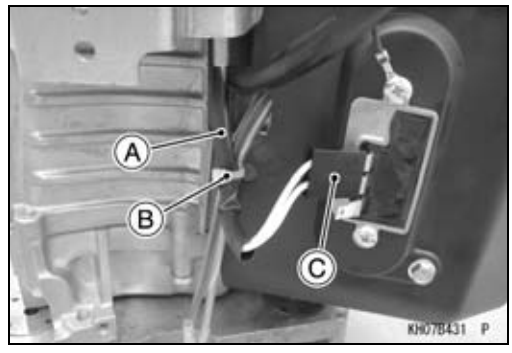
- Install the cooling fan [A].
- Install the plate [B] so that the slits [C] fit to the bosses [D] on the fan.
- Tighten:

Torque - Cooling Fan Plate Mounting Bolts: 6.9 N·m (0.70 kgf·m, 61 in·lb)

- Install the bracket [E] and washer.
- Tighten:

Torque - Flywheel Bolt [F]: 57 N·m (5.8 kgf·m, 42 ft·lb)

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



- Attach the stator coil lead [A], ignition coil lead and solenoid valve connector lead to the engine shroud with the band [B].
- Connect the stator coil lead Connector [C].

- Install the removed parts.

Charging System

Charging System Operational Inspection

● Check the battery condition.

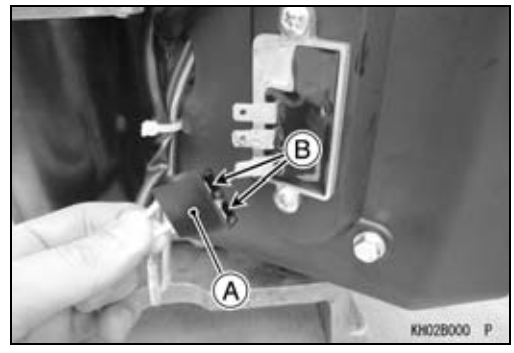
NOTE

○*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 does not rise as the engine speed increase, the regulator is defective or the alternator output is insufficient for the loads.

Regulated Output Voltage
DC 13.8 ~ 14.4 V @21°C (70 °F)

Stator Coil Resistance

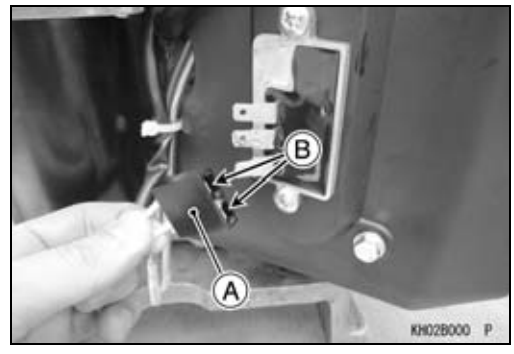


● Disconnect the stator coil lead connector [A].
● Measure the stator coil resistance between starter pins [B] with a tester.

Stator Coil Resistance
About 0.12 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



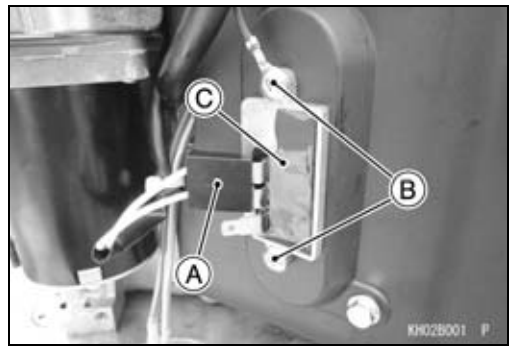
● Disconnect the stator coil lead connector [A].
● Connect AC voltmeter to the stator pins [B].
● Start the engine. Run the engine at the 3 500 rpm speed.
● Voltage reading should be minimum AC 36 V @3 500 rpm.
★If the AC voltage reading is less than the specification, replace the stator with a new one.

Unregulated Stator Output (MIN)
AC 36 V @3 500 r/min (rpm)

Charging System

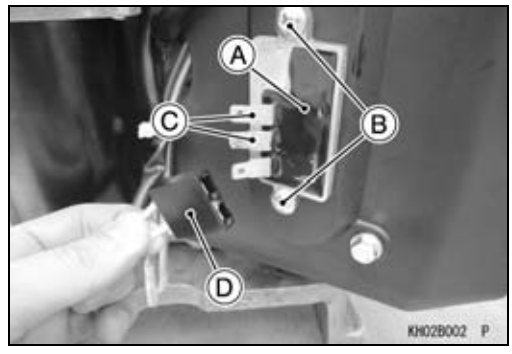
Regulator Removal

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



Regulator Installation

- Install the regulator [A].
- Tighten the regulator mounting screws [B].
- Apply dielectric grease to the regulator terminals [C].
- Connect the stator coil lead connector [D].

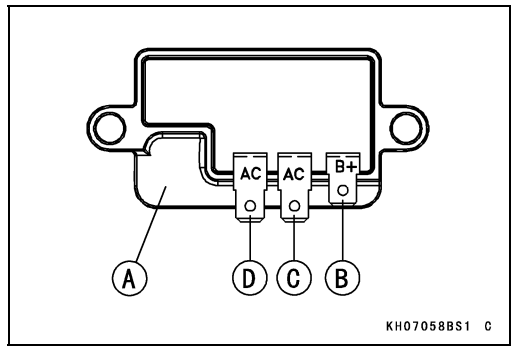


Regulator Resistance

- Remove the regulator (see Regulator Removal).
- 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.*

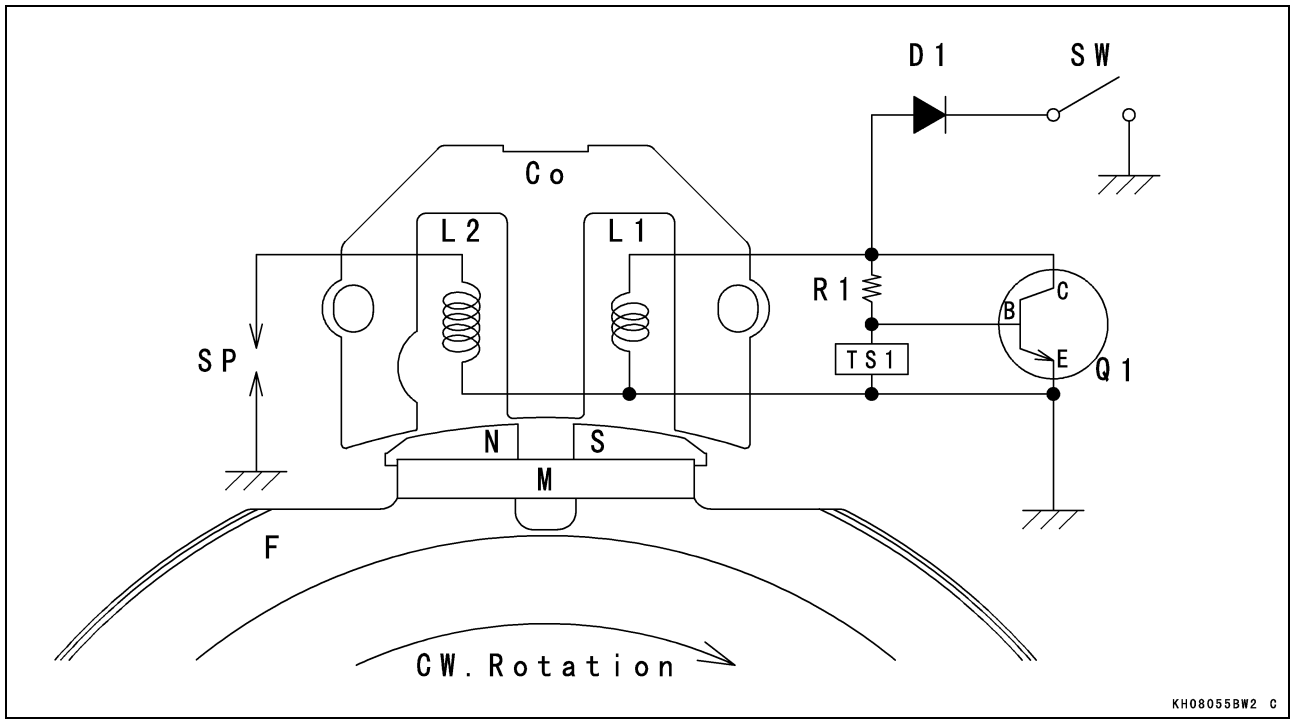
★If the resistance is not as specified, replace the regulator with a new one.

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)].

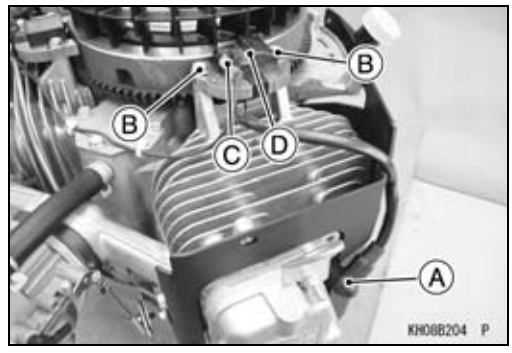
When the base current is flowing, the trigger sensor (TS1) detects optimum time (peak current) to shut off the transistor base current. With the transistor rapidly shutting off the current at the primary coil, counter-electromotive force is generated and voltage in hundreds-volts is induced through the 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.

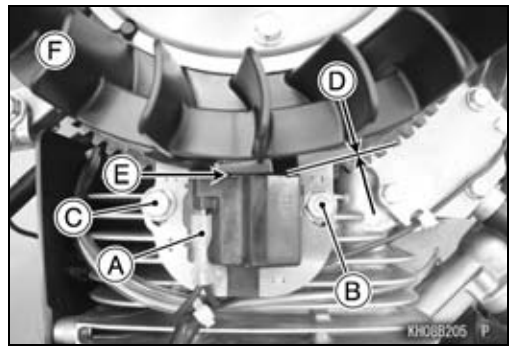
Ignition System

Ignition Coil Removal



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

Ignition Coil Installation

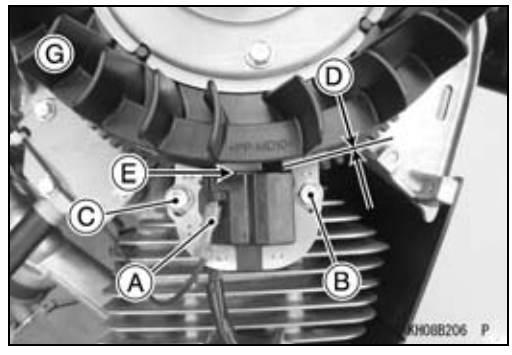


- Install the ignition coil on the crankcase so that the stop switch lead connector [A] face the upward, and tighten bolt [B] first, then tighten bolt [C]. While tightening bolts, adjust the air gaps to specified gap value as shown.

  [D]: between left leg of ignition coil and left pole-plate of magnet

  [E]: between center of ignition coil and right pole-plate of magnet

  #1 Cylinder [F]
  #2 Cylinder [G]

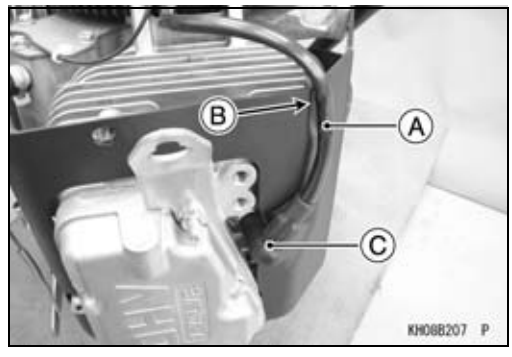


Ignition Coil Air Gap: [D] and [E]
Standard: 0.3 ±0.1 mm (0.01 ±0.004 in.)

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

NOTE

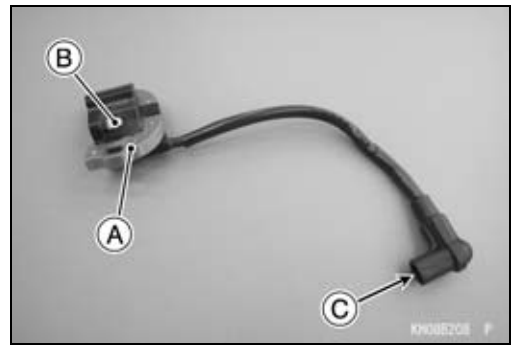
○*Use the above procedure to insure proper coil air gap.*



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

Ignition System

Ignition Coil Inspection



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

○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	–

NOTICE

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 Removal

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

Spark Plug Installation

- Insert the spark plug vertically into the plug hole with the plug installed in the plug wrench.
- Tighten the plugs.

Torque - Spark Plugs: 23 N·m (2.3 kgf·m, 17 ft·lb)

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

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

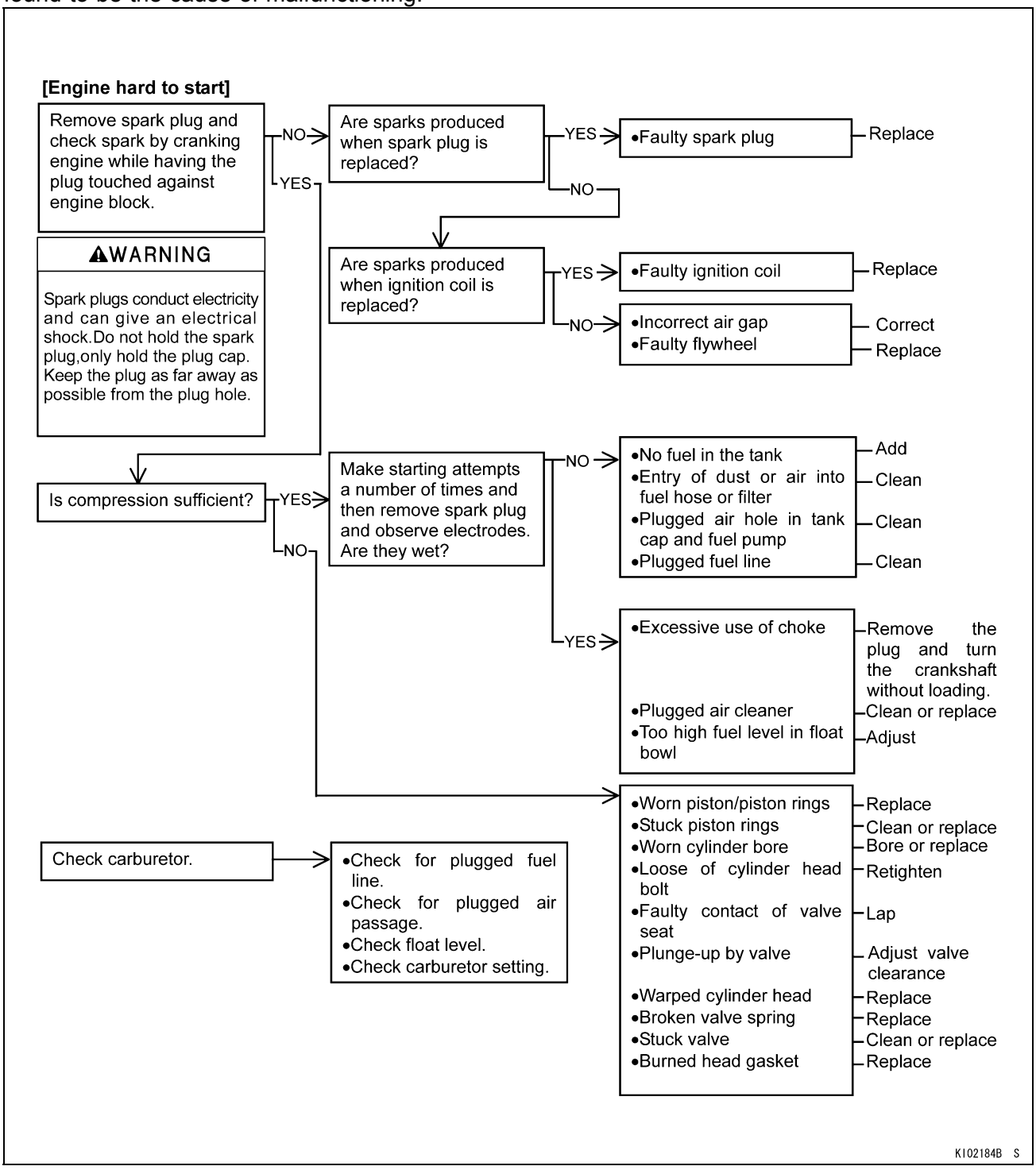
Table of Contents

Engine Troubleshooting Guide

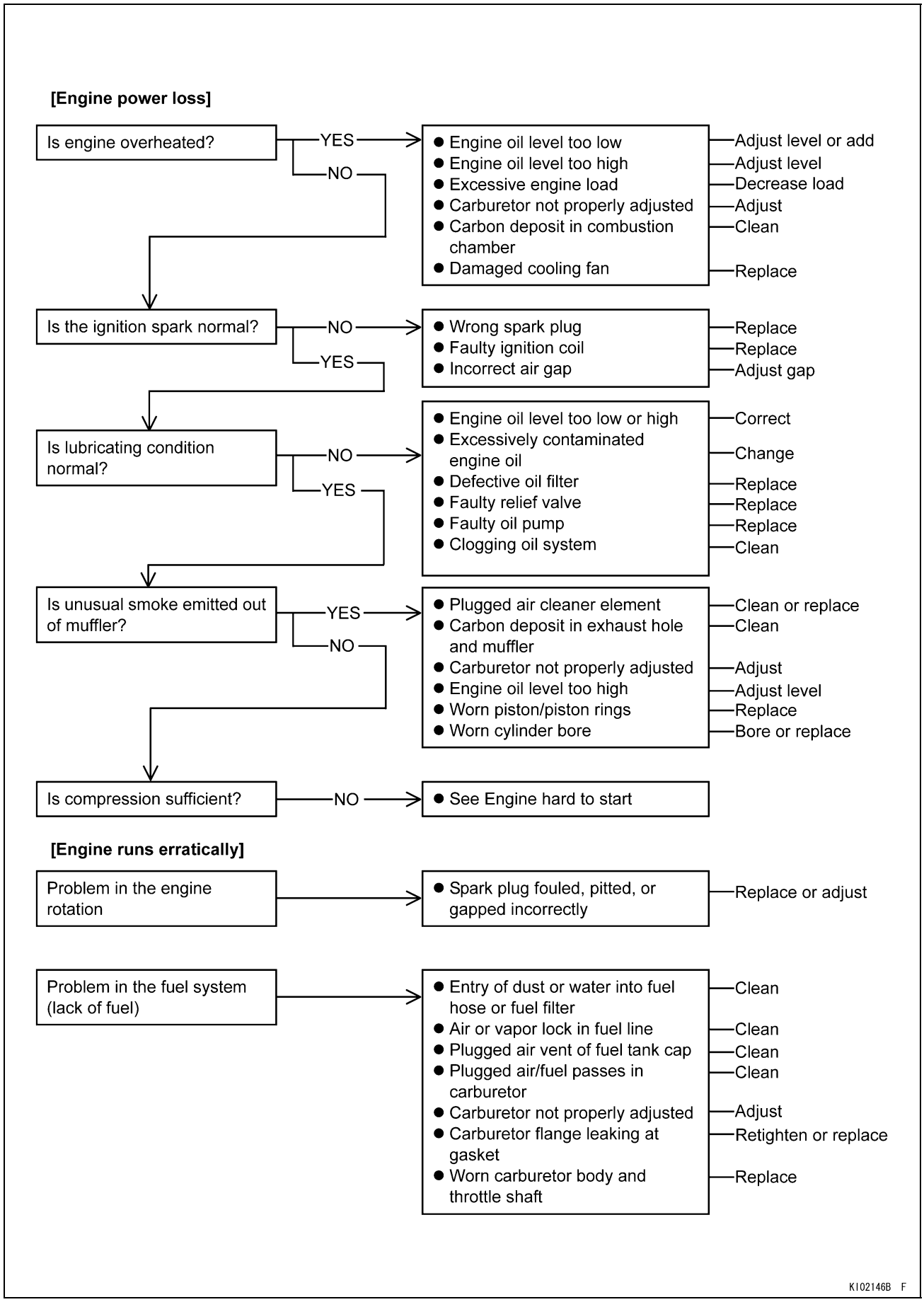
If the engine malfunctions, check if the way the engine is used is correct. If the engine malfunctions even if the engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

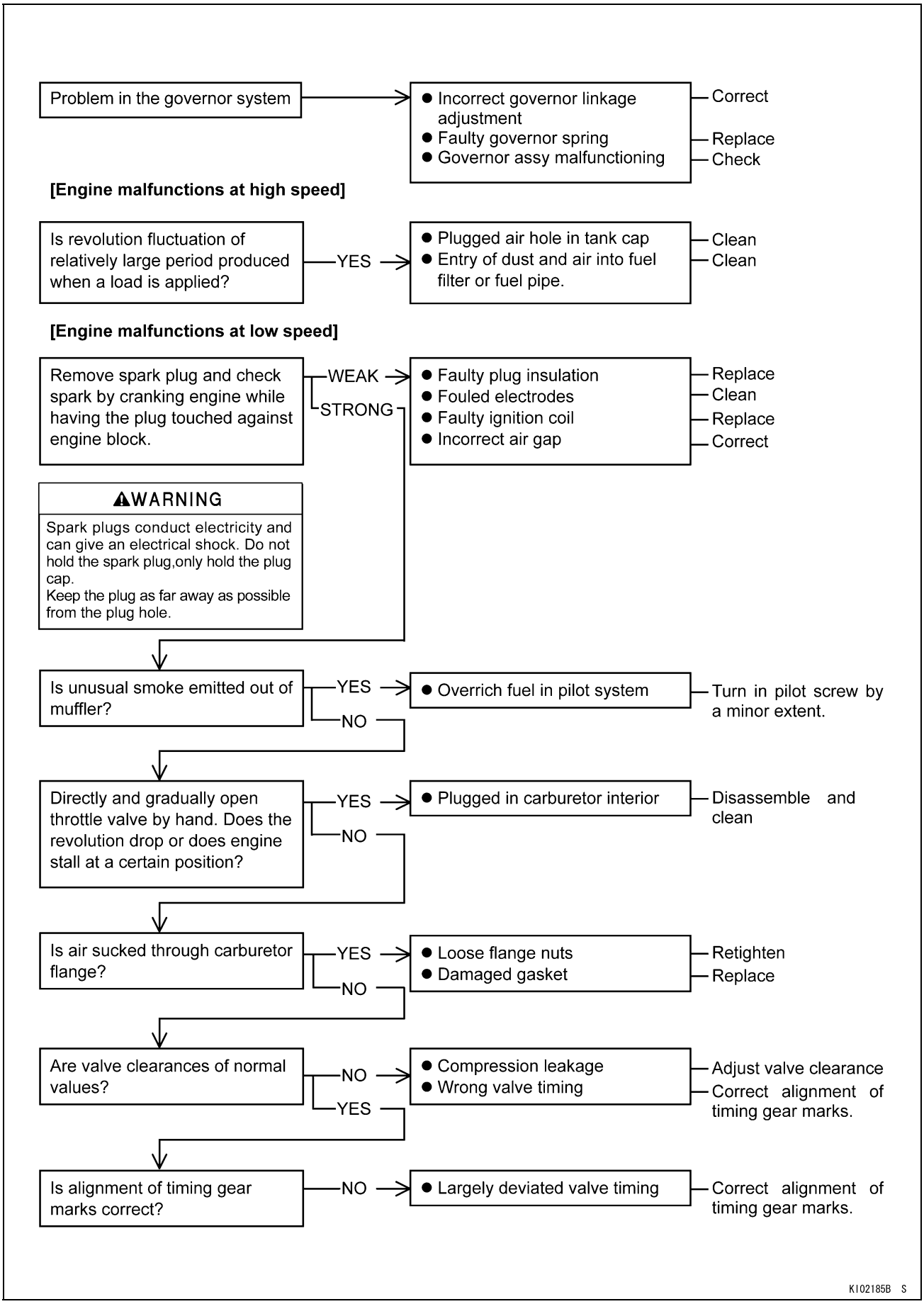
Do not unnecessarily disassemble the carburetor, the magneto or the engine unless it has been found to be the cause of malfunctioning.



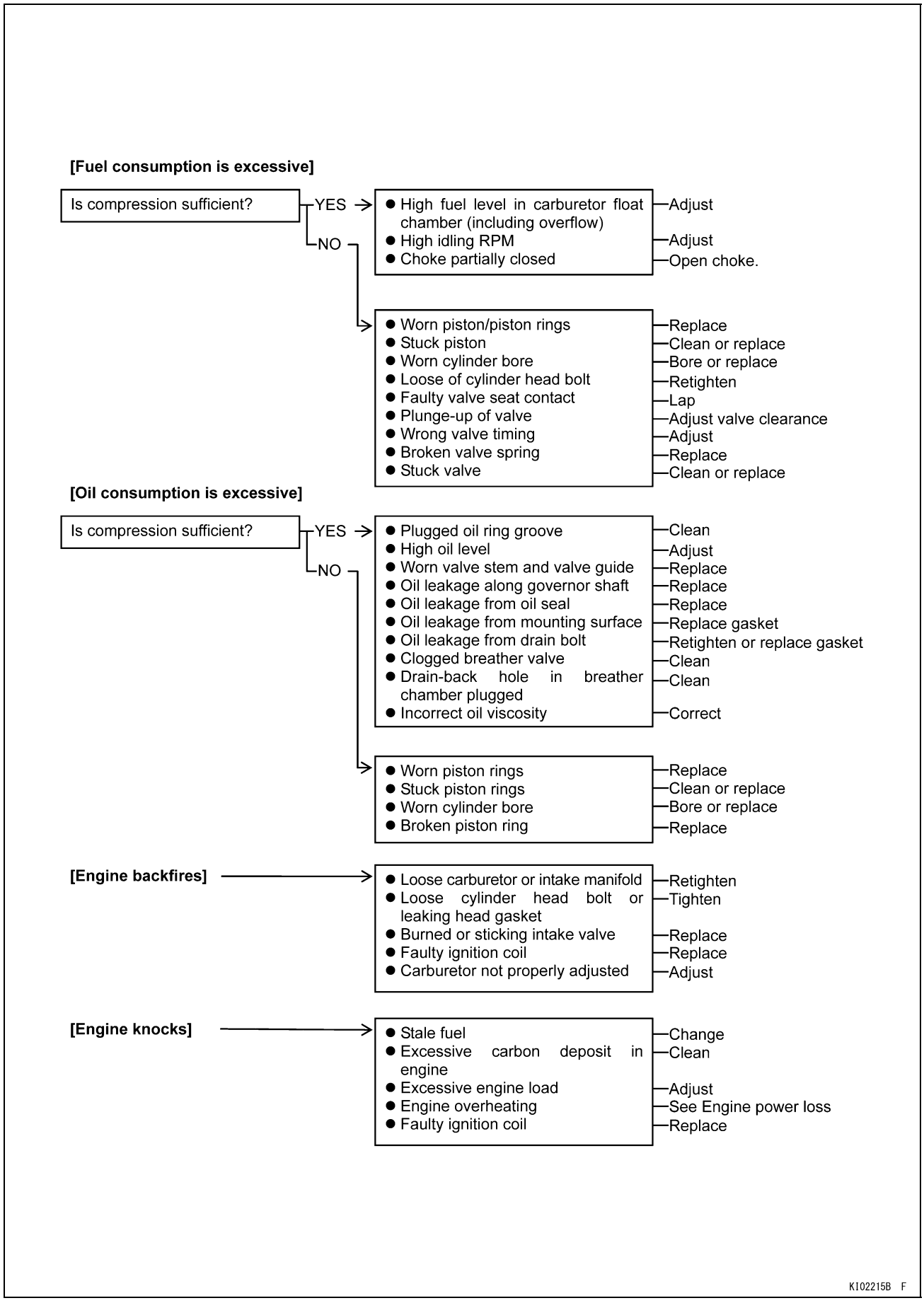
Engine Troubleshooting Guide



Engine Troubleshooting Guide



Engine Troubleshooting Guide



Starter Motor Troubleshooting Guide

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

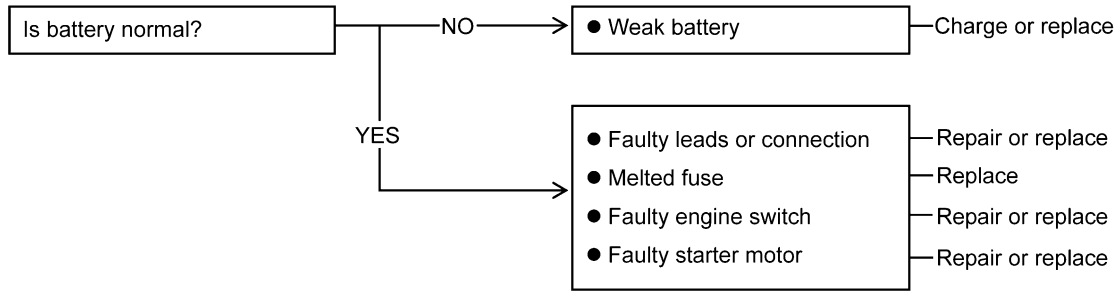
⚠ WARNING

Rotating engine parts can cause serious injury. Since the engine may be cranked during this test, do not touch any rotating engine parts or equipment.

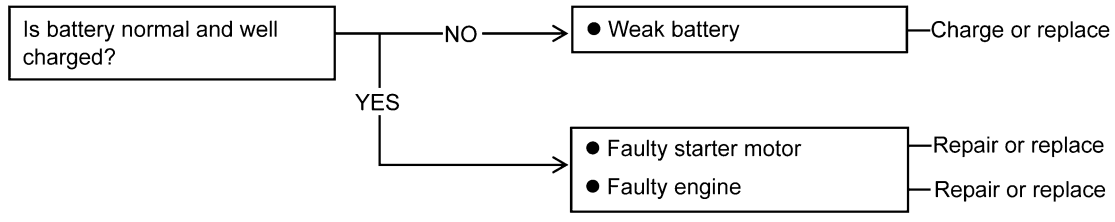
NOTICE

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

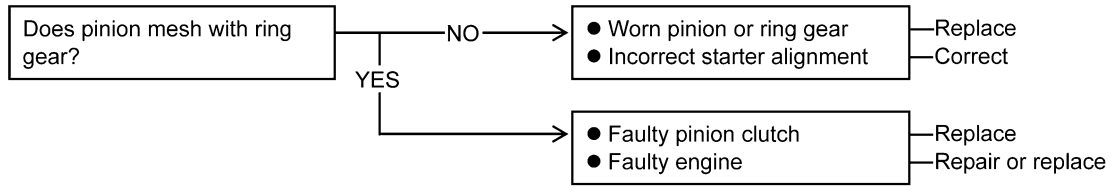
[Starter does not rotate]



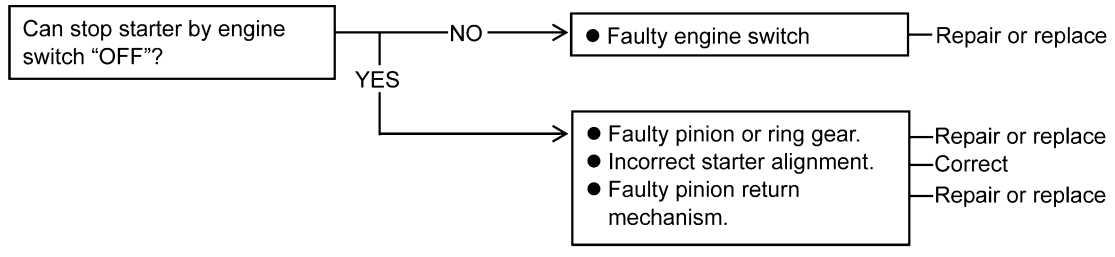
[Starter rotates but slow]



[Starter rotates but engine can not crank]



[Starter does not stop in engine switch “OFF”]



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