Kawasaki

ENGINES

SERVICE MANUAL

4-STROKE ELECTRONIC FUEL INJECTION AIR-COOLED V-TWIN GASOLINE ENGINE

FX730V-EFI

P/N 99924-1521-05

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.

Kawasaki

FX730V
Electronic Fuel Injection

4-Stroke Air-Cooled V-Twin Gasoline Engine

Service Manual

5th Edition (0):June 16, 2016

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 and California Air Resources Board.

1. **Crankcase Emission Control System**

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

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

2. **Exhaust Emission Control System**

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

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

- Fuel injection system 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 hoses

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

Table of Contents

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, throttle body, 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. All of the tightening torque values are for use with dry, solvent - cleaned threads unless otherwise indicated. If a fastener which should have dry, clean threads gets contaminated with lubricant, etc., applying even the specified torque could damage it.

(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. 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.

(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.

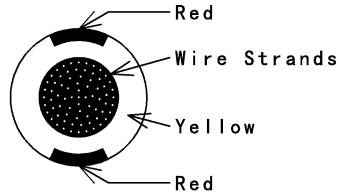
(15)Lubrication

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 (MoS_2) 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	Y/R

GB020601W1 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	

Before Servicing

(19)Service Data

Service Data terms are defined as follows:

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

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

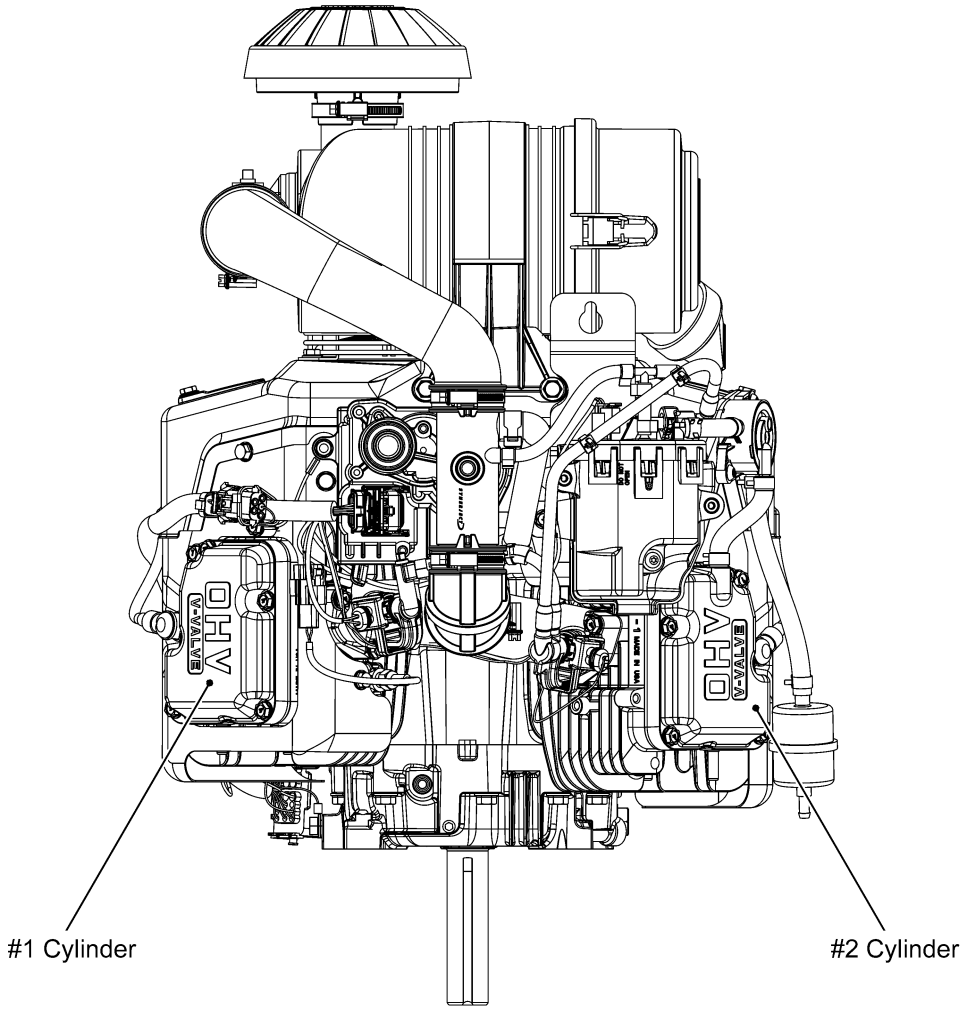
(20)Handling Electronic Parts

Severe impacts to electronic parts such as the ECU, sensor, and relay can damage them. If dropped on a hard surface, replace such parts with new ones.

If a high voltage that is created by static electricity is applied to the electric parts, it could cause them to fail. To avoid this, touch a non-painted metal surface to discharge any static electricity that is accumulated on your body before inspecting or replacing electric parts.

Be careful not to touch the electrical terminals of the electronic parts. The static electricity discharged from your body could damage them or deform the electrical terminals.

(21)Cylinder Number Designation



Model Identification

General Specifications

Item	FX730V EFI
Type of Engine	Forced air-cooled, vertical shaft, OHV, 4-stroke gasoline engine
Cylinder Layout	90° V-Twin
Bore × Stroke	78 mm × 76 mm (3.07 in. × 2.99 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	Inductive ignition
RFI	Per Canada and U.S.A. requirements
Starting System	Electric starter
Charging System	12 V - 30 amps with regulator
Spark Plug	NGK BPR4ES
Fuel System	Electronic Fuel Injection (EFI)
Fuel Pump	Electric pump with diaphragm pulsation pump
Air Cleaner	Dual stage element, Heavy duty type
Governor	Electrical controlled all speed governor
Lubrication System	Pressure feed by positive displacement pump
Oil Filter	Cartridge type full flow filter
Oil Capacity:	
(when engine is completely dry)	2.2 L (2.3 US qt)
(when filter is not removed)	1.8 L (1.9 US qt)
(when filter is removed)	2.1 L (2.2 US qt)
Cooling System	Forced air cooling by fan
Dimensions (L × W × H)	501 mm × 457 mm × 589 mm (19.7 in. × 17.9 in. × 23.2 in.)
Dry Weight (without muffler)	50.1 kg (110.45 lb)

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

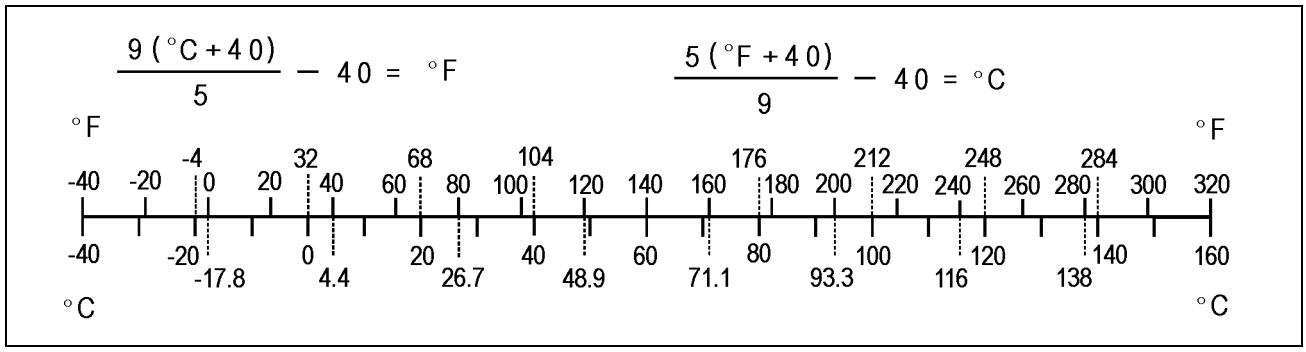
Units of Speed:

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

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

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

MAINTENANCE	INTERVAL					
	Daily	Every 100 hr.	Every 200 hr.	Every 250 hr.	Every 300 hr.	Every 500 hr.
Check and add engine oil	●					
Check for loose or lost nuts and screws	●					
Check for fuel and oil leakage	●					
Check battery electrolyte level	●					
♦ Replace air cleaner primary element				●		
♦ Check air cleaner secondary element				●		
♦ Replace air cleaner secondary element						●
Check inspection panel		●				
♦ ◊ 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 paper element			●			
◊ Clean combustion chamber					●	
◊ Check and adjust valve clearance					●	
◊ Clean and lap valve seating surface					●	

♦: Service more frequently under dusty conditions.

◊: Service to be performed by an authorized Kawasaki 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 engine oil.

L: Apply a non-permanent locking agent.

L1: Apply a non-permanent locking agent (LOCKTITE: VIBRASEAL 516 or equivalent).

R: Replacement Parts

S: Follow the specified tightening sequence.

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Fuel System (EFI)				
Air Cleaner Bracket Mounting Bolts	8.8	0.90	78 in·lb	S
Damper Mounting Nuts	3.7	0.38	33 in·lb	
Throttle Body Mounting Nuts	3.7	0.38	33 in·lb	
Throttle Body Bracket Bolts (M6)	5.9	0.60	52 in·lb	
Throttle Body Bracket Bolts (M8)	17.6	1.79	13.0	
Lift Plate Bolts	5.9	0.60	52 in·lb	
Ignition Coil Mounting Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
Ignition Coil Mounting Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
Crankshaft Position Sensor Bracket Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
Crankshaft Position Sensor Bracket Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
Crankshaft Position Sensor Mounting Bolt	5.9	0.60	52 in·lb	
Fuel Pump Bracket Mounting Bolts	8.8	0.90	78 in·lb	
Intake Manifold Bolts	5.9	0.60	52 in·lb	S
Cylinder Head Temperature Sensor	7.5	0.76	66 in·lb	
Fuel Injector Mounting Bolts	5.9	0.60	52 in·lb	
Cooling System				
Fan Guard Mounting Bolts	5.9	0.60	52 in·lb	
Fan Housing Bolts	5.9	0.60	52 in·lb	
Housing Cover Bolts	5.9	0.60	52 in·lb	
Oil Filler Mounting Bolt	5.9	0.60	52 in·lb	
Cooling Fan Bolts	8.8	0.90	78 in·lb	
Engine Shroud Bolts	5.9	0.60	52 in·lb	
Engine Top End				
Rocker Cover Bolts	8.0	0.82	71 in·lb	
Spark Plugs	22	2.2	16	
Cylinder Head Bolts (L = 65 mm)	46	4.7	34	S
Cylinder Head Bolts (L = 50 mm)	46	4.7	34	S
Connecting Rod Big End Cap Bolts	9.8	1.0	87 in·lb	EO
Rocker Arm Bracket Bolts	21	2.1	15	L
Valve Clearance Adjusting Locknuts	11	1.1	97 in·lb	

Torque and Locking Agent

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Lubrication System				
Oil Filler Mounting Bolt	5.9	0.60	52 in·lb	
Oil Pressure Switch	3.9	0.40	35 in·lb	L1
Oil Filter Pipe	24	2.4	18	
Oil Filter	5.8	0.59	51 in·lb	R
Oil Pump Cover Plate Bolts	5.9	0.60	52 in·lb	
Engine Oil Drain Plug	6.9	0.70	61 in·lb	
Camshaft/Crankshaft				
Breather Chamber Cover Bolts	5.9	0.60	52 in·lb	
Breather Valve Mounting Screw	2.0	0.20	18 in·lb	
Oil Pressure Switch	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 Bolts	27.4	2.79	20.2	S
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 Terminal Locknut	8.8	0.90	78 in·lb	
Electrical System				
Flywheel Bolt	56	5.7	41	
Cooling Fan Bolts	8.8	0.90	78 in·lb	
Starter Motor Mounting Bolts	19.6	2.00	14.5	
Fuse Case Bracket Bolt	17.6	1.79	13.0	
Regulator Mounting Bolts	4.4	0.45	39 in·lb	
Ignition Coil Mounting Bolts (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
Ignition Coil Mounting Bolts (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
Crankshaft Position Sensor Bracket Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
Crankshaft Position Sensor Bracket Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
Crankshaft Position Sensor Mounting Bolt	5.9	0.60	52 in·lb	
Spark Plugs	22	2.2	16	
Stator Coil Screws	3.4	0.35	30 in·lb	
Ground Terminal Bolt	17.6	1.79	13.0	

Torque and Locking Agent

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

2-6 PERIODIC MAINTENANCE

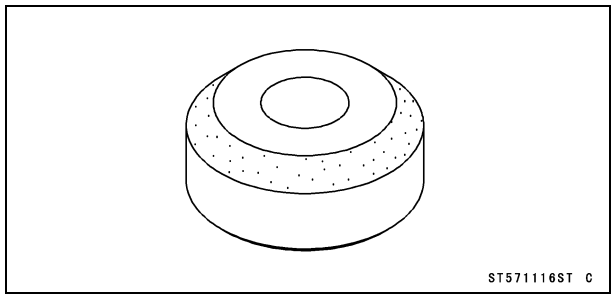
Specifications

Item	Standard
Fuel System	
Idle Speed(1):	
Low Idle Speed	1 550 r/min (rpm) (for reference)
High Idle Speed	3 600 r/min (rpm) (for reference)
Air Cleaner:	
Type	Dual stage element, heavy duty type
Pre-cleaner	Paper element
Second-stage cleaner	Treated media
Engine Top End	
Valve Clearance:	
Intake, Exhaust	0.05 ~ 0.10 mm (0.002 ~ 0.004 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	SAE40, SAE30, SAE20W-50, SAE10W-30/SAE10W-40, or SAE5W-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.)

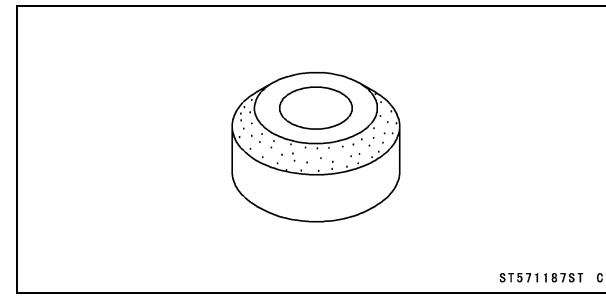
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

Special Tools

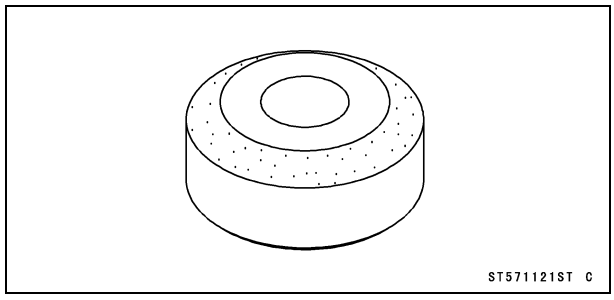
Valve Seat Cutter, 45° - ϕ35:
57001-1116



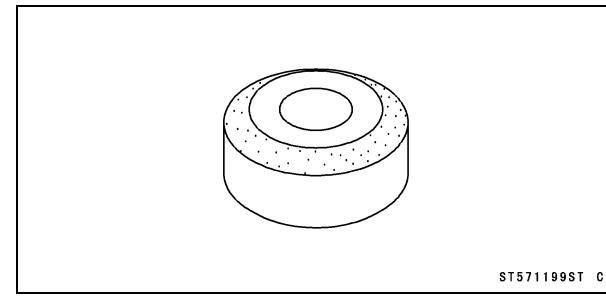
Valve Seat Cutter, 45° - ϕ30:
57001-1187



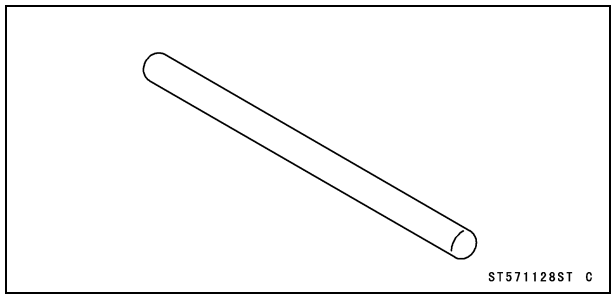
Valve Seat Cutter, 32° - ϕ35:
57001-1121



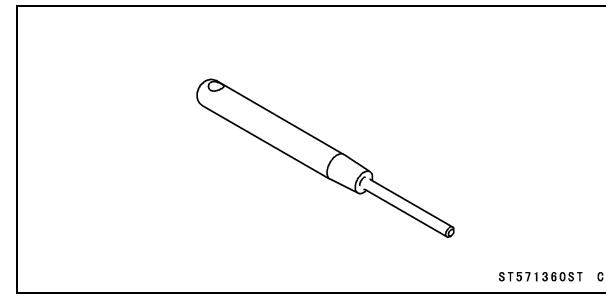
Valve Seat Cutter, 32° - ϕ33:
57001-1199



Valve Seat Cutter Holder Bar:
57001-1128



Valve Seat Cutter Holder, ϕ6:
57001-1360



Periodic Maintenance Procedures

Fuel System

Idle Speed Adjustment

NOTE

- *This engine is equipped with the Auto Idle Speed Control system, so that engine is not necessary to adjust the idle speed.*
- *The idle speed may vary depending on the equipment on which the engine is used. Refer to the equipment specification.*

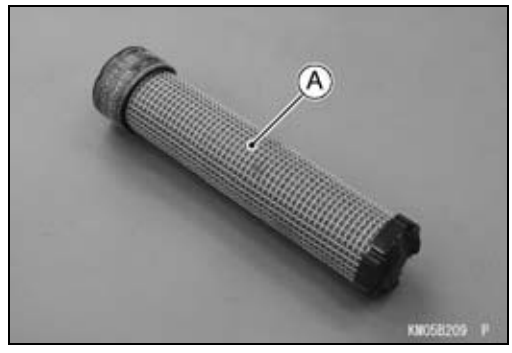
Element Cleaning and Inspection

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

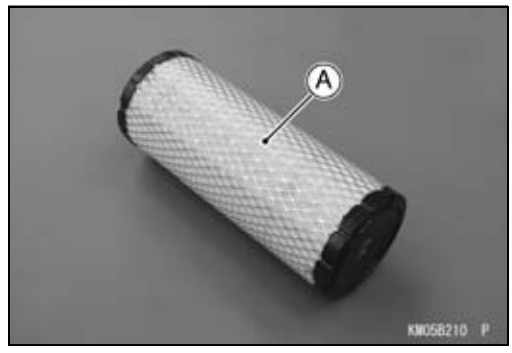
NOTE

- *Operating in dusty condition may require more frequent maintenance.*

- Remove the elements (see Air Cleaner Element Removal in the Fuel System chapter).
- Replace the primary element [A] every according to the maintenance chart.



- Check the secondary element [A] for dirty, clogged or damaged.
- Replace the secondary element with a new one, if the element is very dirty or damaged.
- Replace the secondary air cleaner element according to the maintenance chart.



NOTICE

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

Periodic Maintenance Procedures

Air Cleaner Housing (Cap and Body) Inspection

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

○Seal the housing well and permit only filtered air to reach the throttle body assy.

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

- Check that no foreign material is obstructing the air passage.

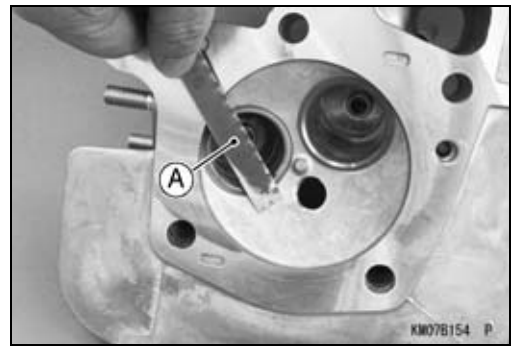
Engine Top End

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

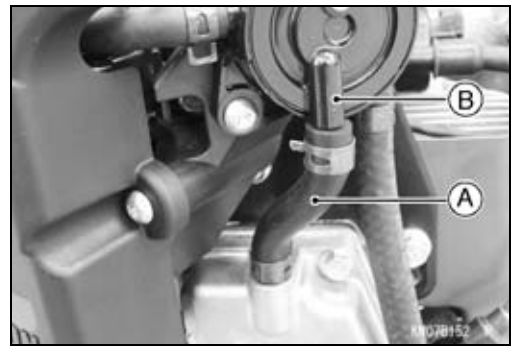
Gasoline and low flash-point solvents can be flammable and/or explosive and cause severe burns. Clean the cylinder head in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low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

Valve Clearance Inspection

NOTE

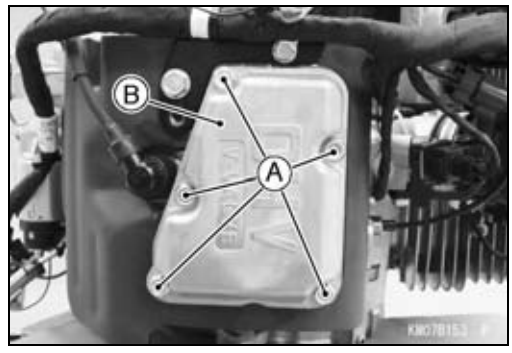
○*Valve clearance must be checked when the engine is cold (at room temperature).*

- Disconnect the pulse hose [A] from the fuel pump [B].

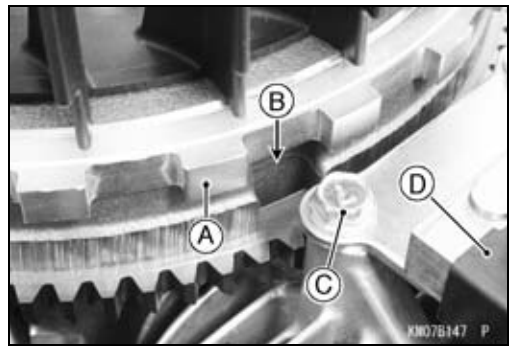


Periodic Maintenance Procedures

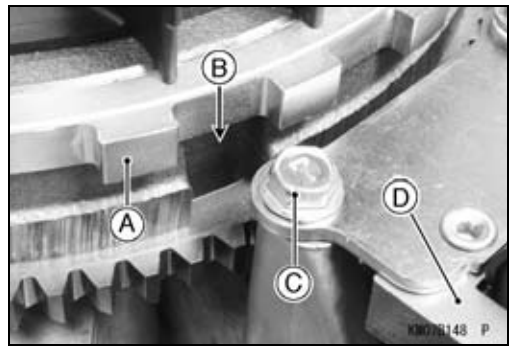
● Remove:
Fan Housing (see Fan Housing Removal in the Cooling System chapter)
Rocker Cover Bolts [A] (both sides)
Rocker Cover [B] (both sides)
● Place the piston at the top dead center (TDC) of the compression stroke by turning the flywheel clockwise.



No.1 Cylinder
● Set the #1 cylinder to TDC by turning the flywheel [A] clockwise until its square cutout [B] is faced toward the right mounting bolt [C] on the #1 ignition coil [D] as shown.
○Check that the intake and exhaust valves are closed completely. If not, turn the flywheel one full turn (360°) clockwise to align the square cutout with the right mounting bolt on the #1 ignition coil again.

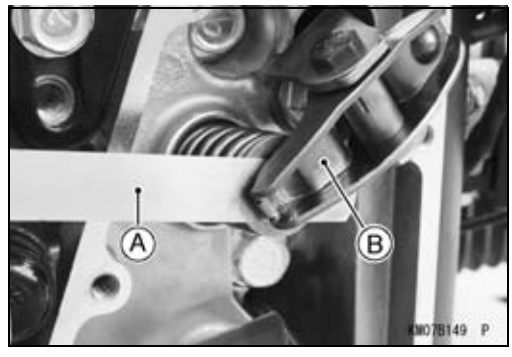


No.2 Cylinder
● Set the #2 cylinder to TDC by turning the flywheel [A] clockwise until its square cutout [B] is faced toward the right mounting bolt [C] on the #2 ignition coil [D] as shown.
○Check that the intake and exhaust valves are closed completely. If not, turn the flywheel one full turn (360°) clockwise to align the square cutout with the right mounting bolt on the #2 ignition coil again.



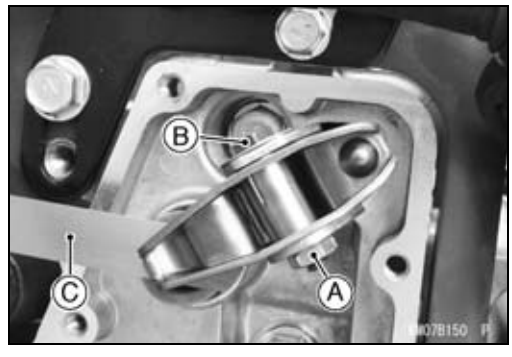
● Then check the valve clearance.
○Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.
★If the valve clearance is incorrect, adjust it.

Valve Clearance
Intake, Exhaust: 0.05 ~ 0.10 mm (0.002 ~ 0.004 in.)

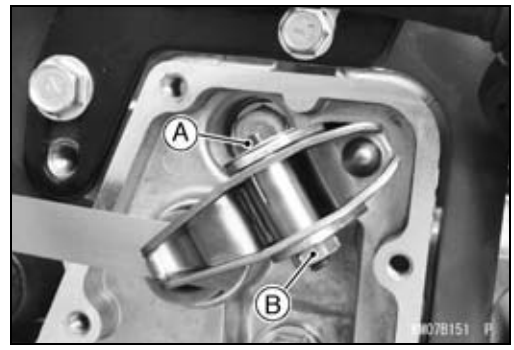


Valve Clearance Adjustment
● Turn the crankshaft in proper direction until the piston is at the TDC of the compression stroke (as described above).
● Loosen the locknut [A] and adjusting bolt [B].
● Insert a 0.07 mm (0.003 in.) thickness gauge [C] between the rocker arm and valve stem end, and turn the 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: 0.05 ~ 0.10 mm (0.002 ~ 0.004 in.)



Periodic Maintenance Procedures

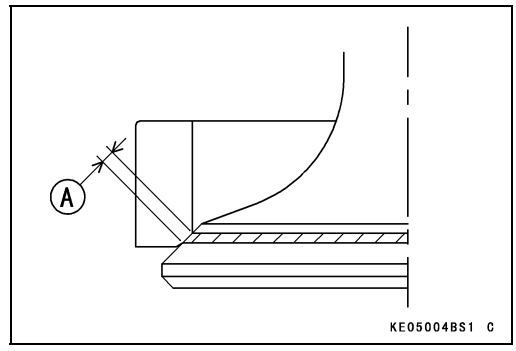


- Holding the adjusting bolt [A] with a suitable tool, tighten the adjusting locknut [B] to the specified torque.

Torque - Valve Clearance Adjusting Locknuts: 11 N·m (1.1 kgf·m, 97 in·lb)

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

Valve Seat Inspection



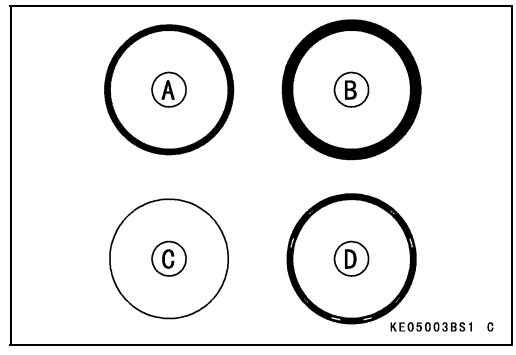
- Remove the valve (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
- Inspect the valve seats for damage.

★If the seats are warped or distorted beyond reconditioning, replace the cylinder head with a new one.

- Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.

NOTE

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



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

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

Valve Seating Surface Width (STD)

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

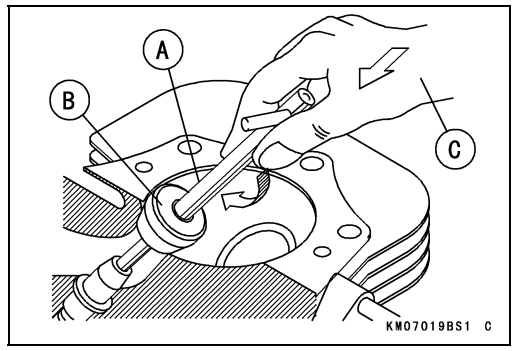
Intake Valve
Valve Seat Cutter, 45° - ϕ35: 57001-1116
Valve Seat Cutter, 32° - ϕ35: 57001-1121

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

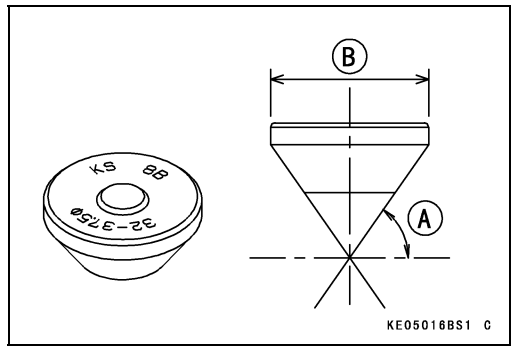
○*Prior to grinding, apply engine oil to the cutter, and during the operation wash off any ground particles sticking to the cutter with washing oil.*

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.

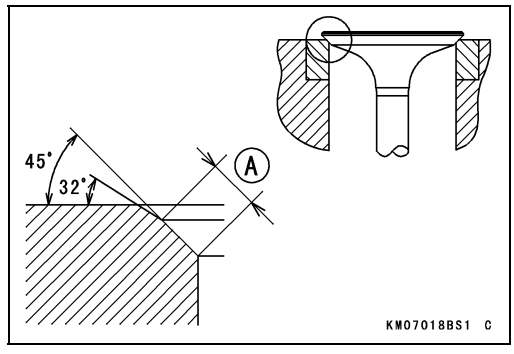
32°	Cutter angle [A]
37.5	Cutter diameter [B]
KS8B	Manufactured lot number



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.

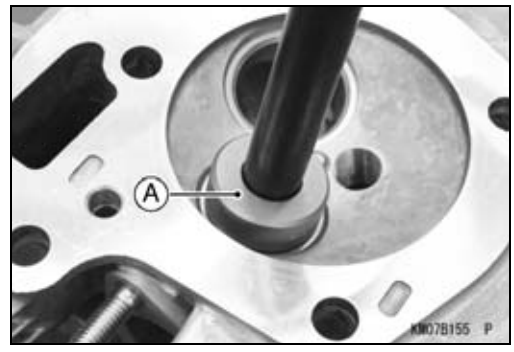
★If the valve seating pattern is not correct, repair the seat.



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.

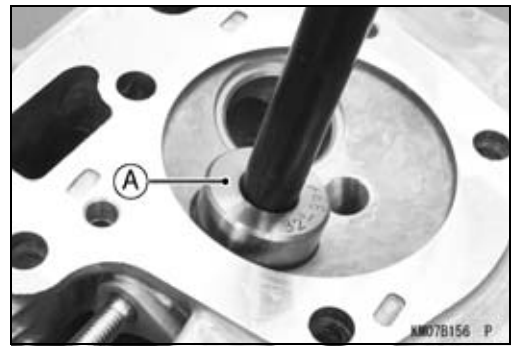


NOTICE

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

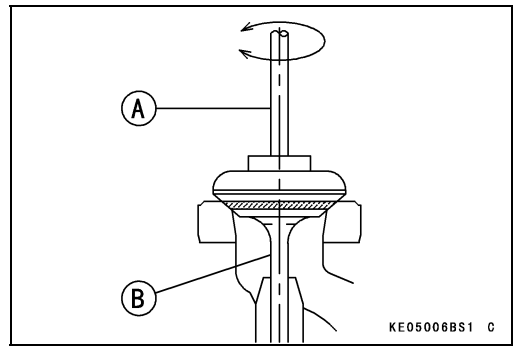
○*Keep the seat width as close as possible to the standard width.*

- 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.

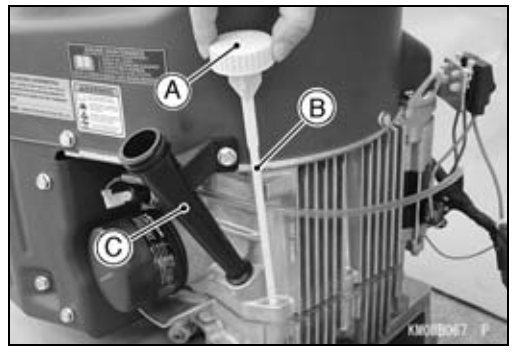
- Coat the face of valve sparingly with a fine lapping compound.
- Use the lapping tool [A], to grip top of the valve [B]. Rotate the valve in a circular motion to lap the valve to the seat.
- Lift the valve slightly from the seat every 8 to 10 strokes, continue lapping operation until a uniform ring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

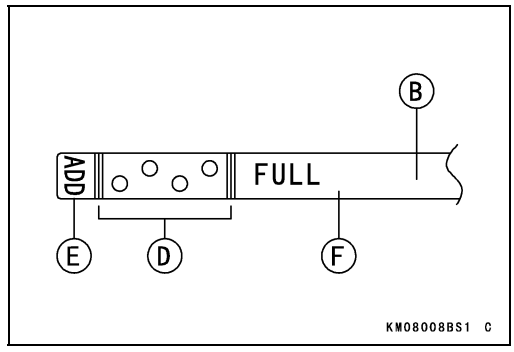
Engine Oil Level Inspection



- 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.



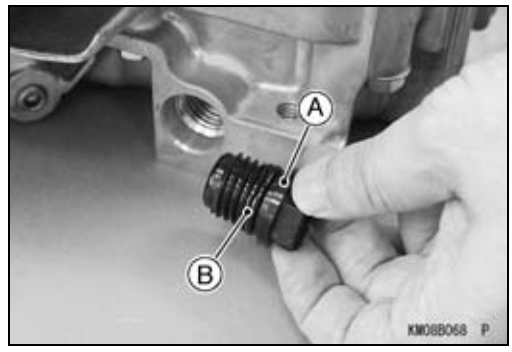
○Use the same type and make of oil that is already in the engine.

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



- Change the oil after first 8 hours of operation. Thereafter change oil every 100 hours.
- 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.

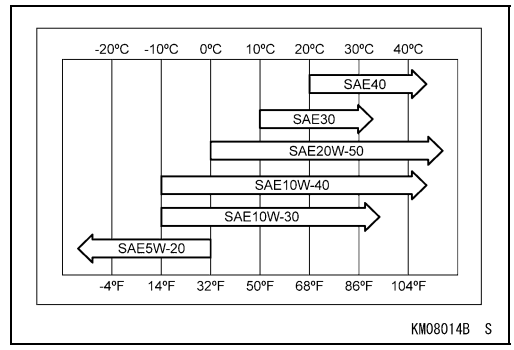
Torque - Engine Oil Drain Plug: 6.9 N·m (0.70 kgf·m, 61 in·lb)

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)

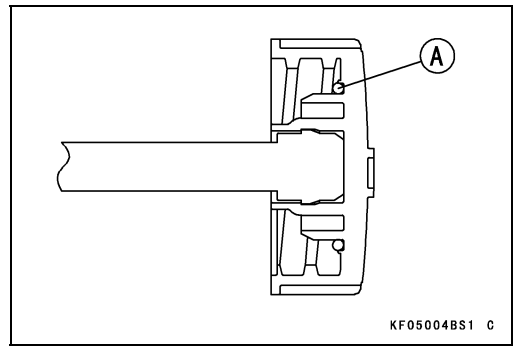


● Check the O-ring [A] on the oil filler cap for damage. Replace the oil filler cap assembly if O-ring is damaged.

★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.*

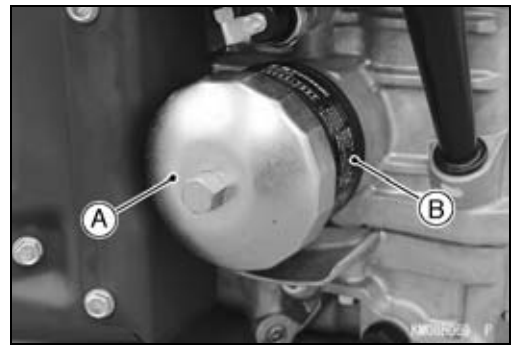


Oil Filter Replacement

● Drain the engine oil (see Engine Oil Change).

● Using a suitable tool [A], remove the oil filter [B].

○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)

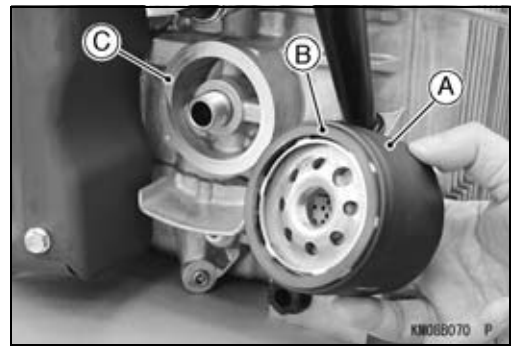
○Turn the filter until the seal contacts mounting surface [C] of the engine. Then turn the filter BY HAND (S) 3/4 turn.

● Fill the engine oil.

● Run the engine at slow idle speed 3 minutes.

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

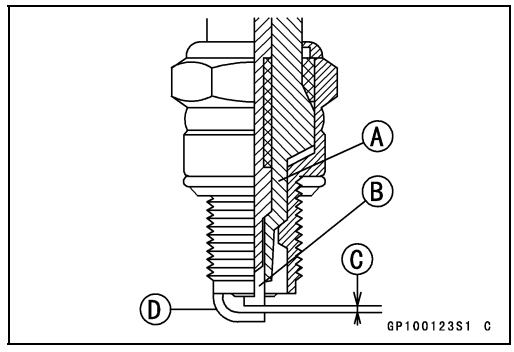
● Stop the engine and check the oil level (see Engine Oil Level Inspection).



Periodic Maintenance Procedures

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]

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 (EFI)

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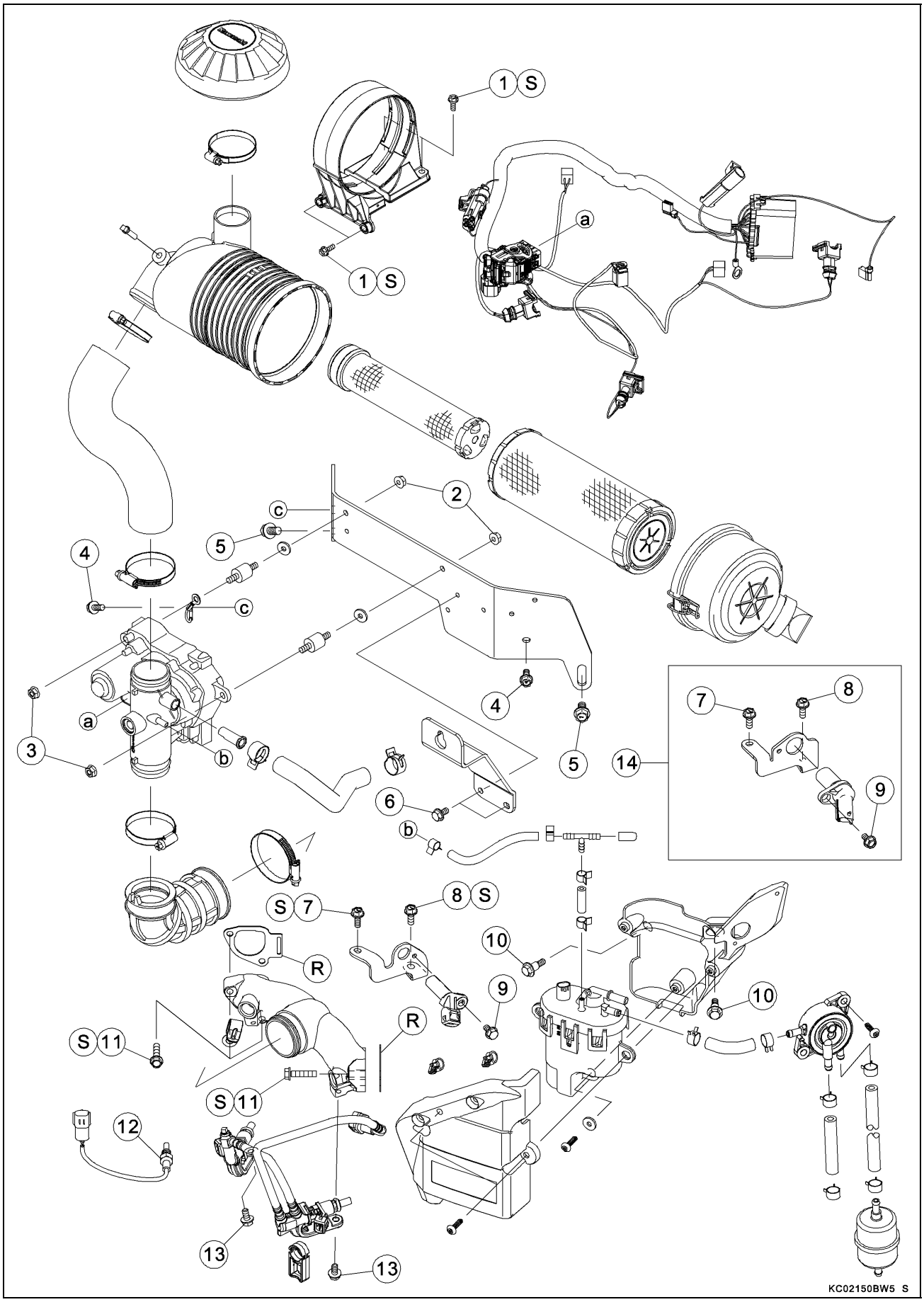
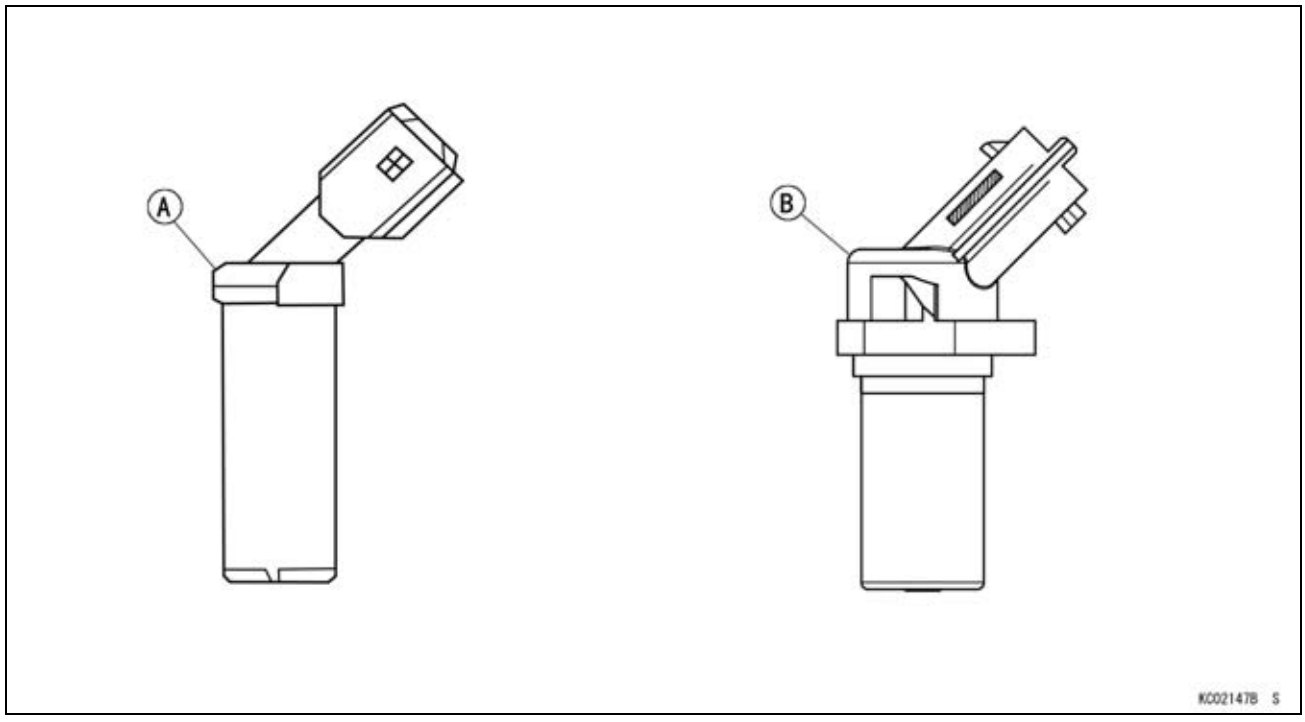
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Air Cleaner Bracket Mounting Bolts	8.8	0.90	78 in·lb	S
2	Damper Mounting Nuts	3.7	0.38	33 in·lb	
3	Throttle Body Mounting Nuts	3.7	0.38	33 in·lb	
4	Throttle Body Bracket Bolts (M6)	5.9	0.60	52 in·lb	
5	Throttle Body Bracket Bolts (M8)	17.6	1.79	13.0	
6	Lift Plate Bolts	5.9	0.60	52 in·lb	
7	Ignition Coil Mounting Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
	Ignition Coil Mounting Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
8	Crankshaft Position Sensor Bracket Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
	Crankshaft Position Sensor Bracket Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
9	Crankshaft Position Sensor Mounting Bolt	5.9	0.60	52 in·lb	
10	Fuel Pump Bracket Mounting Bolts	8.8	0.90	78 in·lb	
11	Intake Manifold Bolts	5.9	0.60	52 in·lb	S
12	Cylinder Head Temperature Sensor	7.5	0.76	66 in·lb	
13	Fuel Injector Mounting Bolts	5.9	0.60	52 in·lb	

14. New Crankshaft Position Sensor
R: Replacement Parts
S: Follow the specified tightening sequence.



A. Old Crankshaft Position Sensor
B. New Crankshaft Position Sensor

Specifications

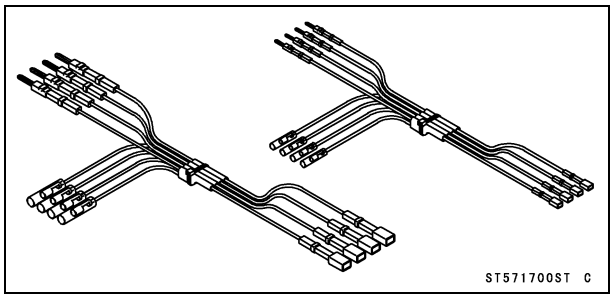
Item	Standard
Digital Fuel Injection System	
Throttle Body/ECU Assy:	
Throttle Valve Type	Single throttle valve
Throttle Bore	ϕ34 mm (1.3 in.)
Cylinder Head Temperature Sensor:	
Resistance	12.9 ~ 15.7 kΩ @20°C (68°F)
Output Voltage	DC 3.94 ~ 4.94 V @20°C (68°F)
Hand Throttle Input Sensor:	
Input Voltage	DC 4.5 ~ 5.5 V
Output Voltage	DC 0.4 ~ 4.6 V at from idle throttle opening to full throttle opening
Crankshaft Position Sensor:	
Air Gap (Old Crankshaft Position Sensor)	0.5 ~ 1.5 mm (0.02 ~ 0.06 in.)
Resistance:	
Old Crankshaft Position Sensor	360 ~ 440 Ω @23°C (73°F)
New Crankshaft Position Sensor	776 ~ 946 Ω @20°C (68°F)
Fuel Injectors:	
Resistance	11.4 ~ 12.6 Ω @20°C (68°F)
Input Voltage	Battery Voltage
Fuel Pump:	
Fuel Pressure	256 ~ 284 kPa (2.61 ~ 2.90 kgf/cm², 37.1 ~ 41.2 psi) (pump operates at 13.5 ±0.1 V, 22 ±5°C/measured at idle speed)
Ignition Coils:	
Primary Winding Resistance	0.68 ~ 0.83 Ω
Secondary Winding Resistance	Not available
Input Voltage	Battery Voltage
Battery Voltage	8 ~ 16 V
Idle Speed[1]	
Low Idle Speed	1 550 r/min (rpm) (for reference)
High Idle Speed	3 600 r/min (rpm) (for reference)
Air Cleaner	
Type	Dual stage element, heavy duty type
Pre-cleaner	Paper element
Second-stage cleaner	Treated media
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.

Specifications

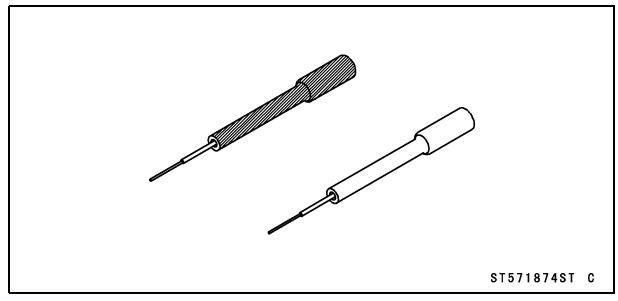
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.
(2) Other fuel requirements:
See fuel and oil recommendations in Owner's Manual.

Special Tools and Sealant

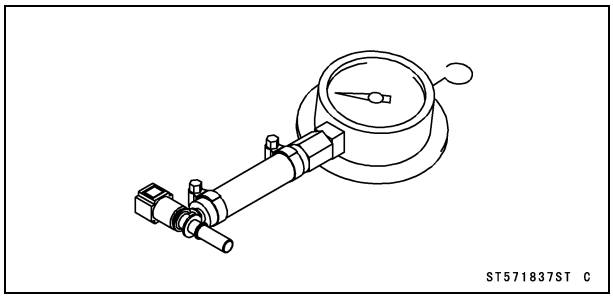
Measuring Adapter:
57001-1700



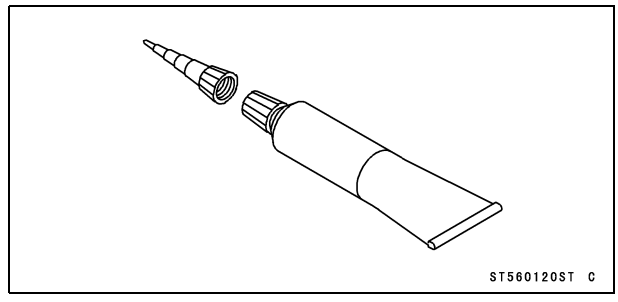
Needle Adapter Set:
57001-1874



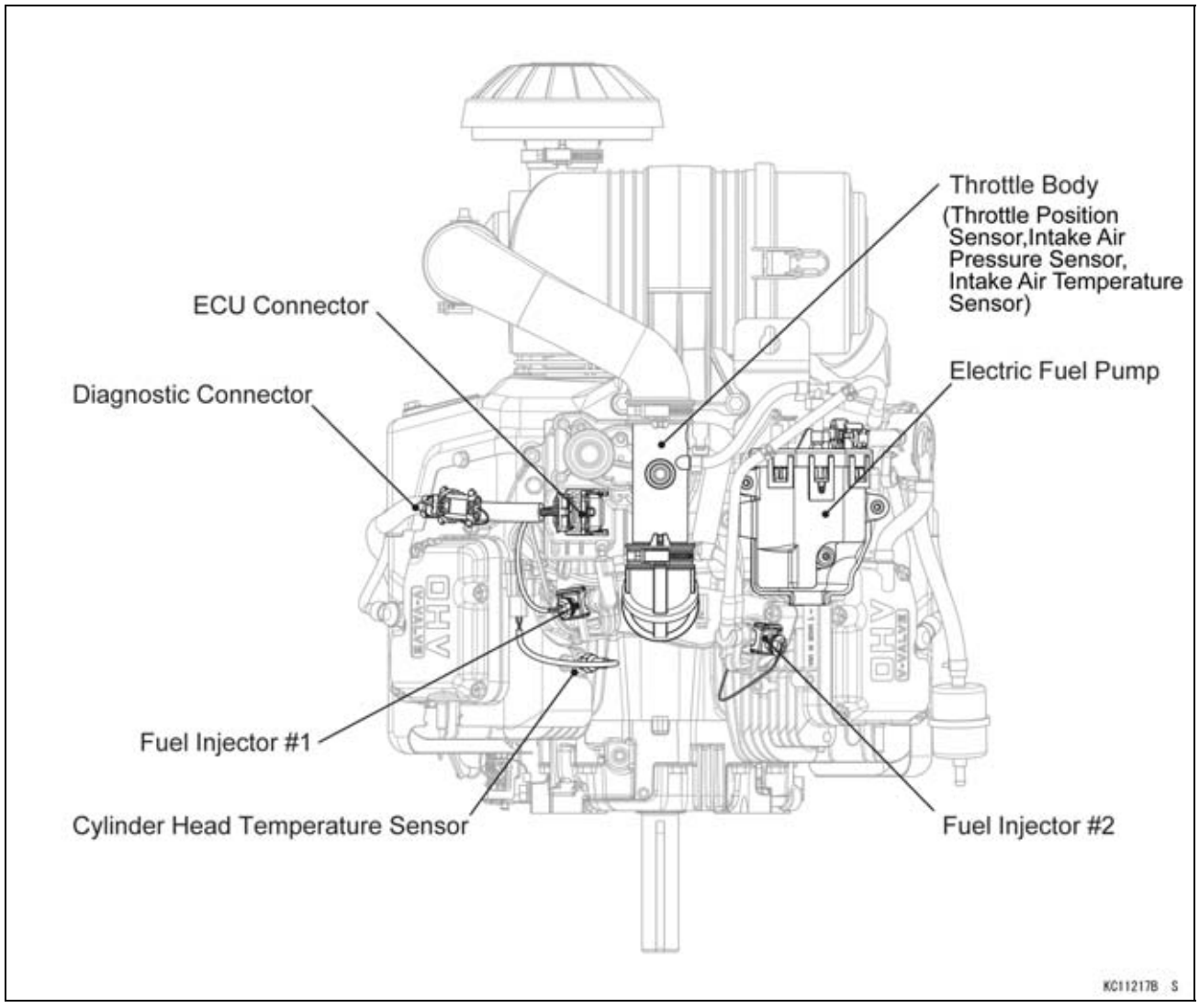
Fuel Pressure Gauge Adapter:
57001-1837



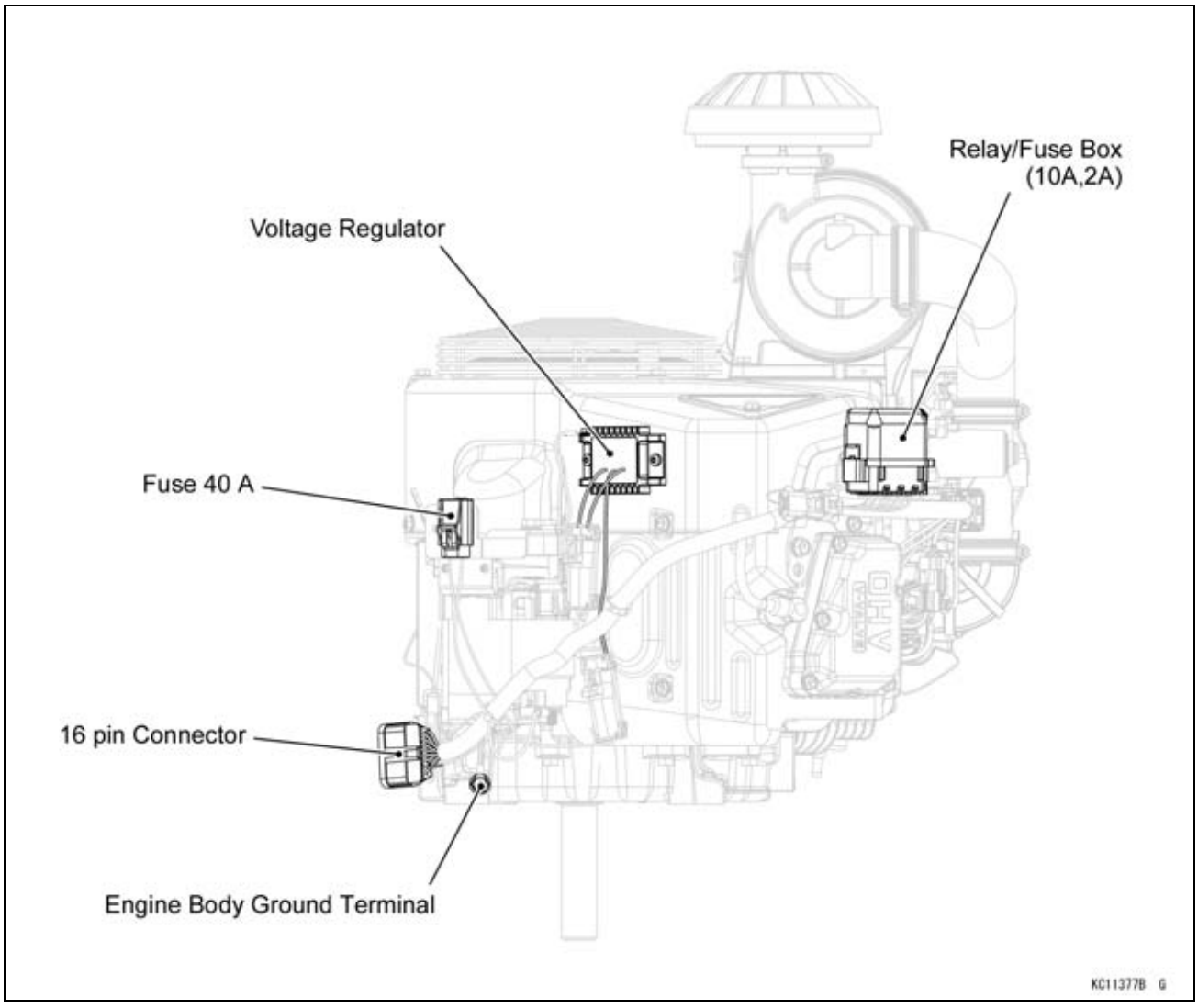
Liquid Gasket, TB1211:
56019-120

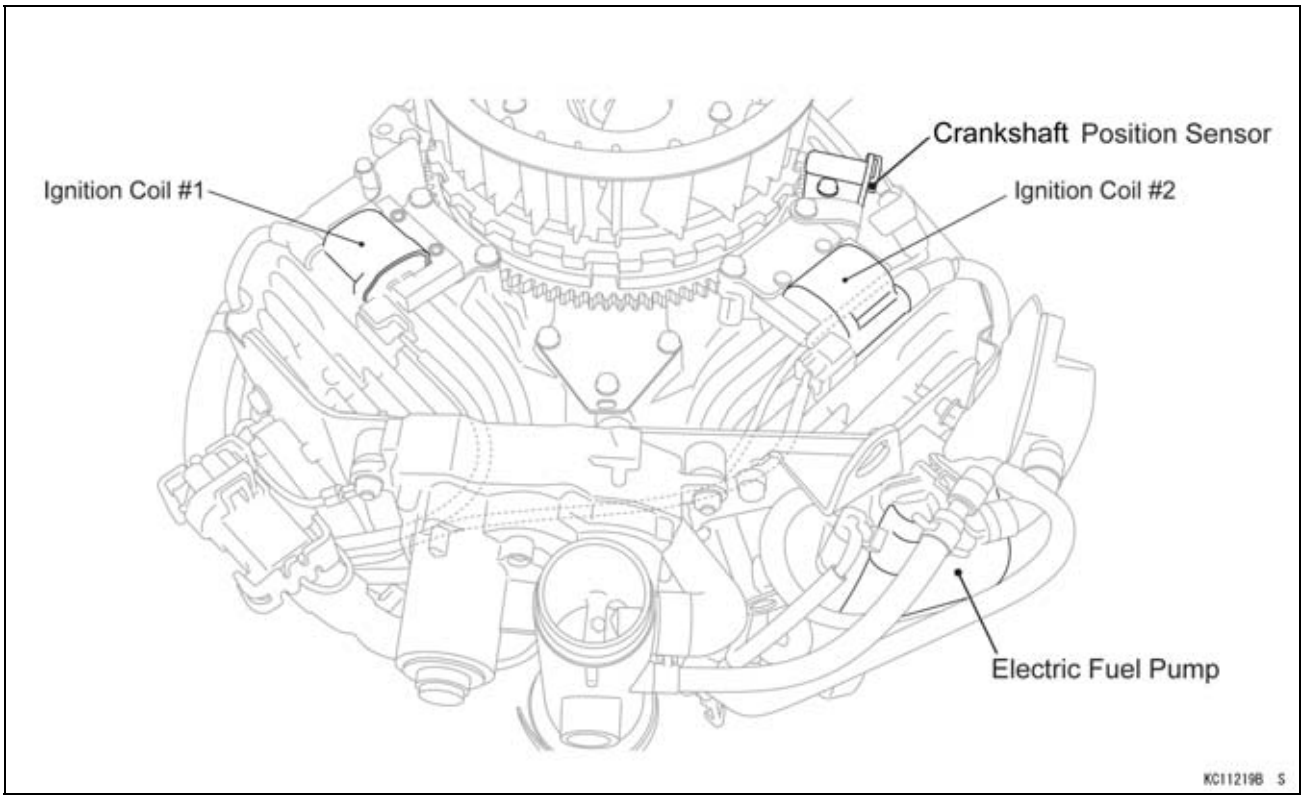


EFI System Parts Location



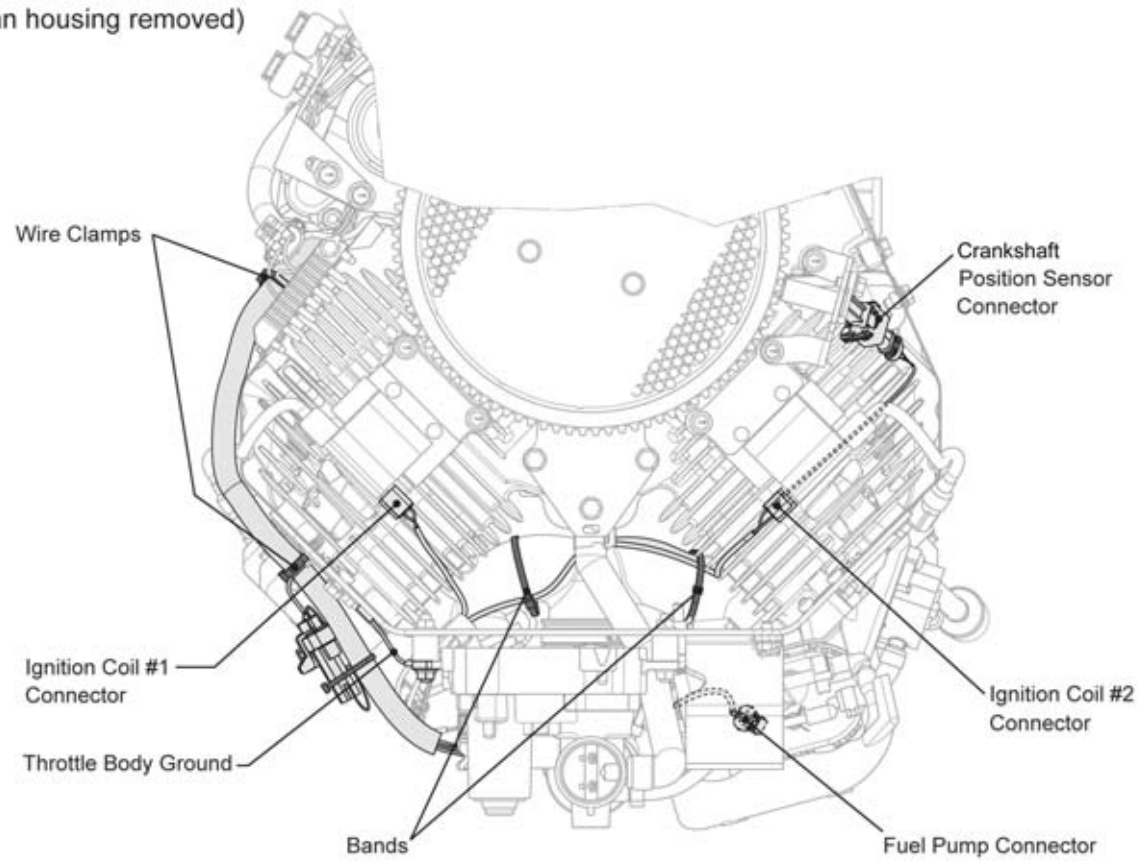
EFI System Parts Location



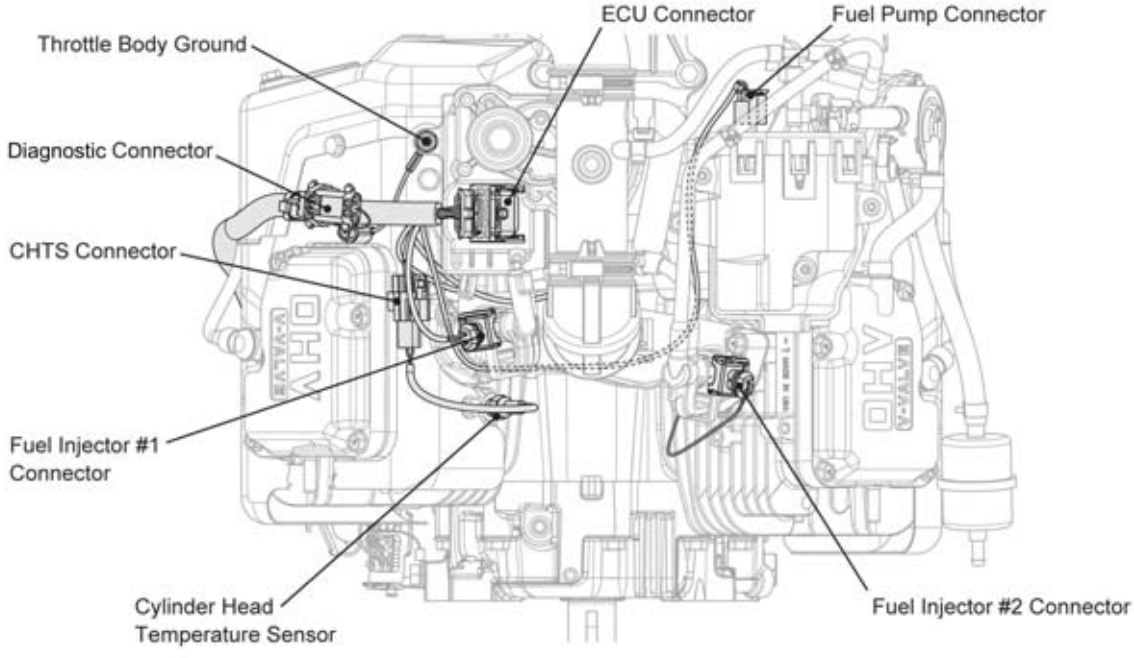


Harness Routing

View from top
(Fan housing removed)



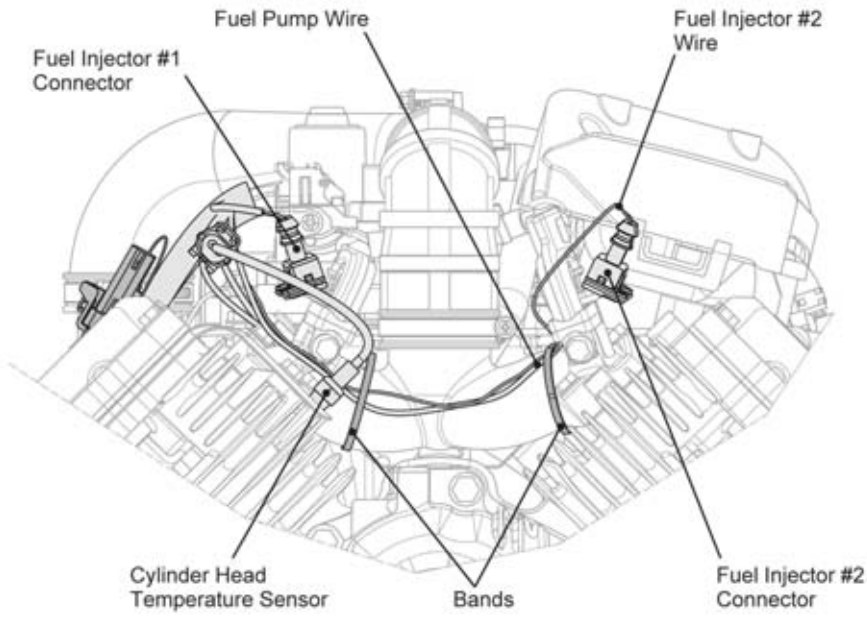
View from front



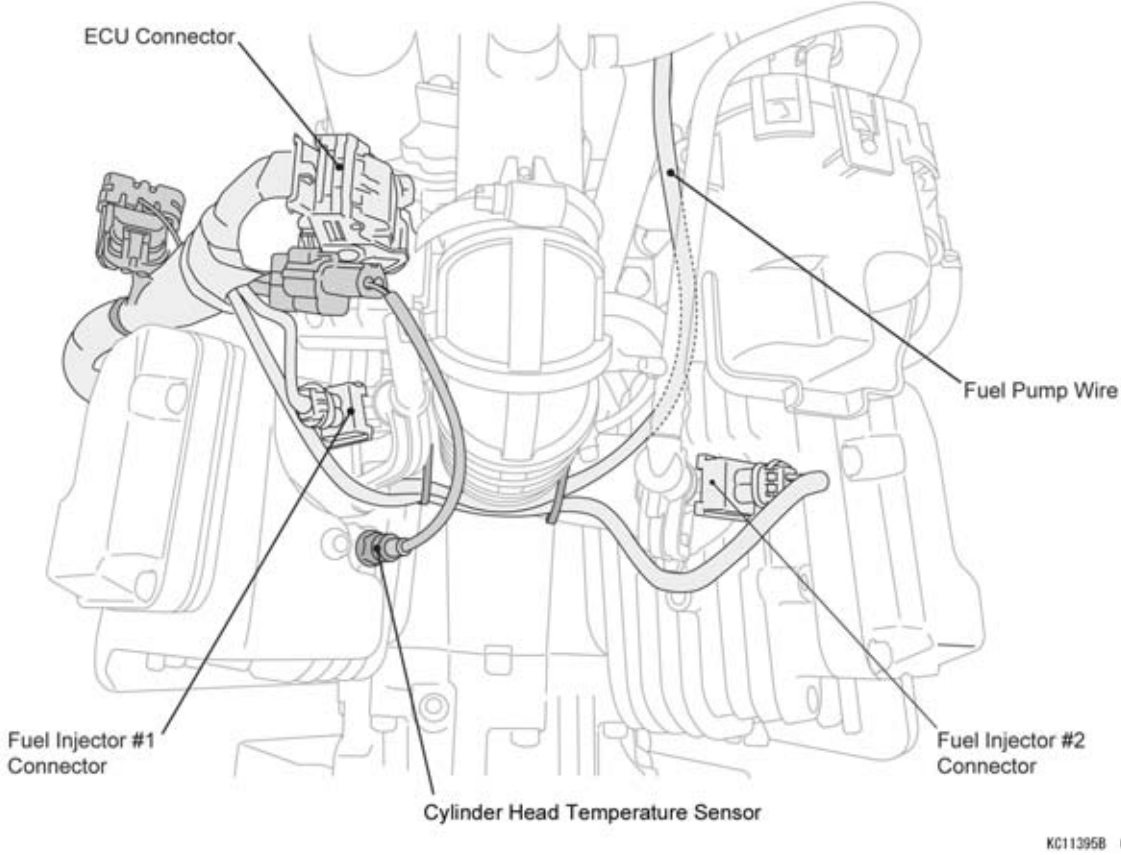
KC11220B S

Harness Routing

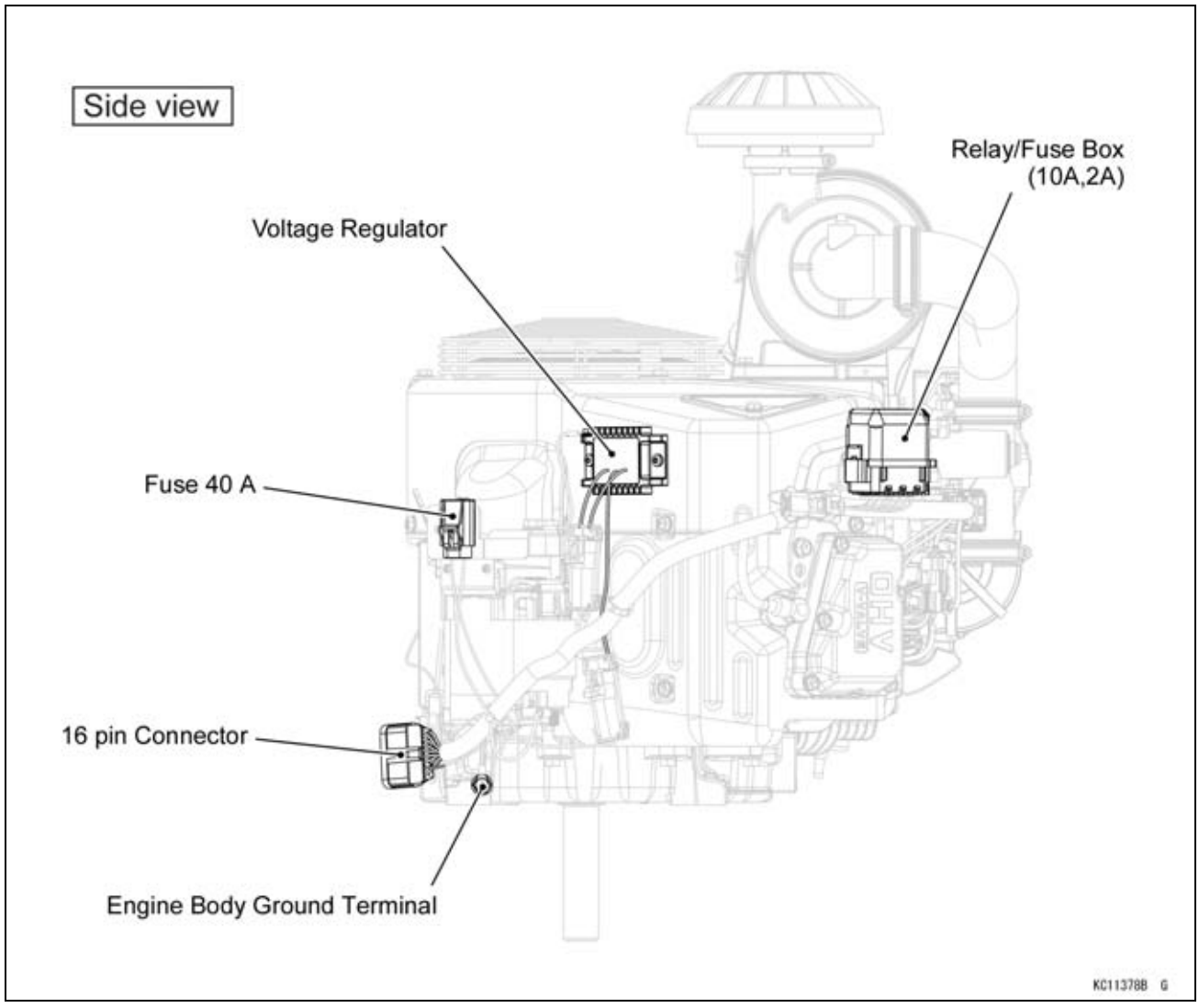
View from bottom



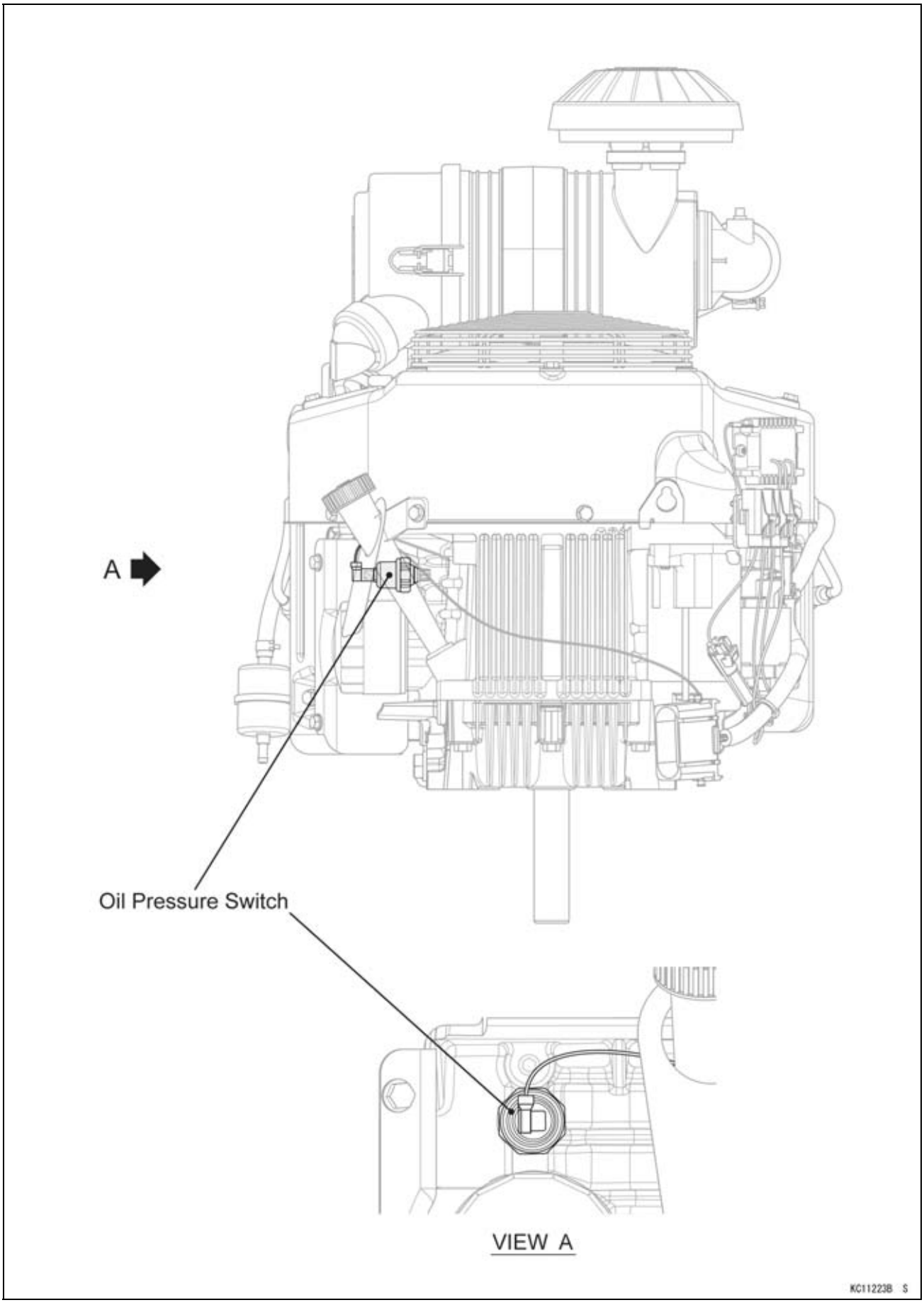
Lower part view



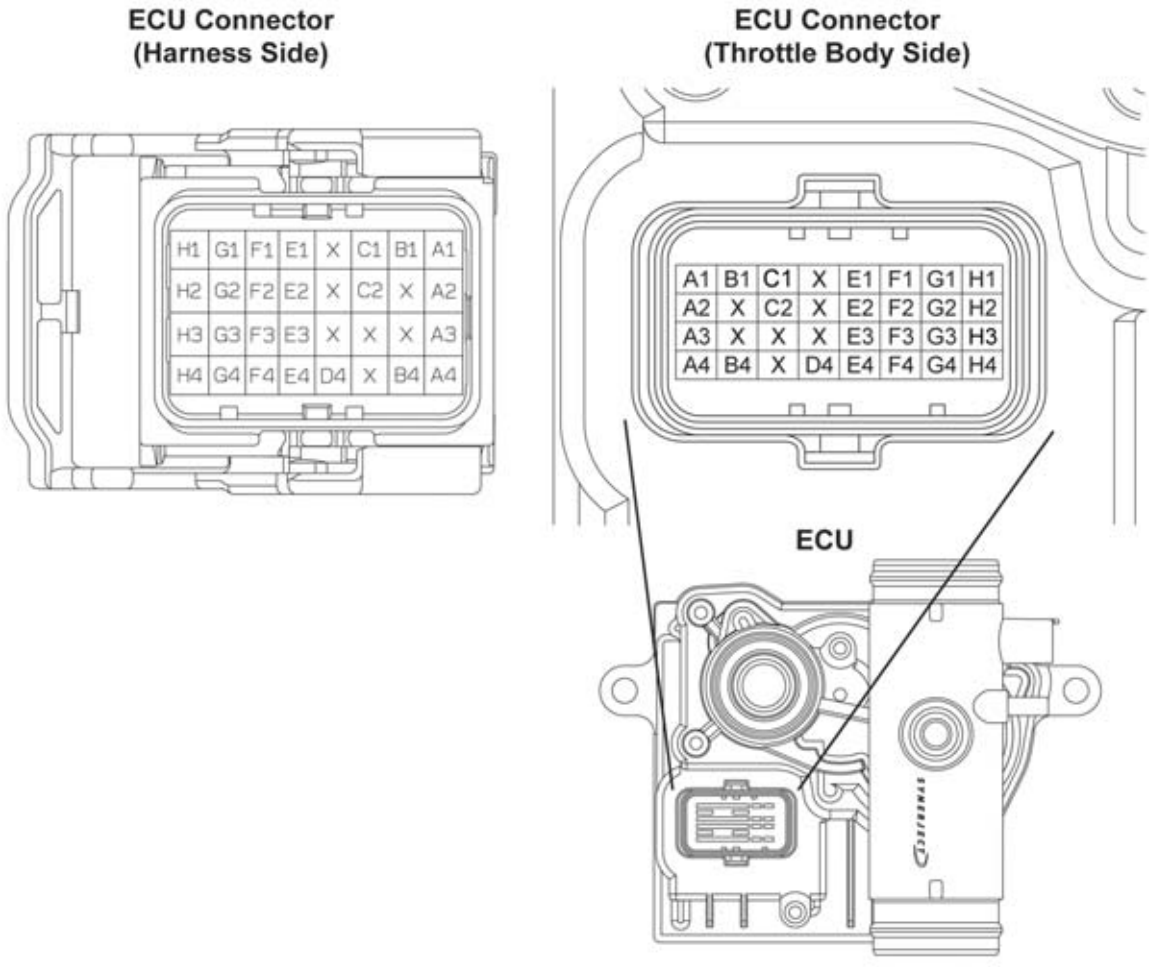
Harness Routing



Harness Routing



Connector's Terminals

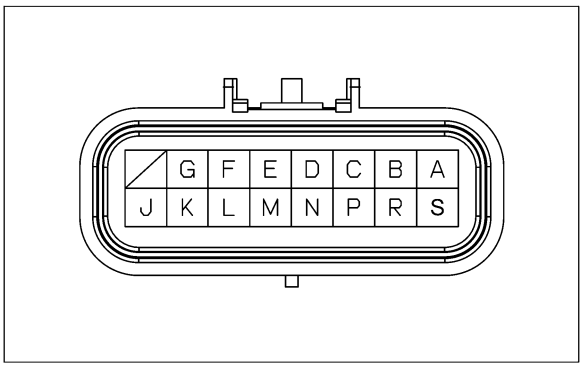


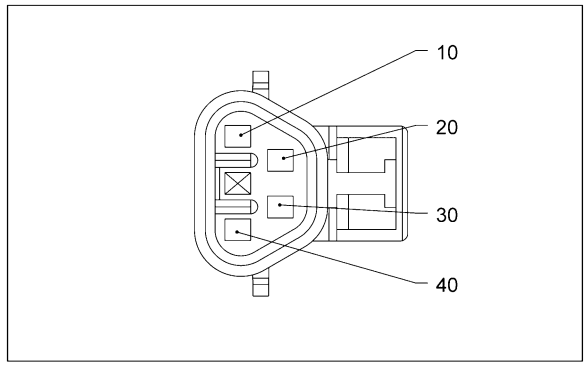
Terminal	Color	Circuit	Terminal	Color	Circuit
A1	W/R	Crankshaft Position Sensor (+)	E1	BL/W	Hand Throttle Input Sensor Power
A2	V/W	Crankshaft Position Sensor (–)	E2	BK	HTIS/ CHTS Ground
A3	BL	CAN Low	E3	O	Keyed +12V
A4	Y/BR	CAN High	E4	P	Oil Pressure Signal or Blade Relay Signal (If installed)
B1	CH	Oil Pressure Switch	F1	G/BK	Fuel Injector #1 Signal
B2			F2	R/P	MIL Ground
B3			F3	CH/W	Oil Temp. Signal (If installed)
B4	W	Hand Throttle Input Sensor Signal	F4	G/W	Main Relay Control
C1	W/BL	Blade Switch (If installed)	G1	R	12V Power for ECU
C2	Y	Safety Switch	G2	BK	Power Ground
C3			G3	BK	Power Ground
C4			G4	BL/W	Ignition Coil #2 Signal
D1			H1	W/BK	Fuel Injector #2 Signal
D2			H2	BR	Fuel Pump Relay Control
D3			H3	G	Oxygen Sensor Heater Switch (If installed)
D4	GY/R	Cylinder Head Temperature Sensor	H4	GY	Ignition Coil #1 Signal

KC11376B G

Connector's Terminals

16 Pin Connector Model





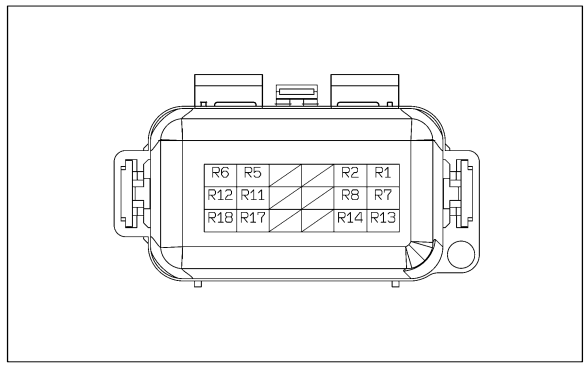
16 PIN Connector (Engine side)

Terminal	Color	Circuit
A	P	Oil Pressure Signal or Blade Relay Signal (If installed)
B	Y/BR	CAN High
C	BK	Hand Throttle Input Sensor Ground
D	W	Hand Throttle Input Sensor Signal
E	BL/W	Hand Throttle Input Sensor Power
F	Y	Safety Switch
G	O	Key +12V
J	CH/W	Oil Temp. Signal (If installed)
K	V	Starter
L	BK/W	Fuel Pump Relay Output
M	R/P	MIL Ground
N	CH	Oil Pressure Switch
P	W/BL	Blade Switch (If installed)
R	BL	CAN Low
S	G	Oxygen Sensor Heater Switch (If installed)

Diagnostic Connector

Terminal	Color	Circuit
10	BL	CAN Low
20	Y/BR	CAN High
30	BK	Ground
40	R	12V Power

Relay Connector



Terminal	Circuit
R5	Fuel Pump Relay Input
R12	Fuel Pump Relay Output
R11	Fuel Pump Relay Power
R6	Fuel Pump Relay Control
R1	Main Relay Input
R8	Main Relay Output
R7	Main Relay Power
R2	Main Relay Control
R18	2A Fuse (to Terminal E3 (ECU))
R17	2A Fuse (from Terminal G (16 Pin Connector))
R14	10A Fuse (from Battery)
R13	10A Fuse (to Main Relay)

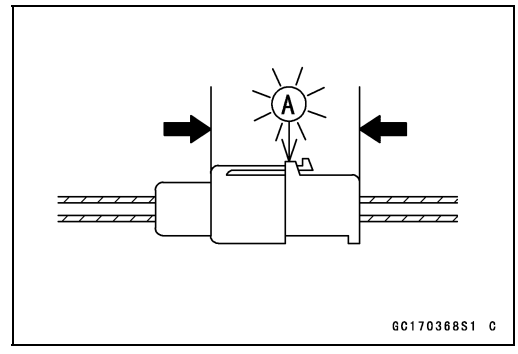
EFI Service Precautions

EFI Service Precautions

There are a number of important precautions that should be followed servicing the EFI system.

- This EFI system is designed to be used with a 12 V sealed battery as its power source. Do not use any other battery except for a 12 V sealed battery as a power source.
- Do not reverse the battery cable connections. This will damage the ECU.
- To prevent damage to the EFI parts, do not disconnect the battery cables or any other electrical connections when the ignition switch is on, or while the engine is running.
- Take care not to short the leads that are directly connected to the battery positive (+) terminal to the chassis ground.
- When charging, remove the battery from the engine. This is to prevent ECU damage by excessive voltage.
- Whenever the EFI electrical connections are to be disconnected, first turn off the ignition switch, and disconnect the battery (–) terminal. Do not pull the lead, only the connector. Conversely, make sure that all the EFI electrical connections are firmly reconnected before starting the engine.

- Connect these connectors until they click [A].



- Do not turn the ignition switch on while any of the EFI electrical connectors are disconnected. The ECU memorizes trouble codes.
- Do not spray water on the electrical parts, EFI parts, connectors, leads and wiring.
- When any fuel hose is disconnected, do not turn on the ignition switch. Otherwise, the fuel pump will operate and fuel will spout from the fuel hose.
- Do not operate the fuel pump if the pump is completely dry. This is to prevent pump seizure.
- Before removing the fuel system parts, blow the outer surfaces of these parts clean with compressed air.
- When any fuel hose is disconnected, fuel may spout out by residual pressure in the fuel line. Cover the hose joint with a piece of clean cloth to prevent fuel spillage.
- When installing the fuel hoses, avoid sharp bending, kinking, flattening or twisting, and run the fuel hoses with a minimum of bending so that the fuel flow will not be obstructed.
- Run the hoses according to Cable, Wire, and Hose Routing instruction.
- To prevent corrosion and deposits in the fuel system, do not add to fuel any fuel antifreeze chemicals.

Self-Diagnosis

Reading Trouble Code

Reading Trouble Code by Diagnostic Tool

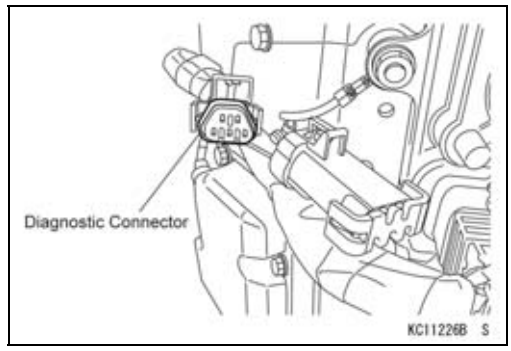
DTC (Diagnostic Trouble Code) shows which part of the EFI system is in trouble.

DTC can be seen by a diagnostic tool. The tool shall be available for SAE J1939 standard.

To see the trouble code, connect the diagnosis tool with the engine at diagnostic connector, and then, turn the ignition switch to the RUN position. Refer to the diagnostic tool's manual for operating instructions.

When you get DTC from the diagnostic tool, refer to the Diagnostic Trouble Codes Table in this manual. The table describes the symptom and pages for reference.

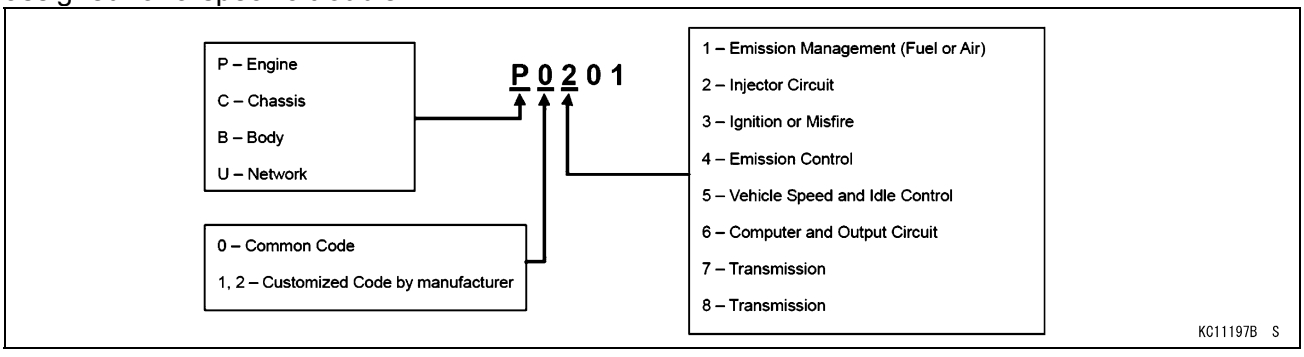
Check the symptom and go to the pages.



Diagnostic Trouble Code (P-code) (reference information)

DTCs (P-code) have an alphabet followed by 4 digit number.

The first alphabet means the section that recodes the trouble. And the remaining 4 digit number is assigned for a specific trouble.



Self-Diagnosis

Diagnosis Trouble Codes Table

○When ECU detects EFI system trouble, the ECU provides diagnosis codes.
○If the ECU provides the codes, go to the page of this table and conduct the inspections.

DTC	SPN	FMI	Problems	Action or see page
P0107	106	4	Intake air pressure sensor malfunction, wiring short to ground	Replace the throttle body. 3-53
P0112	105	4	Intake air temperature sensor malfunction, wiring short to ground	
P0113	105	3	Intake air temperature sensor malfunction, wiring short to power	
P0116	110	2	Cylinder head temperature sensor malfunction. Sensor's input is invalid.	3-31
P0117	110	4	Cylinder head temperature sensor malfunction, wiring short to ground	3-29 ~ 3-31
P0118	110	3	Cylinder head temperature sensor malfunction, wiring short to power	
P0201	651	5	Fuel injector #1 malfunction. Open circuit	3-38 ~ 3-40
P0202	652	5	Fuel injector #2 malfunction. Open circuit	
P0217	110	0	Cylinder head temperature sensor malfunction. Over temperature detected	3-29 ~ 3-31
P0219	190	0	Crankshaft position sensor malfunction. Engine overspeed	3-34 ~ 3-37
P0222	29	4	Hand throttle input sensor malfunction, wiring short to ground	3-32 ~ 3-33
P0223	29	3	Hand throttle input sensor malfunction, wiring short to power	
P0231	1075	4	Fuel pump malfunction, wiring short to ground	3-41 ~ 3-43
P0232	1075	3	Fuel pump malfunction, wiring short to power	
P0261	651	4	Fuel injector #1 malfunction, wiring short to ground	3-38 ~ 3-40
P0262	651	3	Fuel injector #1 malfunction, wiring short to power	
P0264	652	4	Fuel injector #2 malfunction, wiring short to ground	
P0265	652	3	Fuel injector #2 malfunction, wiring short to power	
P0335	636	8	Crankshaft position sensor malfunction. Missing crank tooth defected.	3-34 ~ 3-37
P0351	1268	5	Ignition coil #1 malfunction, wiring short to ground or open circuit	3-44 ~ 3-46
P0352	1269	5	Ignition coil #2 malfunction, wiring short to ground or open circuit	
P0562	168	1	Battery voltage too low	3-48
P0563	168	0	Battery voltage too high	
P0600	629	12	ECU internal communication error	Replace the throttle body. 3-53
P0641	3597	5	Reference voltage for ECU malfunction. ECU detected the voltage is out of range.	3-48

Self-Diagnosis

DTC	SPN	FMI	Problems	Action or see page
P0643	3597	3	Reference voltage for ECU malfunction. Reference voltage wiring short to power	Replace the throttle body. 3-53
P0650	5080	5	Malfunction indicator light malfunction. Open circuit	3-49
P0651	3598	5	Reference voltage for ECU malfunction. Reference voltage wiring short to ground or open circuit	Replace the throttle body. 3-53
P0653	3598	3	Reference voltage for ECU malfunction, wiring short to power	
P0658	3464	4	Throttle position sensor #1 malfunction, wiring short to ground	
P0659	3464	3	Throttle position sensor #1 malfunction, wiring short to power	
P0666	5376	0	Electronic throttle control malfunction. ETC driver over temperature detected.	3-47
P0667	5376	16	Electronic throttle control malfunction. ETC driver detected warm	
P06D2	5080	4	Malfunction indicator light malfunction, wiring short to ground	3-49
P1513	1075	5	Fuel pump malfunction. Open circuit	3-41 ~ 3-43
P1515	5419	12	Electronic throttle control malfunction. ETC driver short circuit between PIN 1 and PIN 2	Replace the throttle body. 3-53
P2100	5419	5	Electronic throttle control malfunction. ETC driver Open circuit	
P2101	3464	2	Electronic throttle control malfunction. Throttle position controller signal is out of range.	
P2102	5375	4	Electronic throttle control malfunction. ETC driver short circuit diagnosis on PIN 1 wiring short to ground	
P2103	5375	3	Electronic throttle control malfunction. ETC driver short circuit diagnosis on PIN 1 wiring short to power	
P2109	5374	1	Throttle position sensor malfunction. Lower position is not reached.	3-28
P210A	5374	13	Throttle position sensor malfunction. Lower mechanical stop adaptation is out of range.	
P210B	5374	7	Throttle position sensor malfunction. Error of lower return spring check	
P210C	5378	4	Electronic throttle control malfunction. ETC driver short circuit diagnosis on PIN 2 wiring short to ground	Replace the throttle body. 3-53
P210D	5378	3	Electronic throttle control malfunction. ETC driver short circuit diagnosis on PIN 2 wiring short to power	
P210E	5377	12	Throttle position sensor malfunction. Adaptation condition exceeded.	

Self-Diagnosis

DTC	SPN	FMI	Problems	Action or see page
P2110	5377	13	Throttle position sensor malfunction. Limp home mode adaptation is out of range.	3-28
P2111	5377	1	Throttle position sensor malfunction. Upper position is not reached.	
P2112	5377	7	Throttle position sensor malfunction. Error of upper return spring check	
P2113	51	13	Throttle position sensor malfunction. Different value between TPS #1 and TPS #2	Replace the throttle body. 3-53
P2114	6650	13	Throttle position sensor malfunction. Ratio between TPS #1 and TPS #2	
P2301	1268	3	Ignition coil #1 malfunction, wiring short to power	3-44 ~ 3-46
P2304	1269	3	Ignition coil #2 malfunction, wiring short to power	
P2670	3465	4	Throttle position sensor #2 malfunction, wiring short to ground	Replace the throttle body. 3-53
P2671	3465	3	Throttle position sensor #2 malfunction, wiring short to power	

Self-Diagnosis

Back-ups by ECU

○The ECU takes back-up actions as below when the ECU detects the EFI system troubles.

Parts or functions	DTC	Signal usable range or criteria	Back-ups
Throttle Position Sensor	P0658	ECU detected the invalid condition of internal TPS signal 1.	If one sensor reading fails, ECU uses the other sensor reading. If both sensors readings fail, ECU enters limp home mode through spring stop.
	P0659		
	P2670	ECU detected the invalid condition of internal TPS signal 2.	
	P2671		
	P210A	ECU self-diagnosis detects condition outside of valid range.	Internal diagnosis
	P210B		
	P2109		
	P210E		
	P2110		
	P2111		
	P2112		
	P2113	Different value between internal TPS 1 and 2 readings	Filtering result is delivered
	P2114	Ratio between internal TPS 1 and 2 readings	Internal diagnosis
Intake Air Pressure Sensor	P0107	12.5 kPa (0.127 kg/cm², 1.81 psi) ≤ range sensor can detect ≤ 121.2 kPa (1.236 kg/cm², 17.57 psi)	If the intake air pressure sensor system fails, the ECU bases injection events on default ECU valve.
Intake Air Temperature Sensor	P0112	Standard voltage of the sensor depends on the ambient temperature.	If the intake air temperature fails, the calibrated value at 20°C (68°F) is used.
	P0113		
Cylinder Head Temperature Sensor	P0117	0.049 V < output voltage range < 4.951 V	If the cylinder head temperature sensor fails, the ECU will use a calculated substitute value for cylinder head temperature and the engine will continue to run.
	P0118		
	P0116	Sensor's input is invalid.	
	P0217	Under 160°C (320°F) is standard cylinder head temperature.	Engine goes to low idle if above 160°C (320°F) .
Hand Throttle Input Sensor	P0222	0.4 V < usable output voltage < 4.6 V	If the hand throttle input sensor fails, the engine goes to low idle rpm.
	P0223		
Crankshaft Position Sensor	P0335	24-2 crank gear configuration	No further action by ECU.
	P0219	Engine speed exceeds 4 224 r/min (rpm)	

Self-Diagnosis

Parts or functions	DTC	Signal usable range or criteria	Back-ups
Fuel Injector #1	P0201	Injector driver self-diagnosis verifies connections to signal and power.	If injector #1 fails, engine runs with only injector #2 active.
	P0261		
	P0262		
Fuel Injector #2	P0202		If injector #2 fails, engine runs with only injector #1 active.
	P0264		
	P0265		
Fuel Pump	P0231	ECU low side driver self-diagnosis verifies connection to the fuel pump relay.	Engine will stop due to lack of fuel pressure.
	P0232		
	P1513		
Ignition Coil #1	P0351	Ignition driver self-diagnosis verifies connections to signal and power.	If ignition coil #1 fails, engine runs with only ignition coil #2 active.
	P2301		
Ignition Coil #2	P0352		If ignition coil #2 fails, engine runs with only ignition coil #1 active.
	P2304		
Electronic Throttle Control	P0666	Microprocessor self-diagnosis	No further action by ECU.
	P0667		
	P2102		Mechanical limp home mode
	P2103		
	P210C		
	P210D		
	P1515		
	P2100		The electronic throttle valve is not driven by ECU, and its valve is set to predetermined limp opening by throttle body.
	P2101		Error management function in the ECU control
Battery Voltage	P0563	10 V ≤ usable voltage ≤ 17 V	If battery voltage is out of standard, the engine rpm will go to low idle rpm.
	P0562		
Reference Voltage for ECU	P0641	4.4 V ≤ usable range for reference voltage 1 ≤ 5.6 V	If reference voltage 1 fails ECU use reference voltage 2 signal. If both reference voltage failed, engine goes to low idle.
	P0643		
	P0651	4.4 V ≤ usable range for reference voltage 2 ≤ 5.6 V	If reference voltage 2 fails ECU use reference voltage 1 signal. If both reference voltage failed, engine goes to low idle.
	P0653		
Malfunction Indicator Light	P06D2	ECU low side driver self-diagnosis verifies connection to MIL.	No further action by ECU.
	P0650		
ECU Internal	P0600	Microprocessor self-diagnosis	Only code is displayed or set.

Self-Diagnosis

Reduced Power Mode

When the ECU detects conditions of the engine as stated below, the ECU reduces the engine speed to low idle (Reduced Power Mode).

Service an engine that has entered reduced power mode as soon as possible. Operating in reduced power mode for extended periods of time can cause engine failure.

Reduced Power Mode Troubleshooting Table

Symptom	DTC	Cause of problem	Remedy
Overheat of the engine (MIL on)	P0217	Debris or dust is inside shroud	Clean (refer to Periodic Maintenance chapter)
	P0116 P0117 P0118	Temperature sensor or circuit malfunction	Refer to Cylinder Head Temperature Sensor section.
Low oil pressure (If oil switch is equipped) (MIL off/Oil light on)	NA	Low oil level	Add oil (refer to Periodic Maintenance chapter)
		Oil switch or circuit malfunction	Refer to wiring diagram.
		Lubrication system malfunction	Refer to Lubrication System chapter.
Battery voltage is abnormal (MIL on)	P0562	Low battery voltage or battery wiring issue.	Refer to Battery in Troubleshooting section in OEM service manual. Refer to Charging System Troubleshooting Procedures section of Kawasaki Engine service manual.
	P0563	Power supply or charging system malfunction	
Hand throttle input sensor malfunction (MIL on)	P0222 P0223	The sensor or circuit malfunction	Refer to Hand Throttle Input sensor section. Refer to the OEM service manual.
Overspeed detected (MIL on)	P0219	The engine gets too much air. Unstable performance of ECU.	Turn off the ignition switch and then turn on. Refer to Overspeed Condition section.
Internal ECU/Throttle body malfunction (MIL on)	Refer to Back-ups by ECU table	Throttle valve control malfunction	Replace the throttle body.
		Throttle position sensor malfunction	

Troubleshooting for EFI System

General Information

- Always check battery condition before replacing the EFI parts. A fully charged battery is a must for conducting accurate tests of the EFI system.
- Trouble may involve one or in some cases all items. Never replace a defective part without determining what CAUSED the problem. If the problem was caused by some other item or items, they too must be repaired, or the new replacement part will soon fail again.
- Measure coil winding resistance when the EFI part is cold (at room temperature).
- Make sure all connectors in the circuit are clean and tight, and examine leads for signs of burning, fraying, short, etc. Deteriorated leads and bad connections can cause reappearance of problems and unstable operation of the EFI system.

★If any wiring is deteriorated, replace the wiring.

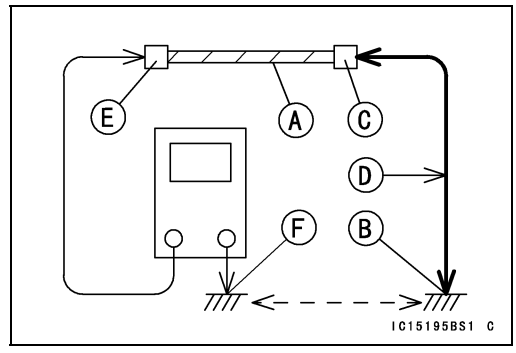
- Pull each connector apart and inspect it for corrosion, dirt, and damage.

★If the connector is corroded or dirty, clean it carefully. If it is damaged, replace it.

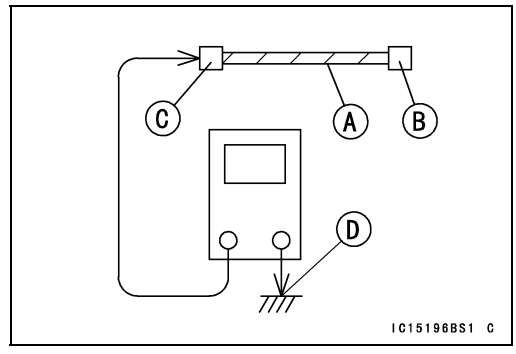
- Connect the connectors securely.
- Check the wiring for continuity.

○Use the wiring diagram to find the ends of the lead which is suspected of being a problem.
○Connect an ohmmeter between the ends of the leads.
★If the tester does not read 0 Ω, the lead is defective. Replace the lead or the main harness or the subharness.

○If both ends of a harness [A] are far apart, ground [B] the one end [C], using a jumper lead [D] and check the continuity between the end [E] and the ground [F]. This enables to check a long harness for continuity. If the harness is open, repair or replace the harness.



○When checking a harness [A] for short circuit to ground, open one end [B] and check the continuity between the other end [C] and ground [D]. If there is continuity, the harness has a short circuit to ground, and it must be repaired or replaced.



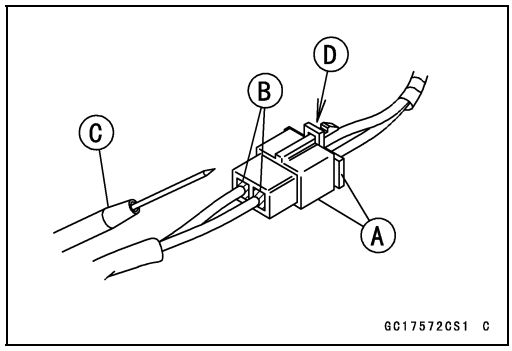
○Narrow down suspicious locations by repeating the continuity tests.
★If no abnormality is found in the wiring or connectors, the EFI parts are the next likely suspects.
★If an abnormality is found, replace the affected EFI part.
★If no abnormality is found in the wiring, connectors, and EFI parts, replace the ECU (throttle body).

Troubleshooting for EFI System

- When checking the EFI parts, use a digital meter which can be read two decimal place voltage or resistance.

○The EFI part connectors [A] have seals [B], including the ECU. When measuring the input or output voltage with the connector joined, use the needle adapter set [C]. Insert the needle adapter inside the seal until the needle adapter reaches the terminal.

Special Tool - Needle Adapter Set: 57001-1874



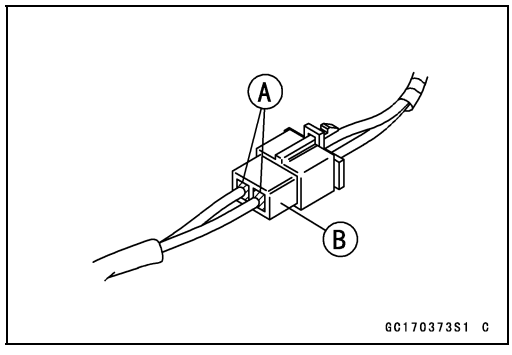
NOTICE
Insert the needle adapter straight along the terminal in the connector to prevent short-circuit between terminals.

- Make sure that measuring points are correct in the connector, noting the position of the lock [D] and the lead color before measurement. Do not reverse connections of a digital meter.
- Be careful not to short-circuit the leads of the EFI or electrical system parts by contact between adapters.
- Turn the ignition switch on and measure the voltage with the connector joined.

NOTICE
Incorrect, reverse connection or short circuit by needle adapters could damage the EFI or electrical system parts.

○After measurement, remove the needle adapters and apply silicone sealant to the seals [A] of the connector [B] for waterproofing.

Sealant - Liquid Gasket, TB1211: 56019-120



EFI System Troubleshooting Table

Engine Won't Run

Symptom or Possible Causes	Actions (see page)
Crankshaft Position Sensor issue	Inspect (3-34).
Ignition coil issue	Inspect (3-44 or 9-14).
Spark plug is dirty, broken or incorrect gap	Inspect and repair (2-15).
Spark plug spec is wrong	Replace (9-18).
ECU ground and power supply issue	Inspect (3-51).
ECU issue	Inspect (3-51).
No or low fuel	Supply fuel (see Owner's Manual).
Fuel injector issue	Inspect and replace (3-38).
Fuel pump issue	Inspect (3-41).
Fuel pump relay issue	Inspect and replace (9-19).
Fuel filter is dirty or clogged	Inspect and replace (3-61).
Fuel line clogged	Inspect and repair.

Poor Engine Speed at Low Engine Speed

Symptom or Possible Causes	Actions (see page)
Spark weak:	
Ignition coil issue	Inspect (3-44).
Spark plug is dirty, broken or incorrect gap	Inspect and replace (2-15).
Spark plug incorrect	Replace (9-18).
ECU issue	Inspect (3-51).
Fuel/air mixture incorrect:	
Low fuel	Supply fuel (see Owner's Manual).
Spark plug is dirty, broken or incorrect gap	Inspect and repair (2-15).
Fuel filter is clogged	Inspect and replace (3-61).
Fuel pump issue	Inspect (3-41).
Unstable idling:	
Fuel pressure too low or too high	Inspect (3-59).
Fuel injector issue	Inspect and replace (3-38).
Throttle position sensor (throttle body) issue	Replace throttle body assy (3-53).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).
Engine stalls easily:	
Spark plug is dirty, broken or incorrect gap	Inspect and replace (2-15).
Throttle position sensor (throttle body) issue	Replace throttle body assy (3-53).
Ignition coil issue	Inspect (3-44).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).
Fuel pump issue	Inspect (3-41).
Fuel injector issue	Inspect and replace (3-38).
Fuel pressure too low or too high	Inspect (3-59).
Fuel line clogged	Inspect and repair.

EFI System Troubleshooting Table

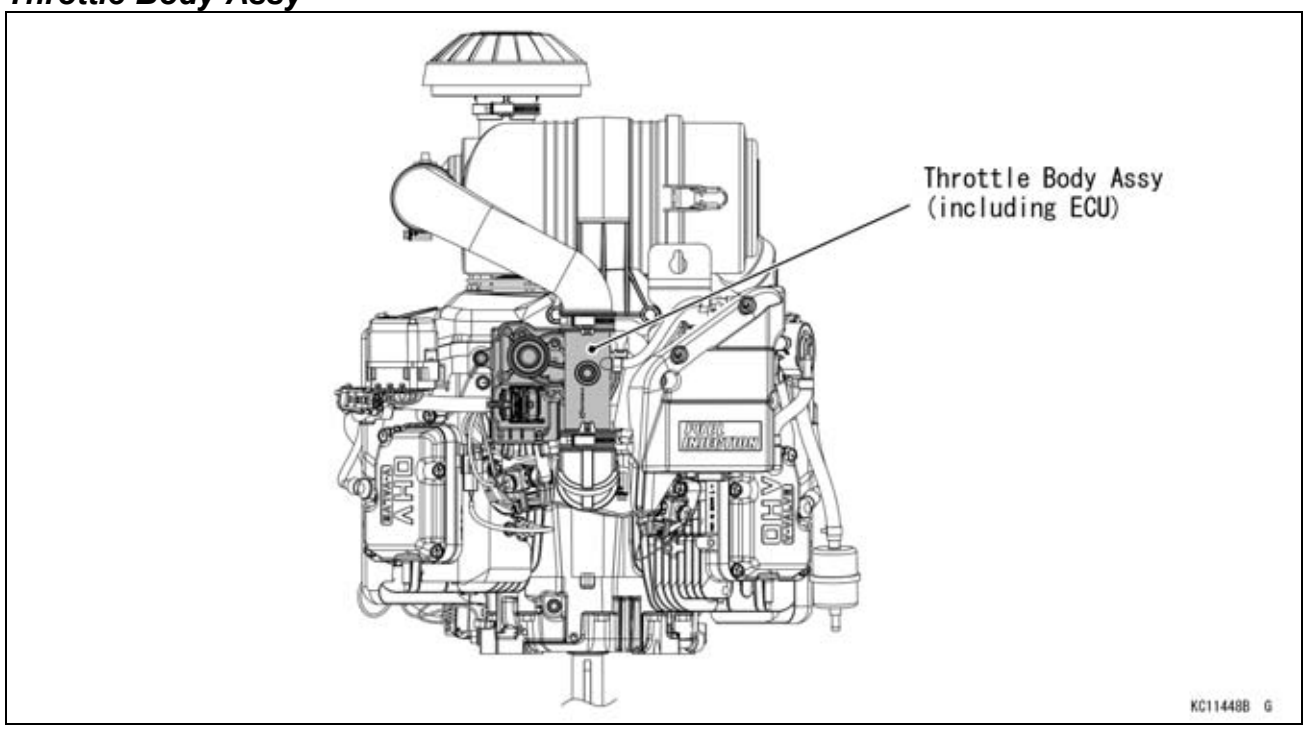
Engine speed does not increase:	
Fuel pressure too low	Inspection (3-59).
Water or foreign matter in fuel	Change fuel. Inspect and clean fuel system.
Fuel filter or pump screen clogged	Inspect and replace (3-41 or 3-61).
Fuel pump issue	Inspect (3-41).
Fuel injector issue	Inspect and replace (3-38).
Throttle position sensor (throttle body) issue	Replace throttle body assy (3-53).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).
Spark plug is dirty, broken or incorrect gap	Inspect and repair (2-15)
Ignition coil issue	Inspect (3-44).
Stumble:	
Fuel pressure too low	Inspect (3-59).
Fuel injector issue	Inspect and replace (3-38).
Throttle position sensor (throttle body) issue	Replace throttle body assy (3-53).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).
Surge:	
Unstable fuel pressure	Inspect and replace fuel pump (3-59).
Fuel injector issue	Inspect and replace (3-38).

Poor Engine Speed or Output Shortage at High Engine Speed

Symptom or Possible Causes	Actions (see page)
Firing incorrect:	
Ignition coil issue	Inspect (3-44).
Spark plug is dirty, broken or incorrect gap	Inspect and repair (2-15)
ECU issue	Inspect (3-51).
Fuel/air mixture incorrect:	
Air cleaner clogged, poorly sealed, or missing	Clean element or inspect sealing (2-7).
Water or foreign matter in fuel	Change fuel. Inspect and clean fuel system.
Fuel injector clogged	Replace (3-62).
Fuel line clogged	Inspect and repair.
Fuel pump issue	Inspect (3-41).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).
Throttle position sensor (throttle body) issue	Replace throttle body assy (3-53).
Knocking:	
Fuel poor quality or incorrect	Change fuel (see Owner's Manual).
Spark plug spec is wrong	Replace with the correct plug (9-18).
Ignition coil issue	Inspect (3-44).
ECU issue	Inspect (3-51).
Intake air pressure sensor (throttle body) issue	Replace throttle body assy (3-53).

Throttle Position Sensor (DTC P210A, P210B, P2109, P2110, P2111, P2112)

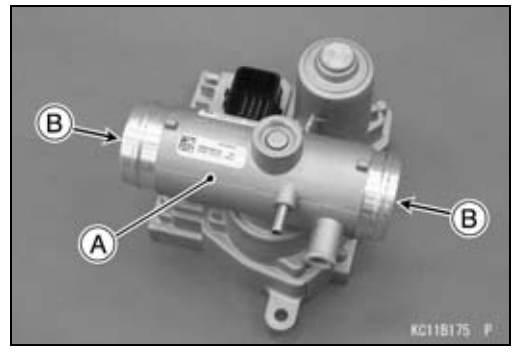
Throttle Body Assy



Throttle Body Cleaning

- Remove the throttle body assy [A] (see Throttle Body Assy Removal).
- Clean the throttle bore [B].
- Visually check the throttle body assy for any damage.

★If the throttle body assy has any damage, replace the throttle body assy.



Initial Operation Inspection

- Check the initial operation with ignition switch ON.

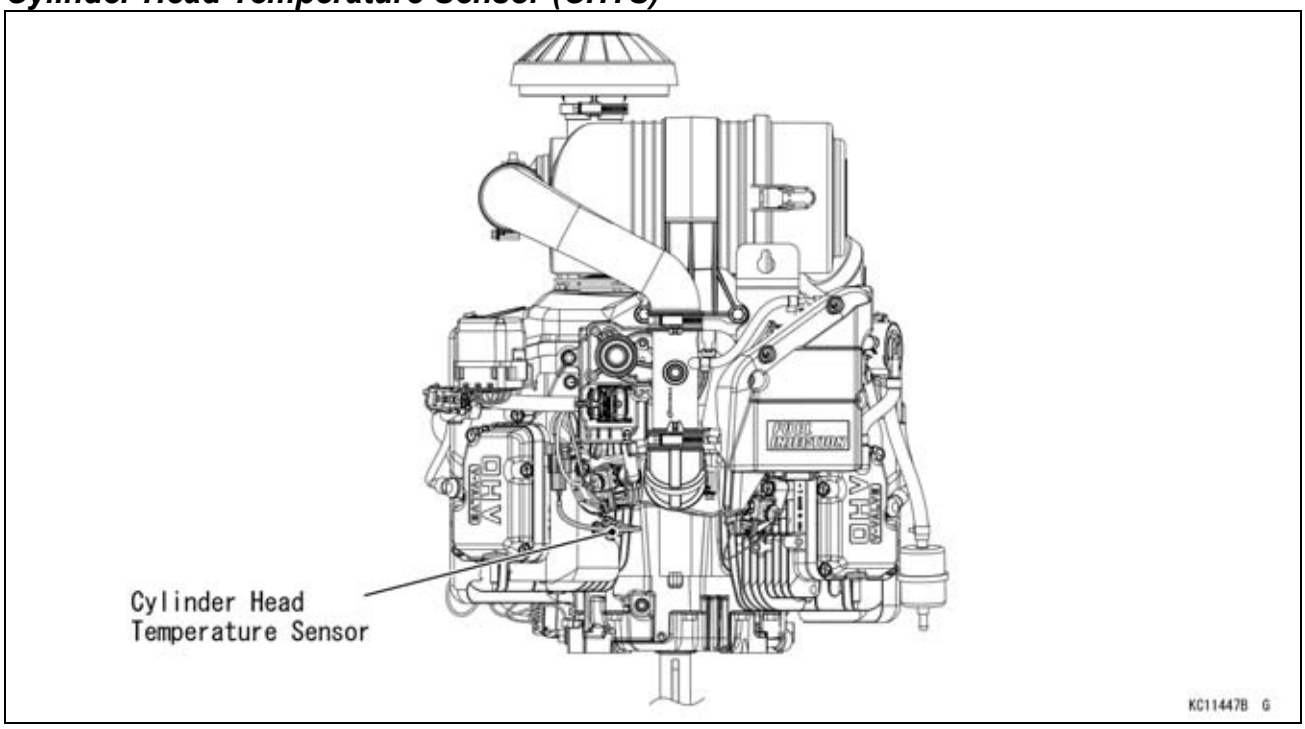
○The throttle body assy should make a mechanical sound for initial learning within 3 seconds.

★If the initial operation is incorrect, replace the throttle body assy.

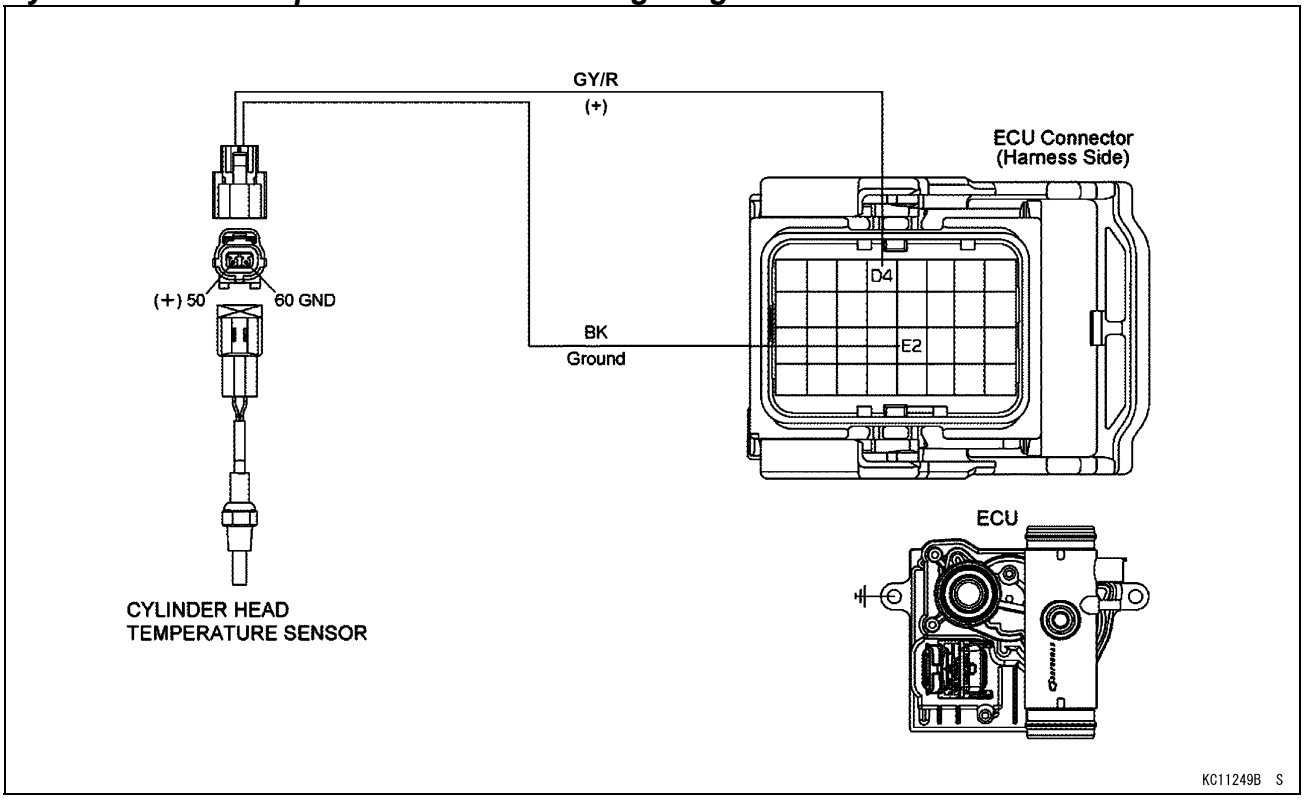
★If a DTC is active with normal initial operation, replace the throttle body assy.

Cylinder Head Temperature Sensor (DTC P0116, P0117, P0118, P0217)

Cylinder Head Temperature Sensor (CHTS)



Cylinder Head Temperature Sensor Wiring Diagram



Cylinder head temperature sensor returns a resistance value as data of the temperature. ECU is connected with terminal D4 and E2.

Cylinder Head Temperature Sensor (DTC P0116, P0117, P0118, P0217)

Engine Oil Level Inspection and Cooling Fan Cleaning

(for DTC P0217)

- Check the engine oil level (see Engine Oil Level Inspection in the Periodic Maintenance chapter).
- Check the engine oil for dirt or contamination.

★If the oil is dirty or contaminated, change the engine oil (see Engine Oil Change in the Periodic Maintenance chapter).

- Remove the fan housing (see Fan Housing Removal in the Cooling System chapter) and clean the cooling fan if needed.
- Remove the engine shroud (see Engine Shroud Removal in the Cooling System chapter) and clean the engine if needed.

★If no issue found, check the output voltage of the cylinder head temperature sensor (see Cylinder Head Temperature Sensor Output Voltage Inspection).

Cylinder Head Temperature Sensor Output Voltage Inspection

(for DTC P0117, P0118, P0217)

NOTE

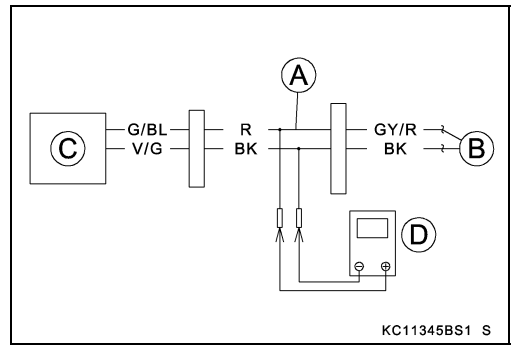
○*Verify the battery is fully charged.*

- Turn the ignition switch off.
- Disconnect the cylinder head temperature sensor connector and connect the measuring adapter [A] between these connectors as shown.

  Main Harness [B]

  Cylinder Head Temperature Sensor [C]

Special Tool - Measuring Adapter: 57001-1700



- Connect a meter [D] to the measuring adapter leads.

Cylinder Head Temperature Sensor Output Voltage

Connections to Adapter:

Meter (+) → R (Main Harness GY/R) lead

Meter (–) → BK (Main Harness BK) lead

- Turn the ignition switch on, measure the output voltage.

Output Voltage

Standard: DC 3.94 ~ 4.94 V @20°C (68°F)

NOTE

○*The output voltage changes according to the cylinder head temperature.*

- Turn the ignition switch off.

★If the reading is the standard, replace the throttle body assy.

★If the reading is not the standard, check the wiring for continuity between harness connectors (see Cylinder Head Temperature Sensor Wiring Connection Inspection).

Cylinder Head Temperature Sensor (DTC P0116, P0117, P0118, P0217)

Cylinder Head Temperature Sensor Wiring Connection Inspection

(for DTC P0117, P0118, P0217)

- Disconnect the ECU and cylinder head temperature sensor connectors.

Wiring Continuity Inspection

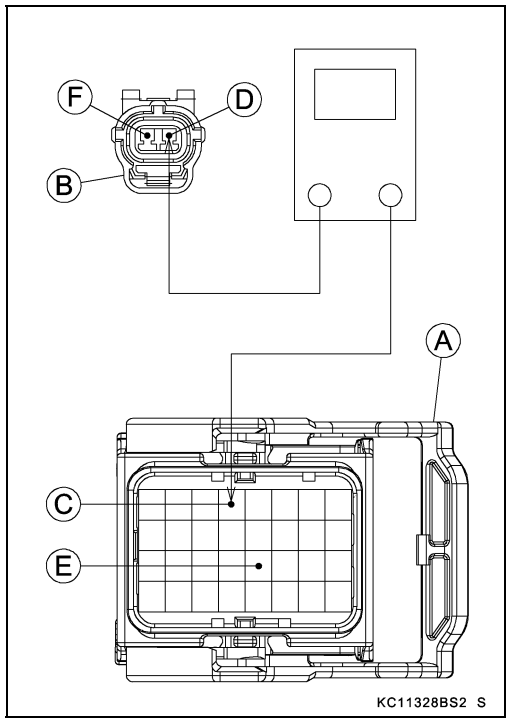
ECU Connector [A] ←→ Cylinder Head Temperature Sensor Connector [B]

ECU Connector D4 [C] ←→ Sensor Connector 50 [D]

ECU Connector E2 [E] ←→ Sensor Connector 60 [F]

★If an open, replace the harness.

★If the wiring continuity is good, check the cylinder head temperature sensor resistance (see Cylinder Head Temperature Sensor Resistance Inspection).



Cylinder Head Temperature Sensor Resistance Inspection

(for DTC P0116, P0117, P0118, P0217)

- Remove the cylinder head temperature sensor (see Cylinder Head Temperature Sensor Removal).
- Suspend the sensor [A] in a container of water so the heat-sensitive portion is submerged.
- Suspend a thermometer [B] with the heat-sensitive portion [C] located in almost the same depth with the sensor.

NOTE

○*The sensor and thermometer must not touch the container side or bottom.*

- Place the container over a source of heat to gradually raise the temperature of the water.
- Connect a meter to the cylinder head temperature sensor lead connector [D], measure the internal resistance of the sensor.

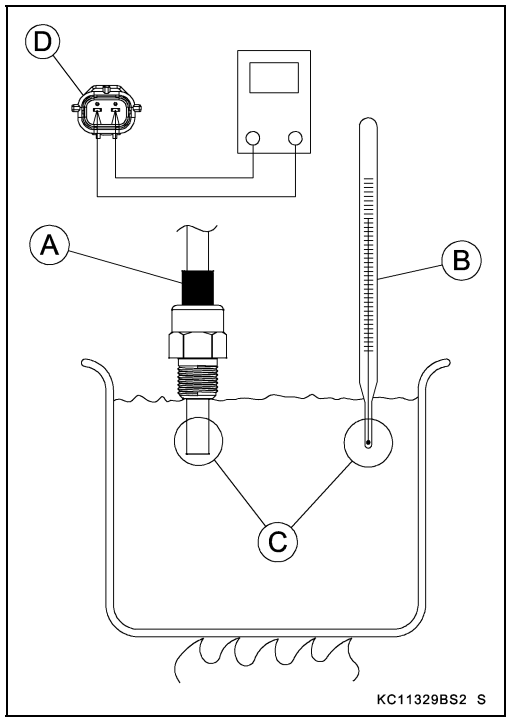
Cylinder Head Temperature Sensor Resistance

Temperature	Resistance (kΩ)
0°C (32°F)	32.6 ~ 39.8
10°C (50°F)	19.4 ~ 23.7
20°C (68°F)	12.9 ~ 15.7
40°C (104°F)	5.0 ~ 6.1
80°C (176°F)	1.2 ~ 1.5

★If the reading is not standard, replace the cylinder head temperature sensor.

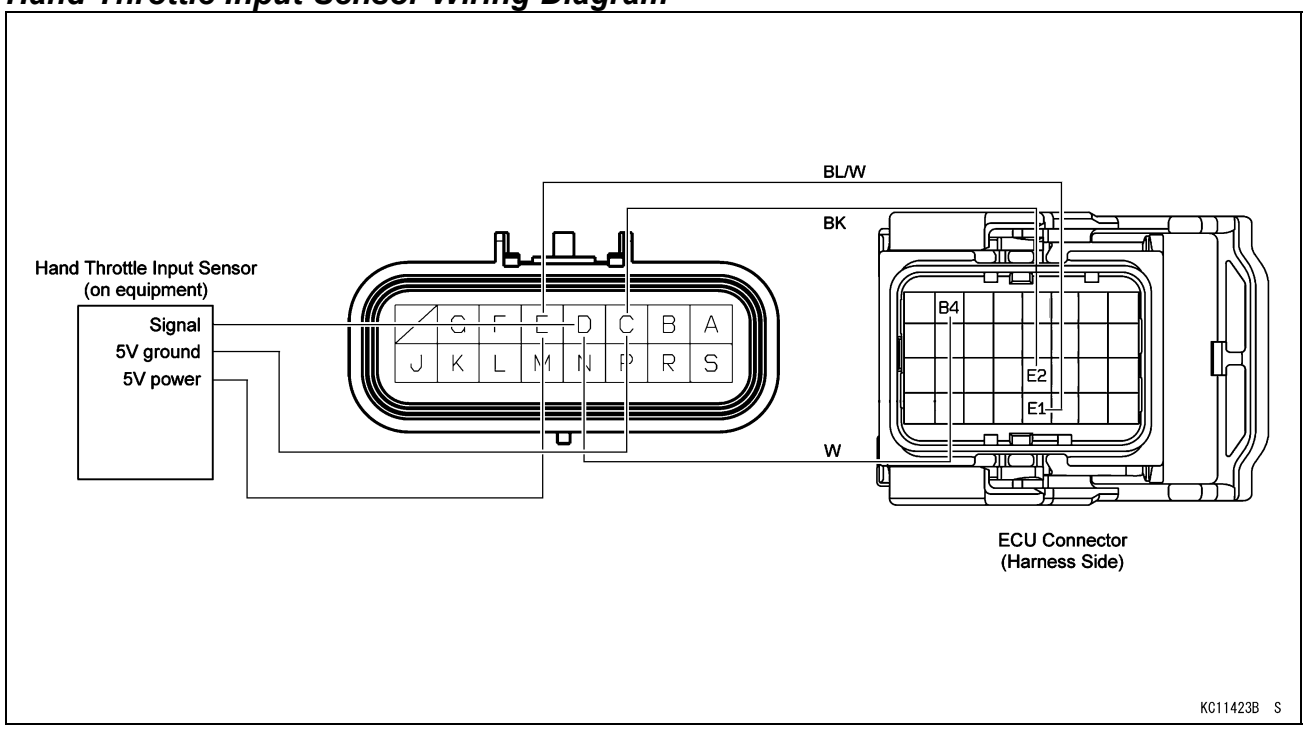
★If the reading is the standard, check the wiring for any shorts or damage.

★If no fault found, replace the throttle body assy.



Hand Throttle Input Sensor (DTC P0222, P0223)

Hand Throttle Input Sensor Wiring Diagram



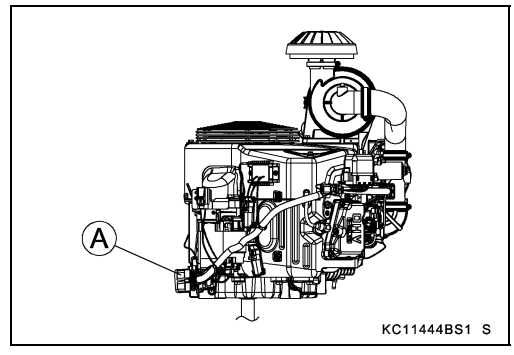
Hand throttle input sensor gets 5 V power from ECU at terminal E1 via terminal E of 16 pin connector.
The sensor returns signal to ECU at terminal B4 via terminal D of 16 pin connector.
The sensor returns ground to ECU at terminal E2 via terminal C of 16 pin connector.

Hand Throttle Input Sensor Input Voltage Inspection

NOTE

○*Verify the battery is fully charged.*

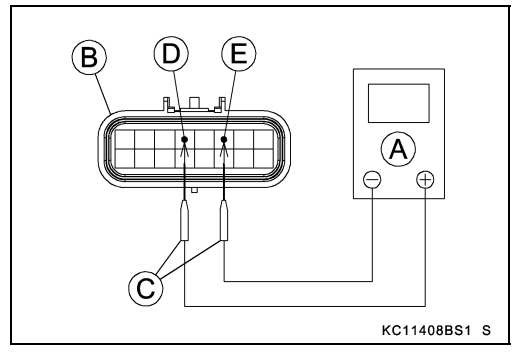
● Turn the ignition switch off.
○Do not disconnect the 16 pin connector [A].



● Connect a meter [A] to the 16 pin connector [B] with needle adapter set [C].

Special Tool - Needle Adapter Set: 57001-1874

Hand Throttle Input Sensor Input Voltage
Connections to 16 pin connector:
Meter (+) → Main Harness BL/W lead [D]
Meter (–) → Main Harness BK lead [E]



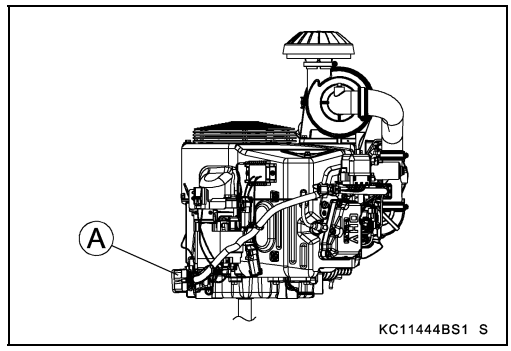
● Turn the ignition switch on, measure the input voltage.

Input Voltage
Standard: DC 4.5 ~ 5.5 V

● Turn the ignition switch off.
★If the reading is not the standard, check the wiring for continuity between harness connectors (see Hand Throttle Input Sensor Wiring Connection Inspection).
★If the reading is the standard, check the output voltage (see Hand Throttle Input Sensor Output Voltage Inspection).

Hand Throttle Input Sensor (DTC P0222, P0223)

Hand Throttle Input Sensor Output Voltage Inspection



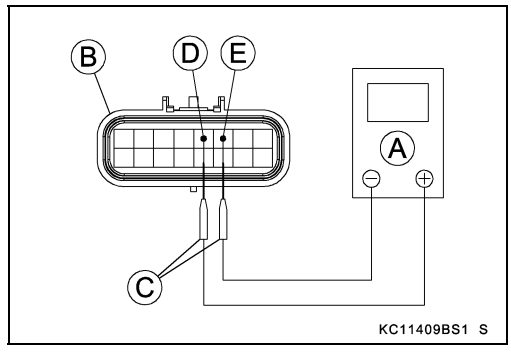
- Measure the output voltage at the hand throttle input sensor in the same way as input voltage inspection.

○Do not disconnect the 16 pin connector [A].

- Connect a meter [A] to the 16 pin connector [B] with needle adapter set [C].

Special Tool - Needle Adapter Set: 57001-1874

Hand Throttle Input Sensor Output Voltage
Connections to 16 pin connector:
Meter (+) → Main Harness W lead [D]
Meter (–) → Main Harness BK lead [E]



- Turn the ignition switch on, measure the output voltage.

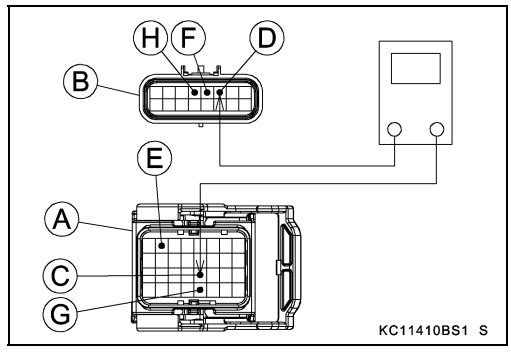
Output Voltage
Standard: DC 0.4 ~ 4.6 V at from idle throttle opening to full throttle opening

- Turn the ignition switch off.

★If the reading is not the standard, check the hand throttle input sensor (Refer to equipment manual).

★If the reading is the standard, check the wiring for continuity between harness connectors (see Hand Throttle Input Sensor Wiring Connection Inspection).

Hand Throttle Input Sensor Wiring Connection Inspection



- Disconnect the ECU and 16 pin connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→ 16 pin Connector [B]
ECU Connector E2 [C] ←→ 16 pin Connector C [D]
ECU Connector B4 [E] ←→ 16 pin Connector D [F]
ECU Connector E1 [G] ←→ 16 pin Connector E [H]

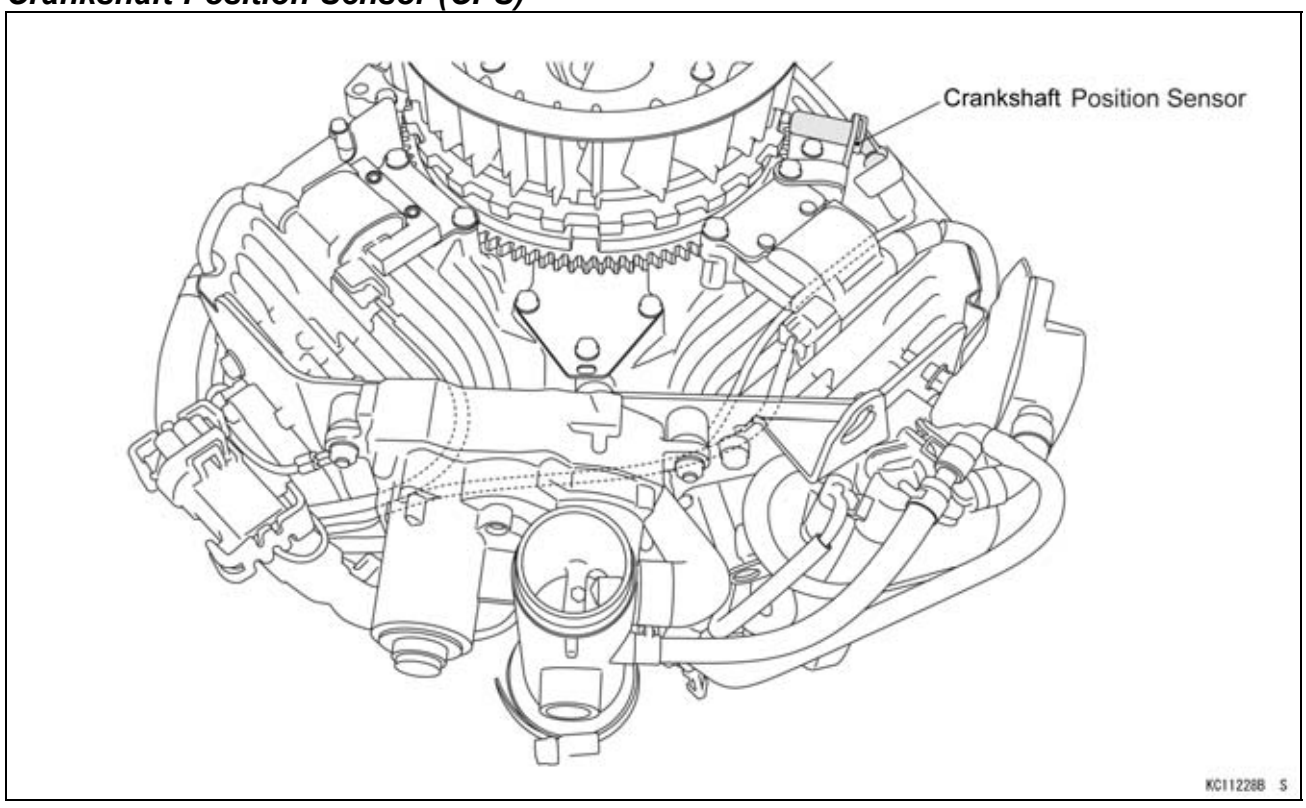
★If an open, replace the harness.

★If good continuity, check the wiring for any shorts.

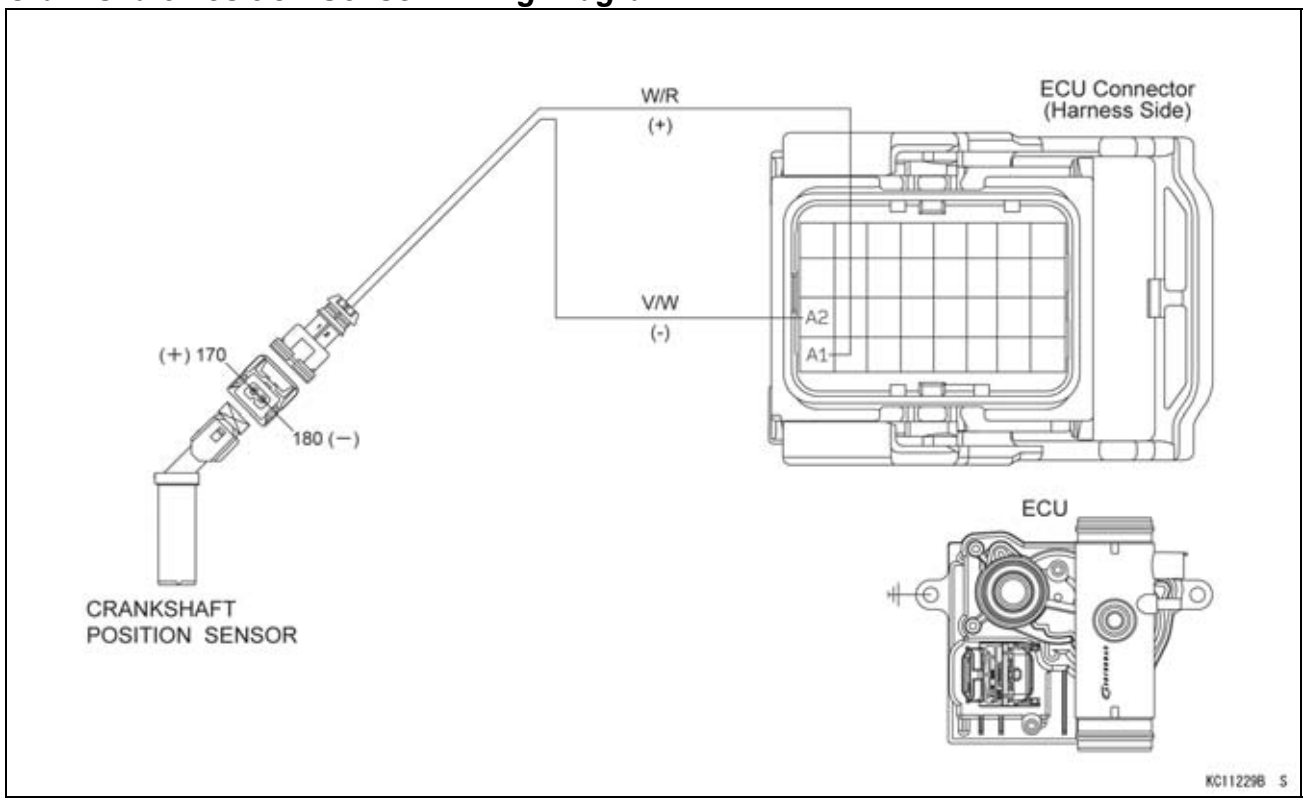
★If no issue with wiring, replace the throttle body assy.

Crankshaft Position Sensor (DTC P0219, P0335)

Crankshaft Position Sensor (CPS)



Crankshaft Position Sensor Wiring Diagram



ECU controls CPS at terminal A1 and A2.
CPS detects the tooth pulses of the flywheel and sends signal to ECU.

Crankshaft Position Sensor (DTC P0219, P0335)

Charging Battery Voltage Inspection

- Check the charging battery voltage (see Charging System Operational Inspection in the Electrical System chapter).

★If the charging battery voltage is normal, check the crankshaft position sensor air gap (see Crankshaft Position Sensor Air Gap Inspection). For P0219, check the throttle valve, intake duct and hose (see Throttle Valve, Intake Duct and Hose Inspection).

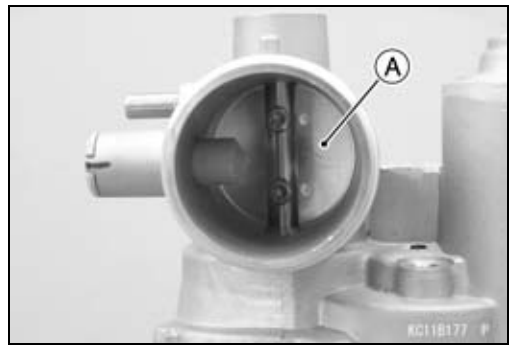
Throttle Valve, Intake Duct and Hose Inspection

(for DTC P0219)

Overspeed Condition

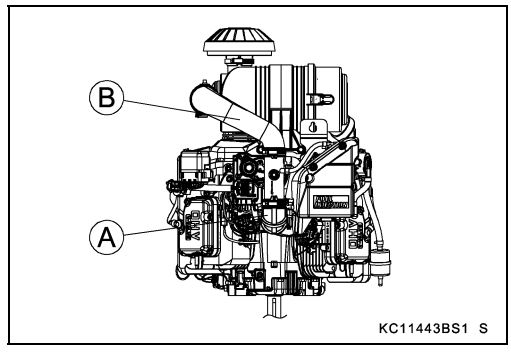
When the engine speed exceeds maximum speed, the ECU provides a diagnostic code, lights the MIL and slows down the engine to low idle speed.

- Make sure the throttle valve [A] is clear of debris.



- Make sure the intake duct [A] and intake hose [B] are secure and there is no damage to the tubes.

★If there are no problem, check the crankshaft position sensor air gap (see Crankshaft Position Sensor Air Gap Inspection).



Crankshaft Position Sensor (DTC P0219, P0335)

Crankshaft Position Sensor Air Gap Inspection (Old Crankshaft Position Sensor)

- Remove:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal)
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)

- Check and adjust the air gap between the crankshaft position sensor and a trigger plate tooth.

Crankshaft Position Sensor Air Gap

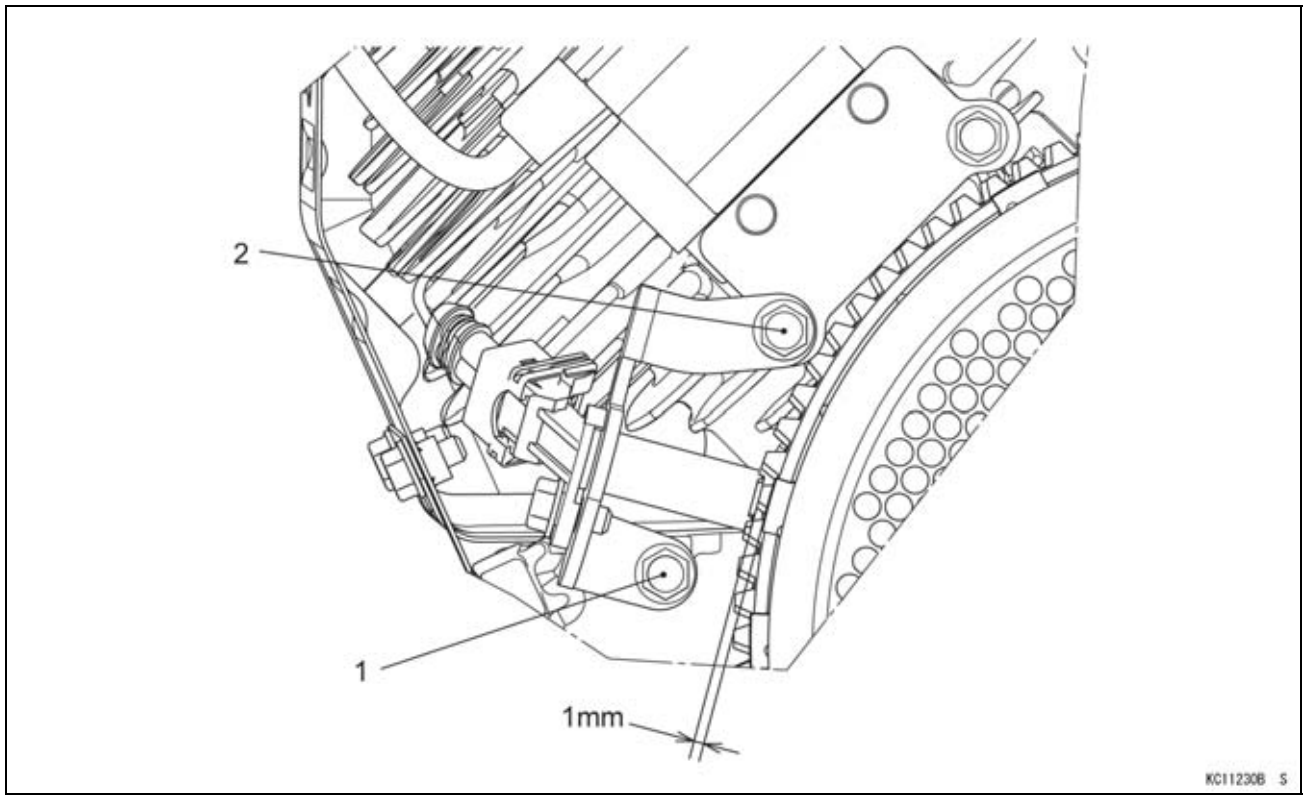
Standard: 0.5 ~ 1.5 mm (0.02 ~ 0.06 in.)

★If the sensor air gap is the standard, check the flywheel (see Flywheel Appearance Inspection).

★If the sensor air gap is not the standard, loosen the mounting bolts and adjust the sensor air gap with a thickness gauge.

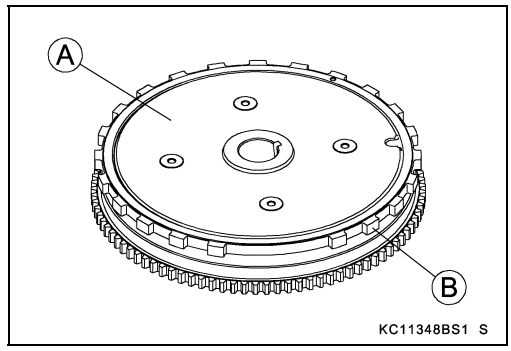
- After adjusting the air gap, tighten the crankshaft position sensor bracket bolts following the tightening sequence [1 ~ 2].

Torque - Crankshaft Position Sensor Bracket Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)



Crankshaft Position Sensor (DTC P0219, P0335)

Flywheel Appearance Inspection

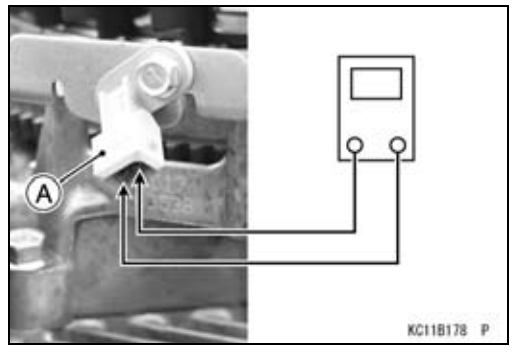


- Clean the flywheel [A].
- Visually check the flywheel for damage or deformed flywheel tooth [B].

★If the flywheel is damaged, replace the flywheel.

★If no issue with flywheel, check the crankshaft position sensor resistance (see Crankshaft Position Sensor Resistance Inspection).

Crankshaft Position Sensor Resistance Inspection



- Turn the ignition switch off.
- Disconnect the crankshaft position sensor connector (see Crankshaft Position Sensor Removal in the Electrical System chapter).
- Measure the resistance between terminals of crankshaft position sensor [A].

Crankshaft Position Sensor Resistance

Standard:

Old Crankshaft Position Sensor:	**360 ~ 440 Ω @23°C (73°F)**
New Crankshaft Position Sensor:	**776 ~ 946 Ω @20°C (68°F)**

★If the reading is not the standard, replace the crankshaft position sensor.

★If the reading is the standard, check the crankshaft position sensor peak voltage (see Crankshaft Position Sensor Peak Voltage Inspection).

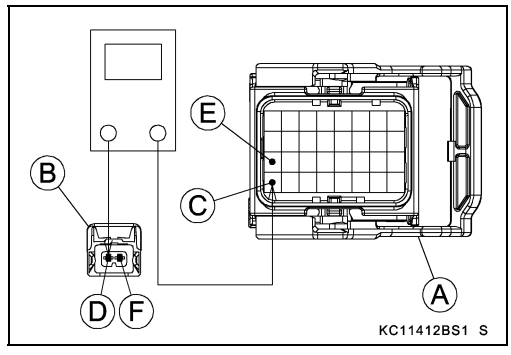
Crankshaft Position Sensor Peak Voltage Inspection

- Refer to the Crankshaft Position Sensor Peak Voltage Inspection in the Electrical System chapter.

★If the crankshaft position sensor peak voltage is not the standard, replace the crankshaft position sensor.

★If the crankshaft position sensor peak voltage is within the standard, check the cylinder compression (see Cylinder Compression Inspection).

Crankshaft Position Sensor Wiring Connection Inspection



- Disconnect the ECU and crankshaft position sensor connectors.

Wiring Continuity Inspection

ECU Connector [A] ←→ Crankshaft Position Sensor Connector [B]

ECU Connector A1 [C] ←→ Sensor Connector 170 [D]

ECU Connector A2 [E] ←→ Sensor Connector 180 [F]

★If an open, replace the harness.

★If good continuity, check the wiring for any shorts.

★If no issue with wiring, replace the throttle body assy.

Crankshaft Position Sensor (DTC P0219, P0335)

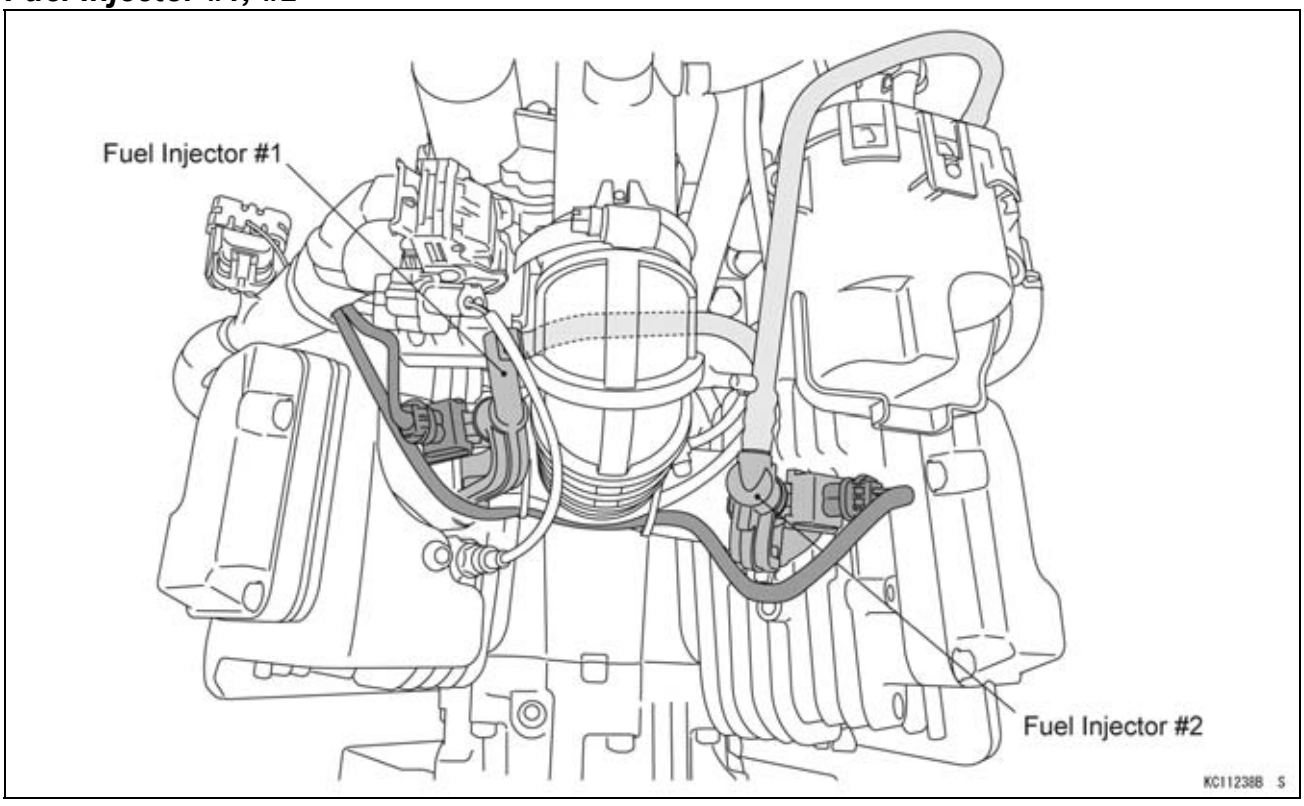
Cylinder Compression Inspection

- Refer to the Compression Measurement in the Engine Top End chapter.

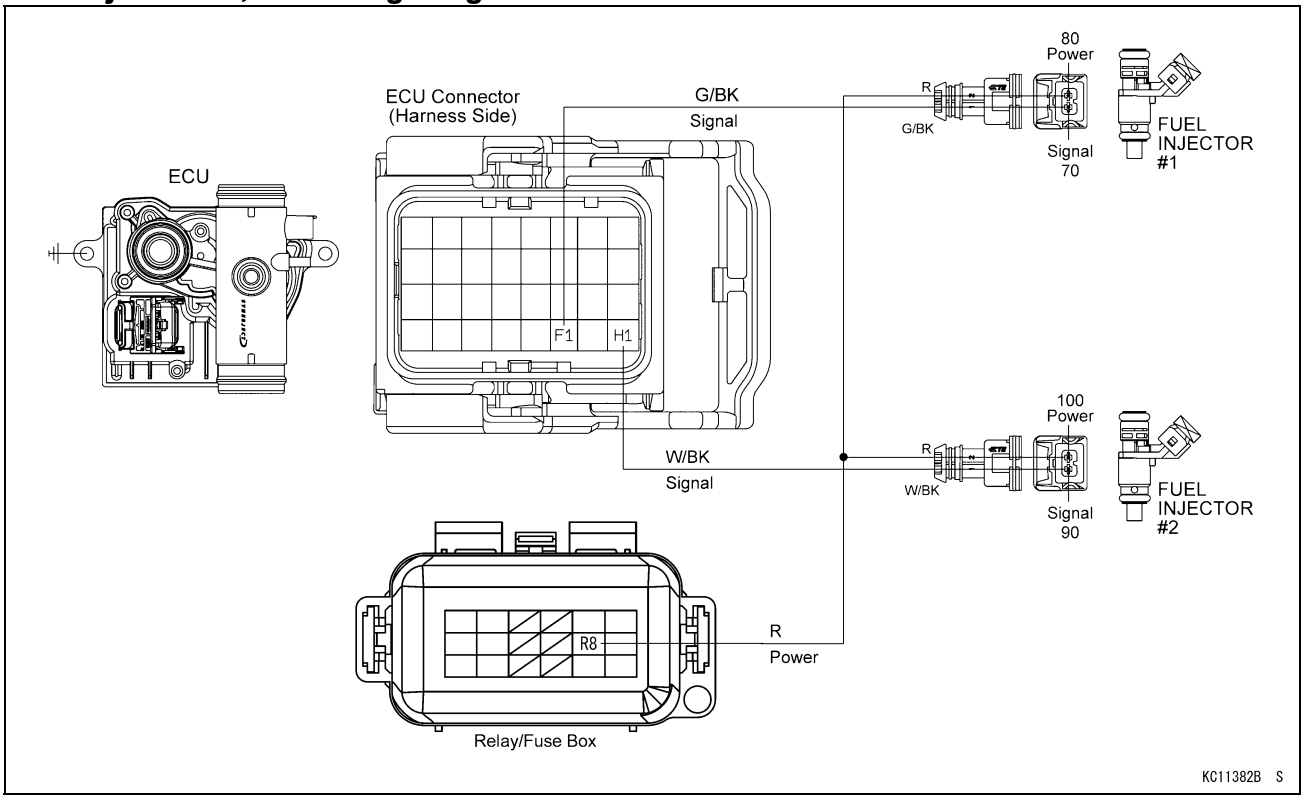
★If the cylinder compression is the standard, check the wiring for continuity between harness connectors (see Crankshaft Position Sensor Wiring Connection Inspection).

Fuel Injector #1 (DTC P0201, P0261, P0262), Fuel Injector #2 (DTC P0202, P0264, P0265)

Fuel Injector #1, #2



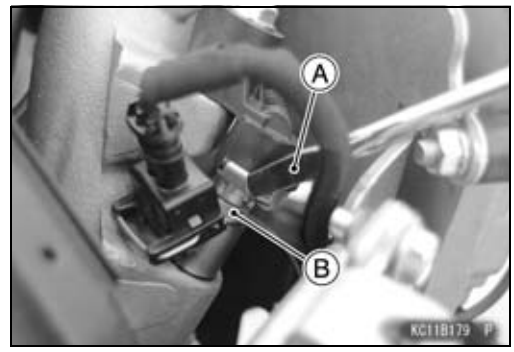
Fuel Injector #1, #2 Wiring Diagram



Fuel injectors get 12 V power from the main relay output terminal via terminal R8 of relay/fuse box.
The main relay is installed to the relay/fuse box.
ECU controls the fuel injector #1 at terminal F1.
ECU controls the fuel injector #2 at terminal H1.

Fuel Injector #1 (DTC P0201, P0261, P0262), Fuel Injector #2 (DTC P0202, P0264, P0265)

Fuel Injector Audible Inspection

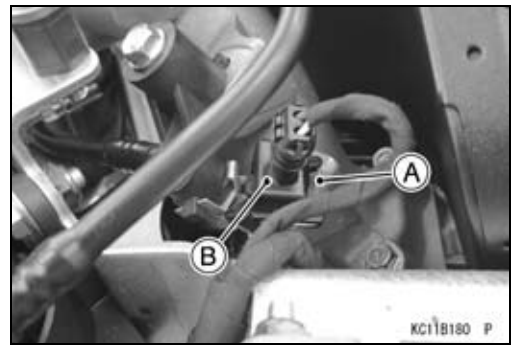


- Apply flat tip screwdriver [A] to the fuel injector [B].
- Turn the ignition switch on.
- Put the grip end of the screwdriver onto your ear and listen for a click sound of the injector.
- A sound scope can also be used for this inspection.
- This inspection may be performed in the engine idling.
- A click interval should become shorter as the engine speed rises.

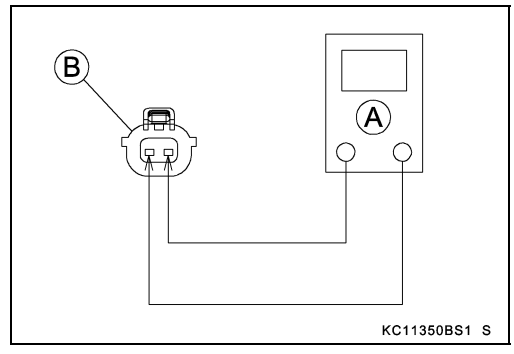
★If both fuel injectors click at regular intervals, the fuel injectors are normal.

★If any fuel injector do not click or not constant intervals, check the fuel injector resistance (see Fuel Injector Resistance Inspection).

Fuel Injector Resistance Inspection



- Remove the engine shroud (see Engine Shroud Removal in the Cooling System chapter).
- Push the lock pin [A] inward to unlock, and disconnect the fuel injector connector [B].



- Connect a meter [A] to the terminals in each fuel injector [B].
- Measure the fuel injector resistance.

Fuel Injector Resistance

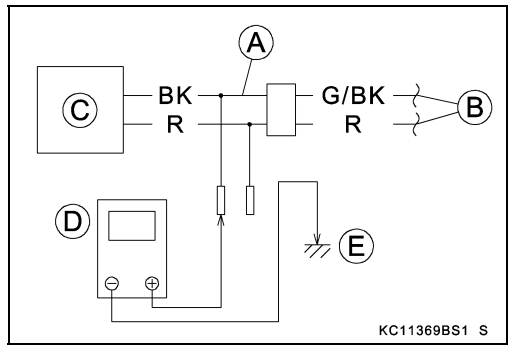
Standard: 11.4 ~ 12.6 Ω @20°C (68°F)

★If the reading is not the standard, replace the faulty fuel injector.

★If the reading is the standard, check the input voltage (see Fuel Injector Input Voltage Inspection).

Fuel Injector #1 (DTC P0201, P0261, P0262), Fuel Injector #2 (DTC P0202, P0264, P0265)

Fuel Injector Input Voltage Inspection



NOTE

○*Verify the battery is fully charged.*

- Disconnect the fuel injector connector and connect the measuring adapter [A] between these connectors as shown.
  Main Harness[B]
  Fuel Injector #1 or #2 [C]

Special Tool - Measuring Adapter: 57001-1700

- Connect a meter [D] to the measuring adapter leads.

Fuel Injector Input Voltage
Connections to Adapter:
For Fuel Injector #1 and #2
Meter (+) → G/BK or W/BK lead
Meter (–) → Ground [E]

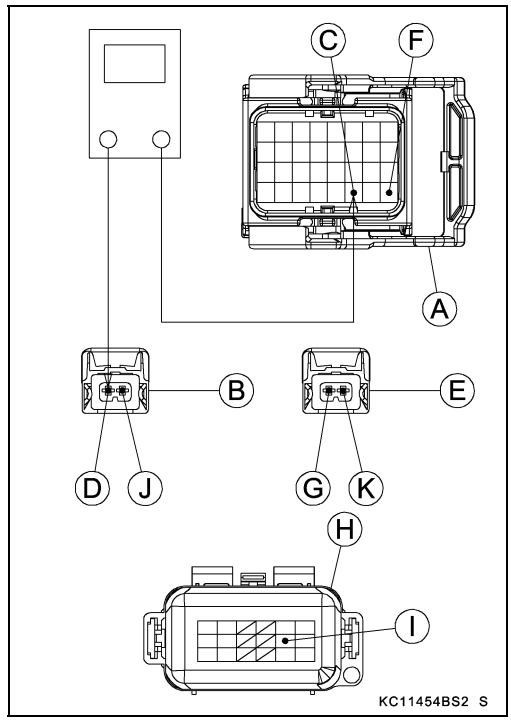
- Turn the ignition switch on, measure the input voltage.

Input Voltage
Standard: Battery Voltage

- Turn the ignition switch off.

★If the reading is not the standard, check the main relay (see Relay Inspection in the Electrical System chapter).
★If the reading is the standard, check the wiring for continuity between harness connectors (see Fuel Injector Wiring Connection Inspection).

Fuel Injector Wiring Connection Inspection



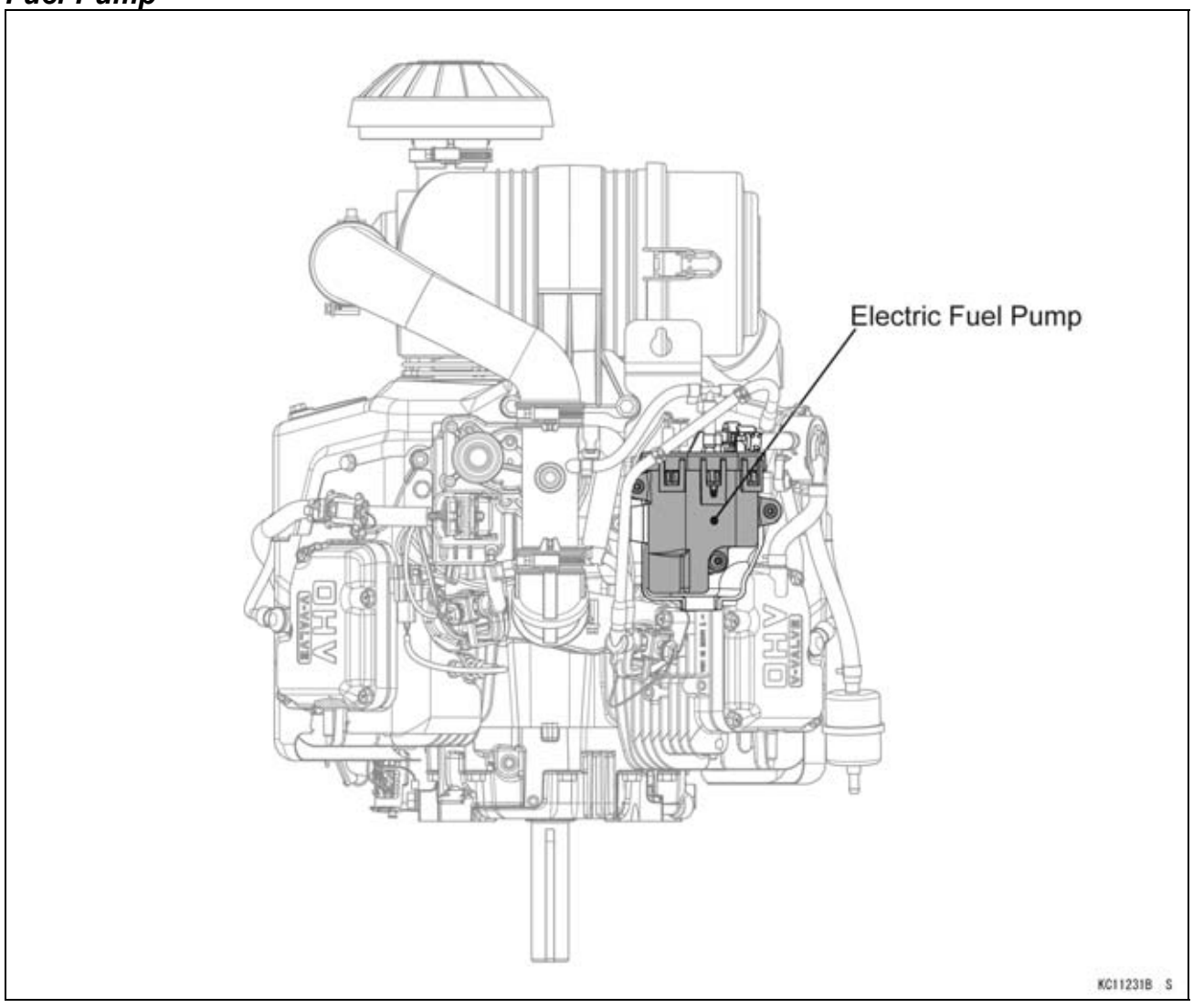
- Disconnect the ECU, injector and main relay connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→ Injector #1 Connector [B]
ECU Connector F1 [C] ←→ Injector #1 Connector 70 [D]
ECU Connector [A] ←→ Injector #2 Connector [E]
ECU Connector H1 [F] ←→ Injector #2 Connector 90 [G]
Main Relay Connector [H] ←→ Injector #1 Connector [B]
Main Relay Connector R8 [I] ←→ Injector #1 Connector 80 [J]
Main Relay Connector [H] ←→ Injector #2 Connector [E]
Main Relay Connector R8 [I] ←→ Injector #2 Connector 100 [K]

★If an open, replace the harness.
★If good continuity, check the wiring for any shorts.
★If no issue with wiring, replace the throttle body assy.

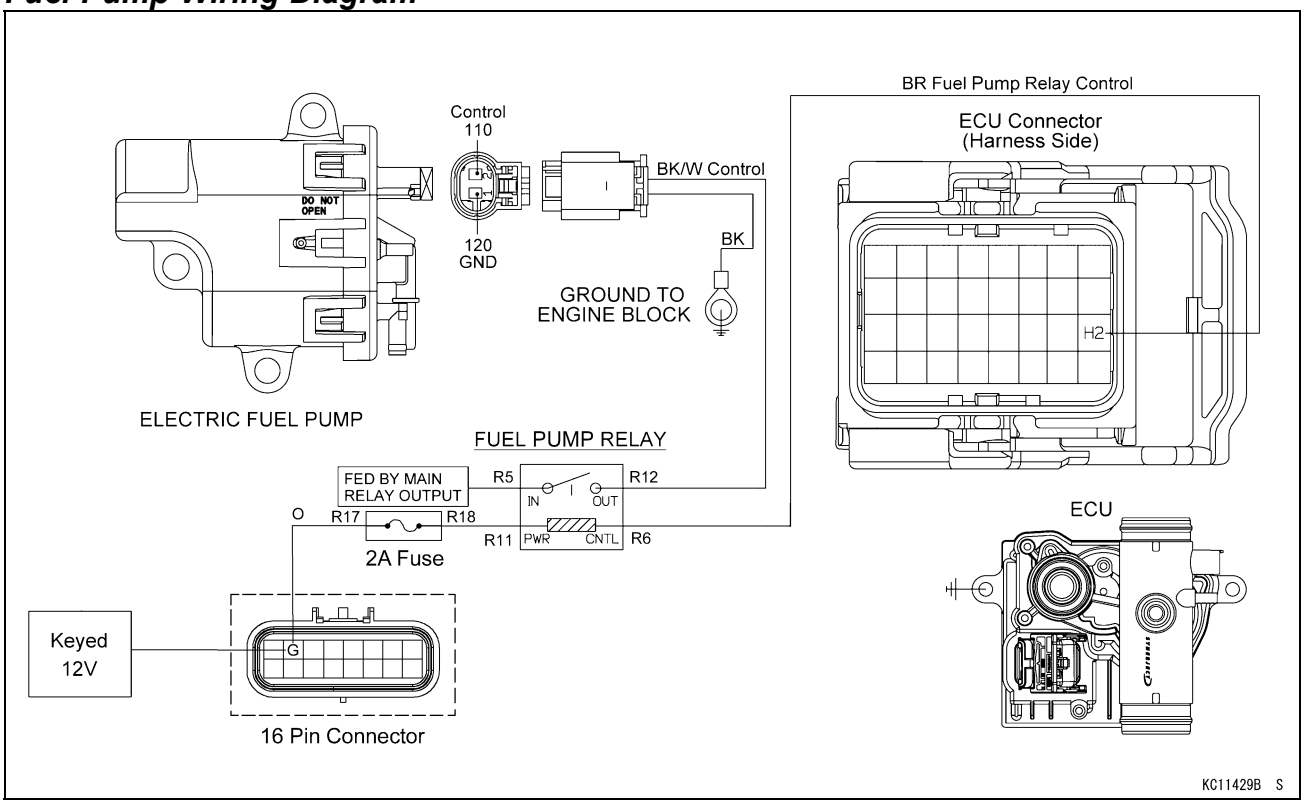
Fuel Pump (DTC P0231, P0232, P1513)

Fuel Pump



Fuel Pump (DTC P0231, P0232, P1513)

Fuel Pump Wiring Diagram



ECU controls the fuel pump relay at H2 terminal via terminal R6 of the relay/fuse box. The fuel pump relay controls 12 V supply for the fuel pump.

The fuel pump relay is installed to the relay/fuse box.

Fuel Pump Audible Inspection

- Turn the ignition switch on and make sure that the fuel pump operates (make light sounds) for 3 seconds, and then stops.
- Turn the ignition switch off.

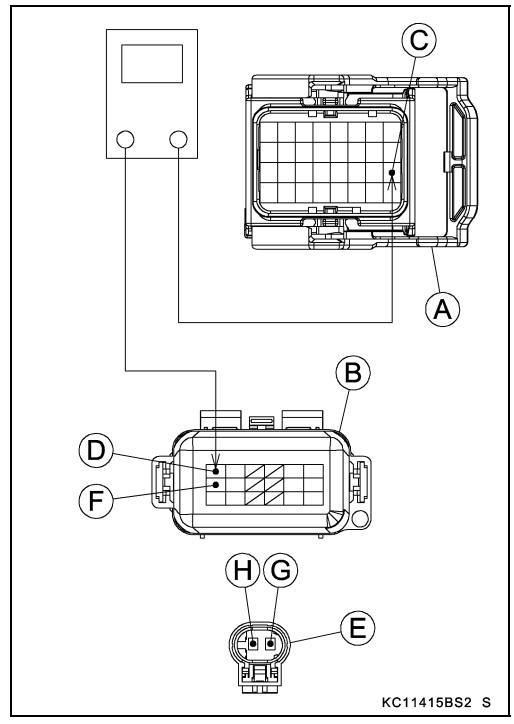
★If the pump does not operate as described above, check the fuel pump relay (see Relay Inspection in the Electrical System chapter).

★If the fuel pump relay is functionally correctly, check the wiring for continuity between harness connectors (see Fuel Pump Wiring Connection Inspection).

Fuel Pump (DTC P0231, P0232, P1513)

Fuel Pump Wiring Connection Inspection

● Disconnect the ECU, fuel pump relay, fuel pump and 16 pin connectors.



Wiring Continuity Inspection

ECU Connector [A] ←→ Fuel Pump Relay Connector [B]

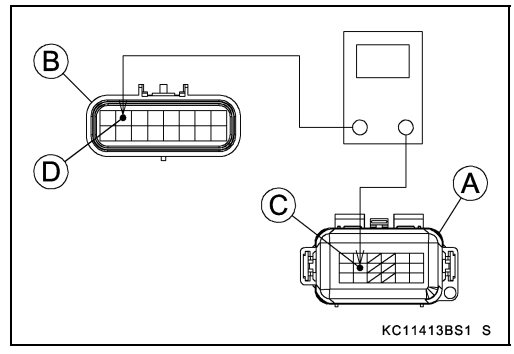
ECU Connector H2 [C] ←→ Fuel Pump Relay Connector R6 [D]

Fuel Pump Relay Connector [B] ←→ Fuel Pump Connector [E]

Fuel Pump Relay Connector R12 [F] ←→ Fuel Pump Connector 110 [G]

Fuel Pump Connector [E] ←→ Ground

Fuel Pump Connector 120 [H] ←→ Ground



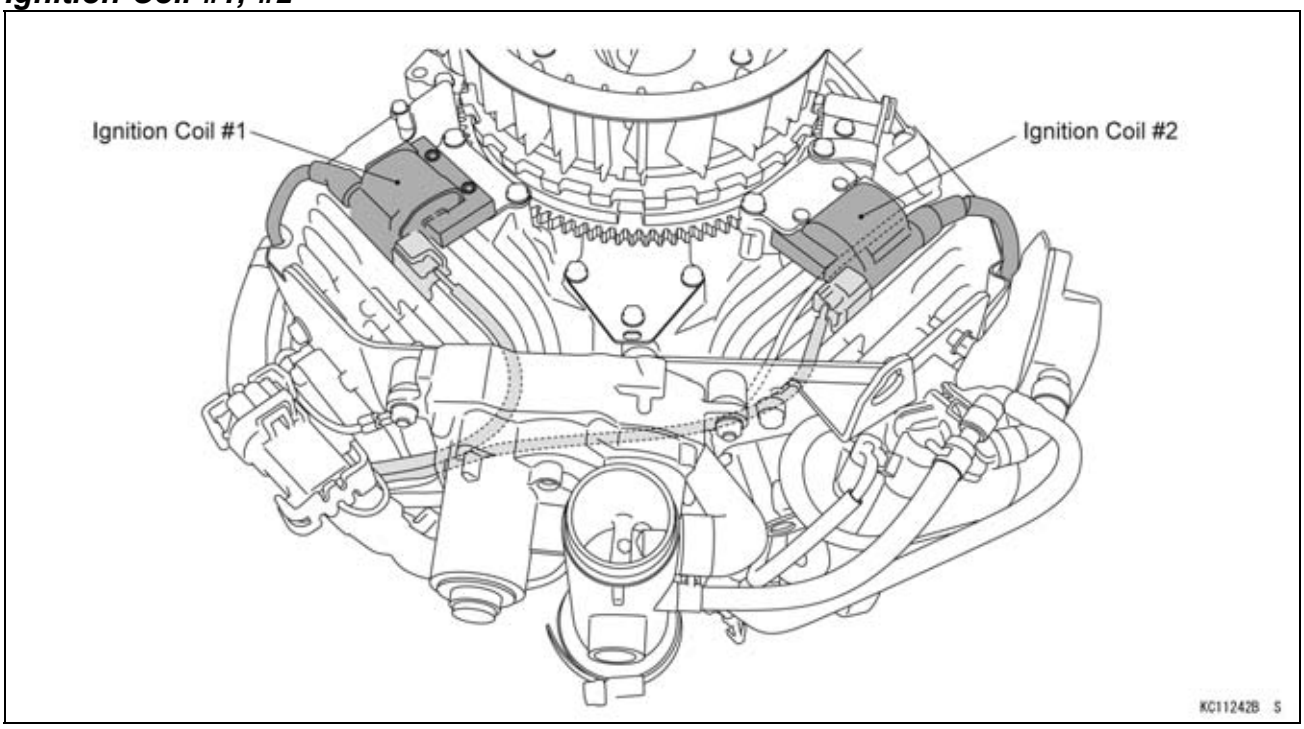
Fuel Pump Relay Connector [A] ←→ 16 pin Connector [B]

Fuel Pump Relay Connector R11 [C] ←→ 16 pin Connector G [D]

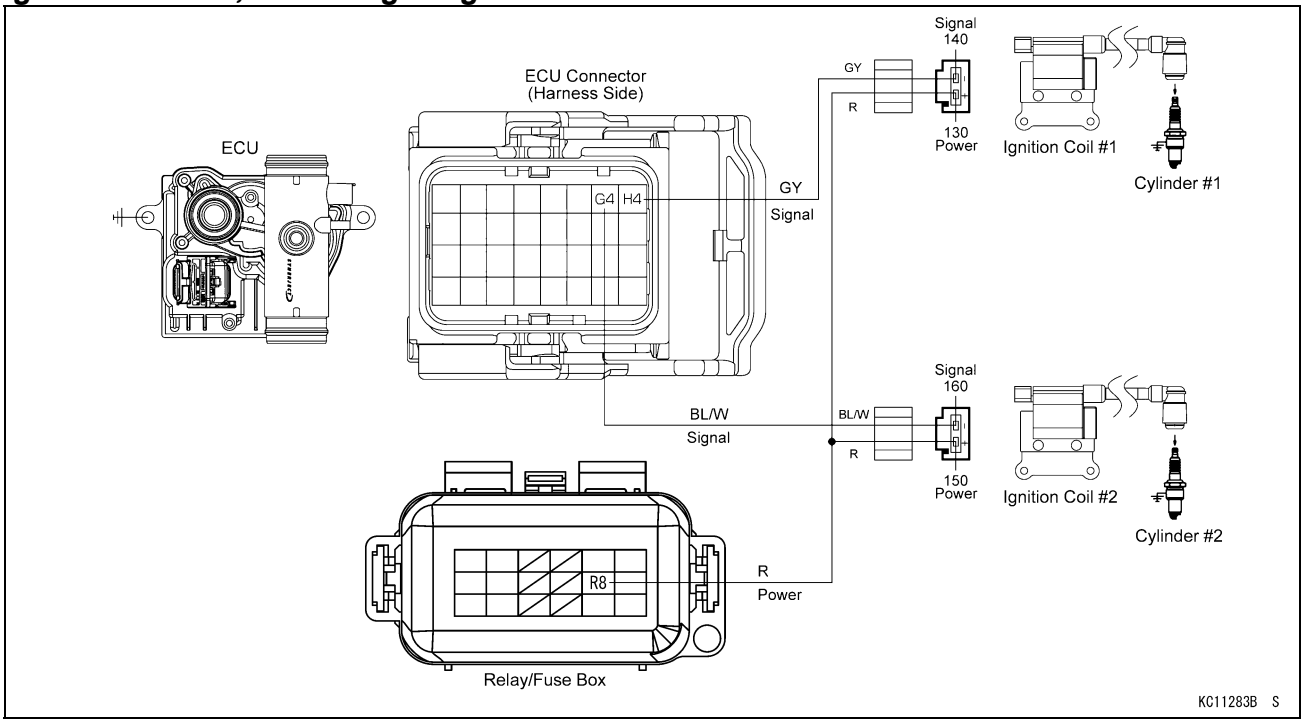
★If an open, replace the 2 A fuse or harness.
★If good continuity, check the wiring for any shorts.
★If no issue with wiring, replace the throttle body assy.

Ignition Coil #1 (DTC P0351, P2301), Ignition Coil #2 (DTC P0352, P2304)

Ignition Coil #1, #2



Ignition Coil #1, #2 Wiring Diagram



Ignition Coil #1 and #2 get 12 V power from the main relay output terminal via terminal R8 of relay/fuse box.

The main relay is installed to the relay/fuse box.

ECU controls the ignition coil #1 at terminal H4.

ECU controls the ignition coil #2 at terminal G4.

Ignition Coil #1 (DTC P0351, P2301), Ignition Coil #2 (DTC P0352, P2304)

Ignition Coil Resistance Inspection

- Refer to the Ignition Coil Inspection in the Electrical System chapter.

★If the ignition coil resistance is the standard, check the ignition coil primary peak voltage (see Ignition Coil Primary Peak Voltage Inspection).

Ignition Coil Primary Peak Voltage Inspection

- Refer to the Ignition Coil Primary Peak Voltage Inspection in the Electrical System chapter.

★If the ignition coil primary peak voltage is the standard, check the wiring for continuity between harness connectors (see Ignition Coil Wiring Connection Inspection).

Ignition Coil Input Voltage Inspection

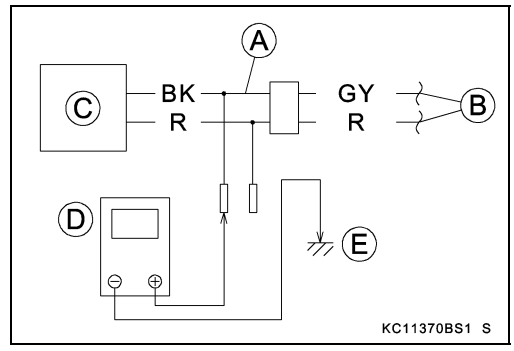
NOTE

○*Verify the battery is fully charged.*

- Disconnect the ignition coil connector and connect the measuring adapter [A] between these connectors as shown.

  Main Harness [B]
  Ignition Coil #1 or #2 [C]

Special Tool - Measuring Adapter: 57001-1700



- Connect a meter [D] to the measuring adapter leads.

Ignition Coil Input Voltage
Connections to Adapter:
For Ignition Coil #1 and #2
Meter (+) → GY or BL/W lead
Meter (–) → Ground [E]

- Turn the ignition switch on, measure the Input voltage.

Input Voltage
Standard: Battery Voltage

- Turn the ignition switch off.

★If the reading is not the standard, check the wiring for continuity between harness connectors (see Ignition Coil Wiring Connection Inspection).

Ignition Coil #1 (DTC P0351, P2301), Ignition Coil #2 (DTC P0352, P2304)

Ignition Coil Wiring Connection Inspection

- Disconnect the ECU, ignition coil and main relay connectors.

Wiring Continuity Inspection

ECU Connector [A] ←→ Ignition Coil #1 Connector [B]

ECU Connector H4 [C] ←→ Ignition Coil #1 Connector 140 [D]

ECU Connector [A] ←→ Ignition Coil #2 Connector [E]

ECU Connector G4 [F] ←→ Ignition Coil #2 Connector 160 [G]

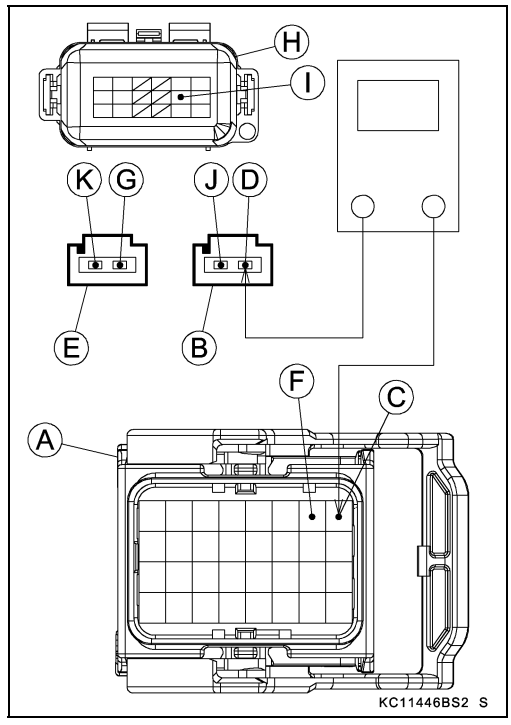
Main Relay Connector [H] ←→ Ignition Coil #1 Connector [B]

Main Relay Connector R8 [I] ←→ Ignition Coil #1 Connector 130 [J]

Main Relay Connector [H] ←→ Ignition Coil #2 Connector [E]

Main Relay Connector R8 [I] ←→ Ignition Coil #2 Connector 150 [K]

★If an open, replace the harness.
★If good continuity, check the wiring for any shorts.
★If no issue with wiring, replace the throttle body assy.



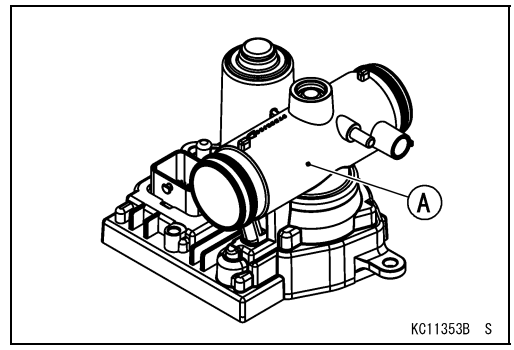
Electronic Throttle Control (DTC P0666, P0667)

Throttle Body Assy Cleaning

- Remove the throttle body assy [A] (see Throttle Body Assy Removal).
- Check for any debris or damage to the throttle body assy.

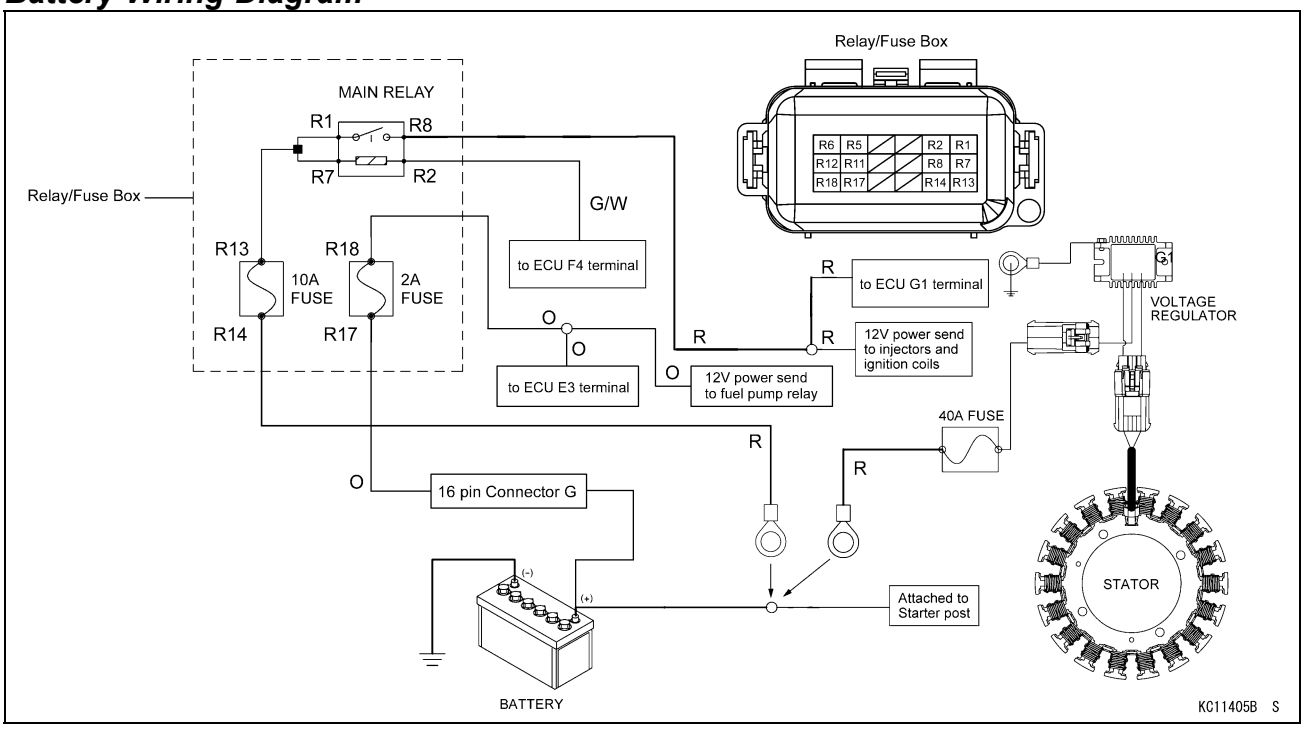
★If necessary, clean the throttle body assy.

★If no issue is found, replace the throttle body assy.



Battery (DTC P0562, P0563, P0641)

Battery Wiring Diagram



Battery sends 12 V power to main relay via terminal R14 of relay/fuse box.

Main relay sends 12 V power to ECU at terminal G1, injectors and ignition coils. The 12 V power is sent through R8 terminal of relay/fuse box.

Battery sends 12 V power from terminal G of 16 pin connector to ECU at terminal E3 via 2 A fuse of relay/fuse box.

Stator coil generates the electric power and sends it to the battery via voltage regulator.

Battery Voltage Inspection

- Disconnect both cables on the battery.
- Check the battery voltage.

Battery Voltage

Standard: 8 ~ 16 V

★If the reading is below the standard, charge battery and retest.

★If the reading is the standard, check the charging battery voltage (see Charging Battery Voltage Inspection).

★If DTC P0641 is active and battery voltage is the standard, replace the throttle body assy.

Charging Battery Voltage Inspection

(for DTC P0562, P0563)

- Refer to the Charging System Operational Inspection in the Electrical System chapter.

★If the battery charging voltage is the standard, check the unregulated stator output voltage (see Unregulated Stator Output Voltage Inspection).

Unregulated Stator Output Voltage Inspection

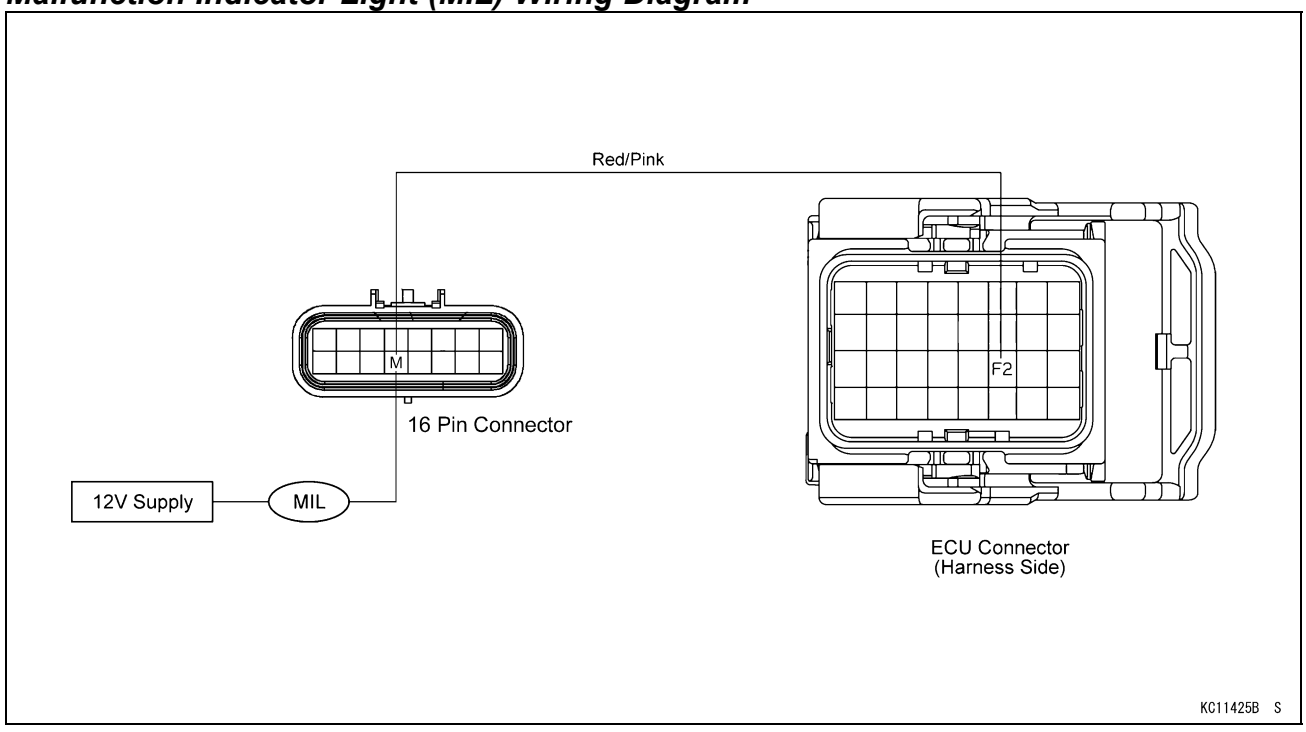
(for DTC P0562, P0563)

- Refer to the Unregulated Stator Output Voltage Inspection in the Electrical System chapter.

★If the unregulated stator output voltage is the standard, replace the throttle body assy.

Malfunction Indicator Light (MIL) (DTC P0650, P06D2)

Malfunction Indicator Light (MIL) Wiring Diagram



MIL gets 12 V supply from the equipment.
ECU controls the MIL at F2 terminal via M of 16 pin connector.

MIL Device Inspection

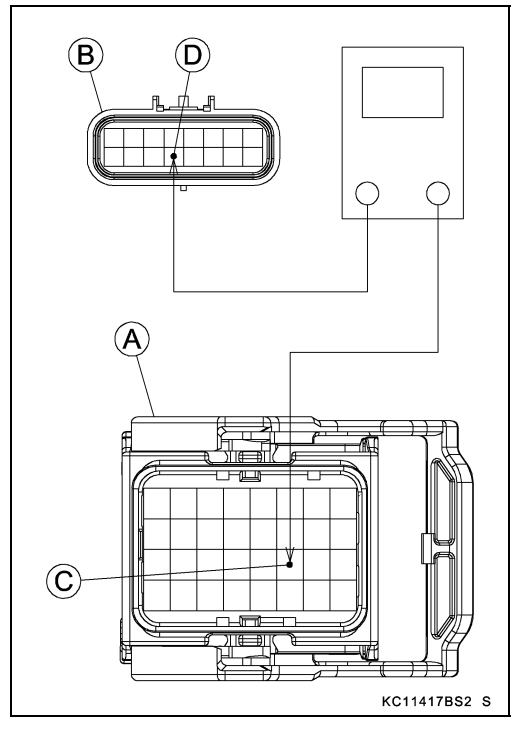
● Refer to the equipment manual for the MIL device.
★If the MIL is not illuminating, check the wiring for continuity between harness connectors (see MIL Wiring Connection Inspection).

MIL Wiring Connection Inspection

● Disconnect the ECU and 16 pin connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→ 16 pin Connector [B]
ECU Connector F2 [C] ←→ 16 pin Connector M [D]

★If an open, replace the harness.
★If good continuity, check the wiring for any shorts.
★If no issue with wiring, replace the throttle body assy.



Internal Problem in Throttle Body Assy (DTC P0107, P0112, P0113, P0600, P0643, P0651, P0653, P0658, P0659, P1515, P2100, P2101, P2102, P2103, P210C, P210D, P210E, P2113, P2114, P2670, P2671)

Throttle Body Assy Replacement

○The above DTC are internal trouble of the throttle body assy. Therefore these DTC cannot be checked directly.

★If these DTC are detected, replace the throttle body assy.

ECU

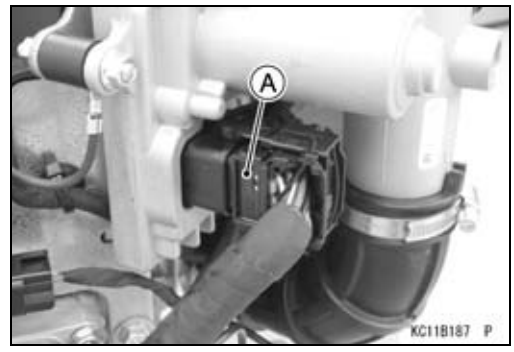
ECU Replacement

○The ECU unites with the throttle body assy. The ECU cannot be removed from the throttle body assy. When the ECU fails, replace the throttle body assy.

ECU Power Supply Inspection

- Visually check the ECU connector [A].

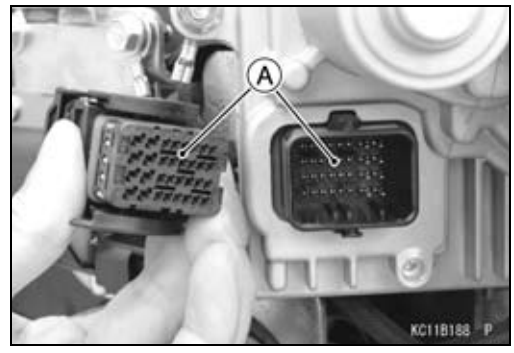
★If the connector is clogged with mud or dust, blow it off with compressed air.



- Disconnect the ECU connector (see Throttle Body Assy Removal).
- Visually check the terminals [A] of ECU and main harness connectors.

★If the terminals of the main harness connector are damaged, replace the main harness.

★If the terminals of the ECU connector are damaged, replace the throttle body assy.



- Set a meter [A] and check the following wiring for continuity.

ECU Grounding Inspection

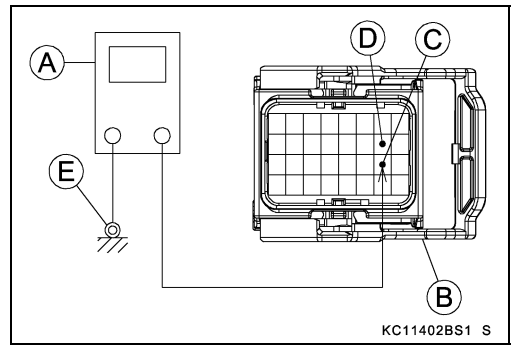
Connections:

ECU Connector [B]

Terminal G2 [C] or G3 [D] ←→ Engine Ground Terminal [E]

Criteria:

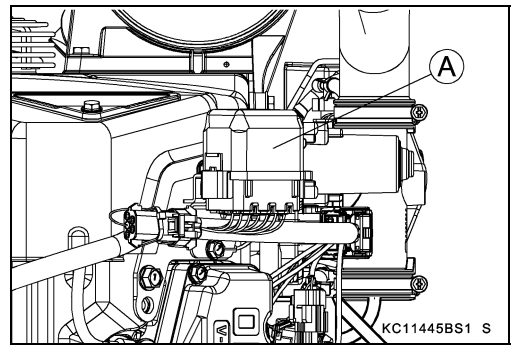
0 Ω



★If no continuity, check the connectors, engine ground lead or main harness, and replace them if necessary.

★If the wiring is good, check the following harnesses are in continuity.

- Remove the relay/fuse box [A].



ECU

● Connect a meter [A] to the ECU connector [B] and relay/fuse box connector [C] with needle adapter set.

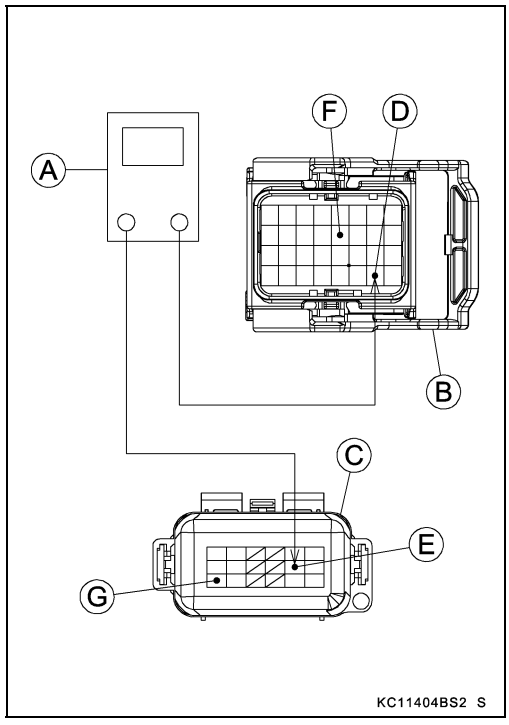
Special Tool - Needle Adapter Set: 57001-1874

Wiring Continuity Inspection

ECU Connector G1 [D] ←→ Relay/Fuse Box Connector R8 [E]

ECU Connector E3 [F] ←→ Relay/Fuse Box Connector R18 [G]

★If an open, replace the harness.



★If the wiring is good, check the power source voltage of the ECU.

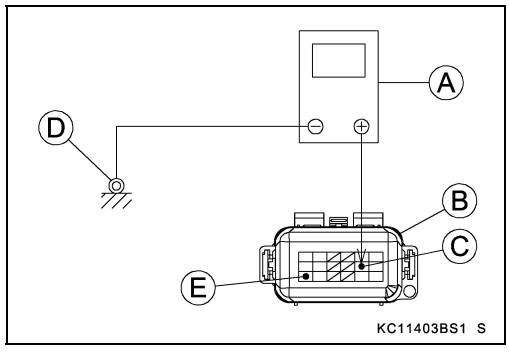
● Connect the ECU connector.

NOTE

○*Be sure the battery is fully charged.*

● Connect a meter [A] to the relay/fuse box connector [B] with needle adapter set.

Special Tool - Needle Adapter Set: 57001-1874



ECU Power Supply Inspection

Connections:

(I) Meter (+) → Relay/Fuse Box Connector R8 [C]

Meter (–) → Engine Ground Terminal [D]

(II) Meter (+) → Relay/Fuse Box Connector R18 [E]

Meter (–) → Engine Ground Terminal

Ignition Switch OFF:

(I) 0 V

(II) 0 V

Ignition Switch ON:

(I) (II) Battery Voltage

★If the reading is out of the specification, check the following.

Fuse 10 A (see Fuse Inspection in the Electrical System chapter)

Fuse 2 A (see Fuse Inspection in the Electrical System chapter)

Main Relay (see Relay Inspection in the Electrical System chapter)

Power Source Wiring (see Battery Wiring Diagram)

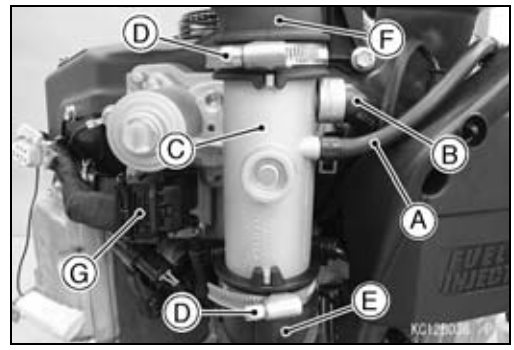
★If the fuse, relay and wiring are good, replace the throttle body assy.

Throttle Body Assy

Throttle Body Assy Removal

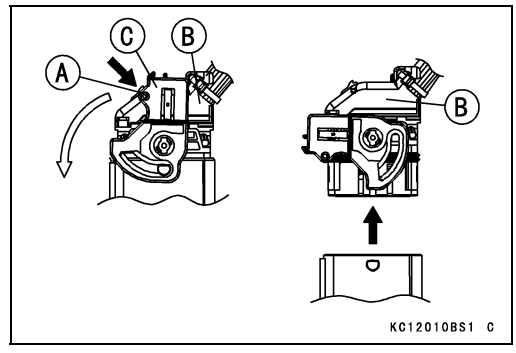
⚠ WARNING

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



- Disconnect the hose [A] and breather hose [B] from the throttle body assy [C].
- Loosen the hose band screws [D] and then disconnect the intake duct [E] and intake hose [F].
- Disconnect the ECU connector [G] from the throttle body assy as described below.

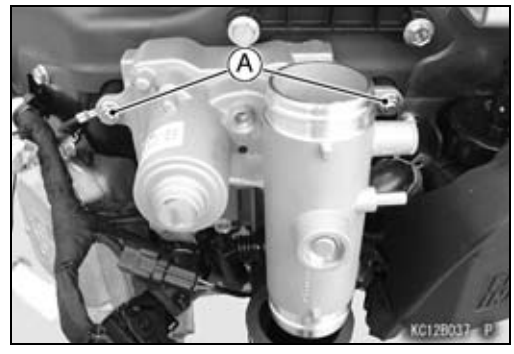
○Push the lock tab [A] on the ECU connector [B], and turn the connector lever [C] until it stops.
○Pull the ECU connector straightly out to disconnect it from the throttle body assy.



- Remove the mounting nuts [A].

NOTICE

Never drop the throttle body assy, especially on a hard surface. Such a shock to the throttle body assy can damage the ECU.



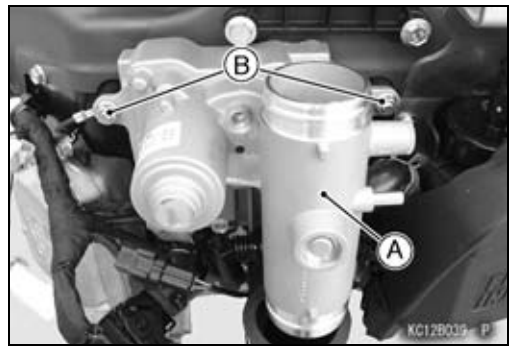
Throttle Body Assy Installation

- Set the ground terminal [A] as shown.

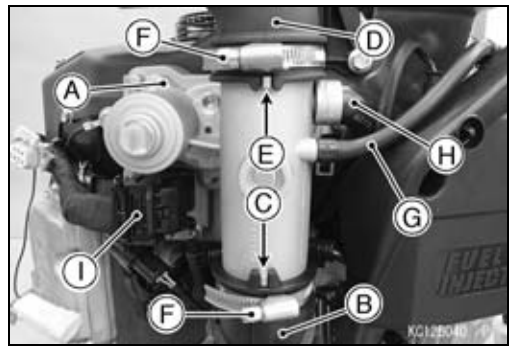
Throttle Body Assy

- Install the throttle body assy [A] and tighten the mounting nuts [B].

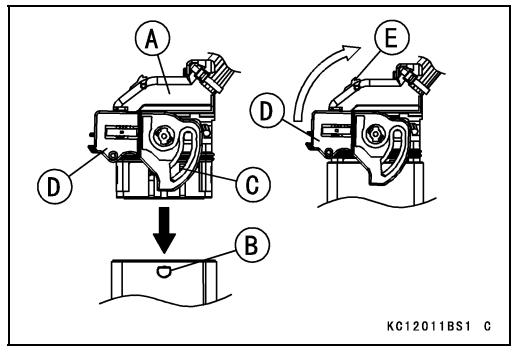
Torque - Throttle Body Mounting Nuts: 3.7 N·m (0.38 kgf·m, 33 in·lb)



- Connect the throttle body assy [A] to the intake duct [B], aligning the projection [C] with the tabs on the intake duct.
- Connect the throttle body assy to the intake hose [D] aligning the projection [E] with the tabs on the intake hose.
- Tighten the hose band screws [F].
- Connect the hose [G] and breather hose [H] to the throttle body assy.
- Connect the ECU connector [I] to the throttle body assy as described below.



○Push the ECU connector [A] fully.
○Align the tabs [B] on the connector case with grooves [C] in the lock lever [D].
○Turn the lock lever until it locked with the lock tab [E] on the ECU connector.



Throttle Body Bracket Assembly Removal

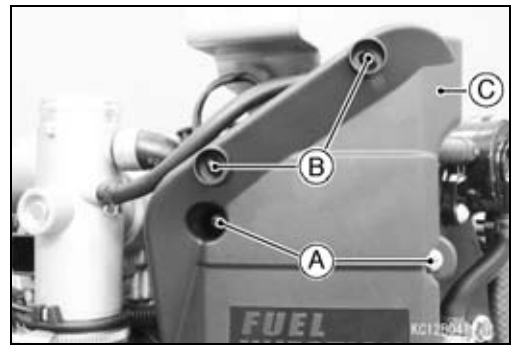
⚠ WARNING

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

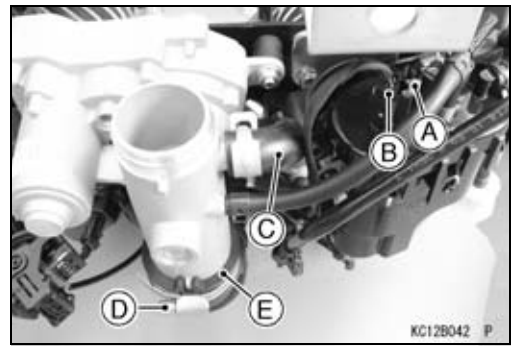
- Remove the fan housing (see Fan Housing Removal in the Cooling System chapter).
- Disconnect the ECU connector from the throttle body (see Throttle Body Assy Removal).

Throttle Body Assy

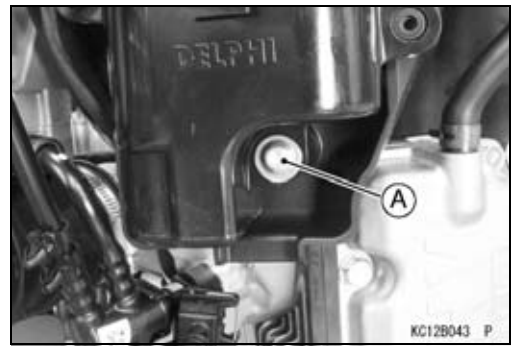
- Remove:
  Fuel Pump Cover Bolts [A]
  Clamps [B]
  Fuel Pump Cover [C]



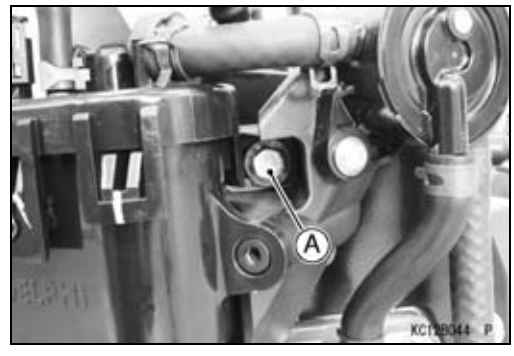
- Pull up the locking tab [A] carefully and disconnect the fuel pump connector [B] from the fuel pump.
- Disconnect the breather hose [C] from the throttle body.
- Loosen the hose band screw [D] and disconnect the intake duct [E].



- Disconnect the fuel tube from the fuel pump (see Fuel Tube Connector Removal).
- Loosen the fuel pump mounting bolt [A].

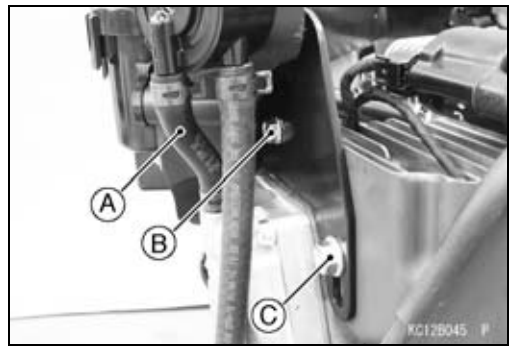


- Loosen the fuel pump bracket mounting bolt [A].

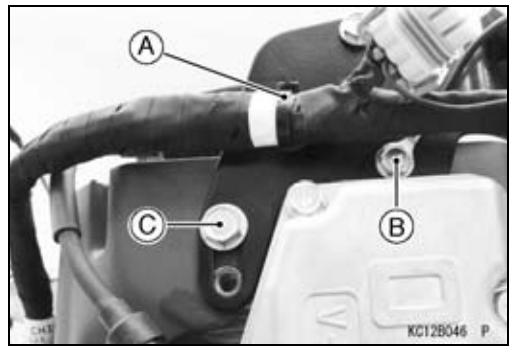


Throttle Body Assy

- Disconnect the pulse hose [A] from the fuel pump.
- Remove the throttle body bracket bolts (M6) [B] and (M8) [C] at the #2 cylinder head.

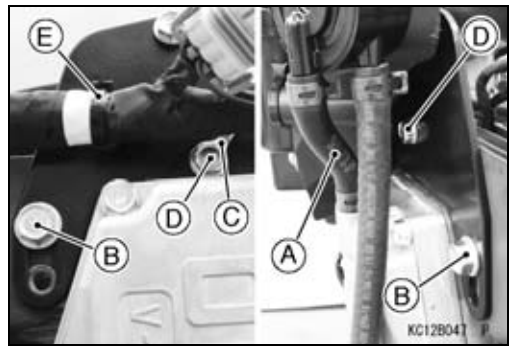


- Pull the main harness clamp [A] out from the throttle body bracket.
- Remove the throttle body bracket bolts (M6) [B] and (M8) [C] at the #1 cylinder head.



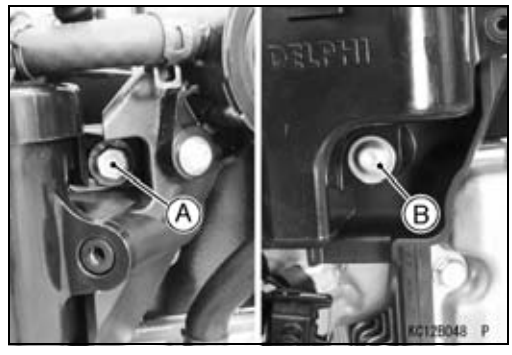
Throttle Body Bracket Assembly Installation

- Connect the throttle body assy with bracket onto the intake manifold.
- Connect the pulse hose [A] to the fuel pump.
- Install:
  Throttle Body Bracket Bolts (M8) [B]
  Ground Terminal [C] (#1 Cylinder Head Side)
  Throttle Body Bracket Bolts (M6) [D]
- Insert the main harness clamp [E] of the main harness to the throttle body bracket.

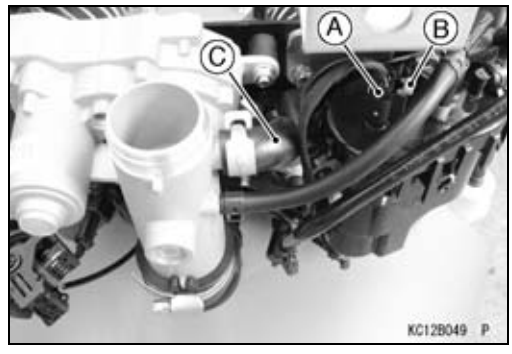


- Tighten:
  Fuel Pump Mounting Bolt [A]
  Fuel Pump Bracket Mounting Bolt [B]

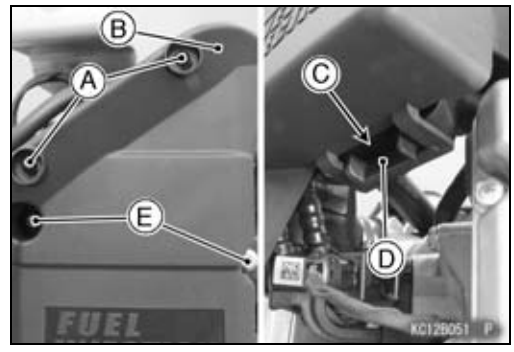
  Torque - Fuel Pump Bracket Mounting Bolt: 8.8 N·m (0.90 kgf·m, 78 in·lb)
- Connect the fuel tube from the fuel pump (see Fuel Tube Connector Installation).



- Connect the fuel pump connector [A] to the fuel pump and push down the locking tab [B].
- Pull the fuel pump connector up gently to check it locked securely.
- Connect the breather hose [C] to throttle body.



Throttle Body Assy

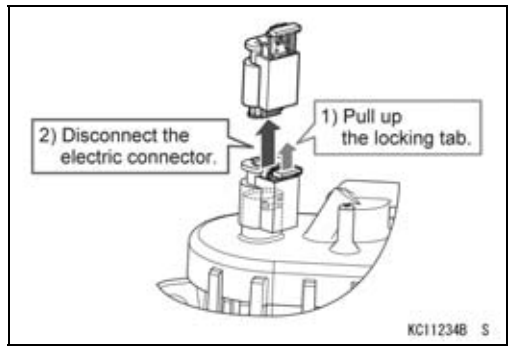


- Install the clamps [A] to the fuel pump cover [B].
- Align the slot [C] in the fuel pump cover to the tab [D] on the fuel pump.
- Install the fuel pump cover bolts [E].

- Connect the ECU connector (see Throttle Body Assy Installation).
- Install the removed parts.

Electric Fuel Pump

Electric Connector Removal



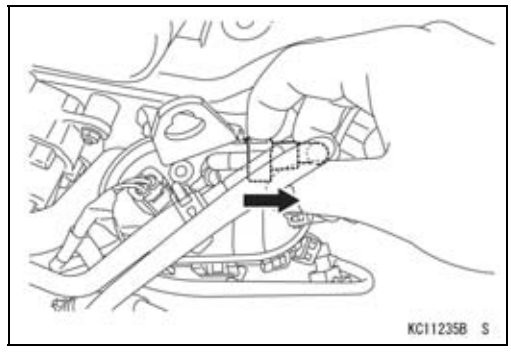
- Pull up the locking tab of the connector.
- Pull and disconnect the connector from the fuel pump.

Fuel Tube Connector Removal

- Loosen bolts and remove the fuel pump cover.
- Clear the evaporator tube from the clamp.
- Unplug the fuel pump and crank the engine only a few times. (Refer to Electric Connector Removal) This procedure reduces inner fuel pressure of the fuel tube.
- Reconnect the electric connector to the fuel pump.
- Place a piece of cloth around the fuel tube connector so as not to spill the fuel remaining in the tube.
- While pressing white clip of the connector, pull the connector out slowly.

NOTE

○*Push the connector before pulling makes it easier.*



Fuel Tube Connector Installation

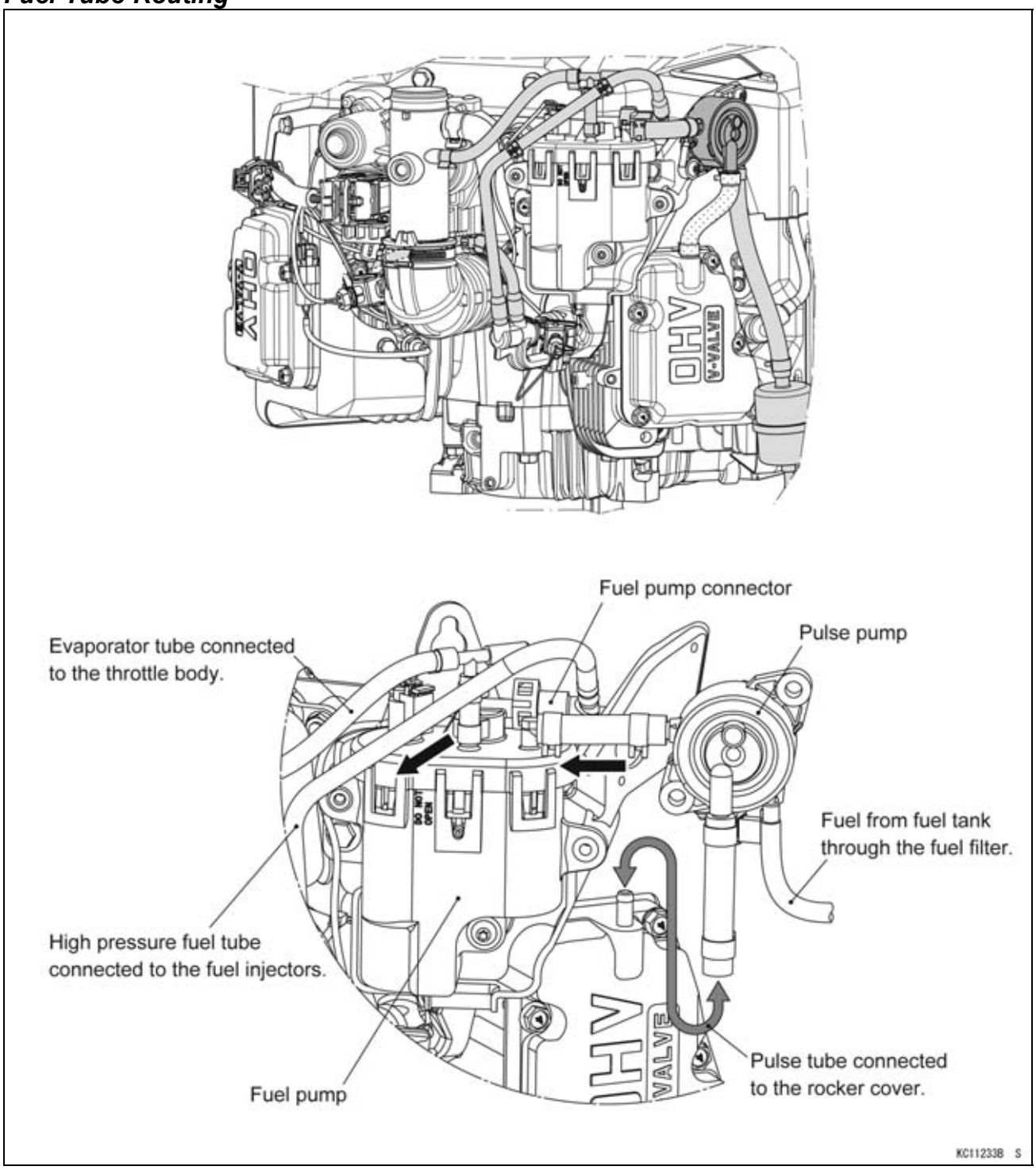
- Install the connector onto the fuel outlet pipe until the retainer snaps in place.
- Move the connector back and forth more than two times, and make sure it is locked and does not pull out.

⚠ WARNING

Leaking fuel can cause a fire or explosion resulting in serious burns. Make sure the hose clamp is installed correctly.

Electric Fuel Pump

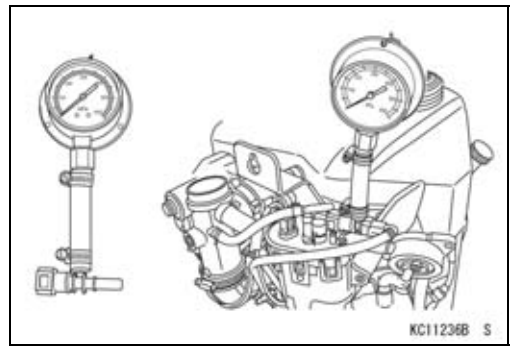
Fuel Tube Routing



Fuel Pressure Inspection

- Verify the battery is fully charged.
- Turn the ignition switch to stop position.
- Loosen bolts and remove the fuel pump cover.
- Loosen bolts and loosen pulse pump and fuel pump. Leave the fuel line connected.
- Detach the fuel tube connector. (Refer to Fuel Tube Connector Removal.)
- Install the fuel pressure gauge adapter between the fuel tube connector and the fuel pump outlet connector.

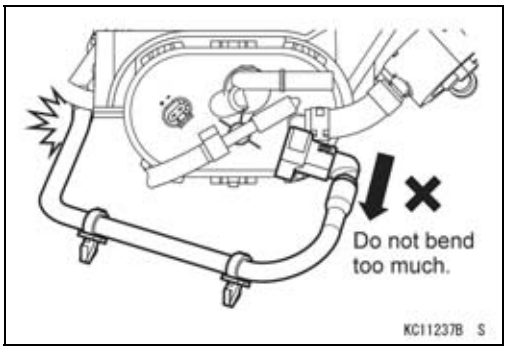
Special Tool - Fuel Pressure Gauge Adapter: 57001-1837



Electric Fuel Pump

NOTICE

Take care not to bend the fuel tube too much when installing and removing the fuel pressure gauge. The fuel tube is not so flexible and can be damaged if the tube is bent too much.



- Turn the ignition switch to run position and check for leaks as fuel pump primes.
- Start the engine.
- Measure the fuel pressure at low idle speed. The fuel pressure does not fluctuate by the engine speed.

Fuel Pressure

Standard: 256 ~ 284 kPa (2.61 ~ 2.90 kgf/cm², 37.1 ~ 41.2 psi) (pump operates at 13.5 ±0.1 V, 22 ±5°C/measured at idle speed)

★If the fuel pressure is not within the standard range, possible causes are as below.
- Fuel pump malfunction
- Fuel tube connection is incomplete.
- Clogged or damaged fuel tube (high pressure tube, pulse pump tubes, fuel filter)
- Evaporator tube malfunction
- Power supply for the fuel pump is out of standard.
- Wiring circuit malfunction (harness wiring, relay, ground, ECU)

NOTE

○*When you turn the ignition switch to run position, the fuel pump operates for a few seconds and then should stop automatically. So the pressure rises at first, and then declines gradually. To measure stable fuel pressure, start the engine and let it low idle.*

⚠ WARNING

Leaking fuel can cause a fire or explosion. Make sure the fuel hoses are connected correctly.

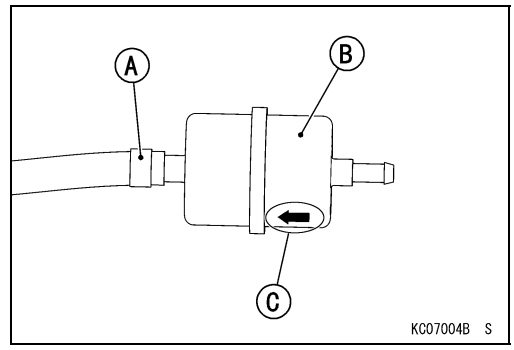
NOTICE

Do not drive fuel pump for 3 seconds or more without fuel in the tank. If the fuel pump is driven without fuel, it may be damaged.

Fuel Filter

Fuel Filter Removal/Installation

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

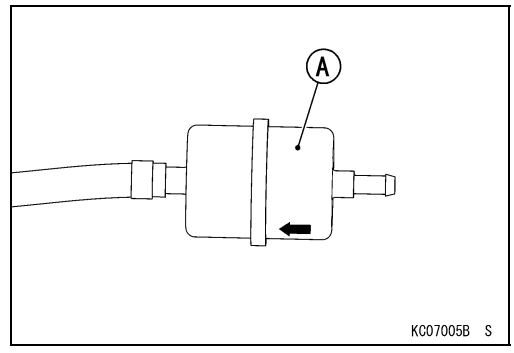


Fuel Filter Inspection

- Visually inspect the fuel filter [A].

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

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



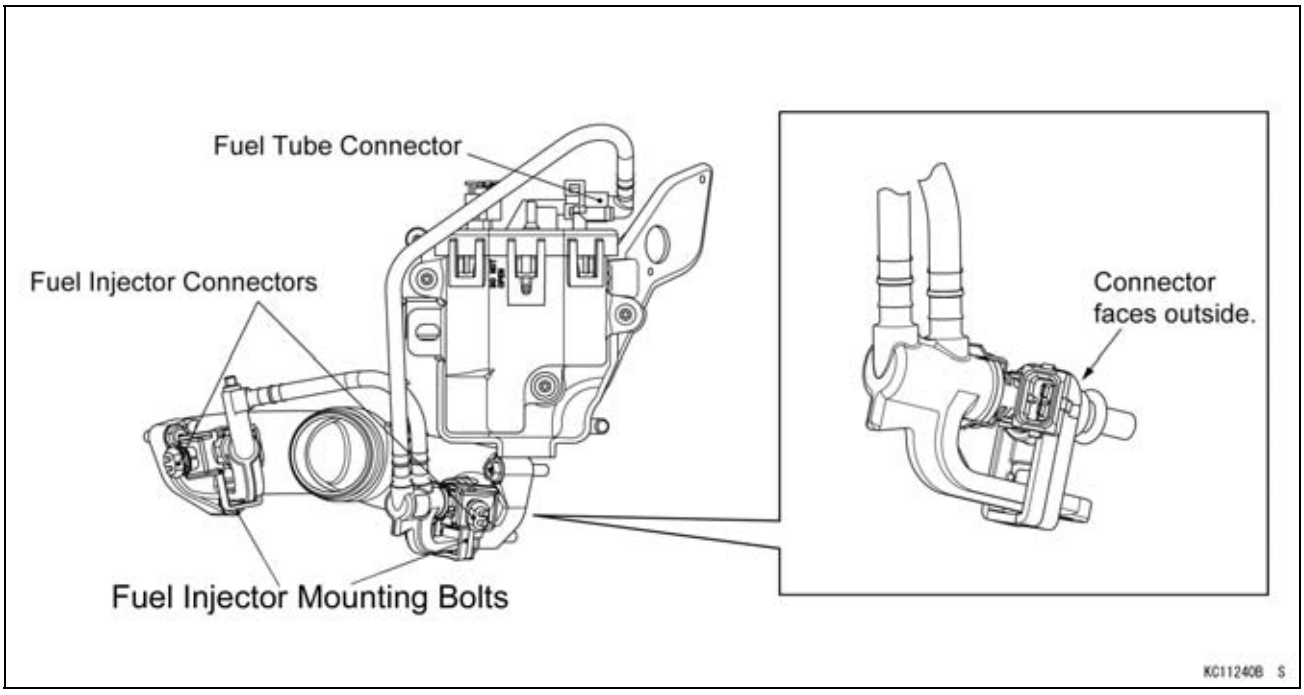
Fuel Injectors and Fuel Tube

Fuel Injectors and Fuel Tube Assembling

Set the fuel injectors assembly so that both injector connectors face outside of the engine.

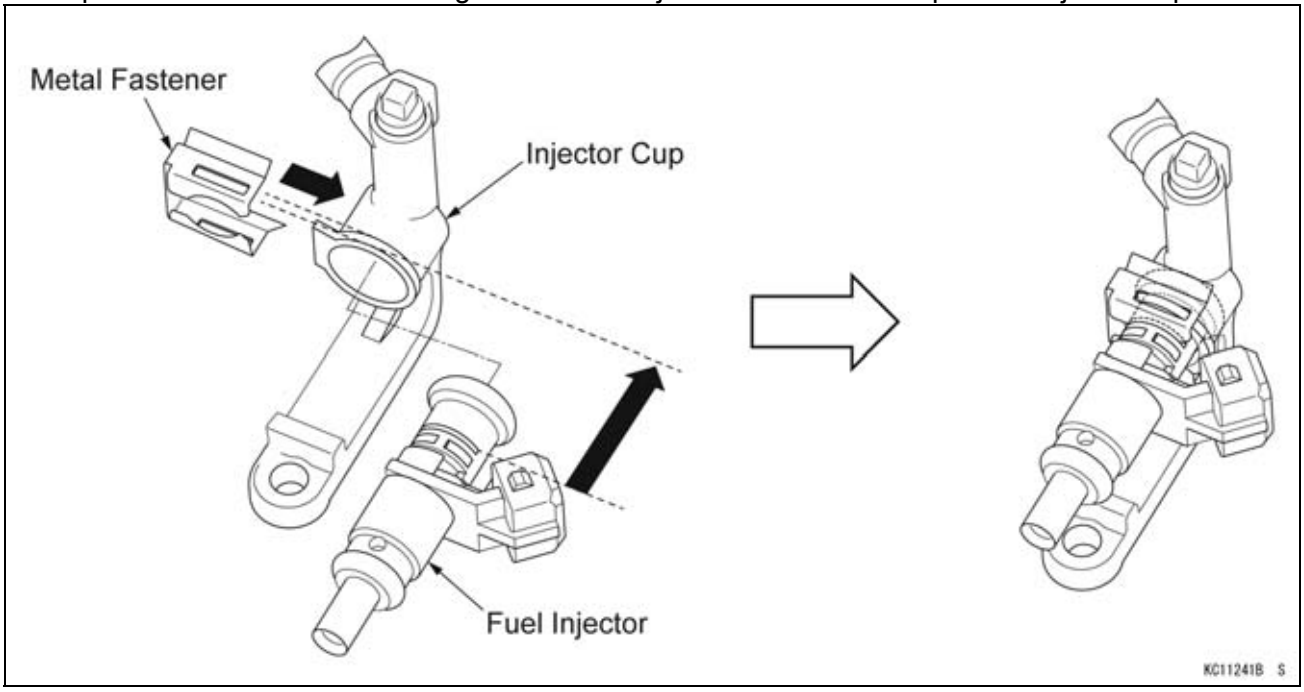
- Firmly and slowly insert injectors into intake manifold ports until seated. Take care not to rotate an injector from its clip and cup assembly.
- Connect the fuel tube connector to fuel pump outlet port. Follow the connector attaching instruction. Refer to Fuel Tube Connector Installation in Electric Fuel Pump section.
- Insert and tighten the fuel injector mounting bolts.

Torque - Fuel Injector Mounting Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)



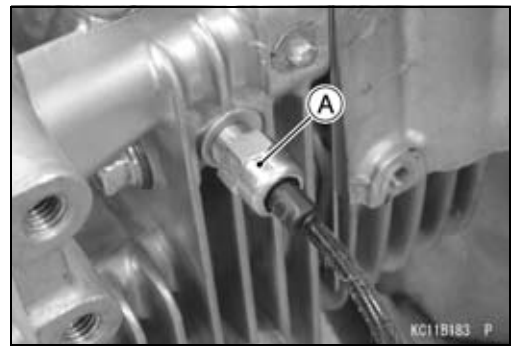
Fuel Injector Installation

- When reinstalling the fuel injector, replace the o-rings with new ones.
- Install the injector into the injector cup slowly so that the injector connector faces outside and the groove of the injector aligns with outer lip of the injector cup.
- Snap the metal fastener into the groove of the injector and the outer lip of the injector cup.



Cylinder Head Temperature Sensor

Cylinder Head Temperature Sensor Removal



- Disconnect the cylinder head temperature sensor lead connector.
- Remove the #1 cylinder engine shroud (see Engine Shroud Removal in the Cooling System chapter).
- Remove the cylinder head temperature sensor [A].

Cylinder Head Temperature Sensor Installation

- Tighten:

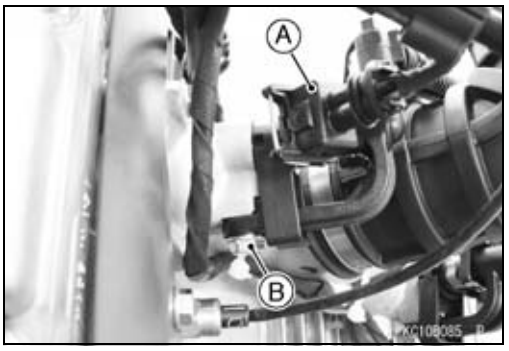
Torque - Cylinder Head Temperature Sensor: 7.5 N·m (0.76 kgf·m, 66 in·lb)

- Install the removed parts.
- Connect the cylinder head temperature sensor lead connector.

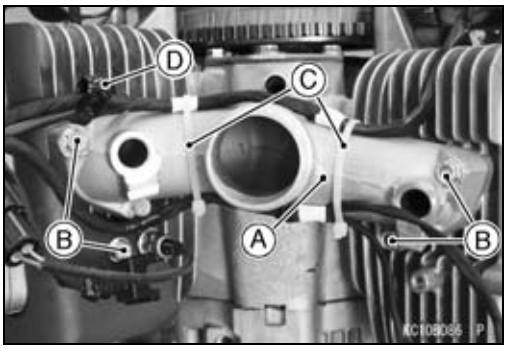
Intake Manifold

Intake Manifold Removal

- Remove the throttle body bracket assembly (see Throttle Body Bracket Assembly Removal).
- Disconnect the fuel injector connectors [A] (both sides).
- Remove the fuel injector mounting bolts [B] (both sides).

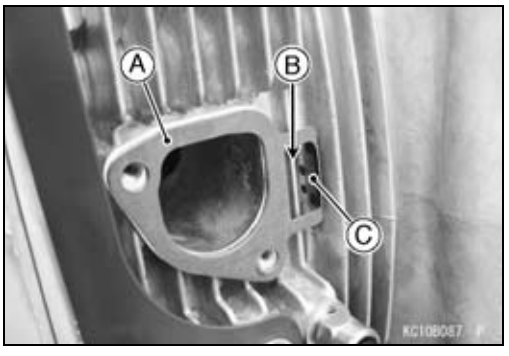


- Clean the intake manifold [A].
- Remove:
  Intake Manifold Bolts [B]
  Intake Manifold and Gaskets
- Cut the bands [C] to free the leads if necessary.
- Open the clamp [D] to free the leads if necessary.



Intake Manifold Installation

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

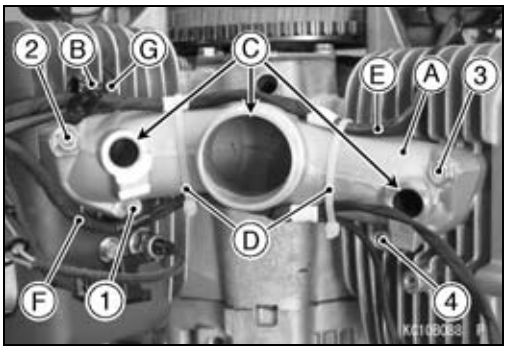


- Install the intake manifold [A] onto the cylinder heads.
- Tighten the intake manifold bolts following the tightening sequence [1 ~ 4] with clamp [B].

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

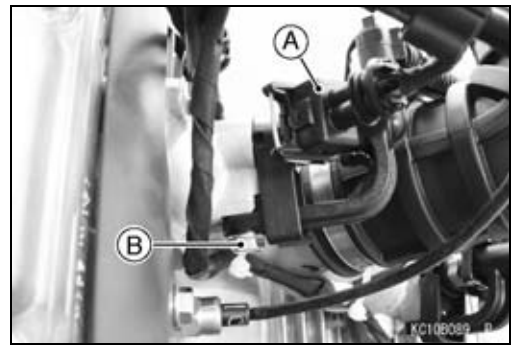
- Clean the mating surfaces [C] for the throttle body assy and fuel injectors on the intake manifold.
- Secure the following leads to the intake manifold with new bands [D].
  #2 Ignition Coil and Crankshaft Position Sensor Leads [E] (Top Side)
  Fuel Pump Lead and #2 Fuel Injector Lead [F] (Bottom Side)
- Hold the #1 ignition coil [G], #2 ignition coil and crankshaft position sensor leads with the clamp.

○Position the wire leads on the intake manifold as shown.



Intake Manifold

- Cut excess length of the bands.
- Connect the fuel injector connectors [A] (both sides).
- Install the fuel injector mounting bolts [B] (both sides).
- Install the throttle body bracket assembly (see Throttle Body Bracket Assembly Installation).



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.

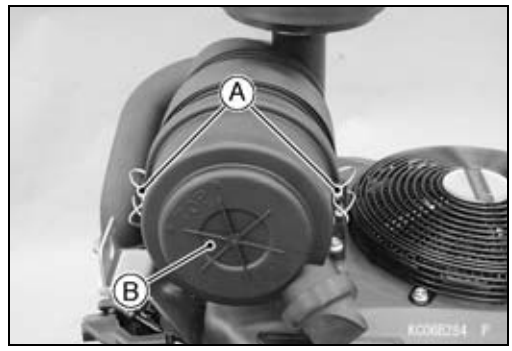
★If a crack is present in the intake manifold, replace it.

- Inspect the gasket surfaces for burrs and nicks.

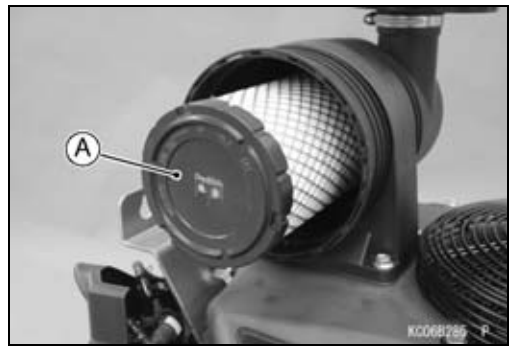
Air Cleaner

Air Cleaner Element Removal

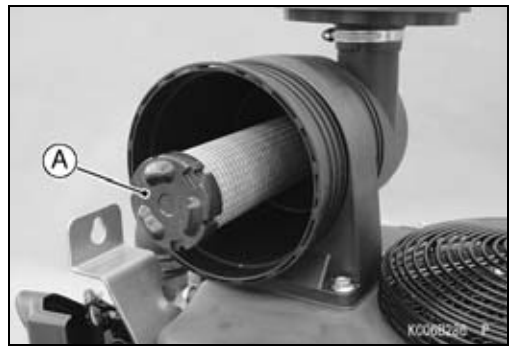
- Unhook the two retaining clamps [A] and remove the air cleaner cap [B] from the air cleaner body.



- Remove the primary element [A].

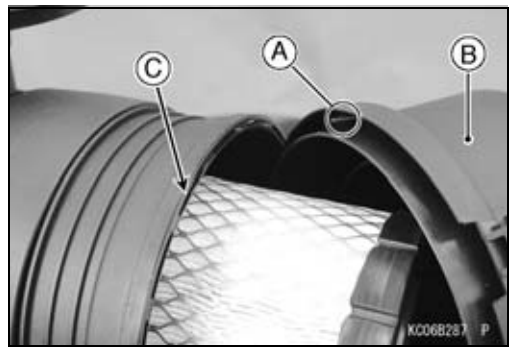


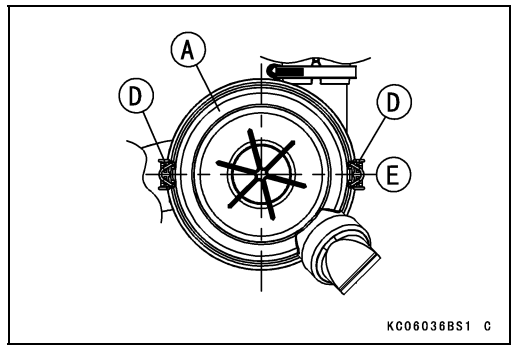
- Remove the secondary element [A].



Air Cleaner Element Installation

- Install the secondary element and primary element into place in the air cleaner body.
- Insert the tab [A] of the air cleaner cap [B] to the slot [C] of the housing.
- Install the air cleaner cap so that the two retaining clamps [D] are positioned horizontally [E].
- Fasten the retaining clamps to secure the air cleaner cap.

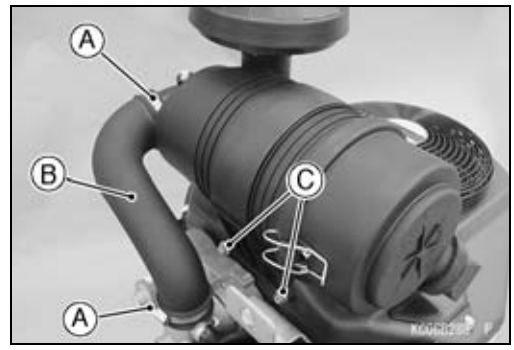




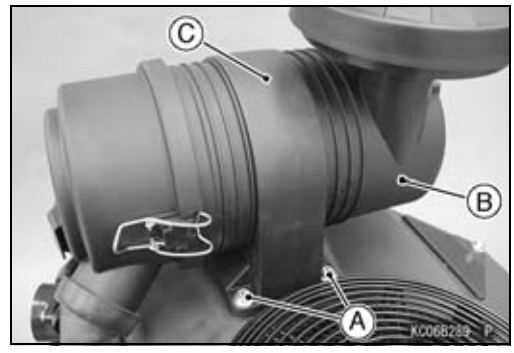
Air Cleaner

Air Cleaner Body and Bracket Removal

- Remove the air cleaner elements, if necessary (see Air Cleaner Element Removal).
- Loosen the clamps [A] and remove the intake hose [B].
- Remove:
  Air Cleaner Body Mounting Bolts [C]

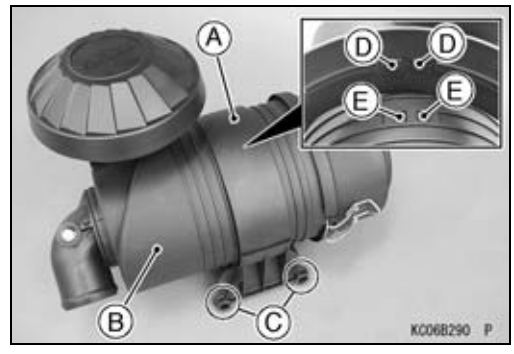


- Remove:
  Air Cleaner Body Mounting Bolts [A]
  Air Cleaner Body [B] with Holder Bracket [C]
- Remove the air cleaner holder bracket from the air cleaner body.



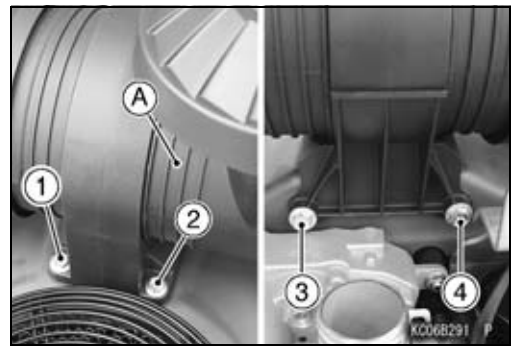
Air Cleaner Body and Bracket Installation

- Install the air cleaner holder bracket [A] to the air cleaner body [B] so that the horizontal mounting bolt holes [C] facing forward.
- Align the tabs [D] behind the bracket to the grooves [E] on the air cleaner body.

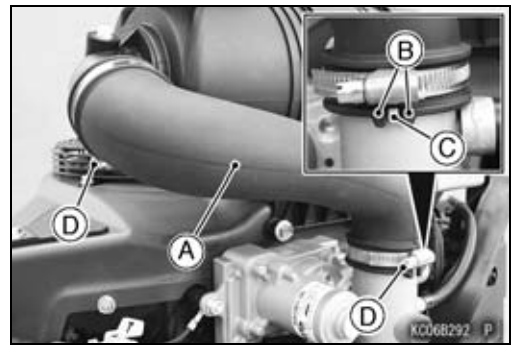


- Install the air cleaner body assembly [A] and tighten the air cleaner bracket mounting bolts following the specified tightening sequence [1 ~ 4].

Torque - Air Cleaner Bracket Mounting Bolts: 8.8 N·m (0.90 kgf·m, 78 in·lb)



- Connect the intake hose [A] aligning its tabs [B] with the projection [C] on the throttle body.
- Tighten the clamp screws [D].



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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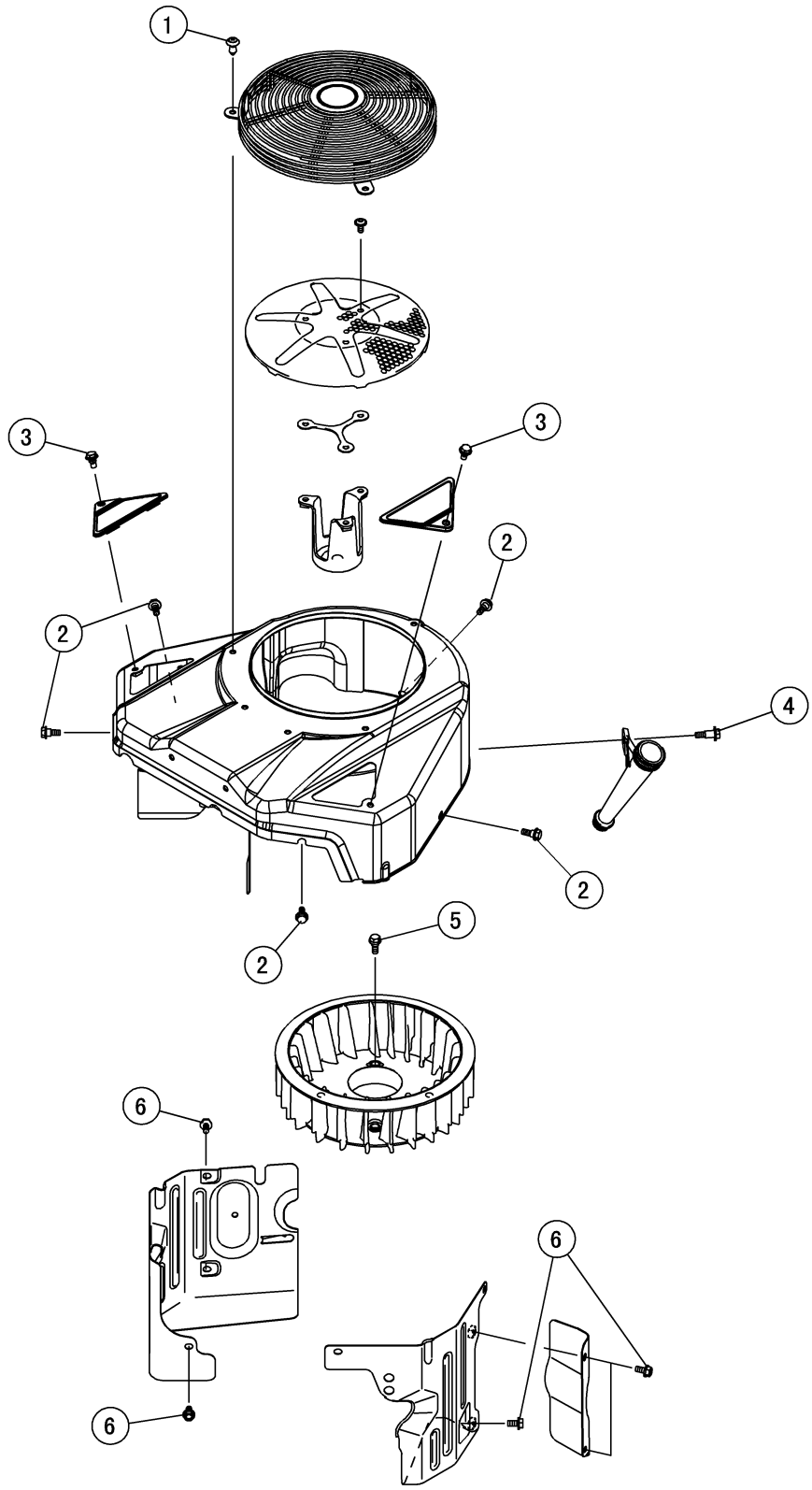
Exploded View



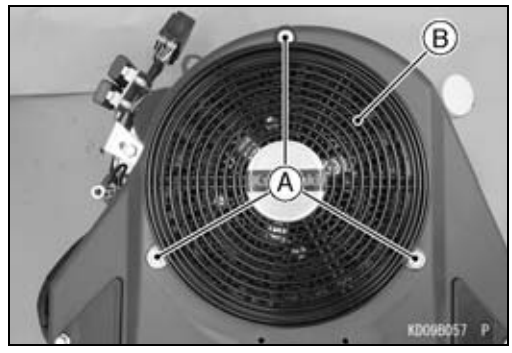
Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Fan Guard Mounting Bolts	5.9	0.60	52 in·lb	
2	Fan Housing Bolts	5.9	0.60	52 in·lb	
3	Housing Cover Bolts	5.9	0.60	52 in·lb	
4	Oil Filler Mounting Bolt	5.9	0.60	52 in·lb	
5	Cooling Fan Bolts	8.8	0.90	78 in·lb	
6	Engine Shroud Bolts	5.9	0.60	52 in·lb	

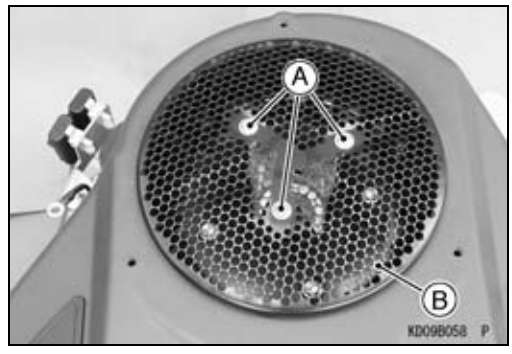
Fan Housing

Fan Housing Removal

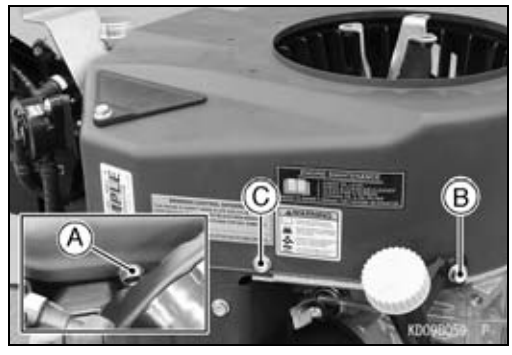
- Remove:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal in the Fuel System (EFI) chapter)
  Regulator (see Regulator Removal in the Electrical System chapter)
  Fan Guard Mounting Bolts [A]
  Guard [B]

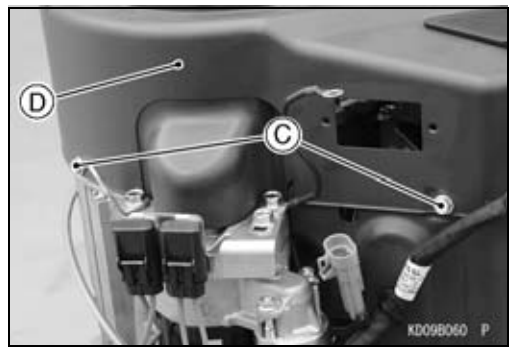


- Remove:
  Fan Screen Bolts [A]
  Screen [B]
  Spacer (at the Back of the Screen)



- Loosen the fan housing bolt [A] (both sides) and oil filler mounting bolt [B] (not necessary to remove).
- Remove the remaining three fan housing bolts [C].
- Remove the fan housing [D].





Fan Housing

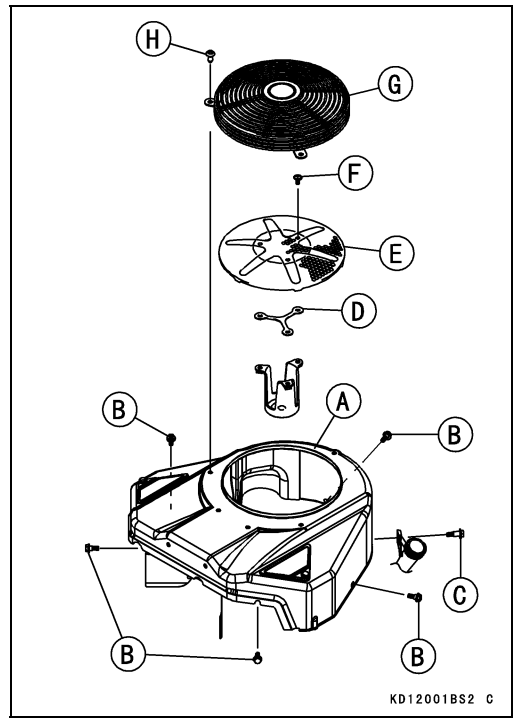
Fan Housing Installation

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

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

- Install the spacer [D] and screen [E].
- Tighten the fan screen bolts [F].
- Install:
  Guard [G]
  Fan Guard Mounting Bolts [H]
- Tighten:

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



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.

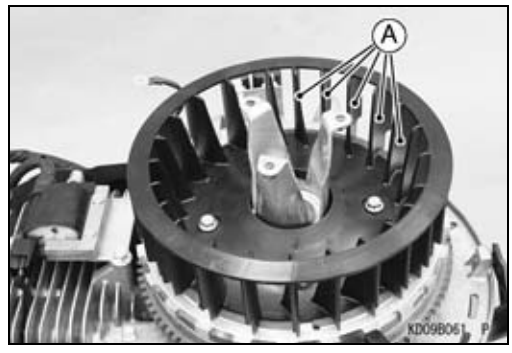
Cooling Fan Inspection

- 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.

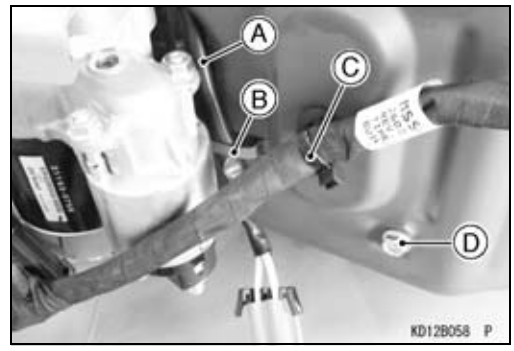
Engine Shroud

Engine Shroud Removal

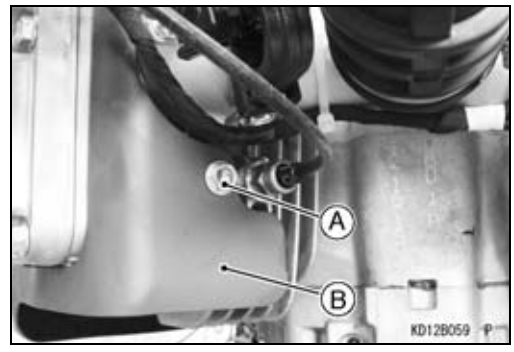
● Remove:
Throttle Body Bracket Assembly (see Throttle Body Bracket Assembly Removal in the Fuel System (EFI) chapter)

#1 Cylinder Side

● Remove the spark plug cap (see Ignition Coil Removal in the Electrical System chapter).
● Free the stator coil lead [A] from the clamp [B] on the engine shroud.
● Remove:
Main Harness Clamp [C]
Engine Shroud Bolt [D]

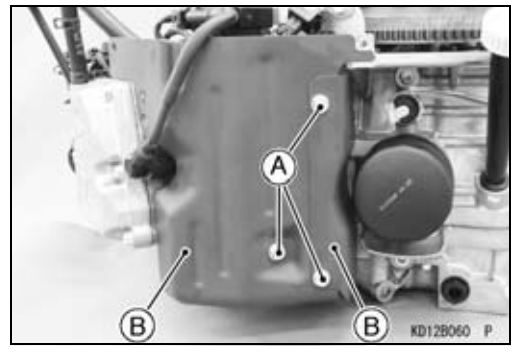


● Remove:
Engine Shroud Bolt [A]
Engine Shroud [B]



#2 Cylinder Side

● Remove:
Engine Shroud Bolts [A]
Engine Shrouds [B]



Engine Shroud Installation

● Installation is the reverse of removal.
● Tighten:

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

● Install the removed parts.

Engine Top End

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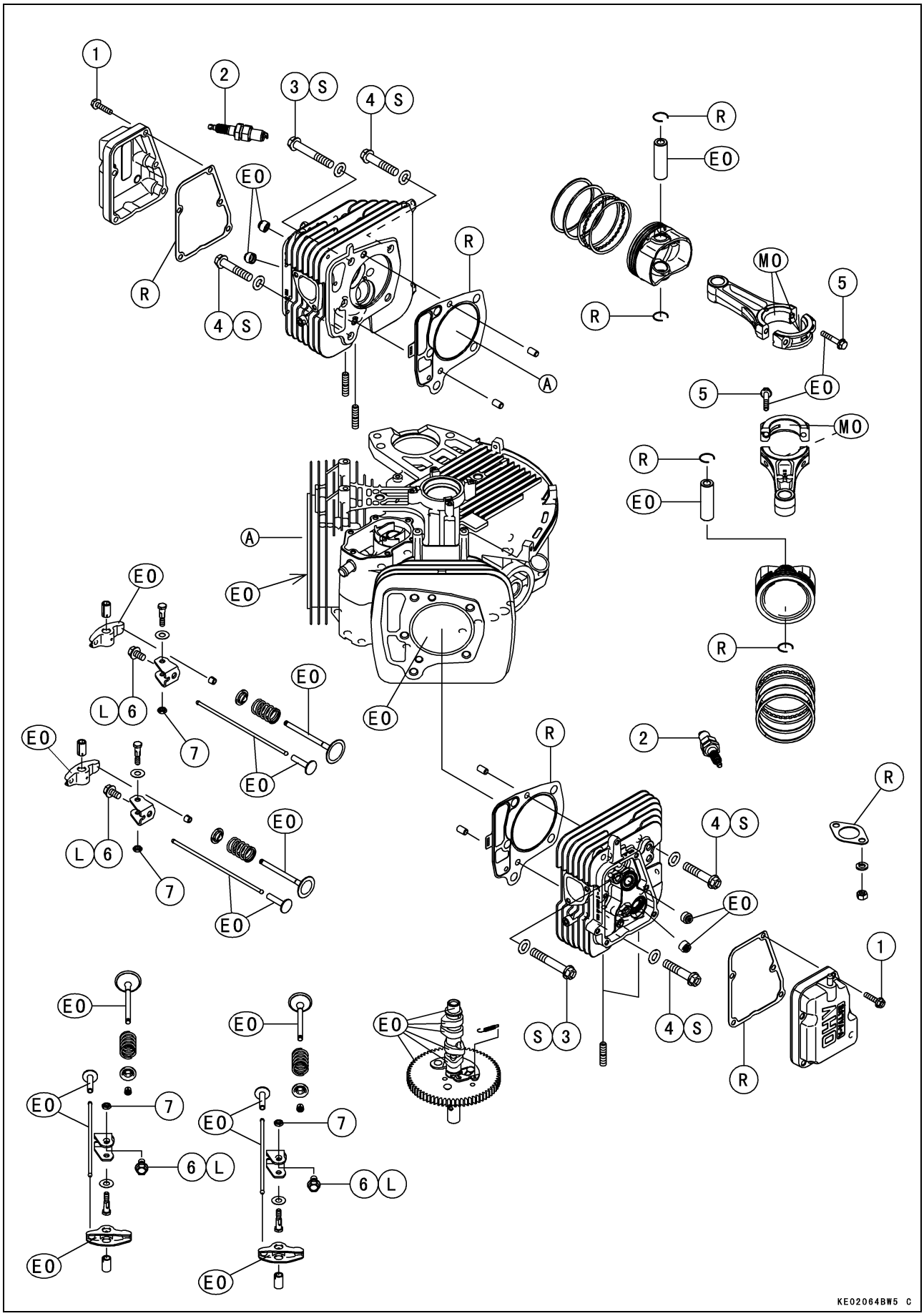
5-2 ENGINE TOP END

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Rocker Cover Bolts	8.0	0.82	71 in·lb	
2	Spark Plugs	22	2.2	16	
3	Cylinder Head Bolts (L = 65 mm)	46	4.7	34	S
4	Cylinder Head Bolts (L = 50 mm)	46	4.7	34	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	11	1.1	97 in·lb	

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

Specifications

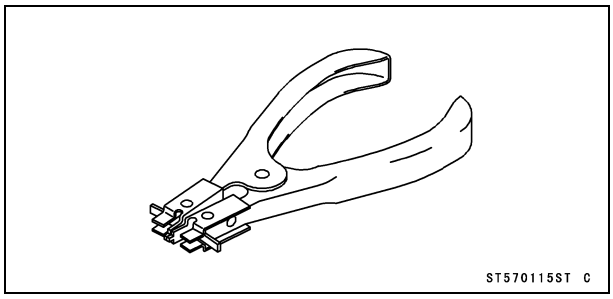
Item	Service Limit
Cylinder Head:	
Cylinder Compression (MIN)	440 kPa (4.5 kg/cm², 64 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 450 r/min (rpm)/5 Seconds
Cylinder Head Warp	0.05 mm (0.002 in.)
Valves:	
Valve Head Thickness:	
Intake, Exhaust	0.8 mm (0.03 in.)
Valve Stem Runout:	
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	0.17 mm (0.0067 in.)
Second	0.18 mm (0.0071 in.)
Piston Ring Thickness:	
Top	1.12 mm (0.0441 in.)
Second	1.12 mm (0.0441 in.)
Piston Ring End Gap:	
Top	0.6 mm (0.02 in.)
Second	0.8 mm (0.03 in.)
Oil	0.9 mm (0.04 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 (0.6716 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

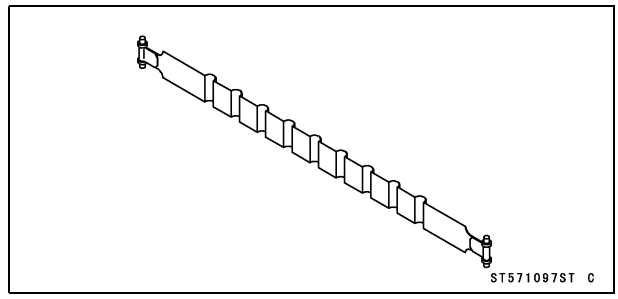
Item	Standard
Valve Clearance:	
Intake, Exhaust	0.05 ~ 0.10 mm (0.002 ~ 0.004 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake	1.2 ~ 1.8 mm (0.047 ~ 0.071 in.)
Exhaust	0.8 ~ 1.6 mm (0.031 ~ 0.063 in.)
Valves Guide Inside Diameter:	
Intake, Exhaust	6.000 ~ 6.012 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

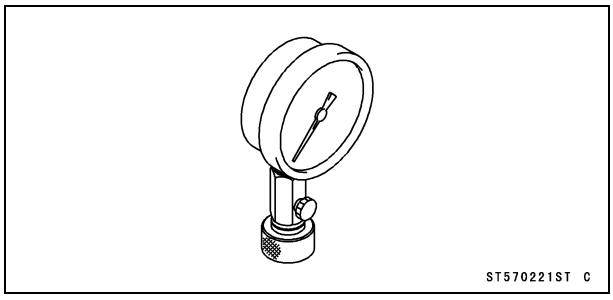
Piston Ring Pliers:
57001-115



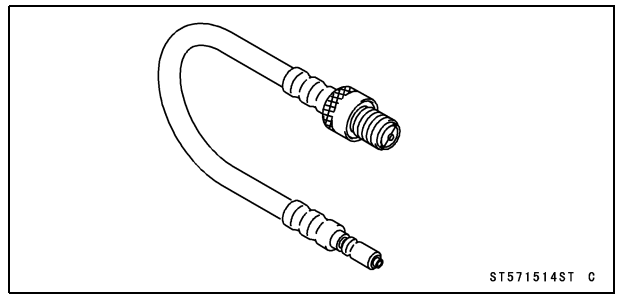
Piston Ring Compressor Belt, ϕ67 ~ ϕ79:
57001-1097



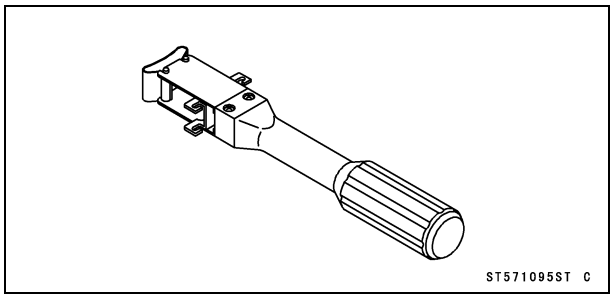
Compression Gauge, 20 kgf/cm²:
57001-221



Compression Gauge Adapter, M14 × 1.25:
57001-1514

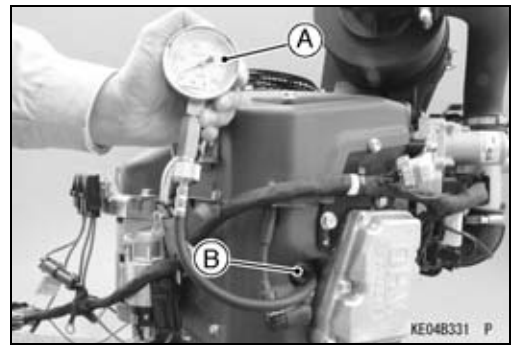


Piston Ring Compressor Grip:
57001-1095



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.

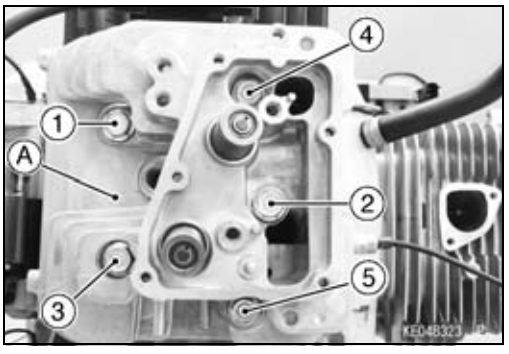
Cylinder Head

Cylinder Head Assembly Removal

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

○Before removing the cylinder head, bring the piston to the top dead center (TDC) of #1 or #2 cylinder head (see Valve Clearance Inspection in Periodic Maintenance).

- Remove:
  Rocker Arm (see Valve Mechanism Removal/Installation)
  Push Rod (see Push Rod Removal)
  Rocker Arm Bracket (see Valve Mechanism Removal/Installation)
- Loosen the cylinder head bolts 1/4 turn in the sequence [1 ~ 5] as shown.



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 [A].

NOTE

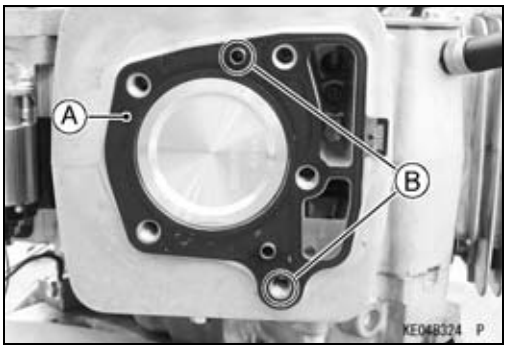
○*Mark the push rods and rocker arms so they can be installed in their original position during assembly.*

Cylinder Head Assembly Installation

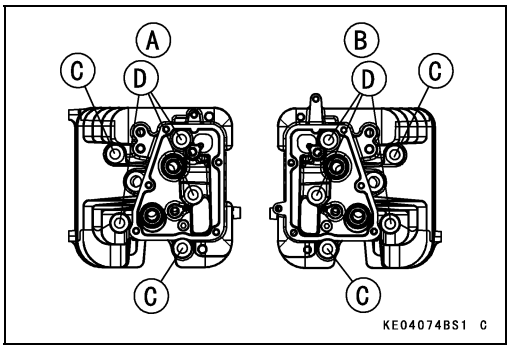
- Clean the mating surfaces of the cylinder heads and cylinders.
- Replace the gasket [A] with a new one.
- Install the dowel pins [B] and new gasket.

NOTE

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



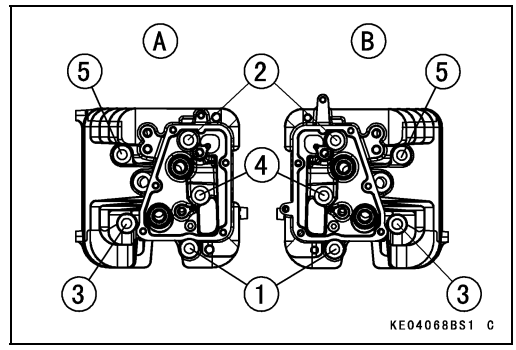
- Install:
  #1 Cylinder Head [A]
  #2 Cylinder Head [B]
  Cylinder Head Bolts (L = 50 mm) [C] and Washers
  Cylinder Head Bolts (L = 65 mm) [D] and Washers



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: 46 N·m (4.7 kgf·m, 34 ft·lb)



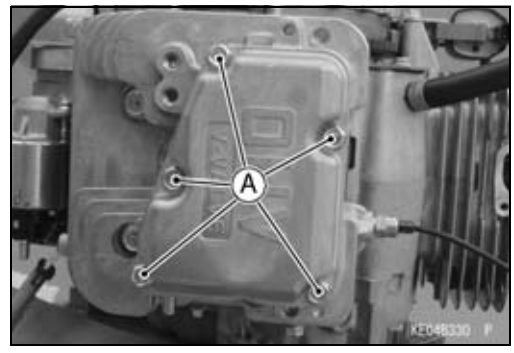
NOTICE

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 (see Valve Mechanism Removal/Installation)
  Push Rod (see Push Rod Installation)
  Rocker Arm (see Valve Mechanism Removal/Installation)
- Install the new gaskets and rocker covers.
- Tighten the rocker cover bolts [A].

Torque - Rocker Cover Bolts: 8.0 N·m (0.82 kgf·m, 71 in·lb)

- Install the removed parts.

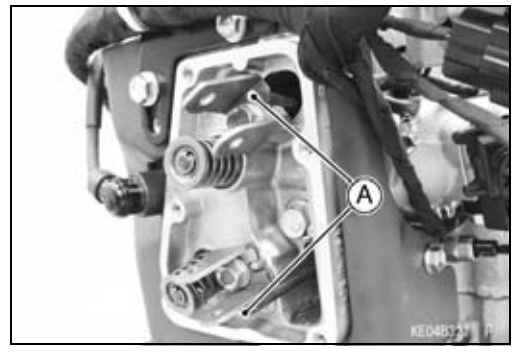


Push Rod Removal

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

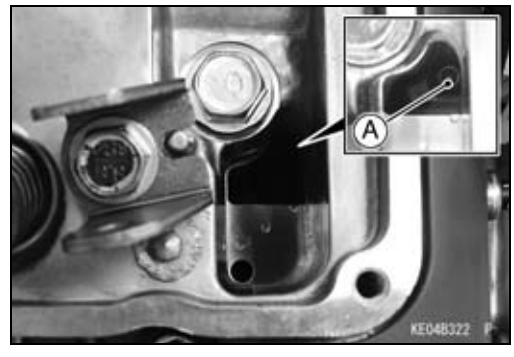
NOTE

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



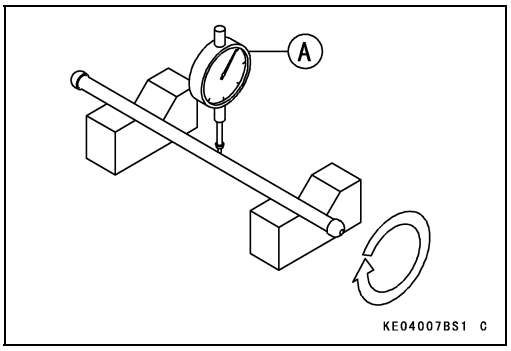
Push Rod Installation

- 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 arm (see Valve Mechanism Removal/Installation).
- Check and adjust the valve clearance (see Valve Clearance Inspection in the Periodic Maintenance chapter).



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.

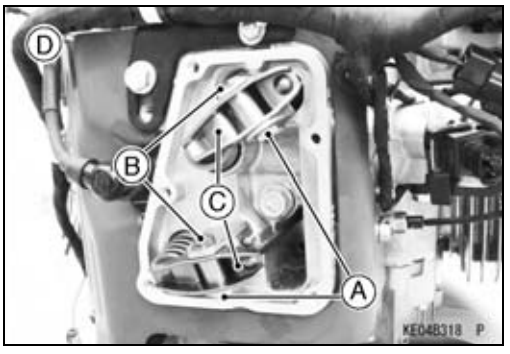
Rocker Arm Push Rod Runout
Service Limit: TIR 0.5 mm (0.02 in.)

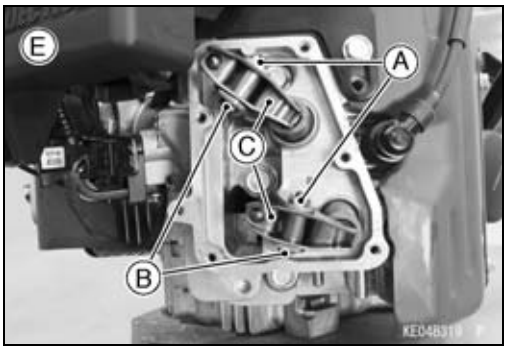
Valve Mechanism Removal/Installation

NOTE

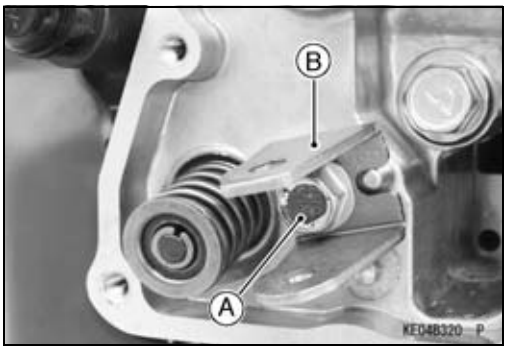
○*When removing the valve mechanism parts, note their position so that they may be reinstalled in their original position during assembly.*

- Set each piston at the top dead center (TDC) of #1 or #2 cylinder head to be removed.
- Remove:
  Rocker Covers
  Valve Clearance Adjusting Locknuts [A]
  Valve Clearance Adjusting Bolts [B] and Washer
  Rocker Shafts
  Rocker Arms [C]
  [D] #1 Cylinder Head
  [E] #2 Cylinder Head



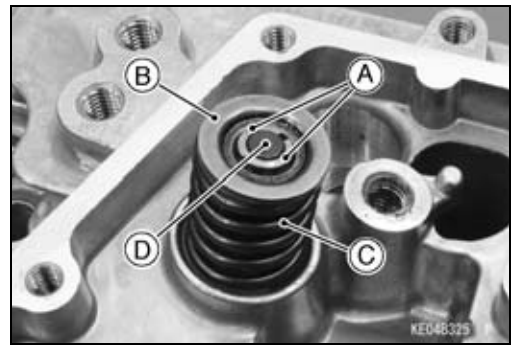


- Remove:
  Push Rods (see Push Rod Removal)
  Rocker Arm Bracket Bolts [A]
  Rocker Arm Brackets [B]



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] .

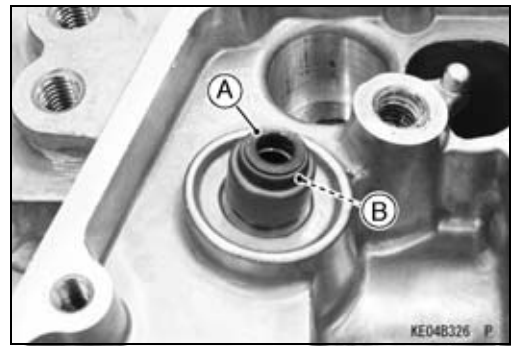


- Remove the stem seals [A].

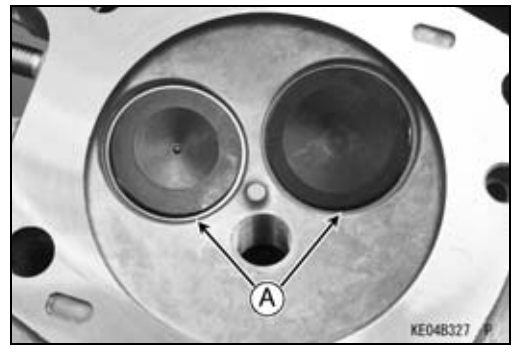
NOTE

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

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



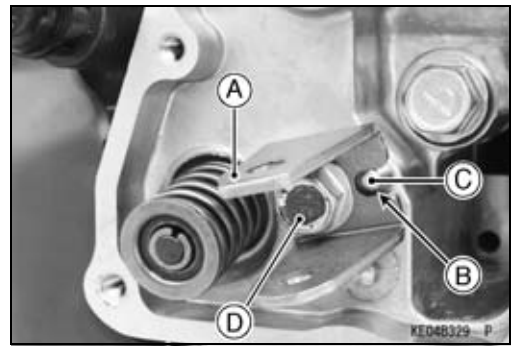
- Apply engine oil to the valve stem to avoid damaging the stem seal.
- Check to see that the valve moves smoothly up and down in the guide.
- Check to see that the valve seats properly in the valve seat [A]. If it does not, repair the valve seat (see Valve Seat Repair in the Periodic Maintenance chapter).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



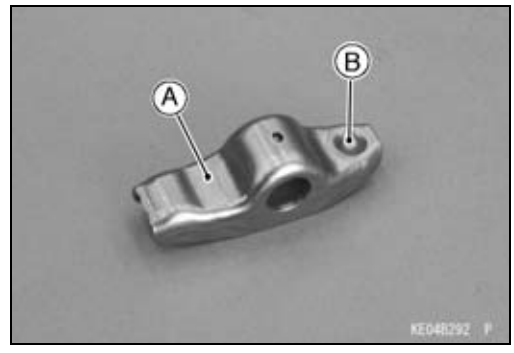
- Install the rocker arm bracket [A] so that bracket hollow [B] fit to the cylinder head projection [C].
- Apply a non-permanent locking agent to the rocker arm bracket bolt [D], and tighten it.

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

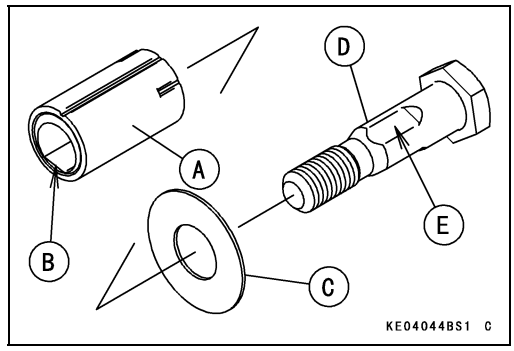
- Install the push rods (see Push Rod Installation).



- 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.

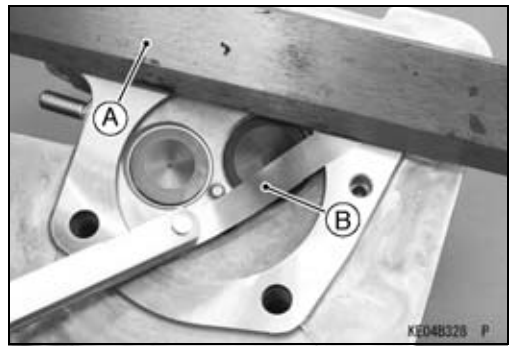
○Align the flatten surface of the rocker shaft with the flatten surface of the valve clearance adjusting bolt.

- 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.

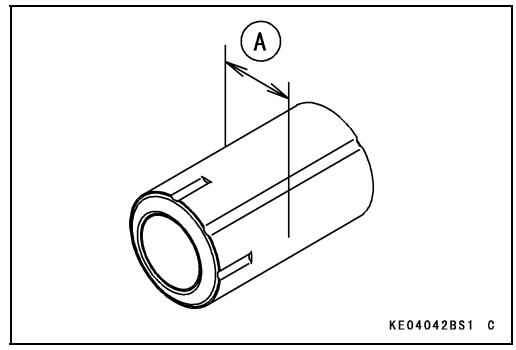
★If warp exceeds the service limit, repair the head by lapping the mating surface with emery paper secured to a surface plate (first No. 200, then No. 400). If the mating surface is badly damaged, replace the cylinder head.

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

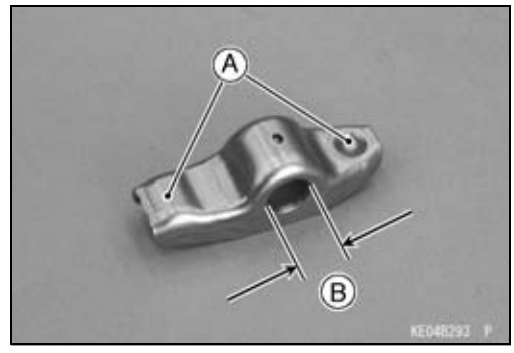


- Measure the diameter [A] of the rocker shaft with a micrometer at several points of bearing the rocker arm.

★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.

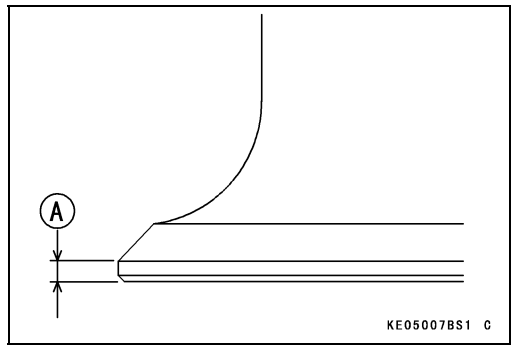
Valve Head Thickness

- 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.)**



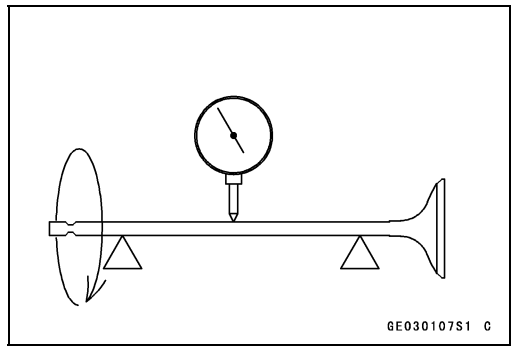
Valve Stem Runout

- 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.)**



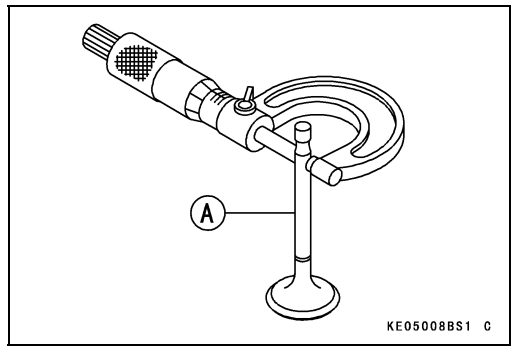
Valve Stem Diameter

- 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.)**



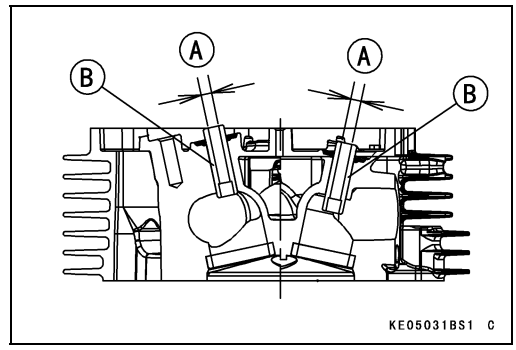
Valves

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.)

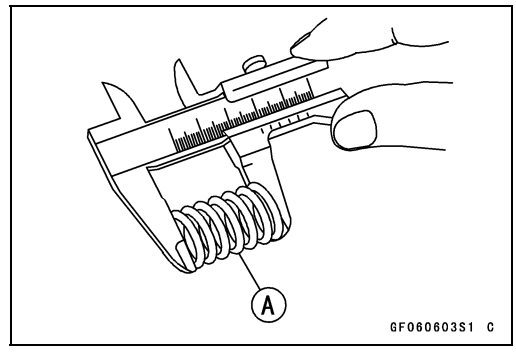


Valve Spring Inspection

- 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.)

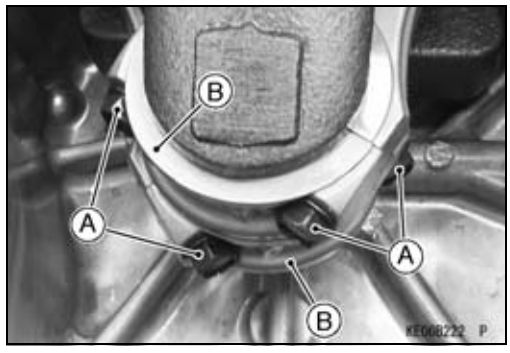


Cylinder, Piston

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.

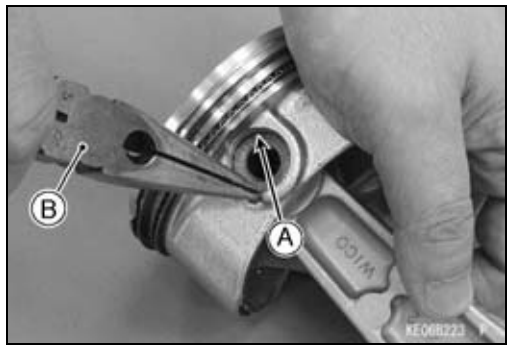


NOTE

○*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].

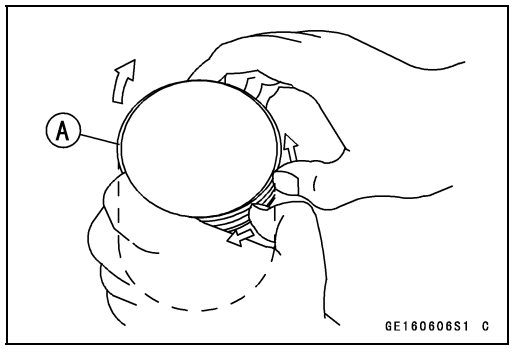


- Remove the piston by pushing the piston pin [A] to the direction from which the snap ring was removed.
- Remove the piston from the connecting rod.

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

Special Tool - Piston Ring Pliers: 57001-115

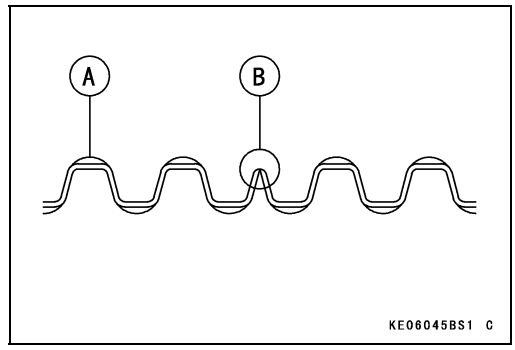
- If the special tool is not available, carefully spread the ring opening with your thumbs, then push up to the opposite side of the ring [A] to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.



Cylinder, Piston

Piston Installation

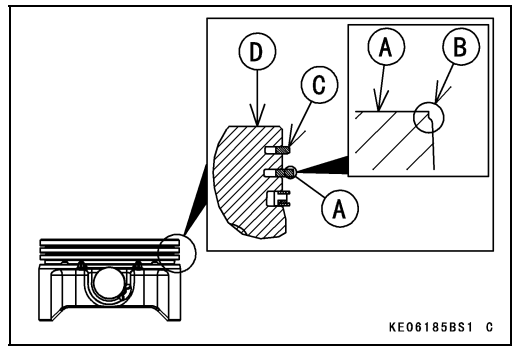
- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap them.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



- Install the second ring [A] so that the notched edge [B] faces upward.

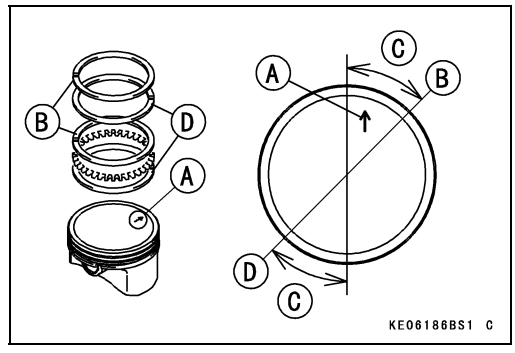
○Do not mix up the top and second rings.

- 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.

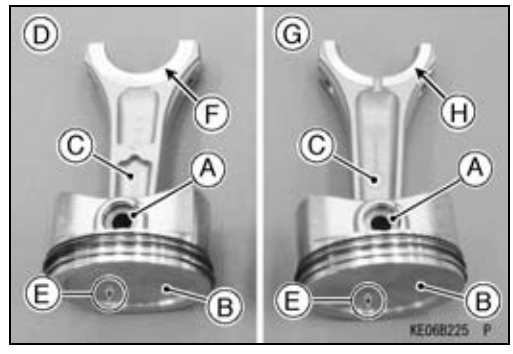
  Arrow Match Marks [A]
  Top Ring End Gap, Upper Steel Rail End Gap [B]
  45° [C]
  Second Ring End Gap, Lower Steel Rail End Gap [D]



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

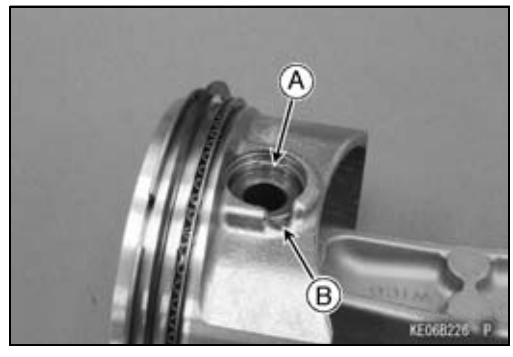
○For the No.1 cylinder [D], the piston with its arrow mark [E] is pointed downward, and the connecting rod with its **flat side** [F] of the big end bore is faced upward.

○For the No.2 cylinder [G], the piston with its arrow mark [E] is pointed downward, and the connecting rod with its **chamfer side** [H] of the big end bore is faced upward.



- 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.

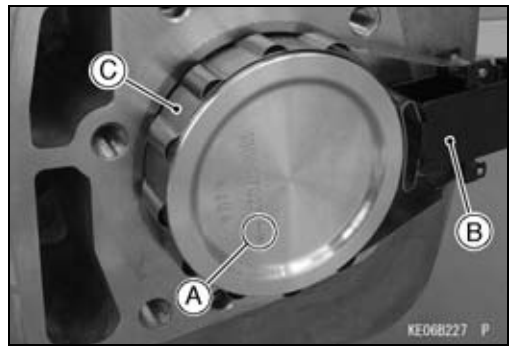


NOTICE
Do not reuse the snap rings, as removal weakens and deforms them. They could fall out and score the cylinder wall.

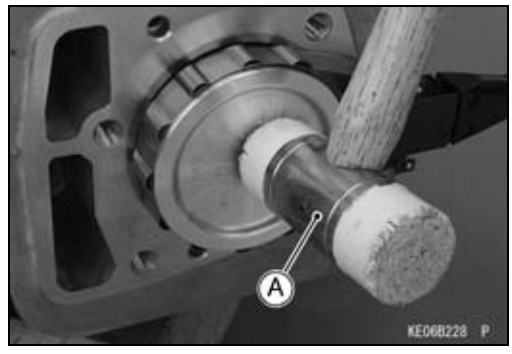
Cylinder, Piston

- 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.



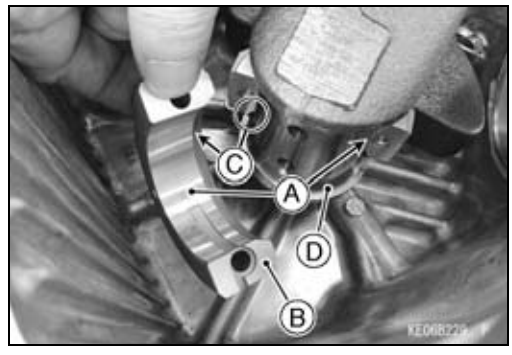
- Apply molybdenum disulfide oil solution oil to the sliding surfaces [A] of the connecting rod big end bore.

○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

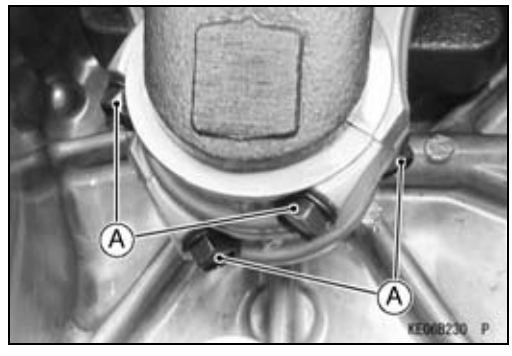
○*Make sure that the chamfers [C] are placed on the rounded area [D] of the crankpin ends.*



- 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.



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.

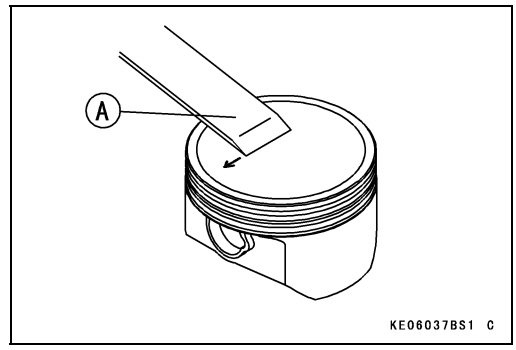
★If the damage is severe, replace the crankcase and pistons.

Cylinder, Piston

Piston Cleaning

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

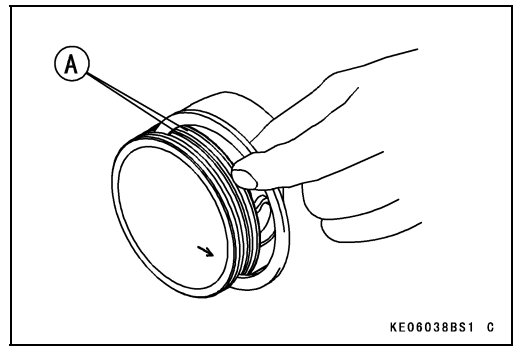
NOTICE
Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.



- 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

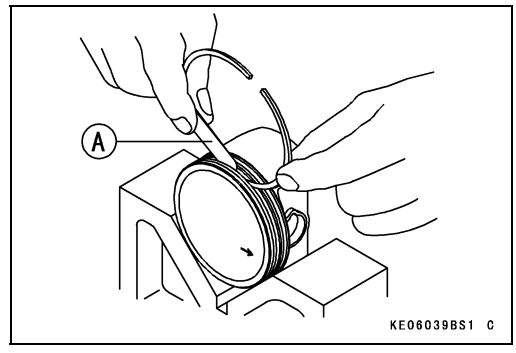
- Clean the piston (see Piston Cleaning).
- Visually inspect the piston rings and ring grooves.

★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:

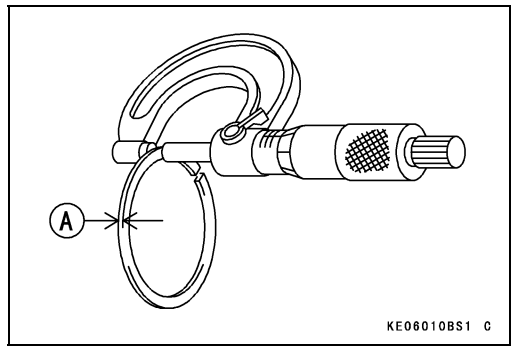
Top	**0.17 mm (0.0067 in.)**
Second	**0.18 mm (0.0071 in.)**

NOTE

○*The oil ring is a three piece assembled ring. It is difficult to measure the ring groove clearance and 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:

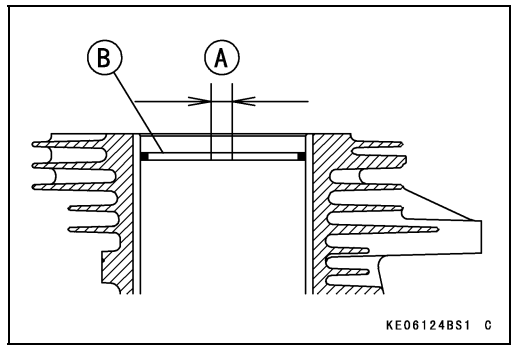
Top	**1.12 mm (0.0441 in.)**
Second	**1.12 mm (0.0441 in.)**

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.

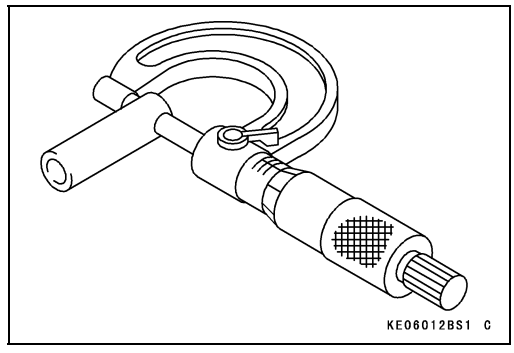


Piston Ring End Gap
Service Limit:

Top	**0.6 mm (0.02 in.)**
Second	**0.8 mm (0.03 in.)**
Oil	**0.9 mm (0.04 in.)**

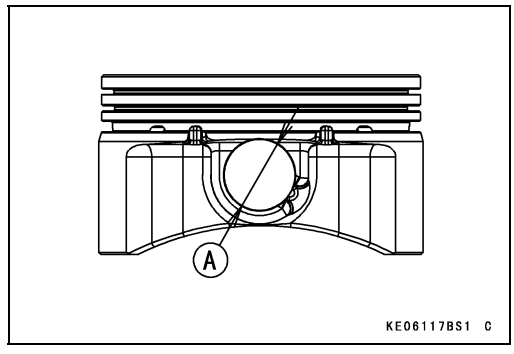
Piston Pin, Piston Pin Hole, and Connecting Rod Wear

● 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 sides. Use a dial bore gauge.
★If the inside diameter is greater than the service limit, replace the piston with a new one.

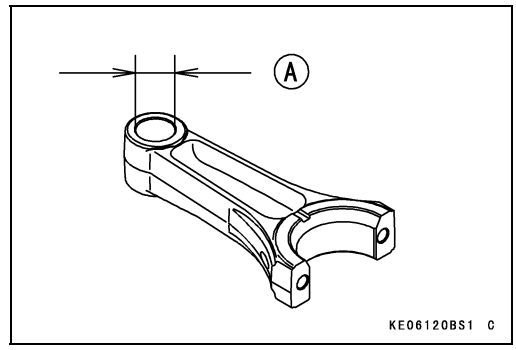


Piston Pin Hole Inside Diameter
Service Limit: 17.08 mm (0.6724 in.)

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.

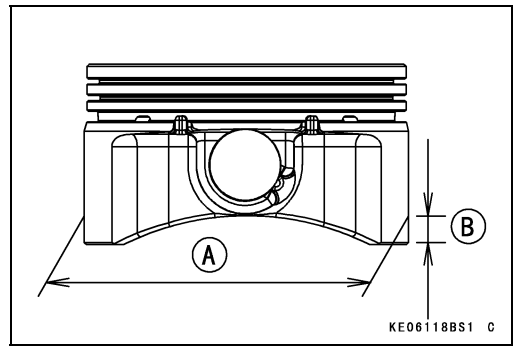
Connecting Rod Small End Inside Diameter
Service Limit: 17.06 mm (0.6716 in.)



Piston Diameter

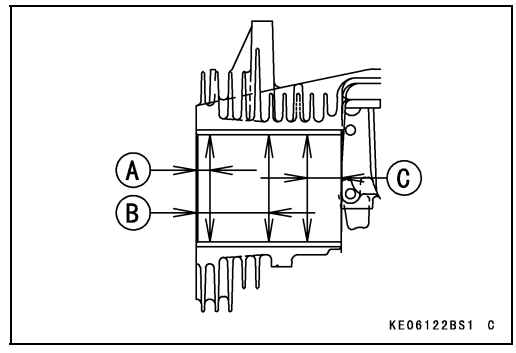
● Measure the outside diameter [A] of the piston 11 mm (0.43 in.) [B] up from the bottom of the piston at a right angle to the direction of the piston pin hole.
★If the measurement is less than the service limit, replace the piston with a new one.

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]
40 mm (1.6 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.)

Cylinder, Piston

Cylinder Boring and Honing

Always resize to exactly 0.50 mm (0.02 in.) over the standard bore size. If this is done accurately, the stock oversize rings and piston will fit perfectly and proper clearance will be maintained. Resizing the cylinder bore can be done by reliable repair shop or by using a drill press and honing tool. Use the stone recommended by the hone manufacturer to produce correct cylinder wall finish. Machine-bore first, the bore diameters should be shown in the table.

Final Boring Bore Diameter

Oversize	Final Boring Bore Diameter
0.50 mm (0.02 in.)	**78.46 ~ 78.48 mm (3.089 ~ 3.090 in.)**

Final Bore Diameter

Oversize	Final Bore Diameter
0.50 mm (0.02 in.)	**78.48 ~ 78.50 mm (3.090 ~ 3.091 in.)**

Change to a honing stone for finishing, the final bore diameter should be as shown in the table. Be sure the correct stone is used and the stone is not worn.

- Clean the cylinder at the top and bottom of the cylinder to remove burns and pieces of the base and head gasket.
- Anchor the cylinder (block) on the drill press table before honing.
- Align the center of the cylinder bore to the press center. Set the press to operate from 200 ~ 250 r/min (rpm).
- Connect the drive shaft to the hone and set the stop on the drill press so the hone can only extend 20 ~ 25 mm (0.8 ~ 1.0 in.) above the top or below the bottom of the cylinder liner.
- Rotate the adjusting nut (knob) on the hone until the stones contact snugly against the cylinder wall at the narrowest point. Do not force.
- Turn the stone by hand. If you cannot turn it, the stone is too tight. Loosen the hone until it can be turned by hand.
- Be sure that the cylinder and hone are centered and aligned with the drive shaft and drill spindle.
- Pour honing oil inside of the cylinder during the honing operation. Start the drill press. Move the hone up and down in the cylinder approximately 20 cycles-per-minute.
- Check the diameter of the cylinder bore regularly during honing, using an inside micrometer.

Lubrication System

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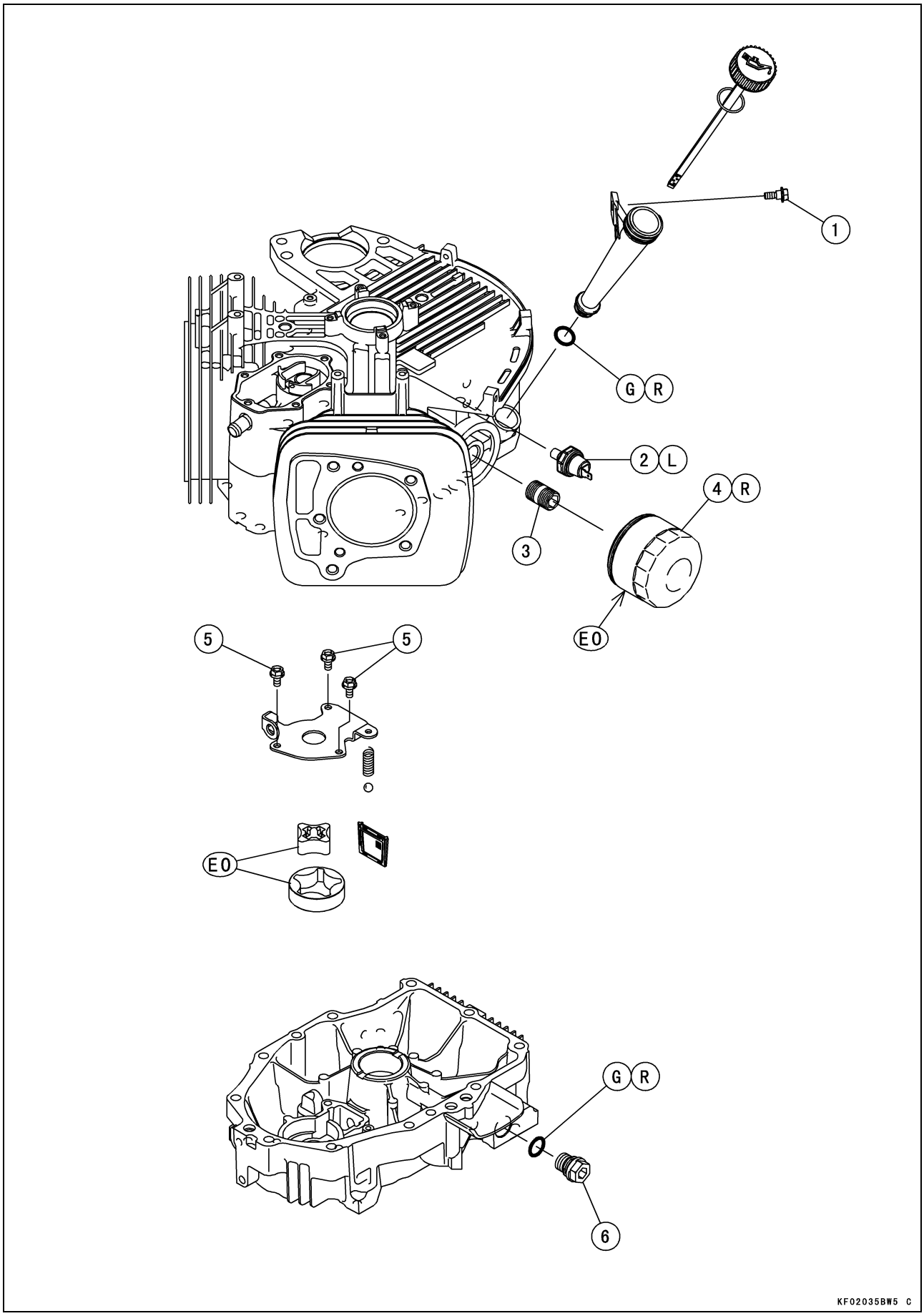
Exploded View

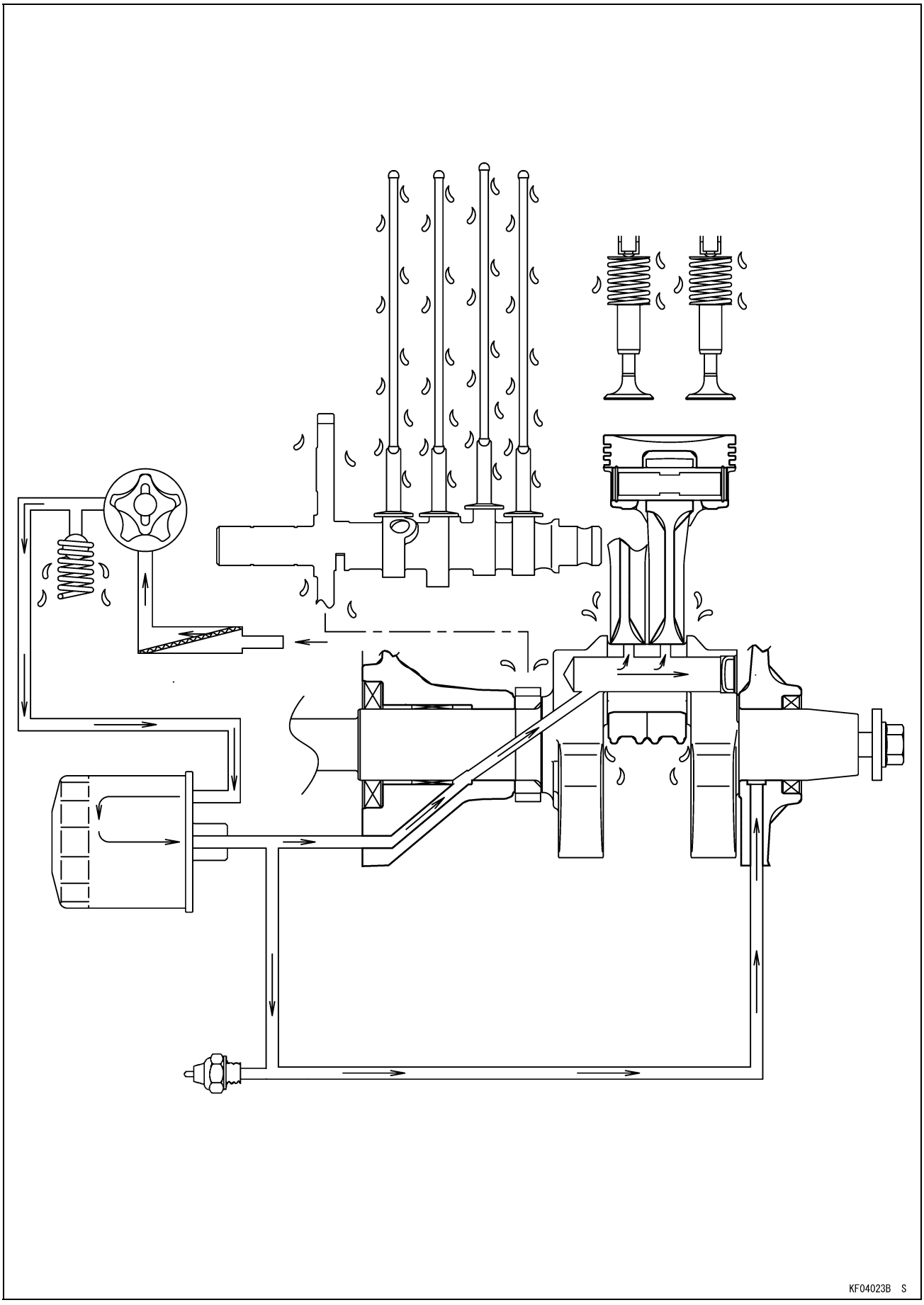


Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Oil Filler Mounting Bolt	5.9	0.60	52 in·lb	
2	Oil Pressure Switch	3.9	0.40	35 in·lb	L
3	Oil Filter Pipe	24	2.4	18	
4	Oil Filter	5.8	0.59	51 in·lb	R
5	Oil Pump Cover Plate Bolts	5.9	0.60	52 in·lb	
6	Engine Oil Drain Plug	6.9	0.70	61 in·lb	

EO: Apply engine oil.
G: Apply grease.
L: Apply a non-permanent locking agent (LOCKTITE: VIBRASEAL 516 or equivalent).
R: Replacement Parts

Engine Oil Flow Chart



KF04023B S

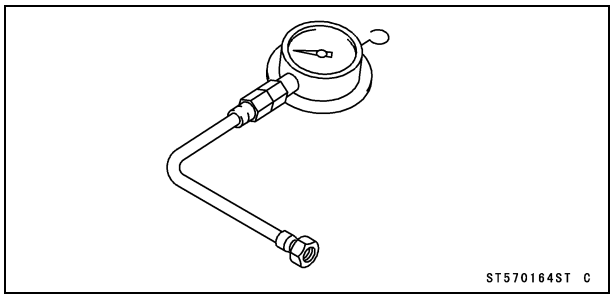
Specifications

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)
Oil Pressure Switch	
Detect Pressure	68.6 ~ 127.4 kPa (0.7 ~ 1.3 kgf/cm², 9.9 ~ 18.5 psi)
Screw	PT 1/8 tapered thread

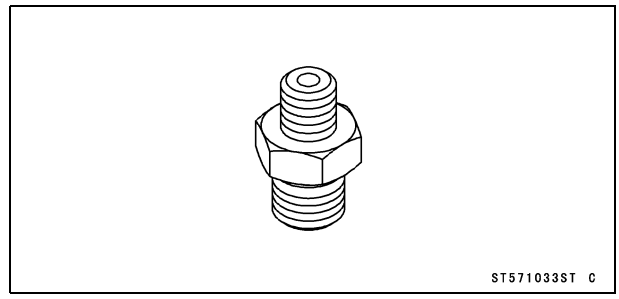
Item	Service Limit
Oil Pump:	
Inner and Outer Rotor Clearance	0.2 mm (0.008 in.)
Outer Rotor Outside Diameter	52.31 mm (2.059 in.)
Outer Rotor Thickness	14.96 mm (0.5890 in.)
Pump Housing Inside Diameter	52.61 mm (2.071 in.)
Pump Housing Depth	15.17 mm (0.5971 in.)
Relief Valve Spring Free Length	20.4 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

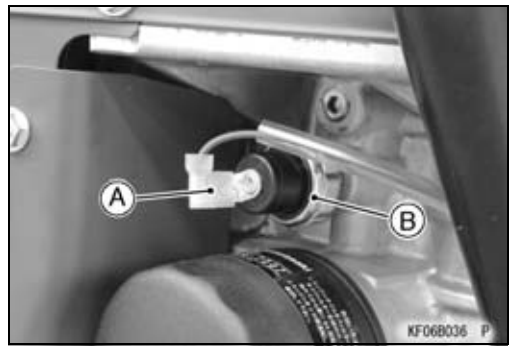
- Refer to the Oil Filter Replacement in the Periodic Maintenance chapter.

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).

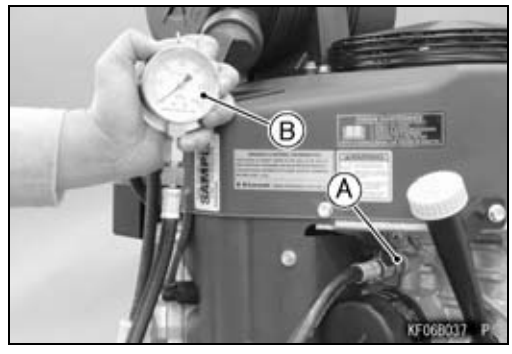
Oil Pressure Measurement

- Disconnect the lead [A] and remove the oil pressure switch [B] from the crankcase.



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

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



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

Oil Pressure
294 ~ 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

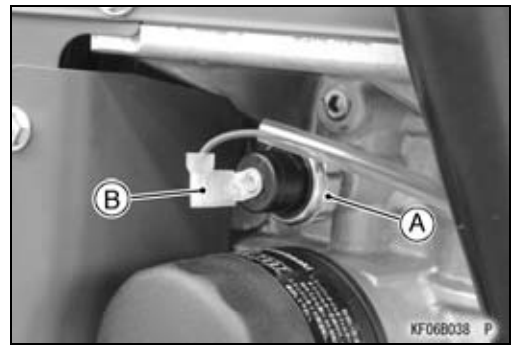
Hot oil can cause severe burns. Beware of hot engine oil that will drain through the oil passage when the gauge adapter is removed.

Pressurized Lubrication System

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

  Torque - Oil Pressure Switch: 3.9 N·m (0.40 kgf·m, 35 in·lb)

- Connect the lead [B] to the oil pressure switch.



Oil Pressure Switch Inspection

When the oil pressure falls below 14 ~ 42 kPa (0.14 ~ 0.43 kgf/cm², 2 ~ 6 psi), the oil pressure switch activates the oil warning lamp to alert the operator or lubricating problem.

Oil Pressure Switch	
Detect Pressure	**68.6 ~ 127.4 kPa (0.7 ~ 1.3 kgf/cm², 9.9 ~ 18.5 psi)**
Screw	**PT 1/8 (Tapered Threads)**

- To check the oil warning system, insert the switch key into the "OFF" position of the engine switch, then turn it to the "RUN" position. The warning light must be illuminated.
- Whenever start the engine, make sure the warning light is not on in started engine.

★If the warning light comes on, stop the engine immediately and check the oil level.

- When starting the engine, note the warning light on dash carefully.

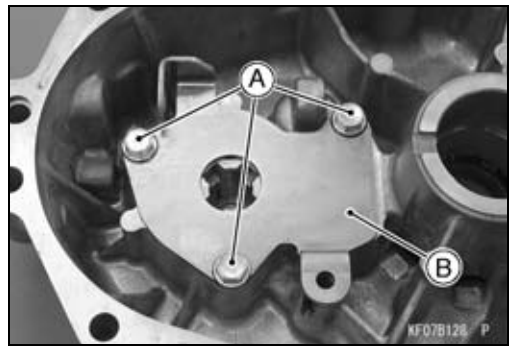
★If the warning light is on in the started engine in spite of adequate oil level, check the lead from the pressure switch to the warning light for short circuit and/or check the pressure switch and replace damaged part.

★If the light is not on at the moment of the engine switch operation, check all leads of the warning light circuit or bulb and replace damaged parts with new ones.

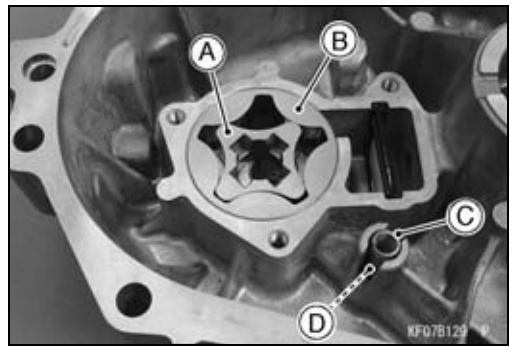
Oil Pump, Relief Valve

Oil Pump, Relief Valve Removal

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



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



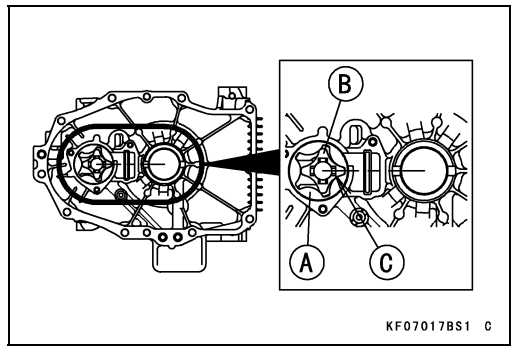
Oil Pump, Relief Valve Installation

- 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: 5.9 N·m (0.60 kgf·m, 52 in·lb)



Oil Pump, Relief Valve Inspection

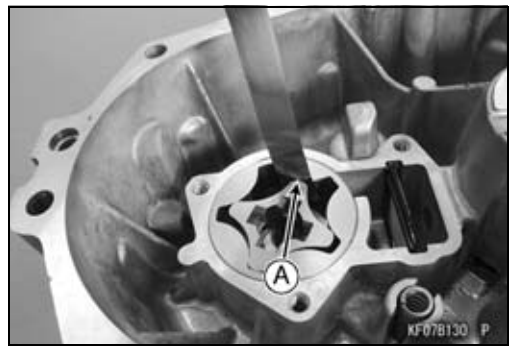
- Remove the oil pump cover plate (see Oil Pump, Relief Valve Removal).
- Visually inspect the pump gear, outer rotor and inner rotor, and oil pump cover plate.

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

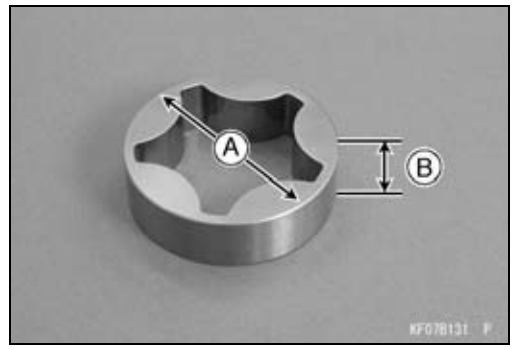
○Check the clearance [A] between the inner rotor and outer rotor with a feeler gauge. Measure the clearance between the high point of the inner rotor and the high point of the outer rotor.

★If the measurement exceed the service limit, replace the rotors as a set 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.

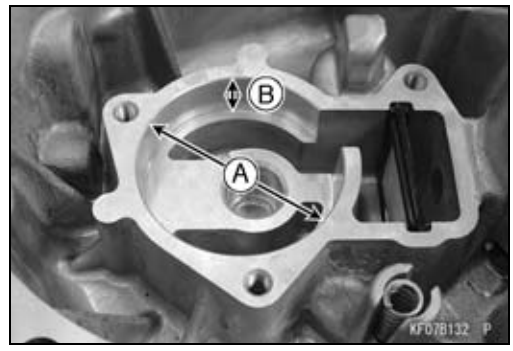
★If the outer rotor diameter is less than the service limit, replace both the inner rotor and outer rotor with new ones.

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 outer rotor thickness is less than the service limit, replace both the inner rotor 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: 52.61 mm (2.071 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.

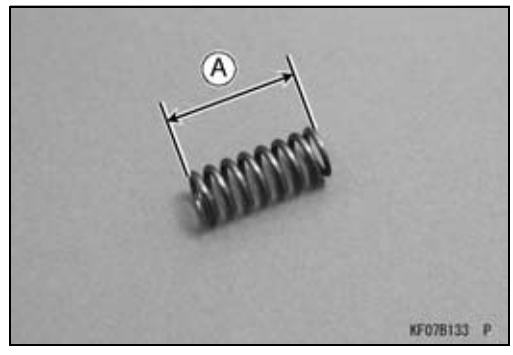
Pump Housing Depth
Service Limit: 15.17 mm (0.5971 in.)

- 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 relief valve ball in position and lightly tap the relief valve ball with a suitable tool to form a perfect seat.

- Measure the free length [A] of the relief valve spring with a vernier caliper.

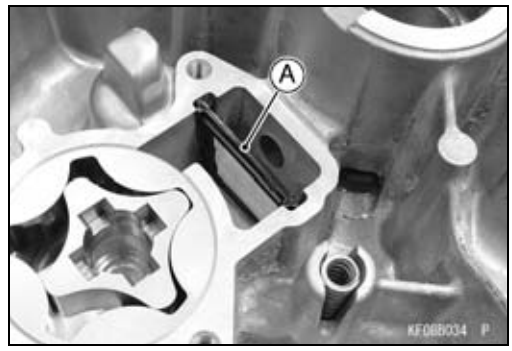
★If the free length of the relief valve spring is less than the service limit, replace the relief valve spring with a new one.

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

Oil Screen

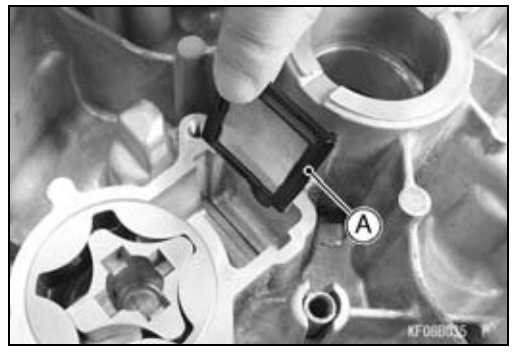
Oil Screen Removal

- 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 (see Cleaning and Inspection).
- Insert the oil screen [A] in position.
- Install the oil pump cover plate (see Oil Pump, Relief Valve Installation).

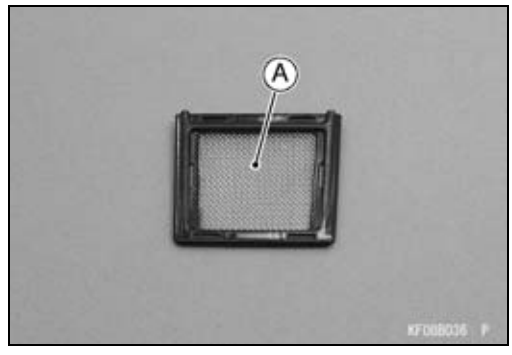


Cleaning and Inspection

- Clean the oil screen [A] with high flash-point solvent and remove any particles stuck to 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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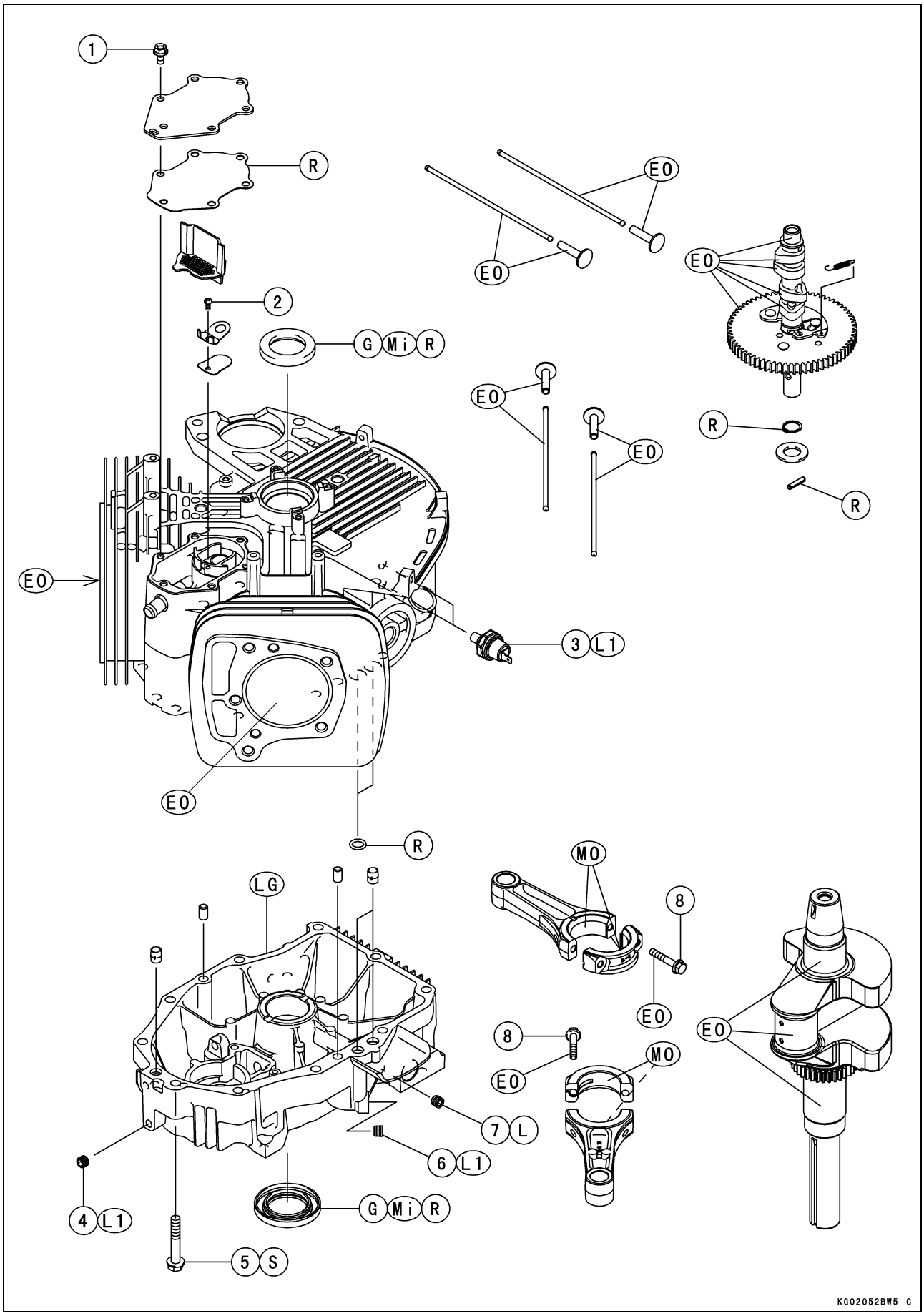
7-2 CAMSHAFT/CRANKSHAFT

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Breather Chamber Cover Bolts	5.9	0.60	52 in·lb	
2	Breather Valve Mounting Screw	2.0	0.20	18 in·lb	
3	Oil Pressure Switch	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	27.4	2.79	20.2	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 (LOCKTITE: 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.

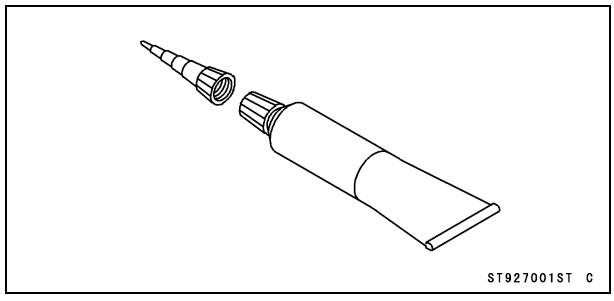
7-4 CAMSHAFT/CRANKSHAFT

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 (0.635 in.)
Crankcase Cover	16.14 mm (0.635 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	22.2 mm (0.874 in.)
Crankpin Width	44.7 mm (1.760 in.)
Connecting Rod Big End Inside Diameter	40.04 mm (1.576 in.)
Crankpin Outside Diameter	39.97 mm (1.574 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 (1.576 in.)
Crankshaft Journal Bearing Inside Diameter:	
Crankcase Cover	40.065 mm (1.577 in.)

Sealant

Liquid Gasket, TB1217H:
92104-7001

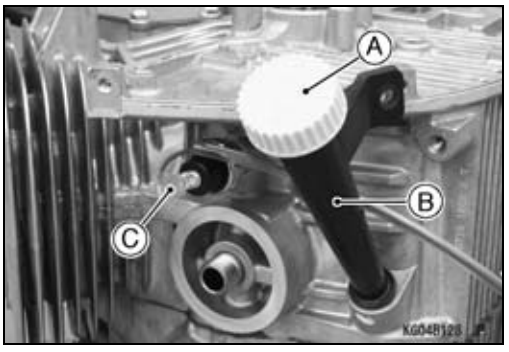


Crankcase

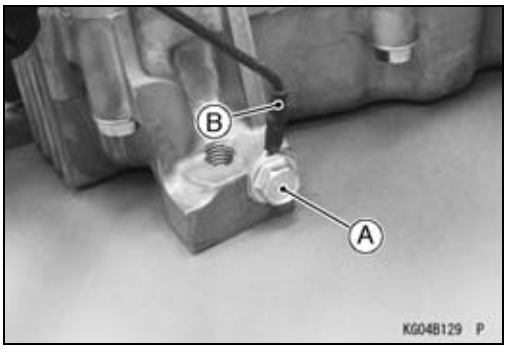
Crankcase Cover Removal

- 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 (EFI) 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)

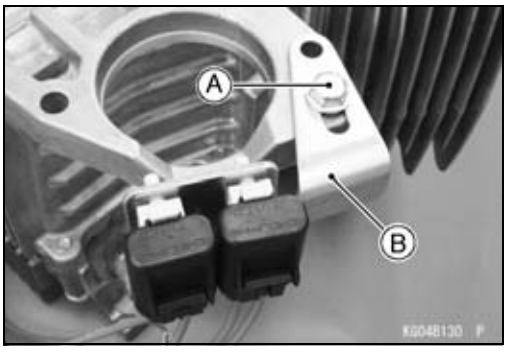
- Remove the dipstick [A] and oil filler tube [B].
- Disconnect the oil pressure switch connector [C].



- Remove the ground terminal bolt [A] to disconnect the ground terminal [B].



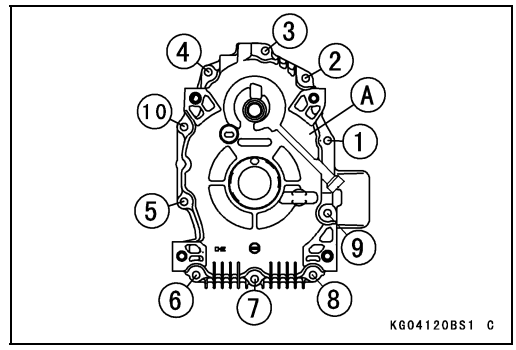
- Remove:
  Fuse Box Bracket Mounting Bolt [A]
  Fuse Box Bracket [B]



Crankcase

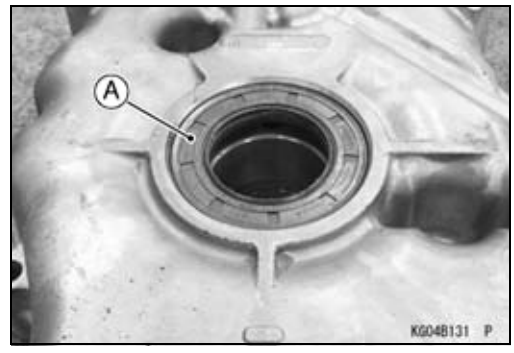
- Turn the engine so that the crankcase cover [A] is facing up.
- Remove the mounting bolts in the order shown [1 ~ 10].
- Tap the crankcase cover gently with a wooden or plastic mallet to remove the crankcase cover from the crankcase.

○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 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.

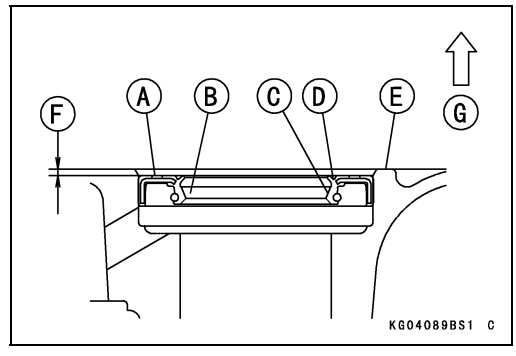
○Apply mineral oil to the crankshaft oil seal outside.

○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 dust lip [C] and seal lip [D].

○Press in the new oil seal using a press or suitable tools until 1 ~ 2.5 mm (0.04 ~ 0.10 in.) [F] lower than the flange surface [E]. Do not damage the seal lip.

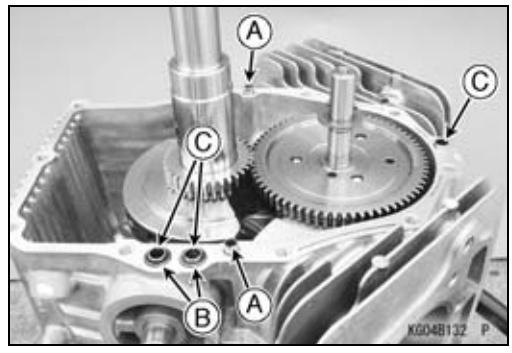
PTO Side [G]



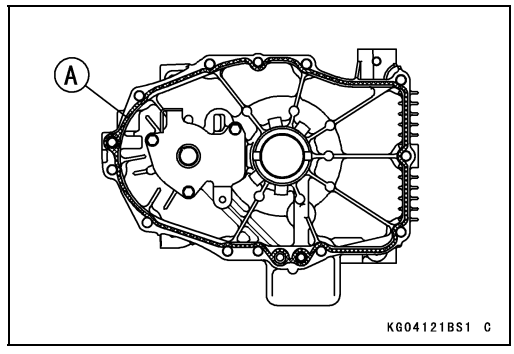
- Install the crankcase cover (see Crankcase Cover Installation).

Crankcase

Crankcase Cover Installation



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



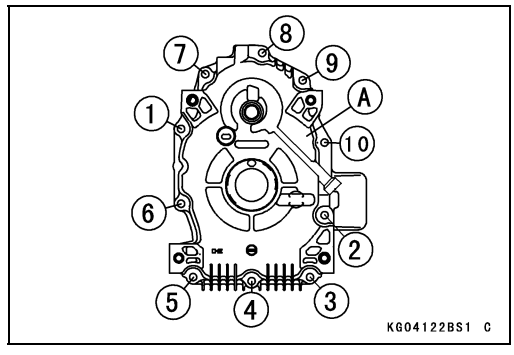
- Align the inner rotor groove to the center of the crankcase cover (see Oil Pump, Relief Valve Installation in the Lubrication System chapter).
- Apply liquid gasket [A] to the mating surface of the crankcase cover.

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.*



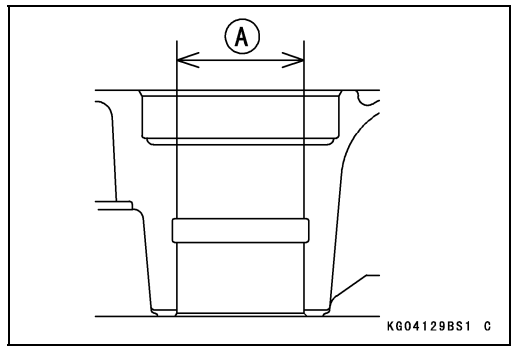
- Install the crankcase cover [A] and tighten the crankcase cover bolts following the tightening sequence as shown.

Torque - Crankcase Cover Bolts: 27.4 N·m (2.79 kgf·m, 20.2 ft·lb)

○To prevent the crankcase cover from distortion, tighten the bolts gradually following the tightening sequence [1 ~ 10] as shown.

- Install the removed parts.

Crankcase Cover Inspection



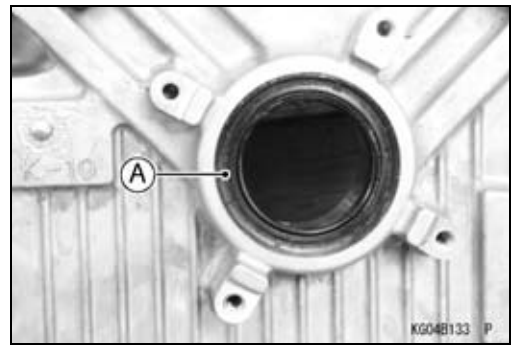
- Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase cover at several points. Replace the crankcase cover if the inside diameter is more than the service limit.

Crankshaft Journal Bearing Inside Diameter
Service Limit: 40.065 mm (1.577 in.)

Crankcase

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.



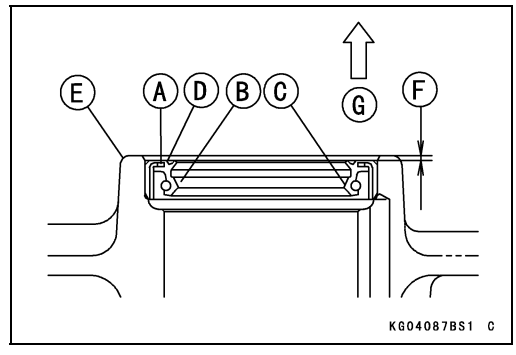
Crankcase Assembly

- 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.

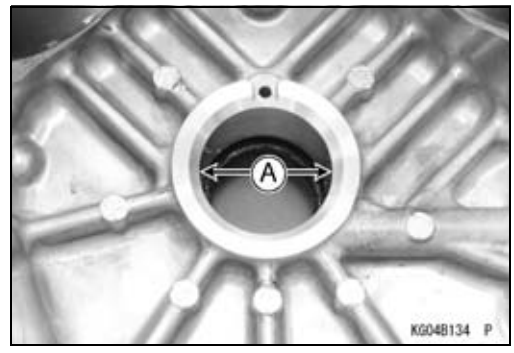
- Be sure to replace any oil seal with a new one if removed.
  ○Apply mineral oil to the crankshaft oil seal outside.
  ○Install the oil seal so that the marks [A] face out.
  ○Thoroughly pack high-temperature grease to 60% volume into the space [B] between the dust lip [C] and seal lip [D]. Press in the new oil seal using a press or suitable tools until it is flush with flange surface [E] or maximum 1 mm (0.04 in.) [F] lower than the flange surface. Do not damage the seal lip.
  Flywheel Side [G]
- Install the removed parts.



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 (1.576 in.)



Crankcase

Crankcase and Crankcase Cover Cleaning

- Remove:
  Oil Pump and Relief Valve (see Oil Pump, Relief Valve Removal in the Lubrication System chapter)
  Camshaft and Tappets (see Camshaft, Tappet Removal)
  Crankshaft (see Crankshaft Removal)
  Breather Valve and Cover (see Breather Valve Removal)
- Clean up the crankcase and cover with a high flash-point solvent, and blow out any foreign particles that may be in the pockets inside of the crankcase with compressed air.

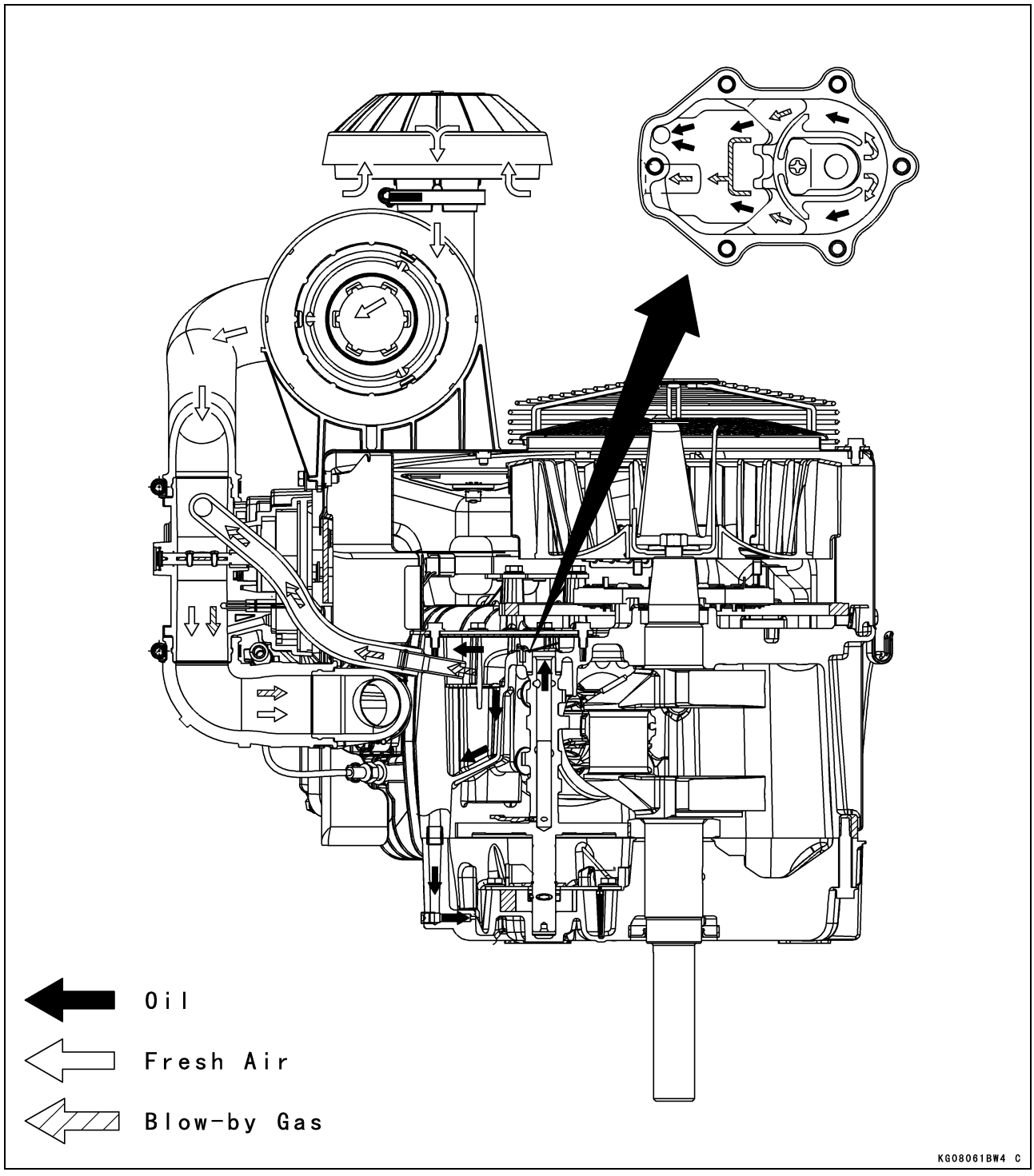
⚠ WARNING

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.

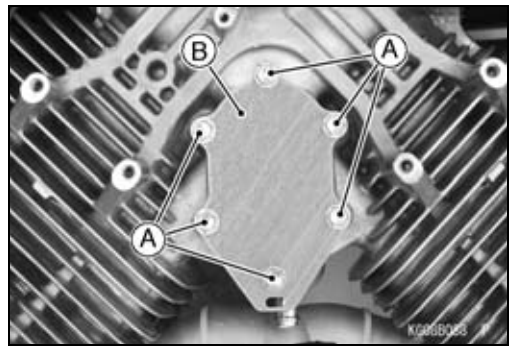
Oil is primarily separated from the gases while passing through the inside of the rocker chamber from the crankcase, and secondly separated from the gases in the breather chamber, and then returned back to the crankcase cover.



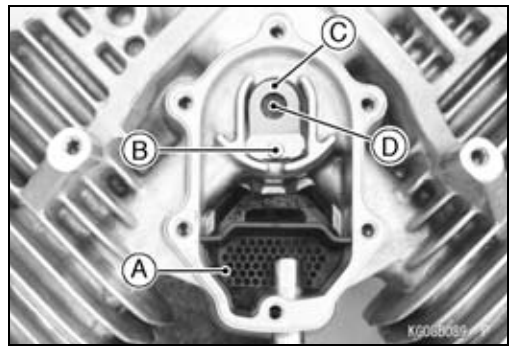
Breather

Breather Valve Removal

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



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

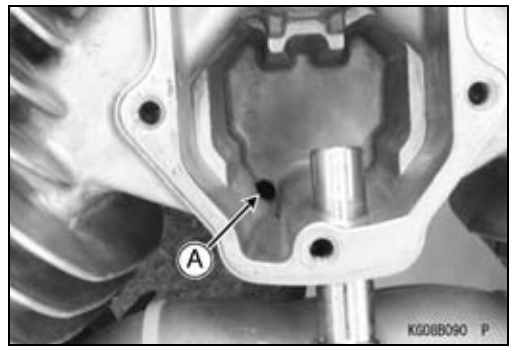


Breather Valve Installation

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

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

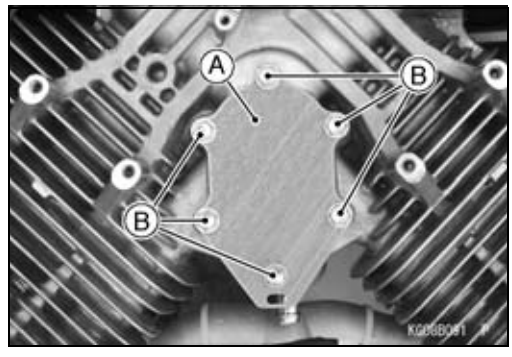
- Be sure the drain hole [A] on the breather chamber does not accumulate with slugs.



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

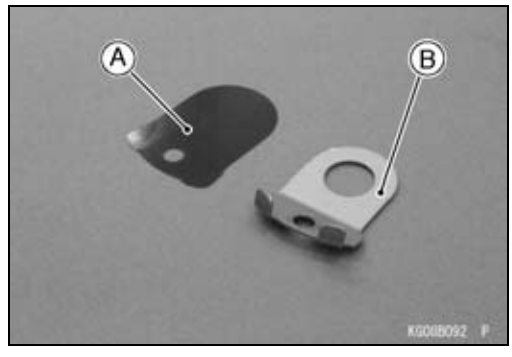
Torque - Breather Chamber Cover Bolts [B]: 5.9 N·m (0.60 kgf·m, 52 in·lb)

- Install the removed parts.



Breather Valve Inspection

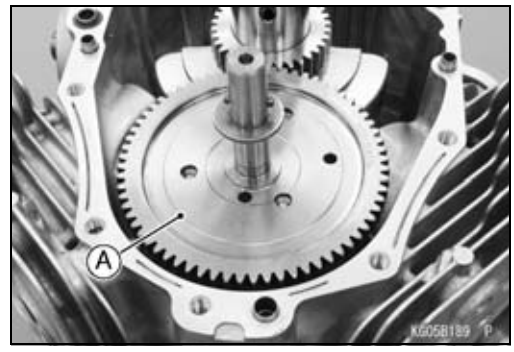
- Inspect the reed valve [A] for breakage, crack or distortion, replace it with a new one if necessary.
- Inspect the back plate [B] for damage or rough contact surface, replace it with a new one if necessary.
- Inspect the valve seating surface. The surface should be no nicks or burrs.



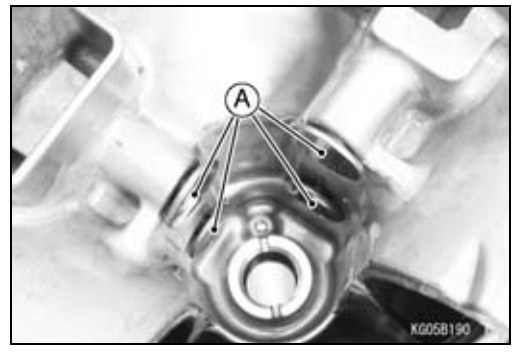
Camshaft, Tappet

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.



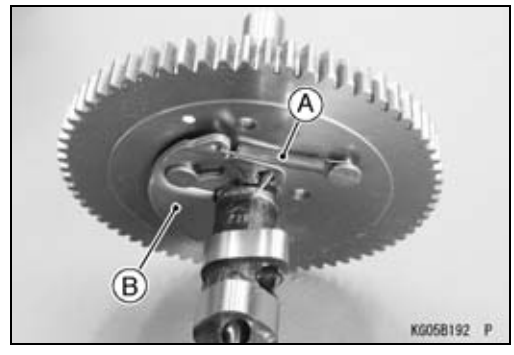
Camshaft, Tappet Installation

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

Camshaft Disassembly

- Remove:
  Spring [A]

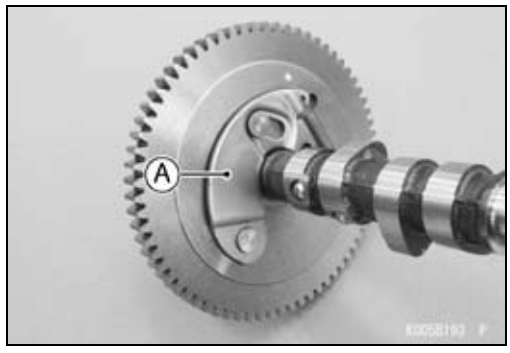
○Do not remove the ACR (automatic compression release) weight [B].



Camshaft, Tappet

Camshaft Assembly

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



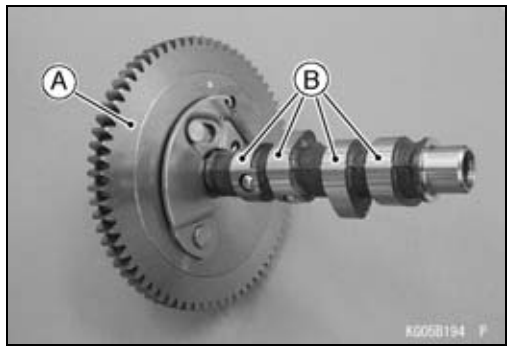
Camshaft Inspection

- 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.



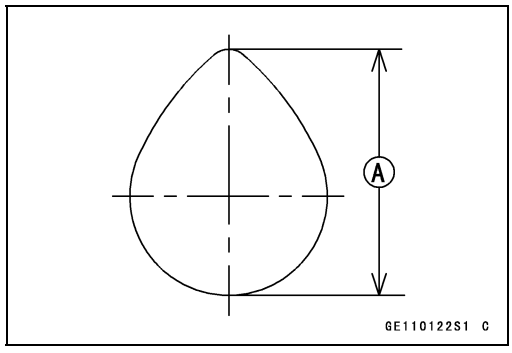
Camshaft Bearing/Journal Wear

- 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 Limit:

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

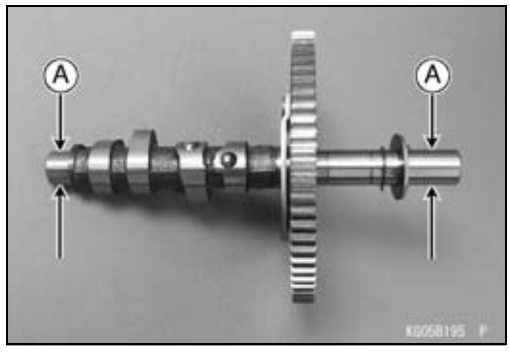


- Measure both camshaft journal diameter [A] at several points around the journal circumference.

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

Camshaft Journal Diameter
Service Limit:

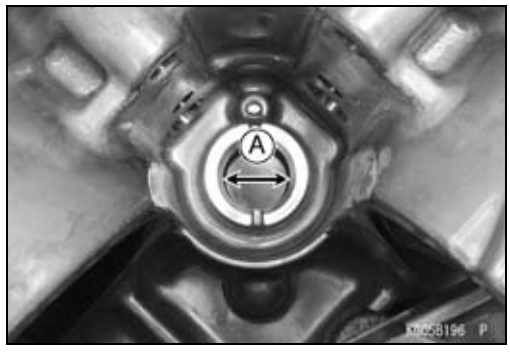
PTO Side	**15.99 mm (0.630 in.)**
Flywheel Side	**15.99 mm (0.630 in.)**



- 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 (0.635 in.)



Camshaft, Tappet

- 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 (0.635 in.)

Crankshaft, Connecting Rod

Connecting Rod Removal

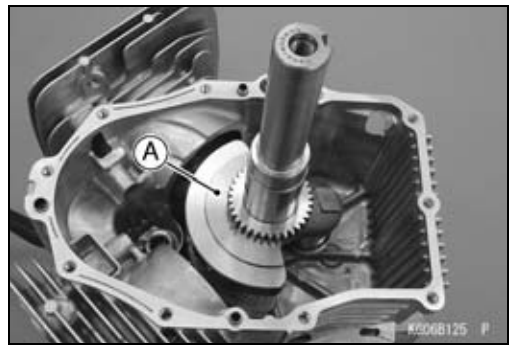
- Remove the pistons (see Piston Removal in the Engine Top End chapter).

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.

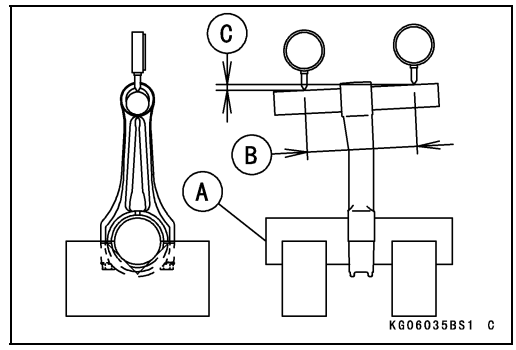
★Replace the crankshaft with a new one if necessary.

- 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.

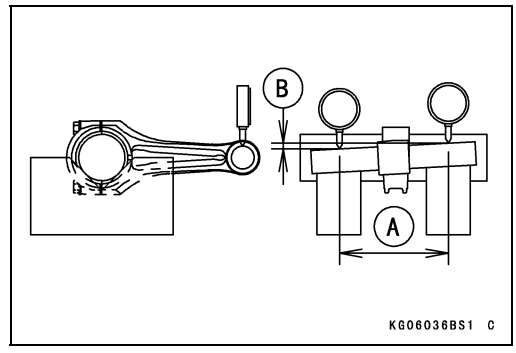
○Select an arbor of the same diameter as the piston pin and at least 100 mm (3.94 in.) [B] long, and insert the arbor through the connecting rod small end.

○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.)



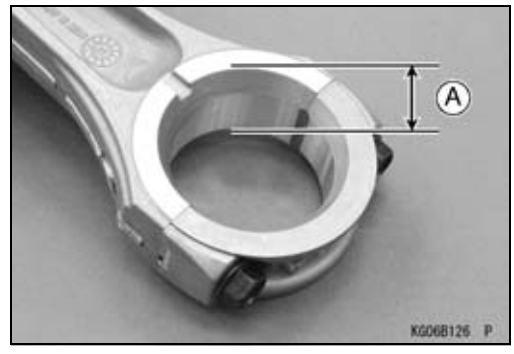
● Measure the connecting rod twist.

○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.

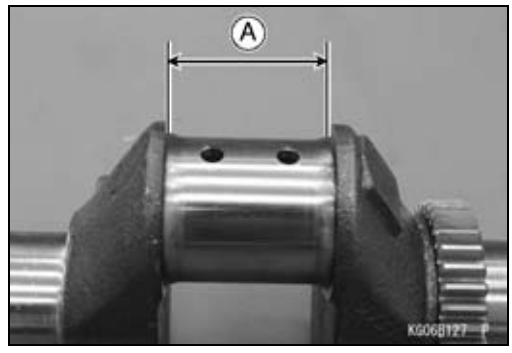
★If the measurement is less than the service limit, replace the connecting rod with a new one.

Connecting Rod Big End Width
Service Limit: 22.2 mm (0.874 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 (1.760 in.)



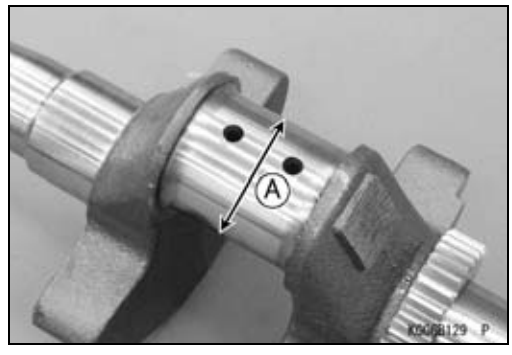
Connecting Rod Big End Bearing/Crankpin Wear Inspection

● 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.

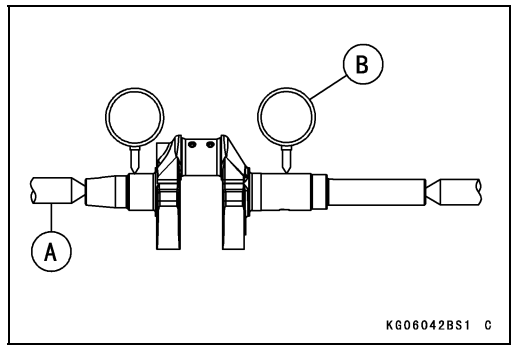
Crankpin Outside Diameter
Service Limit: 39.97 mm (1.574 in.)



Crankshaft Runout Inspection

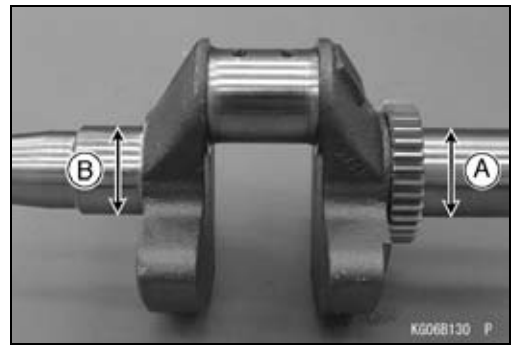
● Measure the crankshaft runout.
○Set the crankshaft in a flywheel alignment jig [A] or on V blocks gauge.
○Set a dial gauge [B] against both bearing journals.
○Turn the crankshaft slowly to measure the runout. The difference between the highest and lowest dial gauge readings (TIR) is the amount of runout.
★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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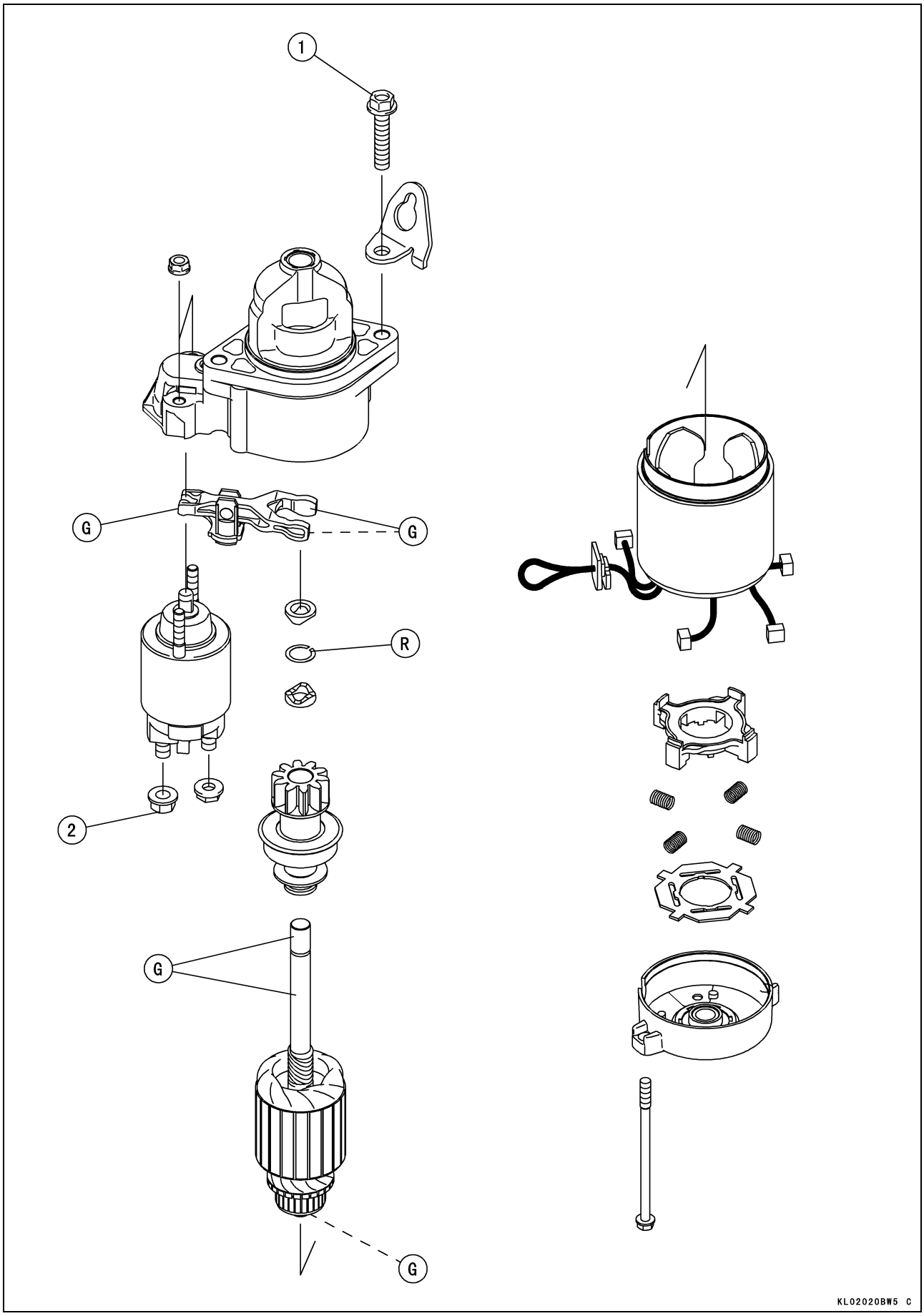
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Starter Motor Mounting Bolts	19.6	2.00	14.5	
2	Starter Motor Terminal Locknut	8.8	0.90	78 in·lb	

G: Apply grease.
R: Replacement Parts

8-4 STARTER SYSTEM

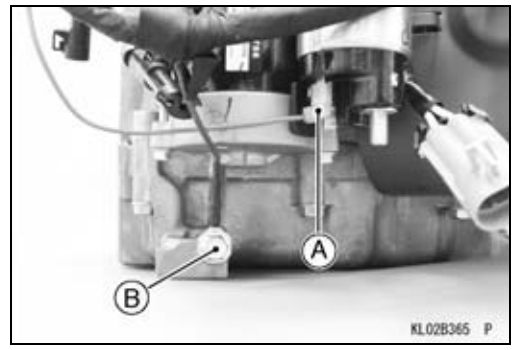
Specifications

Item	Standard	Service Limit
Electric Starter System		
Starter Motor:		
Carbon Brush Length	10.0 mm (0.39 in.)	6.0 mm (0.24 in.)
Commutator Groove Depth	0.6 mm (0.02 in.)	0.2 mm (0.008 in.)
Commutator Diameter	28.0 mm (1.10 in.)	27.0 mm (1.06 in.)
Commutator Runout	– – –	0.4 mm (0.016 in.)

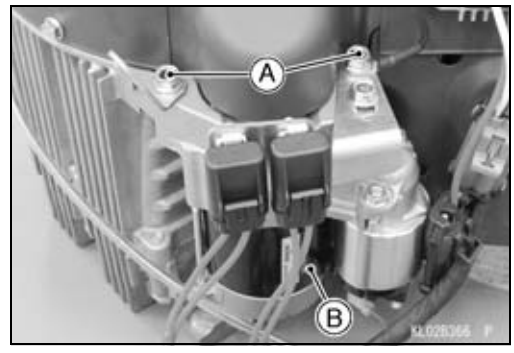
Electric Starter System

Starter Motor Removal

- Disconnect:
  Starter Switch Lead [A]
- Remove:
  Ground Terminal Bolt [B]



- Remove the mounting bolts [A] and pull the starter motor [B] down to remove the starter motor.

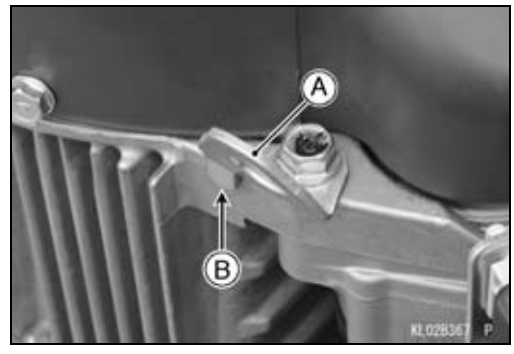


Starter Motor Installation

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

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

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



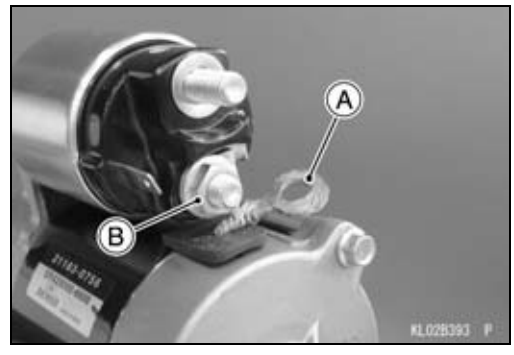
- Connect:
  Ground Terminal
  Starter Switch Lead

Starter Solenoid Inspection

NOTE

○*Be sure the battery is fully charged.*

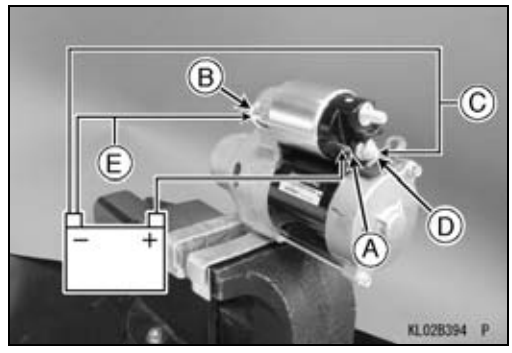
- Remove the starter motor (see Starter Motor Removal).
- Disconnect the starter motor lead [A].
- Tighten the nut [B].
- Hold the starter motor in a vise.



NOTICE
Be careful not to deform the starter motor body when holding it in a vise.

Electric Starter System

Check 1



- Connect a 12 V battery to the starter motor solenoid as shown.

○Connect the battery:
(+) Terminal to Solenoid Terminal [A]
(–) Terminal to Solenoid Body [B]

- Connect the switching lead [C] to the battery negative (-) terminal and the lower stud terminal [D].

○Do not connect the switching lead more than 5 seconds.

Testing Solenoid
Criterion: When Switching lead is connected→Pinion gear must move outward.

★If the solenoid does not work, the solenoid is defective. Replace the solenoid.

- Disconnect the switching lead from the lower stud terminal.

Testing Solenoid
Criterion: When Switching lead is disconnected→Pinion gear should stay outward position.

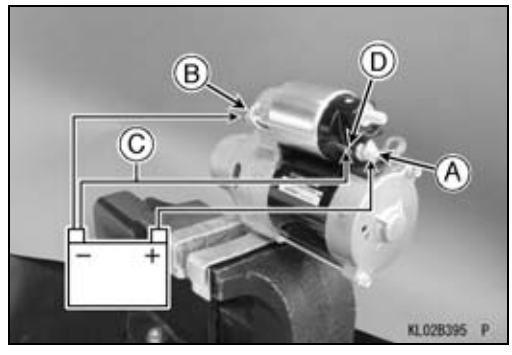
★If the solenoid does not work, the solenoid is defective. Replace the solenoid.

- Disconnect the battery negative (–) cable [E] from the solenoid body.

Testing Solenoid
Criterion: When battery negative (–) cable is disconnected→Pinion gear must return quickly.

★If the solenoid does not work, the solenoid is defective. Replace the solenoid.

Check 2



- Connect a 12 V battery to the starter motor solenoid as shown.

○Connect the battery:
(+) Terminal to Lower Stud Terminal [A]
(−) Terminal to Solenoid Body [B]

- Connect the switching lead [C] to the battery negative (-) terminal and the solenoid terminal [D].

○Do not connect the switching lead more than 5 seconds.

Testing Solenoid
Criterion: When Switching lead is connected→Pinion gear must move outward.

★If the solenoid does not work, the solenoid is defective. Replace the solenoid.

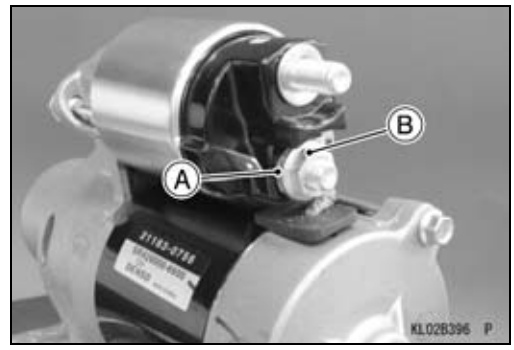
- Disconnect the switching lead from the solenoid terminal.

Testing Solenoid
Criterion: When Switching lead is disconnected→Pinion gear must return quickly.

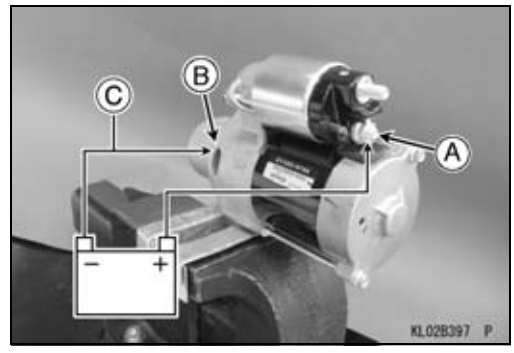
★If the solenoid does not work, the solenoid is defective. Replace the solenoid.

Electric Starter System

Starter Motor Inspection



- Inspect the starter solenoid (see Starter Solenoid Inspection).
- Connect the starter motor lead [A].
- Tighten the nut [B].



- Connect a 12 V battery to the starter motor as shown.

○Connect the battery:
(+) Terminal to Lower Stud Terminal [A]
(–) Terminal to Starter Motor Body [B]

○Do not connect the battery negative (–) cable [C] more than 5 seconds.

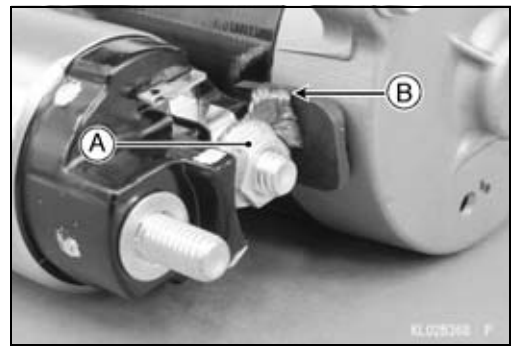
Testing Starter Motor

Criteria: **When battery negative (–) cable is connected→Starter motor should operate.**

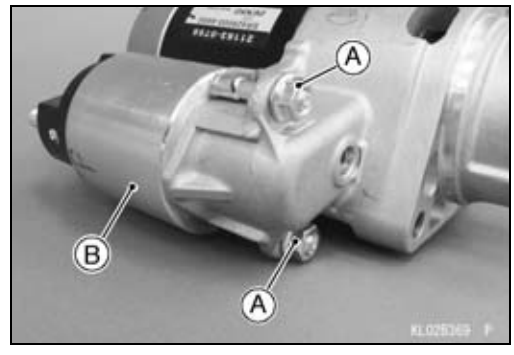
When battery negative (–) cable is disconnected→Starter motor does not operate.

★If the starter motor does not work as specified, the starter motor is defective. Replace the starter motor.

Starter Motor Disassembly



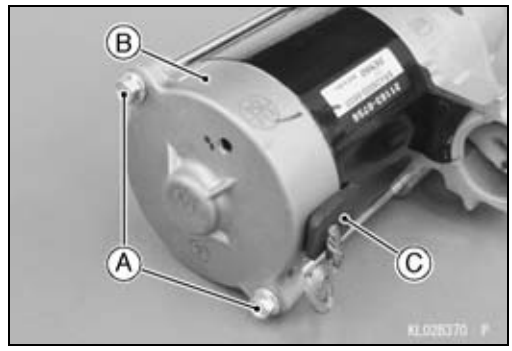
- Remove:
  Starter Motor (see Starter Motor Removal)
  Terminal Nut [A]
- Disconnect the lead [B] from the starter motor to the solenoid.



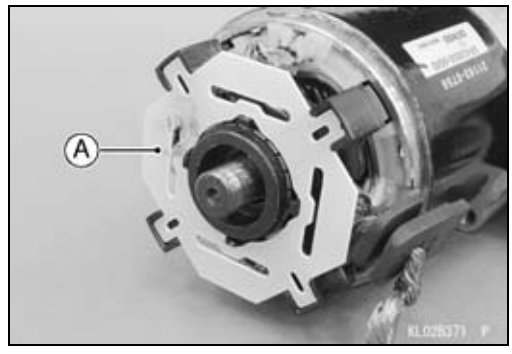
- Remove:
  Nuts [A]
  Starter Solenoid [B]

Electric Starter System

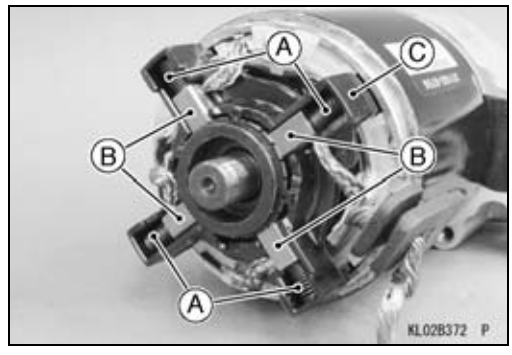
● Remove the through bolts [A] and end cover [B].
○Slide the (–) lead grommet [C] to outside.



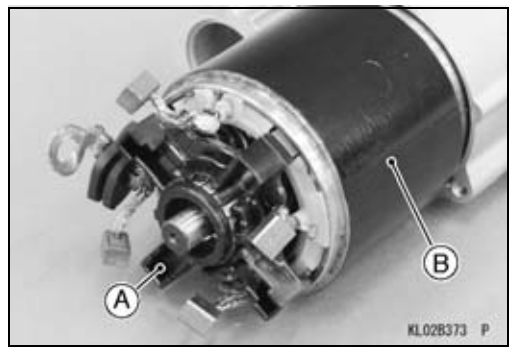
● Remove the insulator [A].



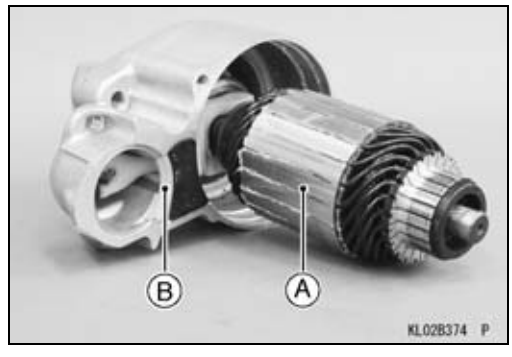
● Remove the springs [A].
● Free the brushes [B] from the brush holder [C].



● Remove:
Brush Holder [A]
Yoke [B]

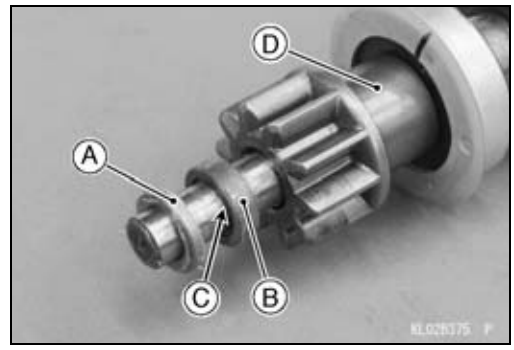


● Remove the armature assembly [A] with pinion gear fork [B].



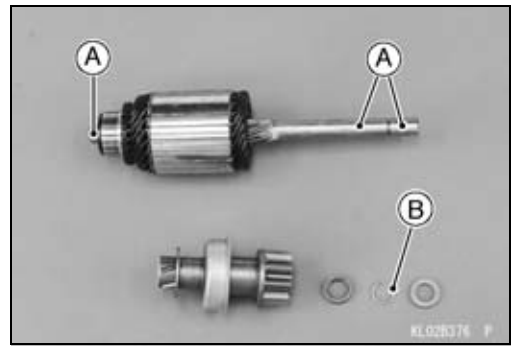
Electric Starter System

- Remove the front stopper [A].
- Push the rear stopper [B] toward the armature with a suitable tool and remove the snap ring [C].
- Pull the rear stopper and pinion clutch [D] from the armature shaft.



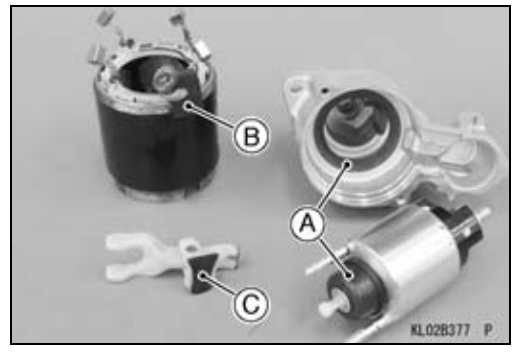
Starter Motor Assembly

- Apply a small amount of grease [A] to the armature shaft as shown.
- Replace the snap ring [B] with a new one.

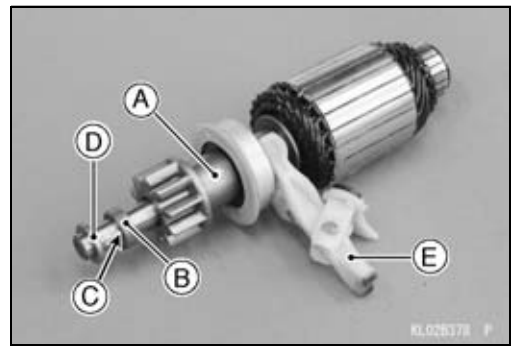


- Inspect the boots [A], grommet [B] and rubber insert [C] for visible damage.

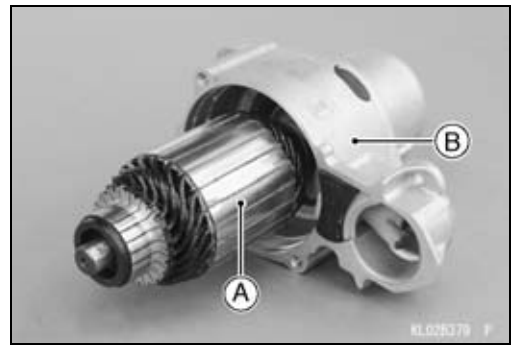
★If it is damaged, replace the related parts.



- Install the pinion clutch [A].
- Install the rear stopper [B] with the stepped side face the outside.
- Install the new snap ring [C] to the groove of the shaft.
- Slide the rear stopper until the stopping with the snap ring.
- Install the front stopper [D] with the flat side face the outside.
- Apply grease to the pinion gear fork fingers.
- Assemble the pinion gear fork [E] as shown.

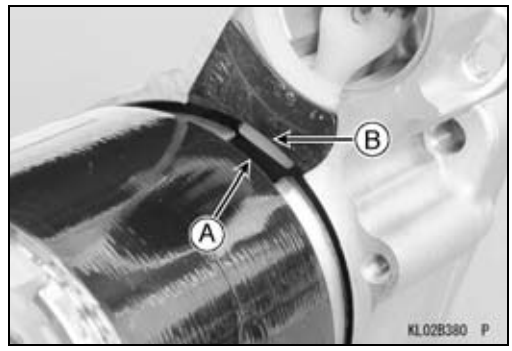


- Install the armature assembly [A] to the pinion gear cover [B].

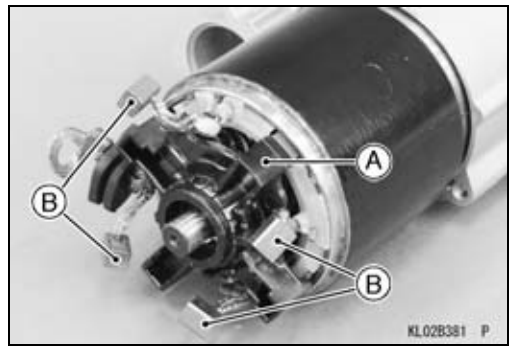


Electric Starter System

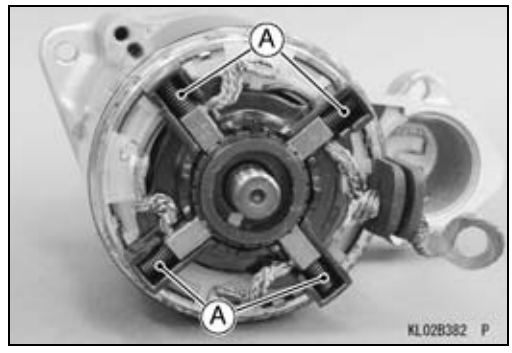
- Install the yoke so that the slits [A] fit the projection [B] of the pinion gear fork.



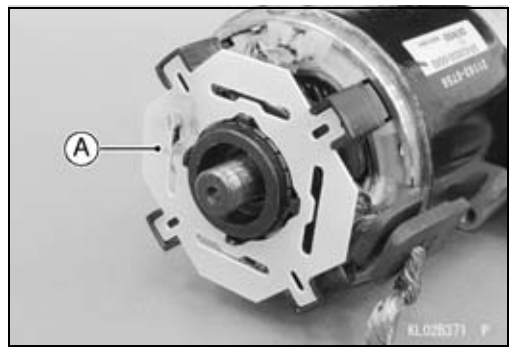
- Install the brush holder [A].
- Install the brushes [B] to the brush holder.



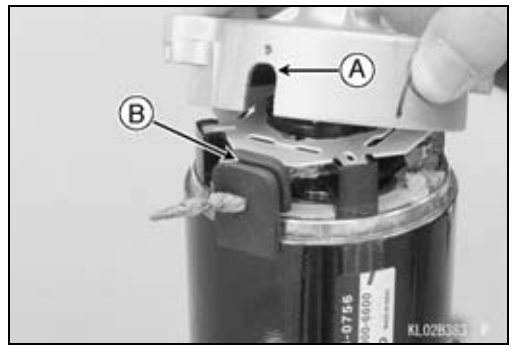
- Install the springs [A].



- Install the insulator [A].

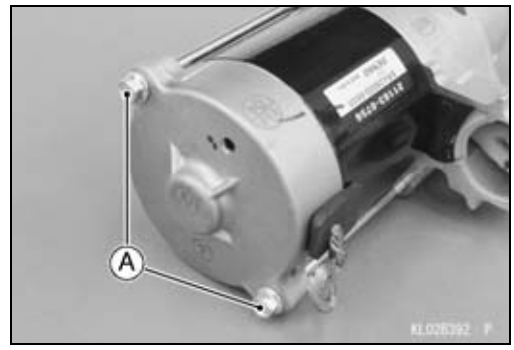


- Install the end cover so that the slit [A] fits the groove [B] of the grommet.

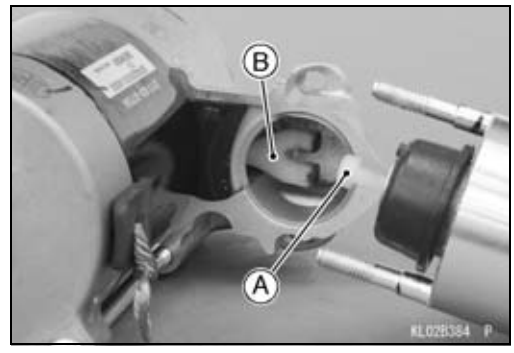


Electric Starter System

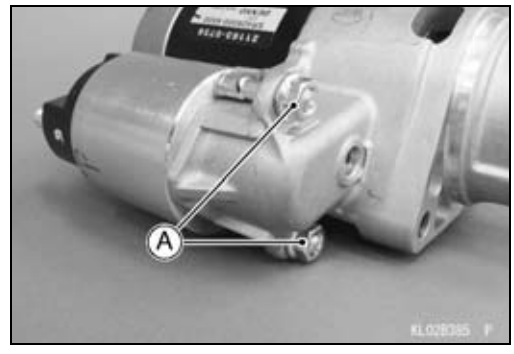
- Tighten the through bolts [A].



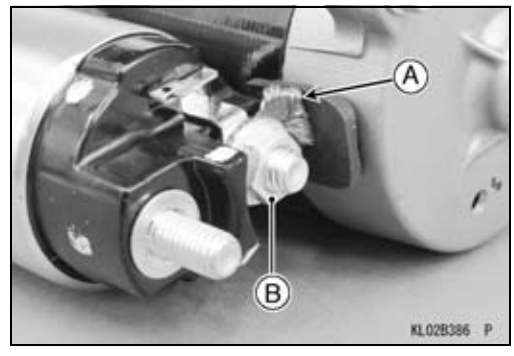
- Engage the hook on the starter solenoid with the hook [A] on the pinion gear fork [B].



- Install the solenoid its shorter terminal faces inside.
- Tighten the solenoid mounting nuts [A].



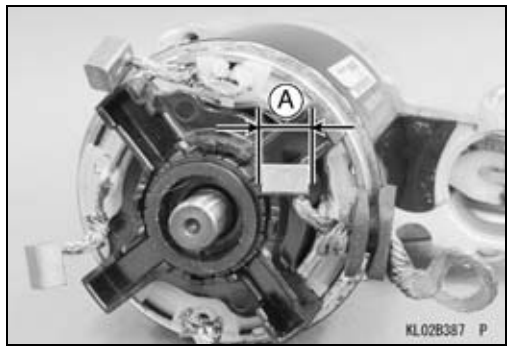
- Connect the starter motor lead [A] to the terminal.
- Tighten the terminal nut [B].



- Install the starter motor (see Starter Motor Installation).

Electric Starter System

Starter Motor Brush Inspection



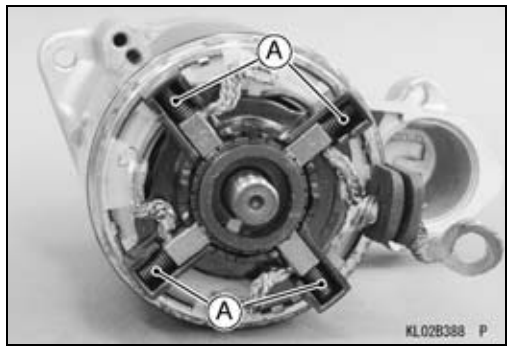
- Measure the overall length [A] of each brush.

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

Brush Length

Standard:	**10.0 mm (0.39 in.)**
Service Limit:	**6.0 mm (0.24 in.)**

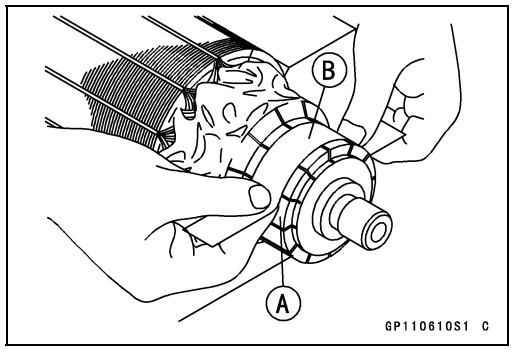
Brush Spring Inspection



- Inspect the brush springs [A] for weakened, distortion, rusting or breaks. Replace the brush plate assembly if necessary.

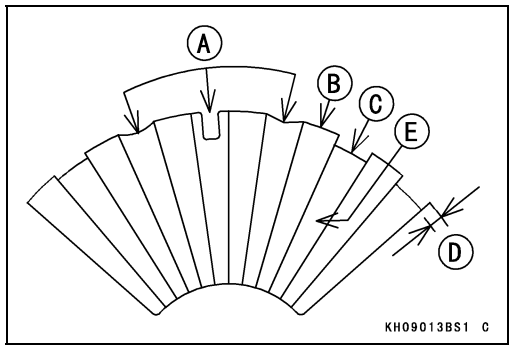
★If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace the brush plate assembly.

Armature Inspection



- Inspect the surface of the commutator [A].

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



- Measure the depth of the grooves between the commutator segments.
  Bad [A]
  Segment [B]
  Good [C]
  Commutator Groove Depth [D]
  Mica [E]

★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

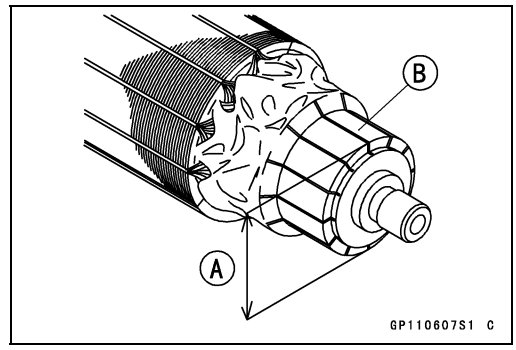
Service Limit:	**0.2 mm (0.008 in.)**

Electric Starter System

● 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 Outside Diameter
Service Limit: 27.0 mm (1.06 in.)

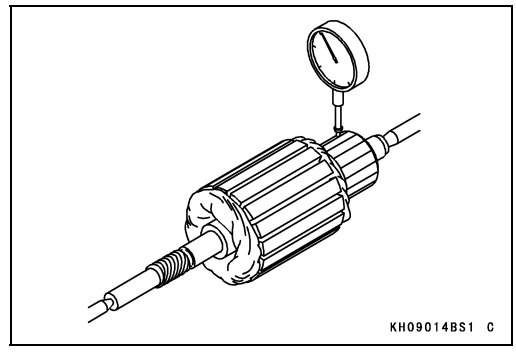


● Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.

● Rotate the armature slowly and read the commutator runout.

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

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

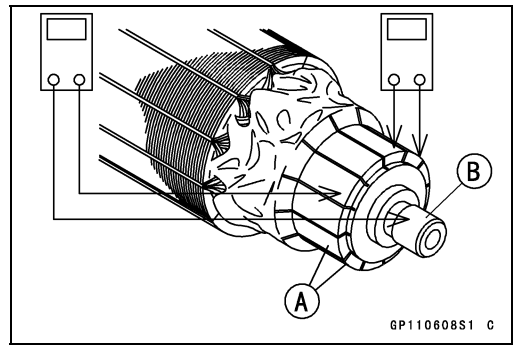


● Using a tester, measure the resistance between any two commutator segments [A].

★If there is a high resistance or no reading (∞) between any two segments, a winding is open and the starter motor must be replaced.

● Using a tester, measure the resistance between the segments and the shaft [B].

★If there is any reading at all, the armature has a short and the starter motor must be replaced.



NOTE

○*Even if the foregoing checks show the armature to be good, it may be defective in some manner not readily detectable with the tester. If all other starter motor and starter motor circuit components check good, but the starter motor still does not turn over or only turns over weakly, replace the starter motor with a new one.*

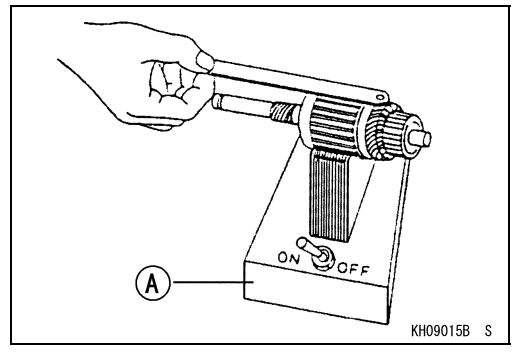
● Test the armature winding for shorts.

○Place the armature on a growler [A].

○Hold a thin metal strip (e.g., hack saw blade) on top of the armature.

○Turn on the growler and rotate the armature one complete turn.

★If the metal strip vibrates, the windings are internally shorted to each other and the starter motor must be replaced.

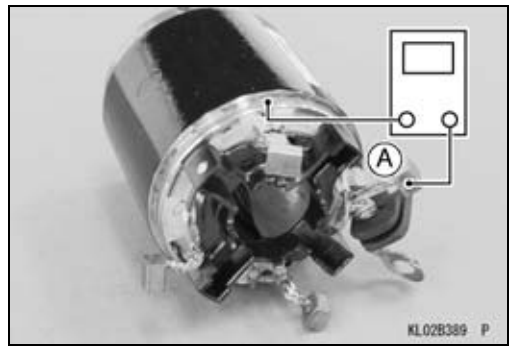


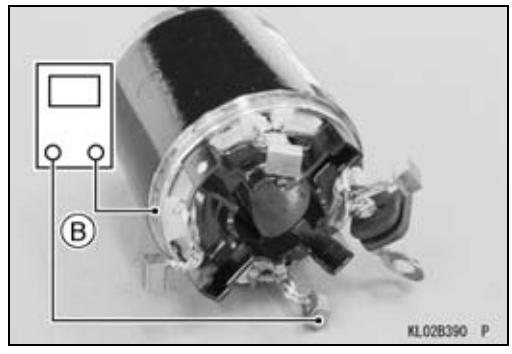
Electric Starter System

Brush Lead Inspection

- Using a tester, measure the resistance as shown.
  Terminal and Positive Brush [A]
  Terminal Plate and Negative Brush [B]

★If there is not close to zero ohms, the brush lead has an open. Replace the brush plate assembly.

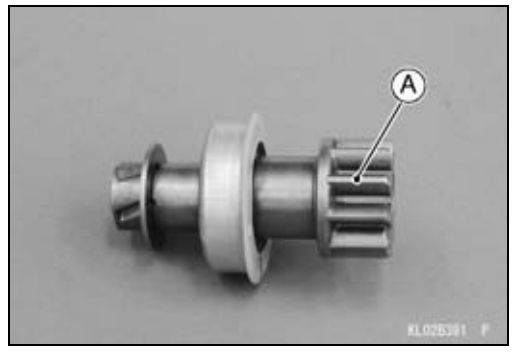




Pinion Clutch Inspection

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

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



Electrical System

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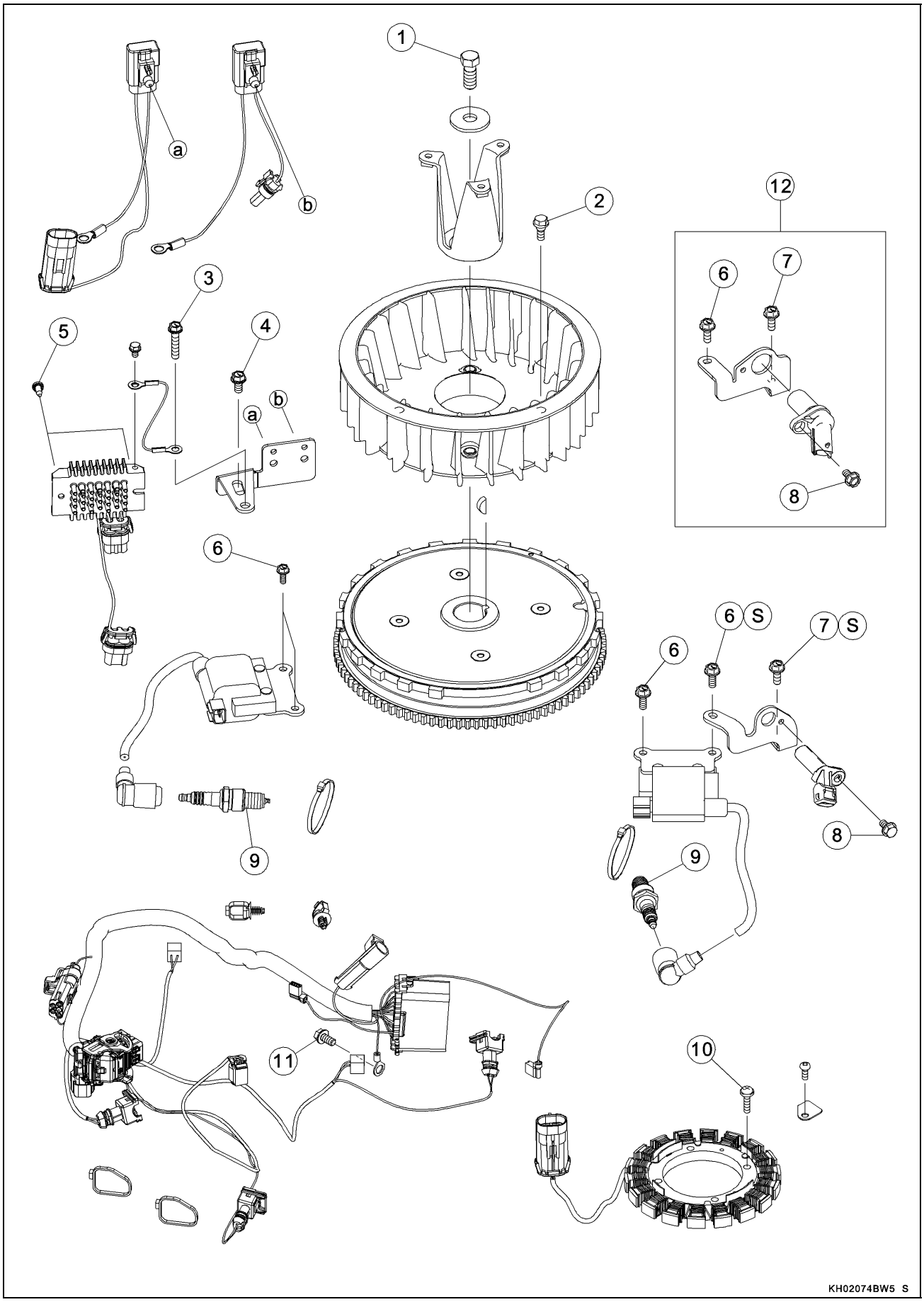
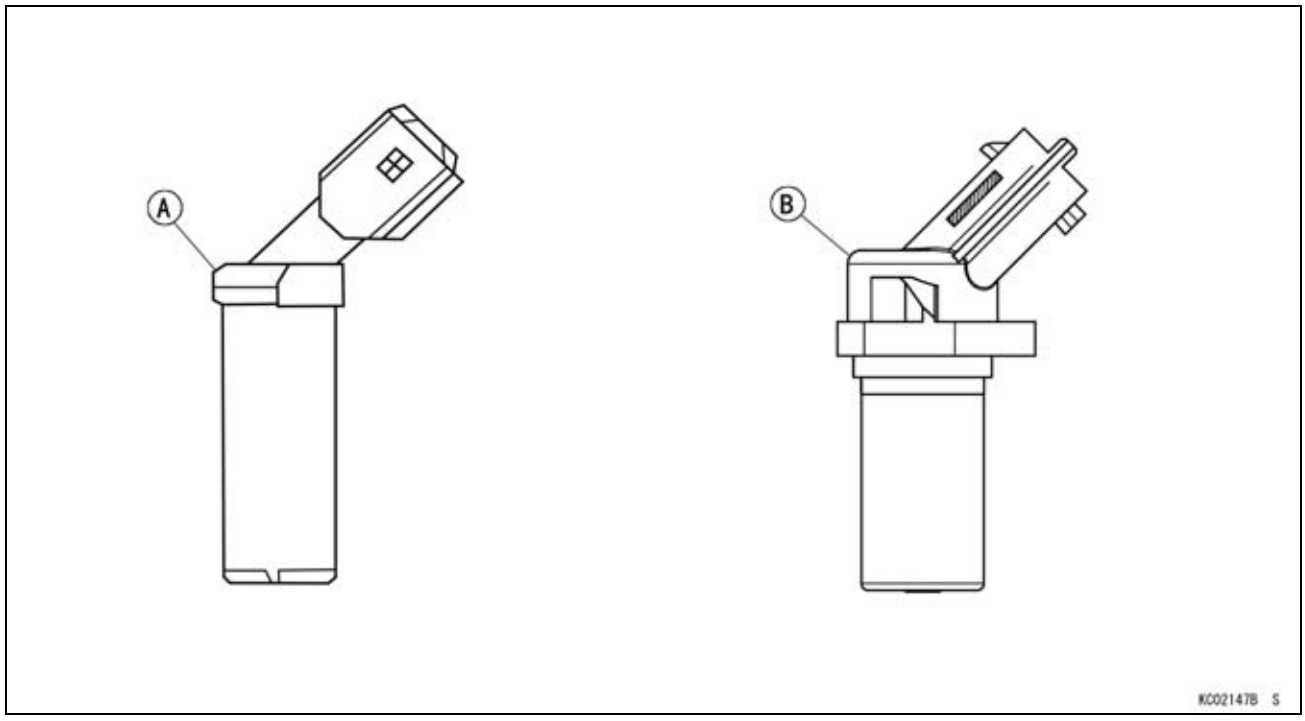
Exploded View



Exploded View

No.	Fastener	Torque			Re-marks
		N·m	kgf·m	ft·lb	
1	Flywheel Bolt	56	5.7	41	
2	Cooling Fan Bolts	8.8	0.90	78 in·lb	
3	Starter Motor Mounting Bolts	19.6	2.00	14.5	
4	Fuse Case Bracket Bolt	17.6	1.79	13.0	
5	Regulator Mounting Bolts	4.4	0.45	39 in·lb	
6	Ignition Coil Mounting Bolts (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
	Ignition Coil Mounting Bolts (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
7	Crankshaft Position Sensor Bracket Bolt (Old Crankshaft Position Sensor)	5.9	0.60	52 in·lb	S
	Crankshaft Position Sensor Bracket Bolt (New Crankshaft Position Sensor)	5.9	0.60	52 in·lb	
8	Crankshaft Position Sensor Mounting Bolt	5.9	0.60	52 in·lb	
9	Spark Plugs	22	2.2	16	
10	Stator Coil Screws	3.4	0.35	30 in·lb	
11	Ground Terminal Bolt	17.6	1.79	13.0	

12. New Crankshaft Position Sensor
S: Follow the specified tightening sequence.



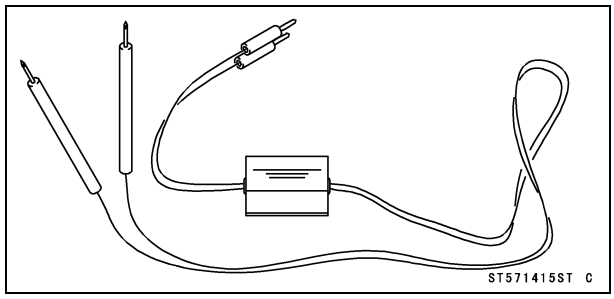
A. Old Crankshaft Position Sensor
B. New Crankshaft Position Sensor

Specifications

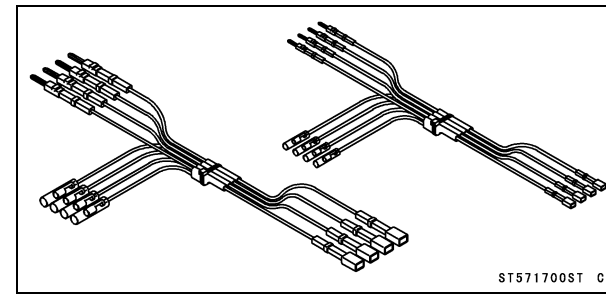
Item	Standard	Service Limit
Charging System		
Regulated Output Voltage	DC 13.9 ~ 14.5 V @3 600 r/min (rpm)	– – –
Stator Coil Resistance	0.11 Ω	– – –
Unregulated Stator Output Voltage	AC 35.5 ~ 48 V @3 600 r/min (rpm)	– – –
Ignition System		
Crankshaft Position Sensor:		
Air Gap (Old Crankshaft Position Sensor)	0.5 ~ 1.5 mm (0.02 ~ 0.06 in.)	– – –
Peak Voltage	3 V or more	– – –
Ignition Coil:		
Primary Winding Resistance	0.68 ~ 0.83 Ω	– – –
Secondary Winding Resistance	Not available	– – –
Primary Peak Voltage	150 V or more	– – –
Spark Plug:	NGK BPR4ES	– – –
Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)	– – –

Special Tools

Peak Voltage Adapter:
57001-1415

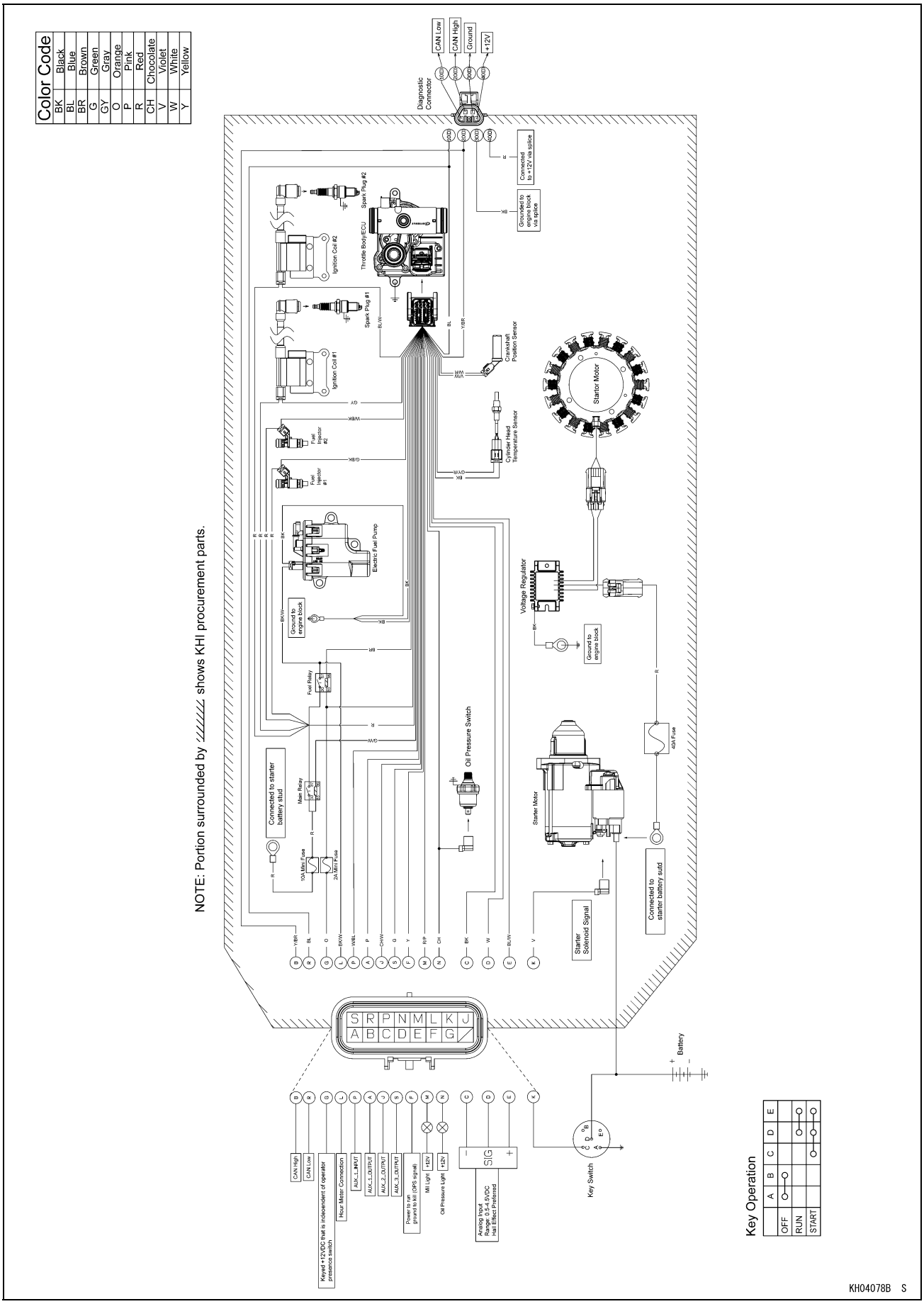


Measuring Adapter:
57001-1700



Wiring Diagram

16 Pin Connector, Relay equipped Model

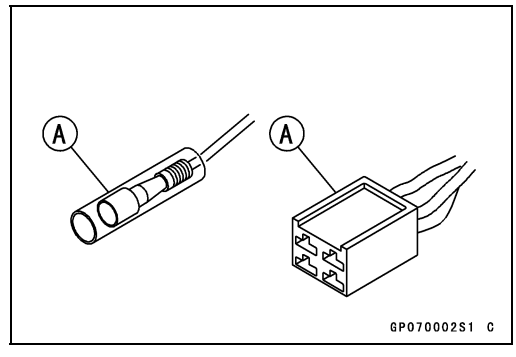


Precautions

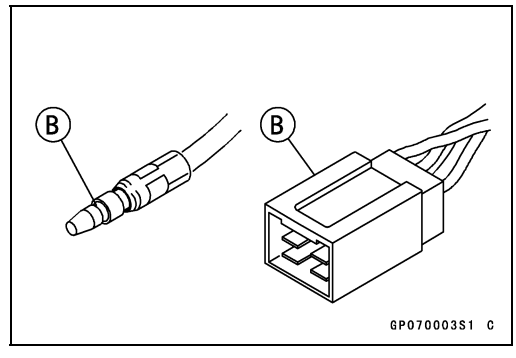
There are a number of important precautions that you must follow when servicing electrical systems. Learn and observe all the rules below.

- ○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]

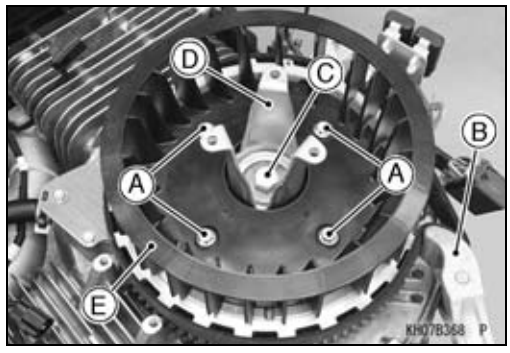


Connectors [B]

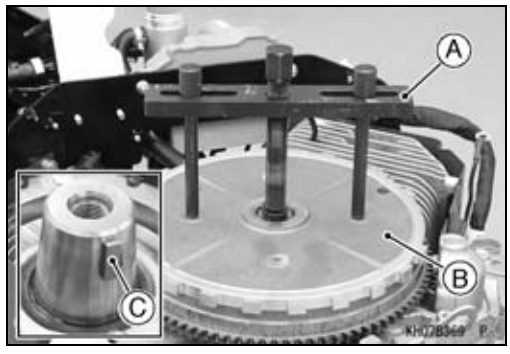


Charging System

Flywheel and Stator Coil Removal



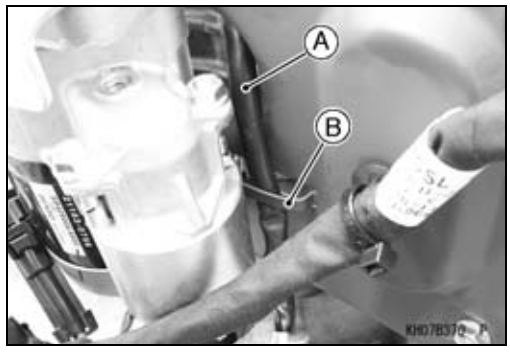
- Remove:
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)
  Ignition Coils (see Ignition Coil Removal)
  Cooling Fan Bolts [A]
- Hold the flywheel with a suitable tool [B], remove the flywheel bolt [C] and lock washer.
- Remove the bracket [D] and cooling fan [E].



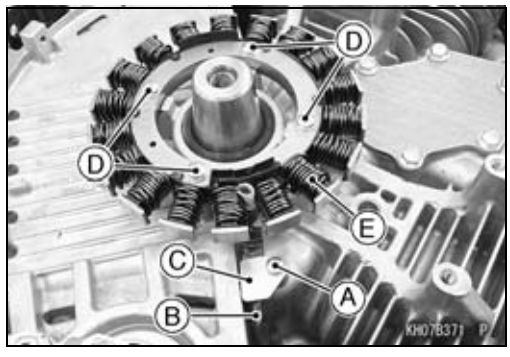
- Using a suitable flywheel puller [A], remove the flywheel [B].

NOTICE
Always use flywheel puller.

- Remove the woodruff key [C] from the crankshaft.

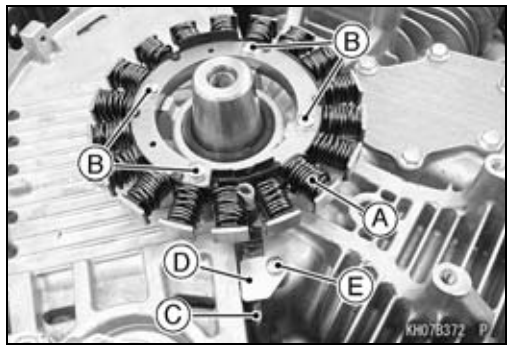


- Free the stator coil lead [A] from the clamp [B] on the engine shroud.



- Loosen the screw [A] and free the stator coil lead [B] from the plate [C].
- Remove:
  Stator Coil Screws [D]
  Stator Coil [E]

Flywheel and Stator Coil Installation



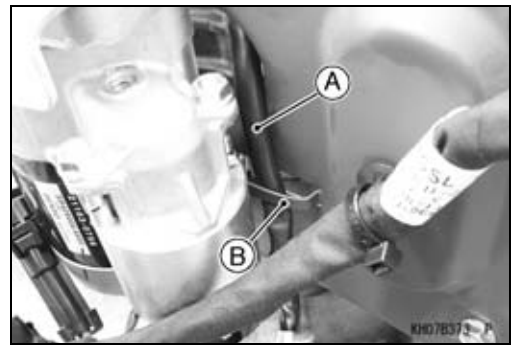
- Install the stator coil [A] and tighten the stator coil screws [B].

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

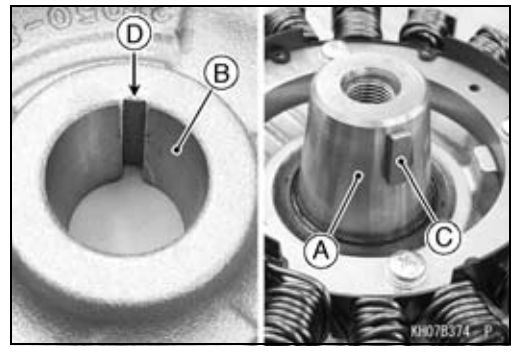
- Run the stator coil lead [C] and secure it with plate [D].
- Tighten the screw [E].

Charging System

- Secure the stator coil lead [A] with clamp [B] on the engine shroud.



- 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 groove [D] in the flywheel.



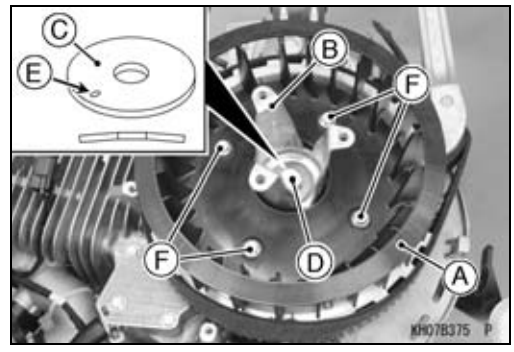
- Install:
  Cooling Fan [A]
  Bracket [B]
  Lock Washer [C]
  Flywheel Bolt [D]

NOTE

○*Install the lock washer with the "0" mark [E] facing up.*

- Hold the flywheel with a suitable tool.
- Tighten:

Torque - Flywheel Bolt: 56 N·m (5.7 kgf·m, 41 ft·lb)
Cooling Fan Bolts [F]: 8.8 N·m (0.90 kgf·m, 78 in·lb)



- Install:
  Ignition Coils (see Ignition Coil Installation)
  Fan Housing (see Fan Housing Installation in the Cooling System chapter)

Charging System

Charging System Operational Inspection

● Check the battery condition.

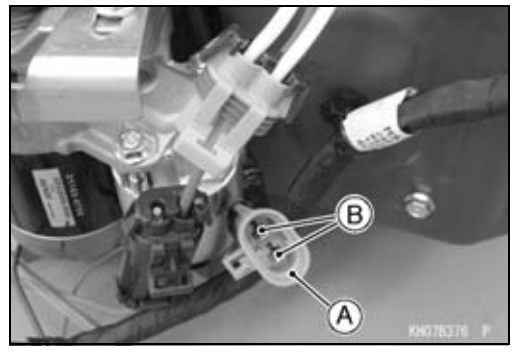
NOTE

○*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
Battery Voltage to DC 13.9 ~ 14.5 V @3 600 r/min (rpm)

Stator Coil Resistance Inspection

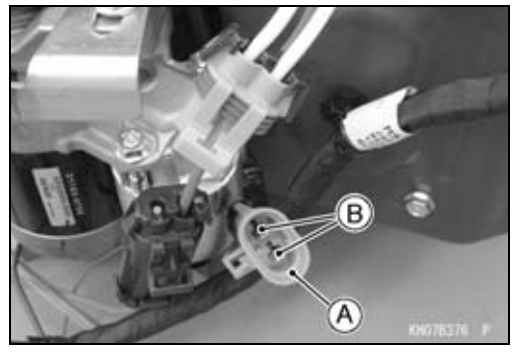


● Disconnect the stator coil lead connectors [A].
● Measure the stator coil resistance between the stator pins [B] with a tester.

Stator Coil Resistance
0.11 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 Voltage Inspection



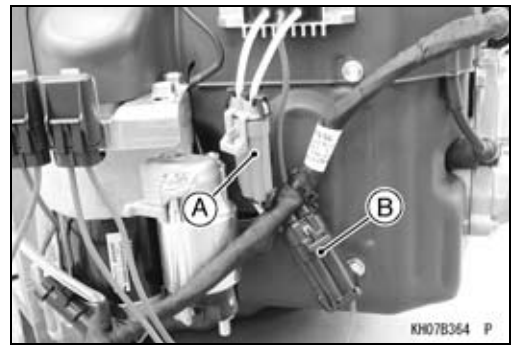
● Disconnect the stator coil lead connectors [A].
● Connect AC voltmeter to the stator pins [B].
● Start the engine. Run the engine at the 3 000 r/min (rpm) speed.
● Voltage reading should be minimum AC 35.5 V @3 600 r/min (rpm).
★If the AC voltage reading is less than the specification, replace the stator with a new one.

Unregulated Stator Output Voltage
AC 35.5 ~ 48 V @3 600 r/min (rpm)

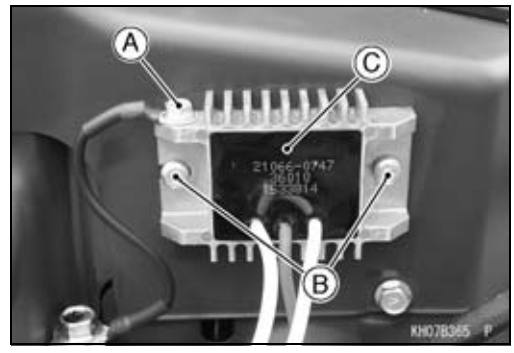
Charging System

Regulator Removal

- Disconnect:
  Stator Coil Lead Connector [A]
  Regulator Output Lead Connector [B]

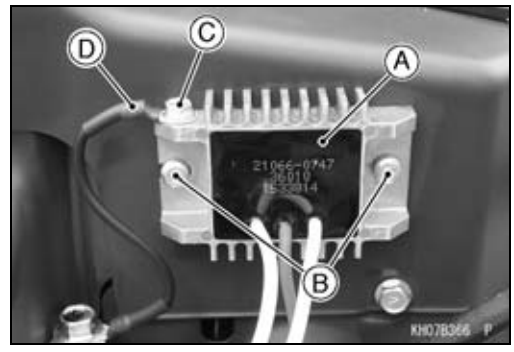


- Remove:
  Ground Terminal Bolt [A]
  Regulator Bolts [B]
  Regulator [C]

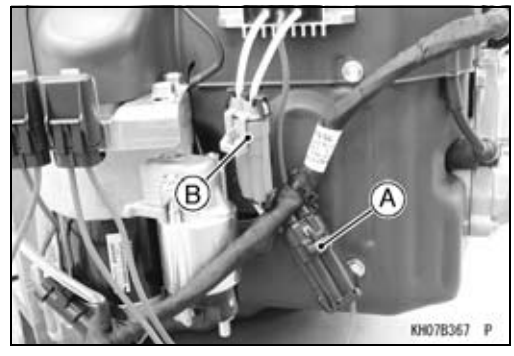


Regulator Installation

- Install the regulator [A] and tighten the bolts [B].
- Install the ground terminal bolt [C] to connect the ground terminal [D].



- Connect:
  Regulator Output Lead Connector [A]
  Stator Coil Lead Connector [B]



Charging System Troubleshooting

- Before inspection, remove all accessories that consume electrical power.

NOTE

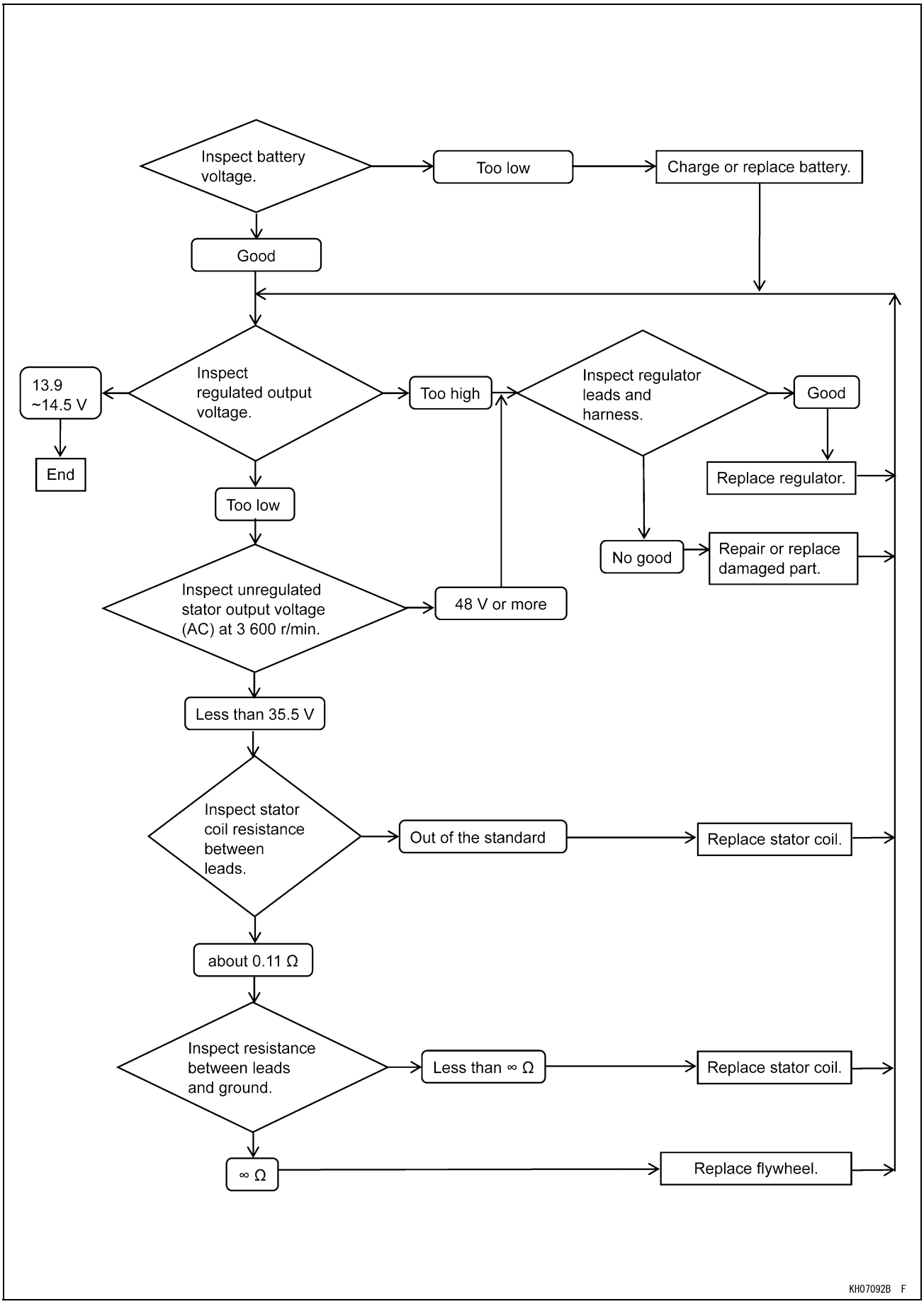
○*Even when the charging system is working properly, the battery may discharge if the machine is equipped with too many accessories.*

- Pay attention to customer's operating conditions which could affect the charging system.

○Example (Battery Discharged):
Frequent start or shorter running time etc.

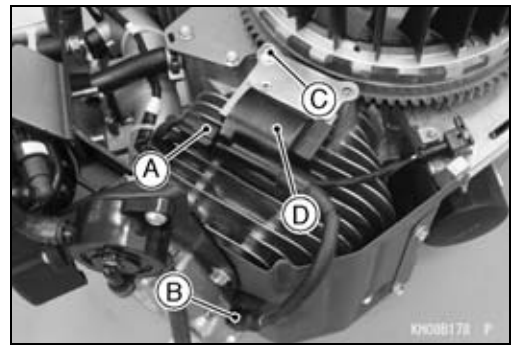
- Recharge the battery if it is discharged.

Charging System



Ignition System

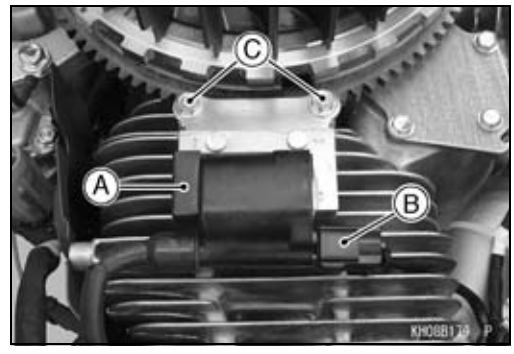
Ignition Coil Removal



- Remove:
  Fan Housing (see Fan Housing Removal in the Cooling System chapter)
  Crankshaft Position Sensor with Bracket (for #2 ignition coil) (see Crankshaft Position Sensor Removal)
  Ignition Coil Connector [A]
  Spark Plug Cap [B]
  Ignition Coil Mounting Bolt(s) [C]
  Ignition Coil [D]

○The #1 ignition coil is symmetrical with the #2 ignition coil except the crankshaft position sensor.

Ignition Coil Installation



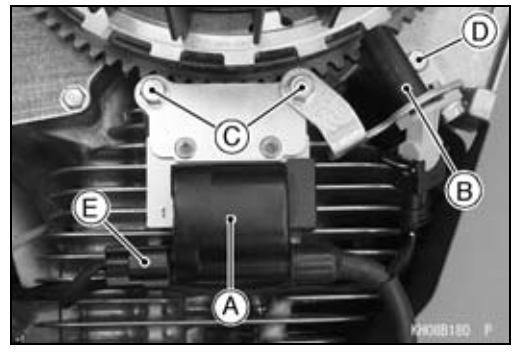
- Install the ignition coil [A] on the crankcase so that the ignition coil connector [B] face to the throttle body.

#1 Ignition Coil

- Tighten the ignition coil mounting bolts [C].

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

- Connect the ignition coil connector.

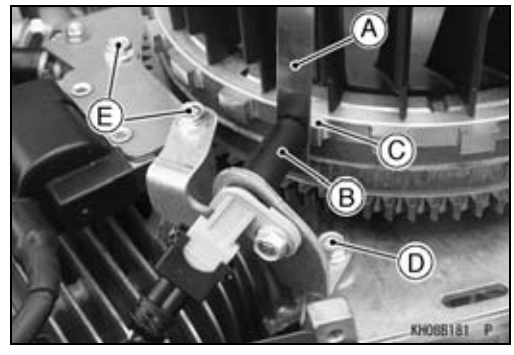


#2 Ignition Coil (Old Crankshaft Position Sensor)

- Run the crankshaft position sensor lead under the #2 ignition coil.
- Install (Temporarily):
  #2 Ignition Coil [A]
  Crankshaft Position Sensor [B]
  Ignition Coil Mounting Bolts [C]
  Crankshaft Position Sensor Bracket Bolt [D]

○Do not tighten the bolts at this time.

- Connect the ignition coil connector [E].



- Insert the 1.0 mm (0.04 in.) of non-metallic feeler gauge [A] between the tip of the crankshaft position sensor [B] and a lug on the rotor [C].
- First, tighten the crankshaft position sensor bracket bolt [D] while inserting the feeler gauge.

Torque - Crankshaft Position Sensor Bracket Bolt: 5.9 N·m (0.60 kgf·m, 52 in·lb)

- Then, tighten ignition coil mounting bolts [E].

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

- Remove the feeler gauge and recheck the crankshaft position sensor air gap.

Crankshaft Position Sensor Air Gap
Standard: 0.5 ~ 1.5 mm (0.02 ~ 0.06 in.)

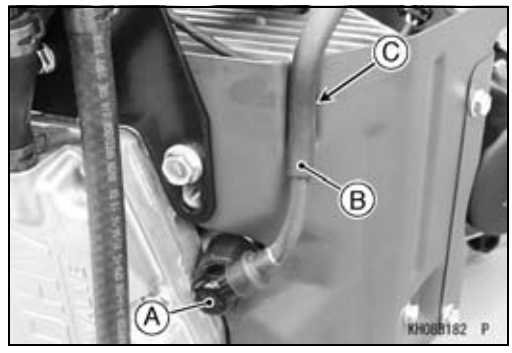
Ignition System

#2 Ignition Coil (New Crankshaft Position Sensor)

- Run the crankshaft position sensor lead under the #2 ignition coil.
- Install:
  #2 Ignition Coil
  Crankshaft Position Sensor
- Tighten:

Torque - Crankshaft Position Sensor Bracket Bolt: 5.9 N·m (0.60 kgf·m, 52 in·lb)
Ignition Coil Mounting Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)

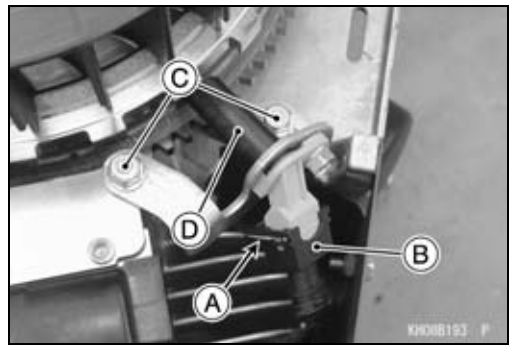
- Connect the ignition coil connector.
- Connect the spark plug cap [A].
- Fit the ignition coil leads [B] to the each engine shroud groove [C].



Crankshaft Position Sensor Removal

- Remove the fan housing (see Fan Housing Removal in the Cooling System chapter).
- Push the lock pin [A] inward to unlock, and disconnect the crankshaft position sensor connector [B].
- Remove:
  Crankshaft Position Sensor Bracket Bolts [C]
  Crankshaft Position Sensor [D] with Bracket

○Remove the bracket from the crankshaft position sensor if necessary.



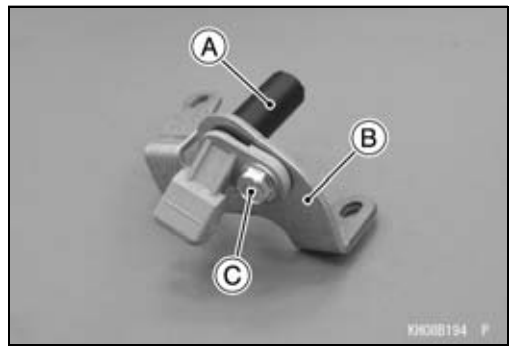
Crankshaft Position Sensor Installation

- Install the crankshaft position sensor [A] to the bracket [B] if removed.
- Tighten:

Torque - Crankshaft Position Sensor Mounting Bolt [C]: 5.9 N·m (0.60 kgf·m, 52 in·lb)

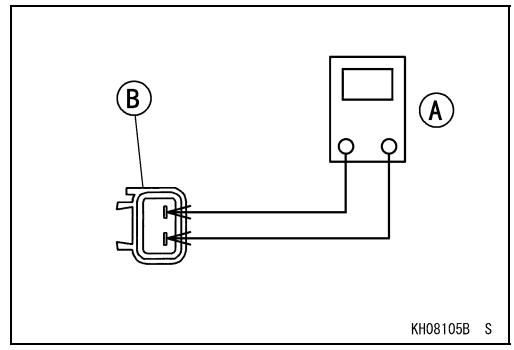
○When installing the sensor which is fastened by bolt, tighten the bolt after placing the sensor on the bottom surface completely.

- Install the crankshaft position sensor (see Ignition Coil Installation).



Ignition System

Ignition Coil Inspection



- Remove:
  Ignition Coil
- Connect a meter [A] to the terminals in each ignition coil connector [B], measure the ignition coil resistance.

Primary Winding Resistance: 0.68 ~ 0.83 Ω

Secondary Winding Resistance: Not available

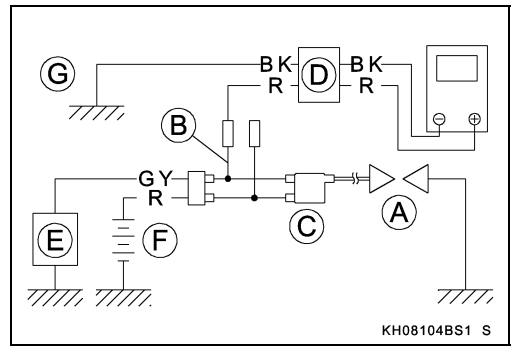
★If the meter does not read as specified, replace the ignition coil.

★If the meter reads as specified, the ignition coil winding is probably good. However, if the ignition system still does not perform as it should after all other components have been checked, test replace the coil with one known to be good.

- Check the ignition coil lead for visible damage.

★If the ignition coil lead is damaged, replace or repair the harness.

Ignition Coil Primary Peak Voltage Inspection



NOTE

○*Verify the battery is fully charged.*

- Remove the spark plug caps, but do not remove the spark plugs.
- Install a new spark plug [A] into the spark plug cap.
- Disconnect the ignition coil connector and connect the measuring adapter [B] between these connectors as shown.
  Ignition Coil #1 or #2 [C]

Special Tool - Measuring Adapter: 57001-1700

- Set a digital meter, and connect it to the peak voltage adapter [D].

Special Tool - Peak Voltage Adapter: 57001-1415
Type: KEK-54-9-B

ECU [E]
Battery [F]

Connections (Ignition Coil #1):

		Peak Voltage Adapter		Tester
Terminal (GY Lead)	←	**R Lead**	→	**(+)**
Ground [G]	←	**BK Lead**	→	**(–)**

Connections (Ignition Coil #2):

		Peak Voltage Adapter		Tester
Terminal (BL/W Lead)	←	**R Lead**	→	**(+)**
Ground [G]	←	**BK Lead**	→	**(–)**

⚠ WARNING

To avoid extremely high voltage shocks, do not touch the spark plugs or tester connections.

Ignition System

- Turn the ignition switch on.
- Ground the new spark plug onto the engine.
- Using the switch of the equipment, turn the engine 4 ~ 5 seconds to measure the primary peak voltage.
- Repeat the measurements 5 times.

Ignition Coil Primary Peak Voltage
Standard: 150 V or more

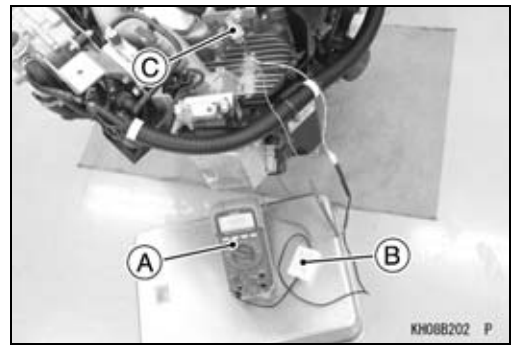
★If the reading is less than the specified value, check the following:
Ignition Coil (see Ignition Coil Inspection)
Crankshaft Position Sensor (see Crankshaft Position Sensor Resistance Inspection in the Fuel System (EFI) chapter)

★If the ignition coil and crankshaft position sensor are normal, the wiring for continuity between harness connectors (see Ignition Coil Wiring Connection Inspection in the Fuel System (EFI) chapter).

★If the wiring continuity is good, replace the throttle body assy.

Ignition System

Crankshaft Position Sensor Peak Voltage Inspection



NOTE

○*Verify the battery is fully charged.*

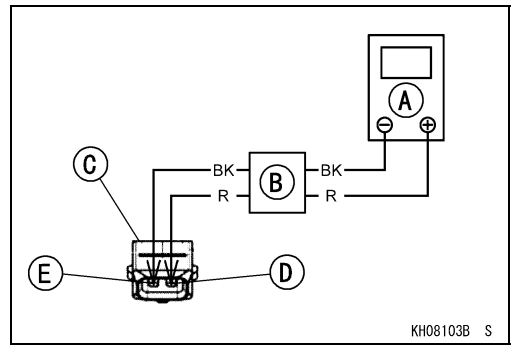
○*Using the peak voltage adapter is more reliable way to determine the condition of the crankshaft position sensor than crankshaft position sensor internal resistance measurements.*

● Disconnect the crankshaft position sensor lead connector (see Crankshaft Position Sensor Removal).

○For the explanation, the engine is not mounted on the equipment in the photograph.

● Set a tester [A], and connect it to the peak voltage adapter [B].

Special Tool - Peak Voltage Adapter: 57001-1415
Type: KEK-54-9-B



● Connect the peak voltage adapter to the terminals of the crankshaft position sensor connector [C].

Connections:

Crankshaft Position Sensor		Peak Voltage Adapter		Tester
Terminal 1 [D]	←	R Lead	→	(+)
Terminal 2 [E]	←	BK Lead	→	(–)

● Turn the ignition switch on.

● Using the switch of the equipment, turn the engine 4 ~ 5 seconds to measure the peak voltage.

● Repeat the measurements 5 times.

Crankshaft Position Sensor Peak Voltage
Standard: 3 V or more

★If the reading is less than the standard, inspect the crankshaft position sensor (see Crankshaft Position Sensor Resistance Inspection in the Fuel System (EFI) chapter).

★If the crankshaft position sensor is normal, check the wiring for continuity between harness connectors (see Crankshaft Position Sensor Wiring Connection Inspection in the Fuel System (EFI) chapter).

★If the wiring continuity is good, replace the throttle body assy.

Ignition System

Ignition System Inspection

NOTE

○*Check the MIL (Malfunction Indicator Light) on the equipment or read the trouble code with the diagnostic tool, before checking the ignition system (see Reading Trouble Code in the Fuel System (EFI) chapter).*

○*When checking wiring, check the wire, terminations and connectors.*

● Check the battery condition.

★If the voltage is abnormal, recharge or replace the battery.

● Test the ignition spark using commercially available ignition spark tester.

○The spark tester should be available for testing 5 ~ 10 mm (0.20 ~ 0.39 in.) spark gap. Follow the safety instructions of the spark tester's manual.

● Check the sparks of both cylinders.

★If the spark jumps 7 ~ 8 mm (0.28 ~ 0.31 in.) gap, there is no problem with ignition coil and its wiring.

★If the spark is normal, but the engine misses fire, replace the spark plug.

★If the spark of the only one side is abnormal, check the wiring for the ignition coil on that side (see Ignition Coil #1, #2 Wiring Diagram in the Fuel System (EFI) chapter).

★If the wiring is no problem, replace the ignition coil and test the spark again.

★If sparks of the both side cylinders are abnormal, check the followings.

Ignition Coil Primary Peak Voltage
Crankshaft Position Sensor Peak Voltage
Wiring for Ignition Coils (see Ignition Coil #1, #2 Wiring Diagram in the Fuel System (EFI) chapter)
Crankshaft Position Sensor and its Wiring (see Crankshaft Position Sensor Wiring Diagram in the Fuel System (EFI) chapter)
Power Supply Wiring for ECU (see Battery Wiring Diagram in the Fuel System (EFI) chapter)

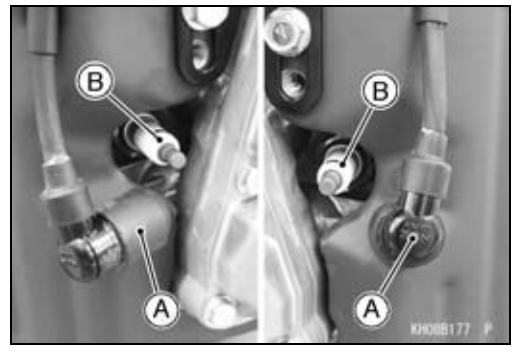
● It may be necessary to see the equipment side. Check the followings.

Power Supply Wirings from Battery to Main Engine Connector (see Battery Wiring Diagram in the Fuel System (EFI) chapter and Equipment Manual)
Switch Circuit (see Equipment Manual)

★If all parts above are normal and the condition still remains, ECU can be faulty. Replace the throttle body and retest.

Ignition System

Spark Plug Removal



- Carefully pull the plug caps [A] from the spark plugs [B].
- 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: 22 N·m (2.2 kgf·m, 16 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.

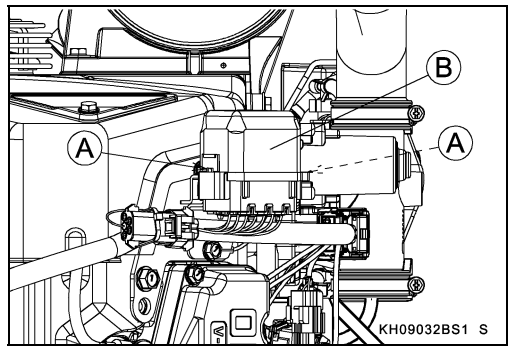
Spark Plug Gap Inspection

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

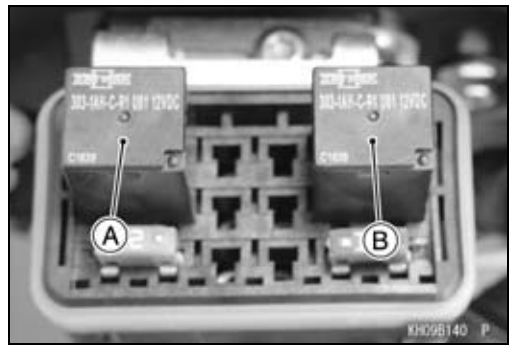
Relay

Relay Removal

● Unlock the hooks [A] to lift up the lid [B].



● Pull the relay straight out of the relay/fuse box.
Main Relay [A]
Fuel Pump Relay [B]

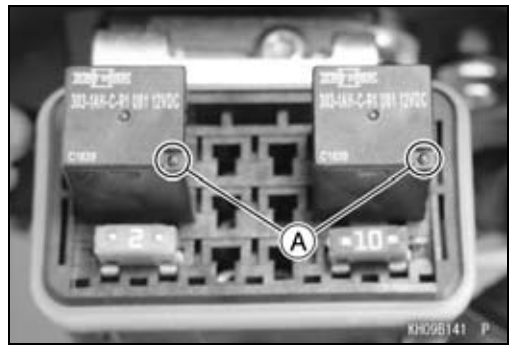


Relay Installation

NOTE

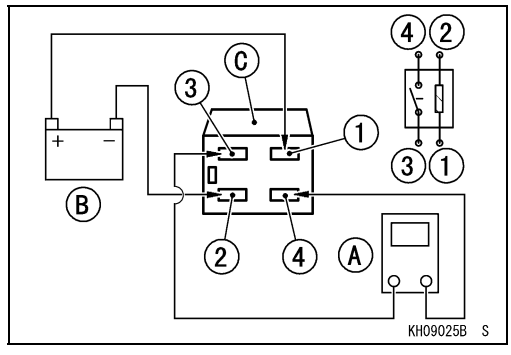
○*The main relay and fuel pump relay are identical.*

● Install the relay so that its circle point [A] faces direction as shown.



Relay Inspection

● Remove the relay (see Relay Removal).
● Connect a tester [A] and a 12 V battery [B] to the relay [C] as shown.



Testing Relay
Connections:

(1) Battery → Terminals [1] and [2] (Relay Coil)
Tester → Terminals [3] and [4] (Relay Switch)

(2) Battery → Disconnected
Tester → Terminals [3] and [4] (Relay Switch)

Criteria: (1) 0 Ω
(2) ∞ Ω

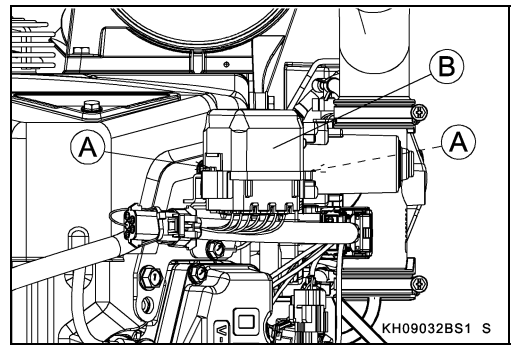
★If the relay does not work as specified, the relay is defective. Replace the relay.

Fuse

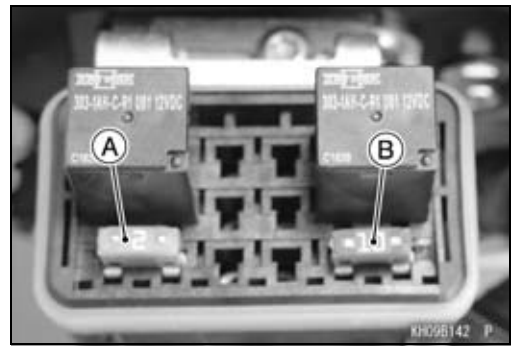
Fuse Removal

Relay/Fuse Box (2A,10A)

- Unlock the hooks [A] to lift up the lid [B].

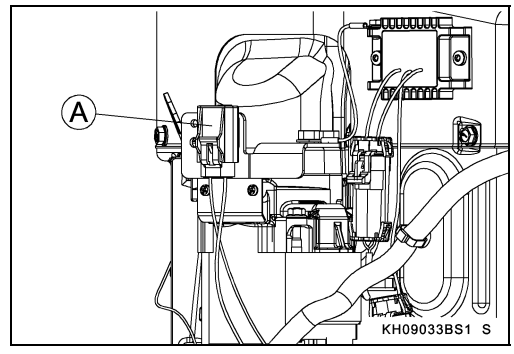


- Pull the fuse straight out of the relay/fuse box with needle nose pliers.
  2 A Fuse [A]
  10 A Fuse [B]

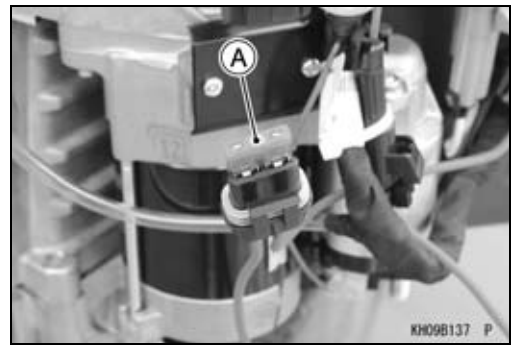


Fuse Case (40 A)

- Disconnect the cap [A].



- Pull the 40 A fuse [A] straight out of the fuse case with needle nose pliers.



Fuse Installation

★If a fuse fails during operation, inspect the electrical system to determine the cause, and then replace it with a new fuse of proper amperage.

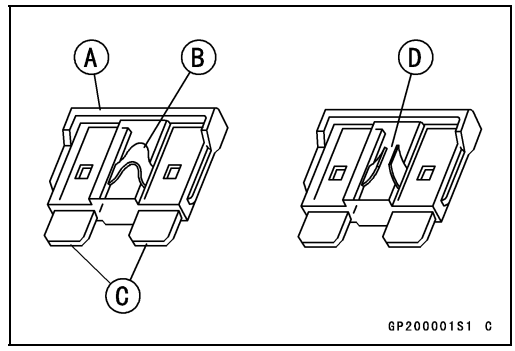
- Install the fuses on the original position as specified on the case.

Fuse

Fuse Inspection

- Remove the fuse (see Fuse Removal).
- Inspect the fuse element. If it is blown out, replace the fuse. Before replacing a blown fuse, always check the amperage in the affected circuit. If the amperage is equal to or greater than the fuse rating, check the wiring and related components for a short circuit.

  Housing [A]
  Fuse Element [B]
  Terminals [C]
  Blown Element [D]



NOTICE

When replacing a fuse, be sure the new fuse matches the specified fuse rating for that circuit. Installation of a fuse with a higher rating may cause damage to wiring and components.

Troubleshooting

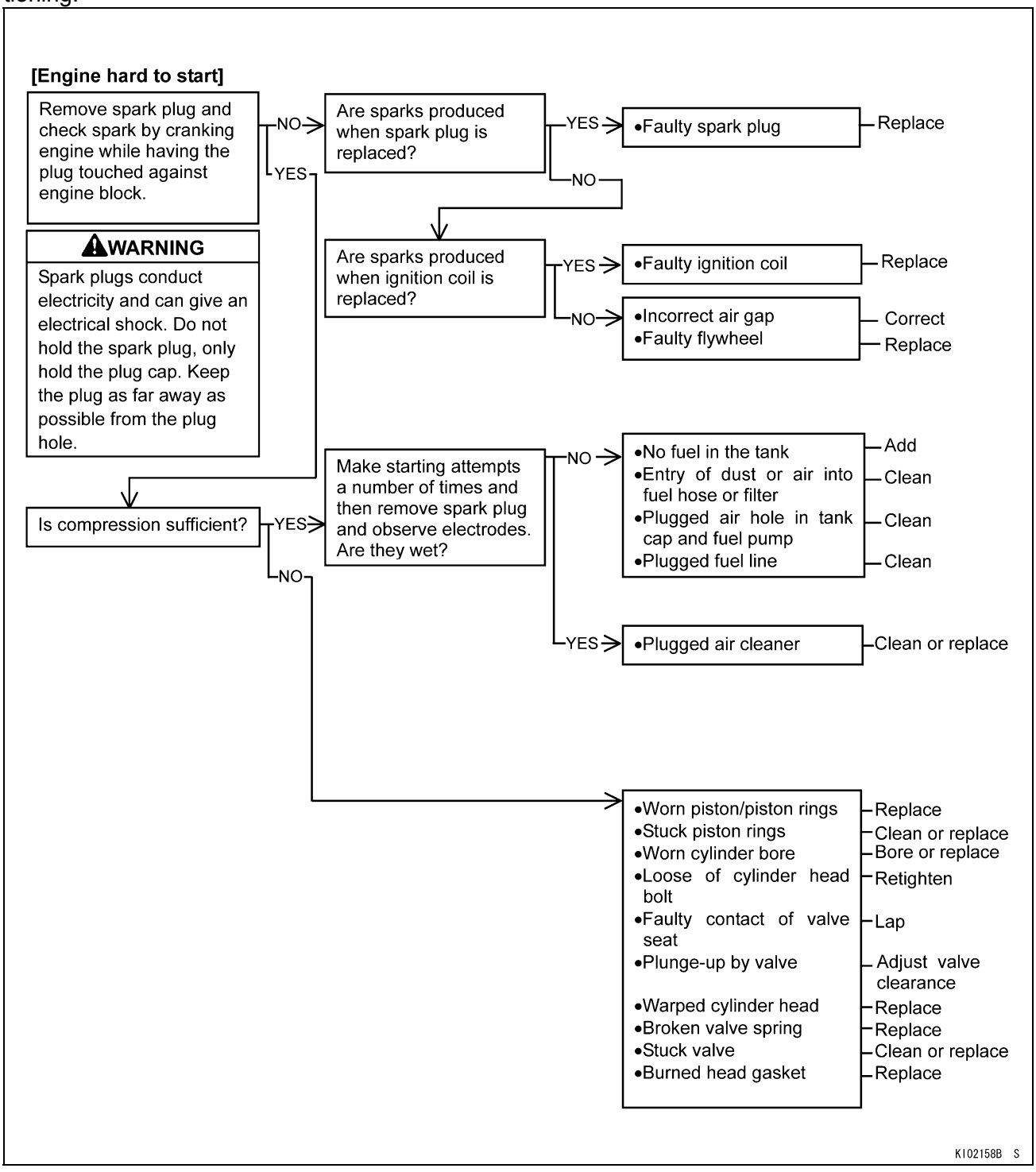
Table of Contents

Engine Troubleshooting Guide

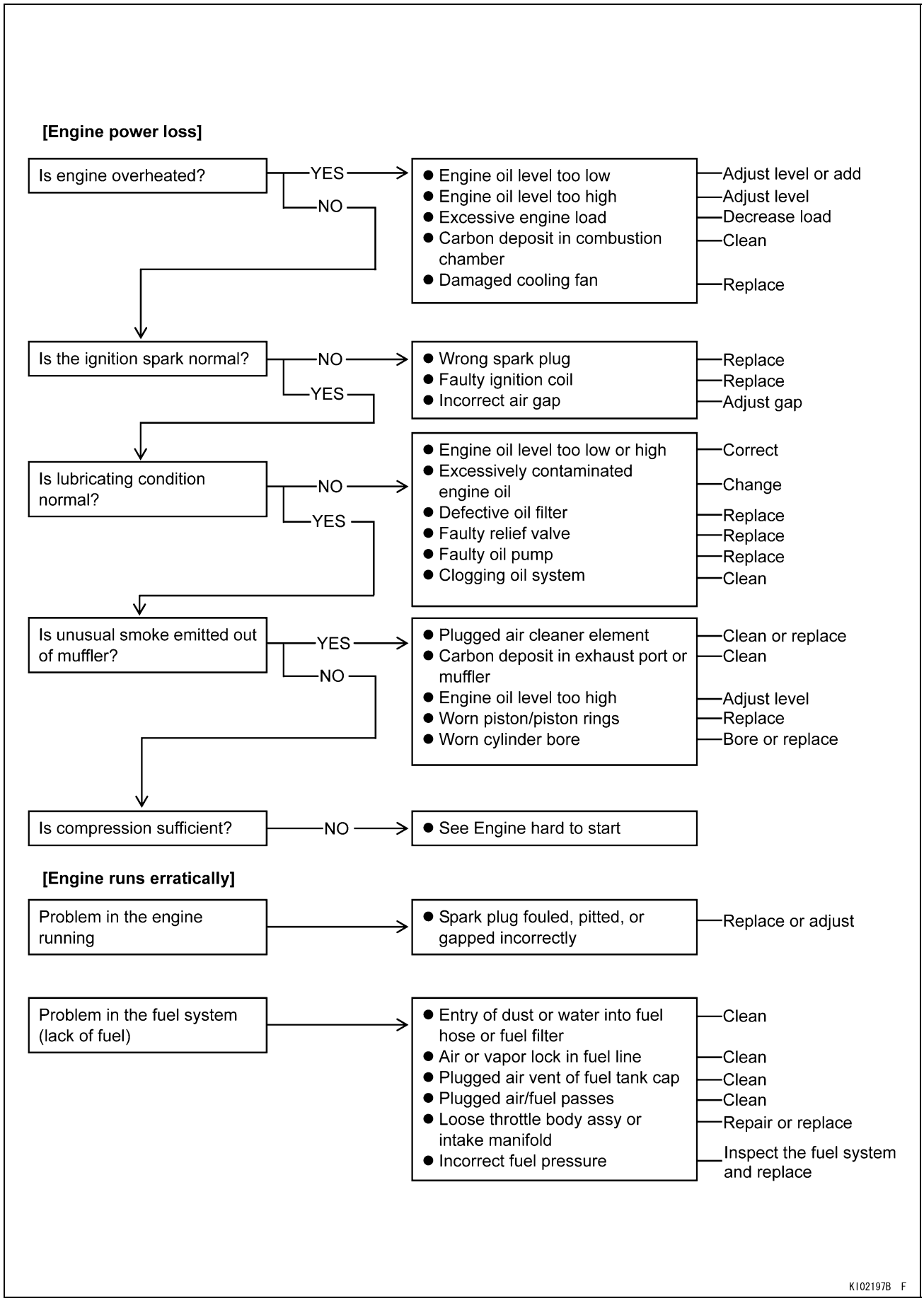
If the engine malfunctions, check if the way the engine is used is correct. If the engine malfunctions even if the engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

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



Engine Troubleshooting Guide



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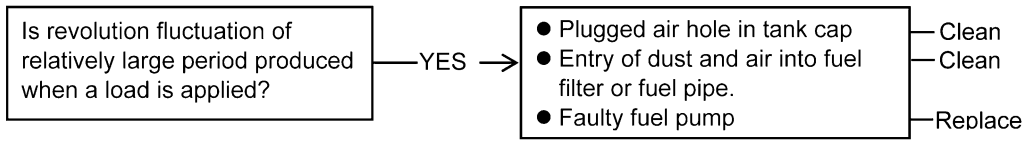
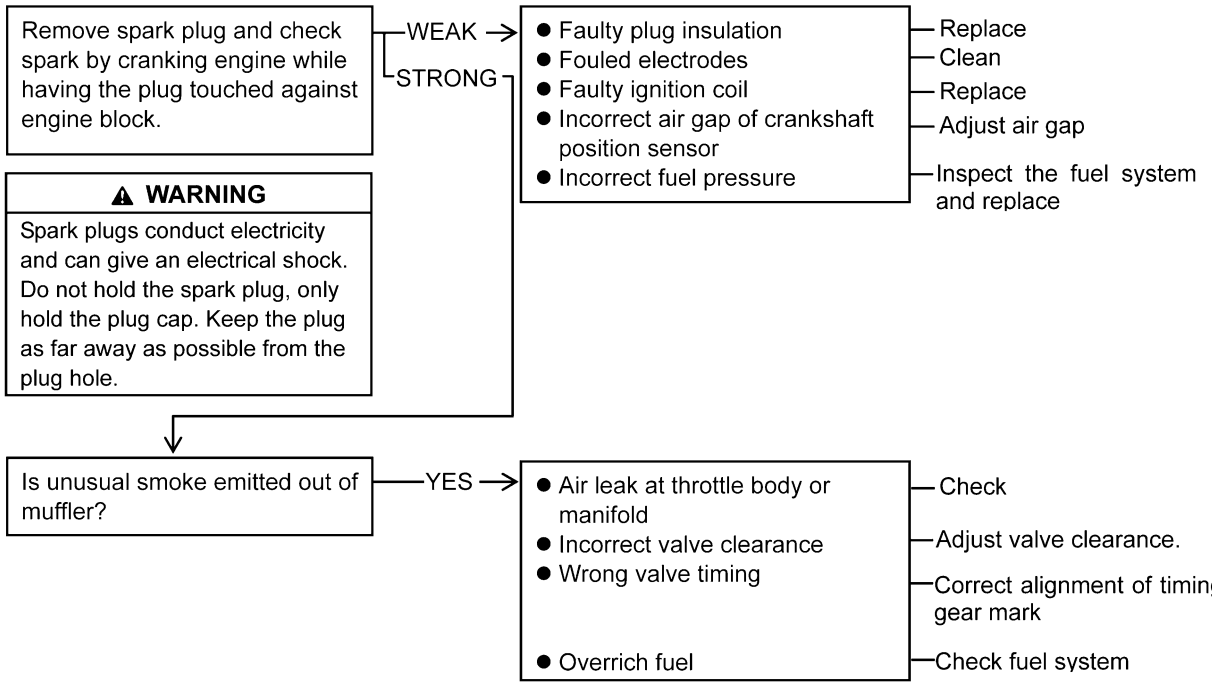
Engine Troubleshooting Guide

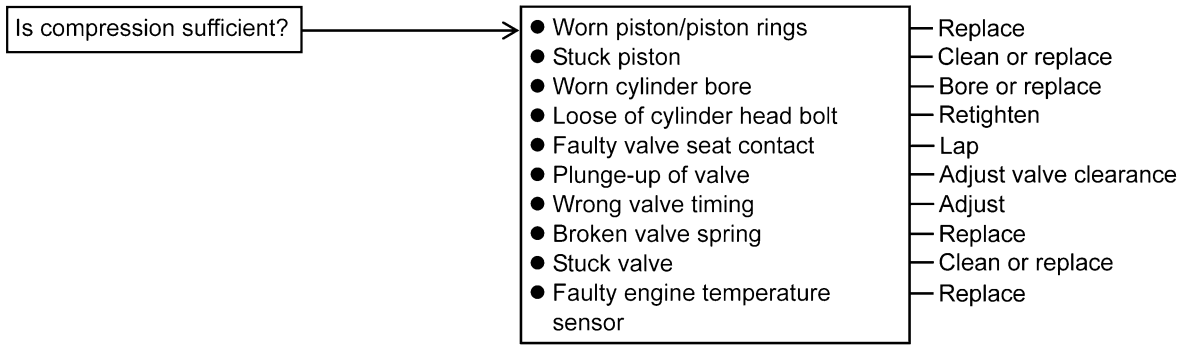
[Engine malfunctions at high speed]



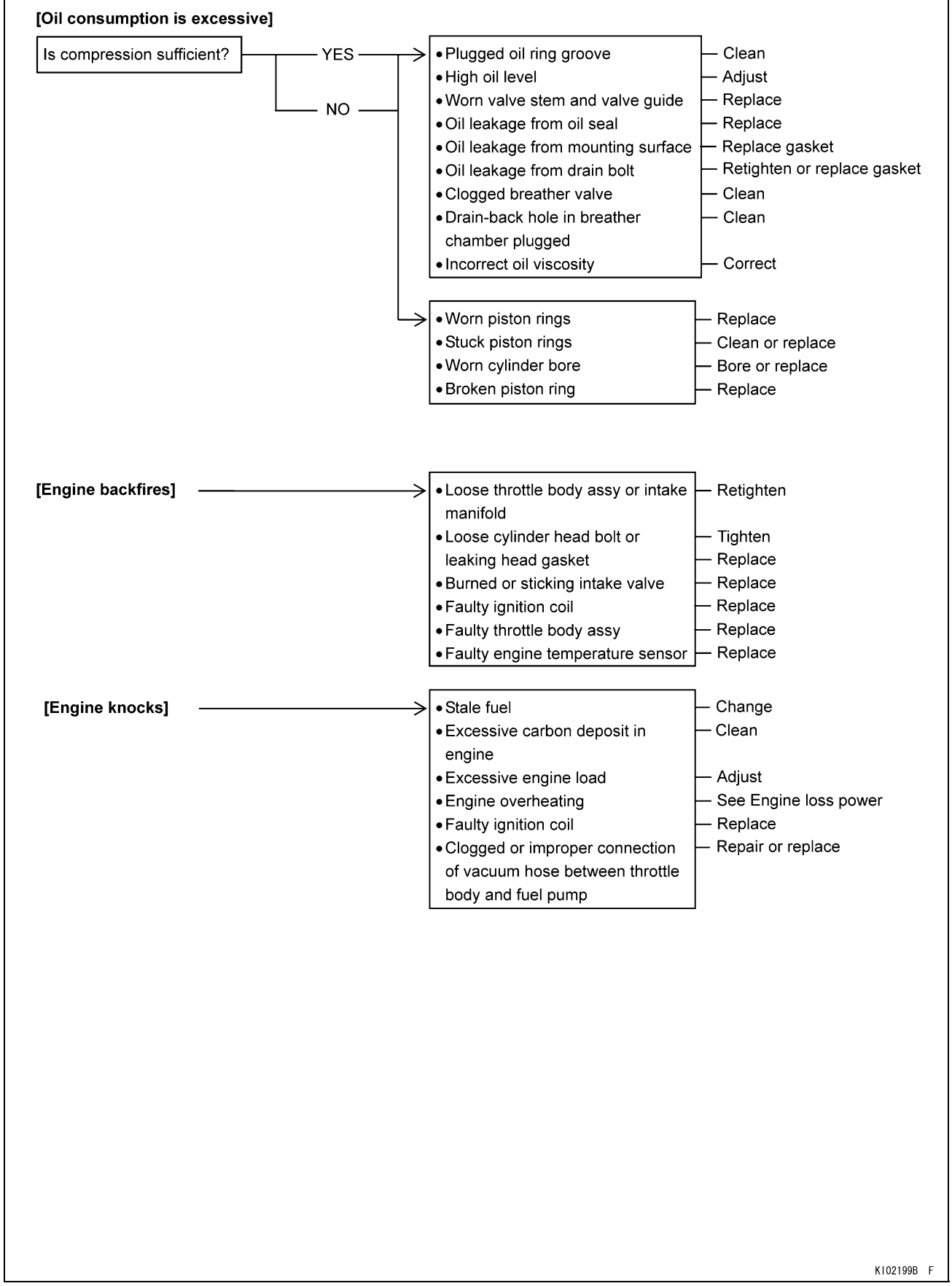
[Engine malfunctions at low speed]



[Fuel consumption is excessive]



Engine Troubleshooting Guide



Engine Troubleshooting Guide

EFI System Troubleshooting

Troubleshooting guide shows the relationship between systems and inspection items which could be causing the trouble.

Operations ↓ / Symptoms →		Engine will not start	Engine starts but falls to keep running	Engine runs but misses	Engine will not idle	Engine runs erratically	Engine loses power	Engine does not maintain constant speed (surges)	Engine overheats	Engine knocks	Engine back fires	Engine after fires	Exhaust smokes excessively	Excessive fuel consumption	
Fuel pump inspection		●	●		●		○								
Fuel pump relay inspection		●	○												
Fuel injection	Aural inspection	●	○		●	○	○					○		○	
	Injector signal inspection	○			○			○	○	○	○	○			
Crankshaft position sensor inspection		●	●												
Fuel pressure inspection		●	●	●	●	○	●	●	●	●	●	○	●	●	
Fuel leak inspection		○	○		○	○	●		●	●		○		●	
Fuel system cleaning		○	○		○	●	●	○	○		○	○	●	●	
Fuel filter inspection		○	○		○	○	●	○			○	○	○	●	
Engine temperature sensor inspection		○		○			○	○	○	○	●	●	●	●	
Intake air vacuum tube inspection		○	○	●	●	○	○	●	○	●	○	○	○	●	
Throttle valve inspection			●		●	●		●							
Harness inspection		●	●	○		●	●	○	●	●	●	●	●	○	
Air leak inspection		○	○		●	●	○	●	●	●	○	○		○	
Replace ECU		●	○	○	○	○	●	○	○	○	●	○	●	●	

NOTE

○*For troubles in digital fuel injection system only. Prerequisite is that the ignition system and the engine be in satisfactory condition.*

● : Main inspection items
○: Subordinate inspection items

Starter Motor Troubleshooting Guide

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

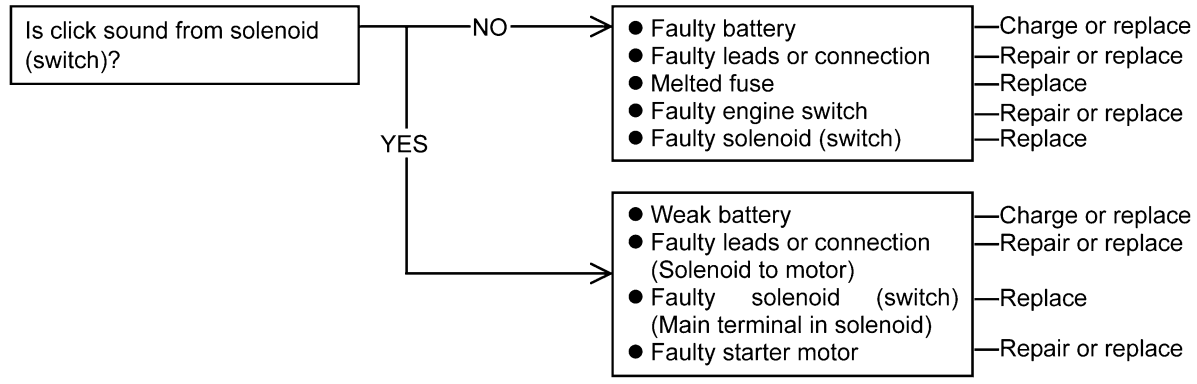
⚠ WARNING

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.

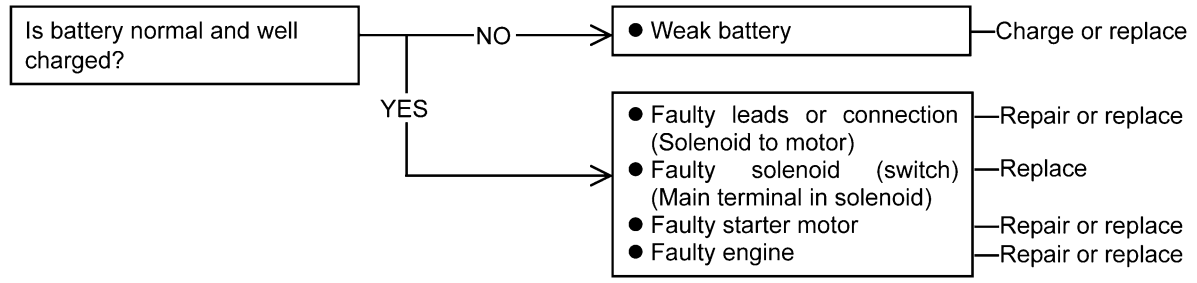
NOTICE

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

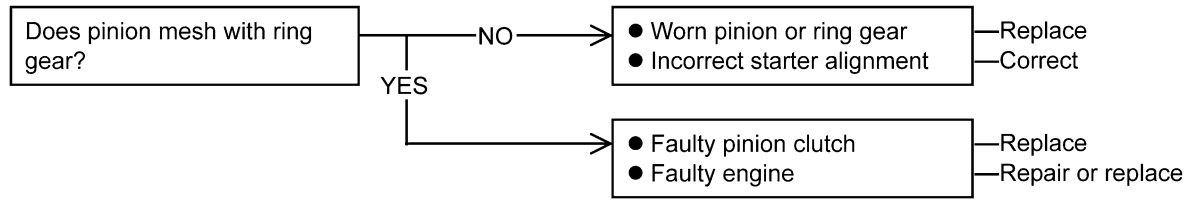
[Starter does not rotate]



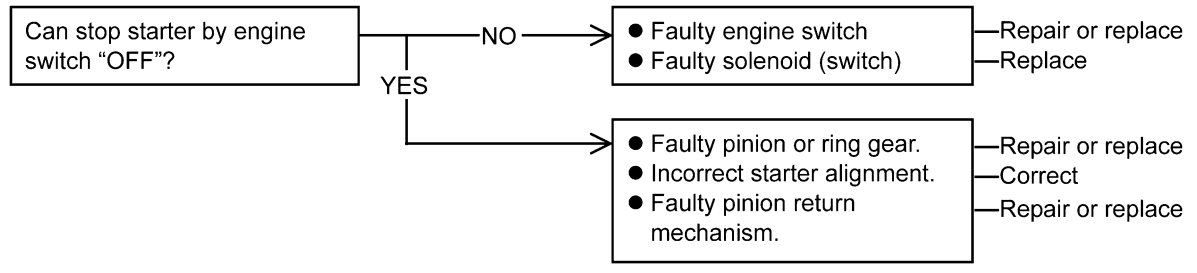
[Starter rotates but slow]



[Starter rotates but engine can not crank]



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



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