Kawasaki

ENGINES

SERVICE MANUAL

4-STROKE LIQUID COOLED V-TWIN GASOLINE ENGINE

FD851D DFI

P/N 99924-2097-02

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

FD851D DFI

4-Stroke Liquid-Cooled V-Twin Gasoline Engine

Service Manual

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2nd Edition (0) : June. 3, 2010

LIST OF ABBREVIATIONS

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

EMISSION CONTROL INFORMATION

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

1. **Crankcase Emission Control System**

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

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

2. **Exhaust Emission Control System**

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

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

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

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

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

- Carburetor or DFI 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 hose

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 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.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate 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

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

- Indicates a procedural step or work to be done.

○Indicates a procedural sub-step or how to do the work of the procedural step it follows. It also precedes the text of a NOTE.

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

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

General Information

Table of Contents

1-2 GENERAL INFORMATION

Before Servicing

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

Especially note the following

(1) Dirt

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

(2) Battery Ground

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

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

(3) Tightening Sequence

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

(4) Torque

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

(5) Force

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

(6) Edges

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

(7) High-Flash Point Solvent

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

(8) Gasket, O-ring

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

(9) Liquid Gasket, Non-Permanent Locking Agent

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

(10) Press

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

(11) Ball Bearing, Needle Bearing

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

Before Servicing

(12)Oil Seal and Grease Seal

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

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

(13)Seal Guide

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

(14)Circlip, Retaining Ring and Cotter Pin

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

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

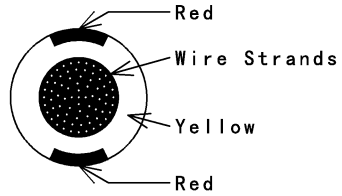
(15)Lubrication

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

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

(16)Electrical Wires

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

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

GBO20601W1 C

(17)Replacement Parts

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

(18)Inspection

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

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

(19)Service Data

Service Data terms are defined as follows:

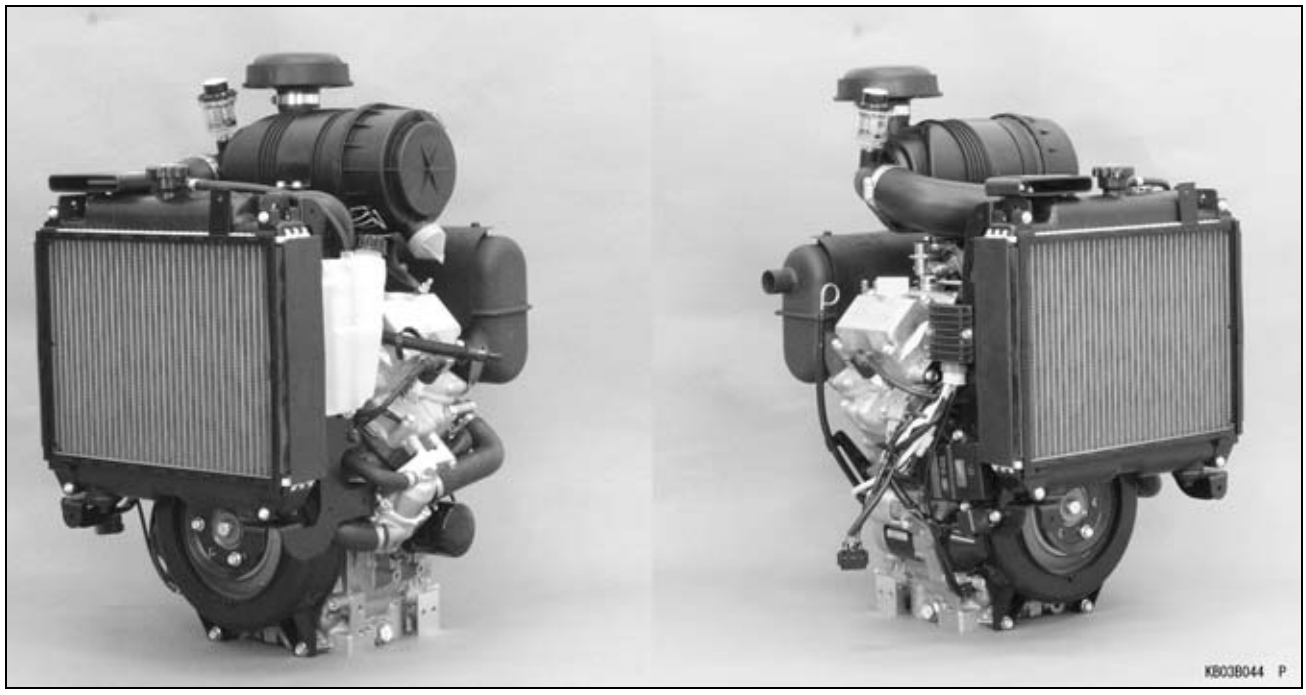
"Standards" show dimensions or performances which brand-new parts or systems have.

Before Servicing

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

Model Identification

FDI851D DFI



Cylinder Number Designation:

No.1 Cylinder. is on the oil filter side.

No.2 Cylinder. is on the electric starter side.

General Specifications

Items	FD851D DFI
Type of Engine	Liquid-cooled, OHV, 4-stroke, gasoline engine.
Cylinder Layout	90° V-Twin
Bore × Stroke	82 mm × 78 mm (3.23 in. × 3.07 in.)
Piston Displacement	824 mL (50.3 cu in.)
Direction of Rotation	Counterclockwise facing the PTO shaft end
Low Idle Speed	1 550 rpm
High Idle Speed	3 600 rpm
Ignition System	Battery, Full transistor
RFI	Per Canada and U.S.A. requirements
Starting System	Shift type electric starter
Charging System	12 V - 20 A with regulator 12 V - 30 A with regulator
Fuel System	DFI (Digital Fuel Injection)
Fuel Pump	Electro magnetic pump (in-line type)
Air Cleaner	Dual stage element, heavy duty type
Lubrication System	Pressure feed by positive displacement pump
Oil Filter	Cartridge type full flow filter
Oil Pressure switch	ON-OFF switch
Oil Capacity	1.8 L (1.9 US qt) (When oil filter is not removed) 2.0 L (2.1 US qt) (When oil filter is removed)
Cooling System	Pressurized forced circulation type
Radiator	2-rows with louverless corrugated fin (aluminum)
Dimensions (H × W × L)	713 mm × 523 mm × 451 mm (28.1 in. × 20.6 in. × 17.8 in.)
Dry Weight (without muffler)	57.5 kg (127 lb)

Specifications are subject to change without notice.

Periodic Maintenance

Table of Contents

2-2 PERIODIC MAINTENANCE

Periodic Maintenance Chart

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

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

OPERATION	INTERVAL								
	Daily	First 8 hr.	Every 25 hr.	Every 100 hr.	Every 200 hr.	Every 250 hr.	Every 300 hr.	Every 400 hr.	Every 500 hr.
Check and add engine oil	●								
Check coolant level in the overflow reservoir	●								
Check for loose or lost bolts, nuts, and screws	●								
Check for fuel and oil leakage	●								
Check battery electrolyte level	●								
Check and clean radiator screen	●								
Tighten bolts, nuts, and screws			●						
Change engine oil		●		●					
Clean and regap spark plugs				●					
Inspect radiator and hoses leakage					●				
Change oil filter					●				
Replace air cleaner primary element (1)						●			
Check air cleaner secondary element (1)						●			
Replace air cleaner secondary element (1)									●
♦ Clean combustion chambers							●		
♦ Check and adjust valve clearance							●		
♦ Clean and lap valve seating surface							●		
♦ Inspect radiator and hoses					●				
♦ Check fan belt conditions and tension					●				
♦ Change coolant								●	

(1): Service more frequently under dusty conditions.

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

Torque and Locking Agent

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

Letters used in the “Remarks” column mean:
EO: Apply oil to the threads.
Lh: Left-hand threads.
R: Replacement Parts
S: Tighten the fasteners following the specified sequence.
SS: Apply silicone sealant.

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Fuel System (DFI)				
Governor Arm Clamp Nut	8	0.8	71 in·lb	Lh
Throttle Body and Intake Pipe Mounting Bolts	12	1.2	106 in·lb	
Throttle Body and Intake Pipe Mounting Nuts	12	1.2	106 in·lb	
Water Temperatur Sensor	22	2.2	16	SS
Cooling System				
Cooling Fan Mounting Bracket Bolts	20	2.0	15	
Cooling Fan Belt Pulley Mounting Bolts	20	2.0	15	
Thermostat Tightening Bolts	10	1.0	89 in·lb	
Water Hose Clamp Screws	1.3	0.13	12 in·lb	
Engine Top End				
Connecting Rod Big End Cap Bolts	21	2.1	15	EO
Cylinder Head Bolts	27	2.8	20	S
Exhaust Pipe Nuts	20	2.0	15	
Muffler Bracket Bolts	20	2.0	15	
Rocker Arm Bracket Bolts	22	2.2	16	
Rocker Cover Bolts	10	1.0	89 in·lb	
Spark Plugs	25	2.6	18	
Valve Clearance Adjusting Locknuts	11	1.1	96 in·lb	
Lubrication System				
Engine Oil Drain Plugs	25	2.6	18	
Oil Level Gauge Mounting Bolt	22	2.2	16	
Oil Filter Joint Pipe	27	2.8	20	
Oil Pressure Switch	15	1.5	11	SS
Camshaft/Crankshaft				
Connecting Rod Big End Cap Bolts	21	2.1	15	EO
Crankcase Cover Bolts	22	2.2	16	S
Starter System				
Starter Motor Mounting Bolts	20	2.0	15	
Electrical System				
Flywheel Bolt	56	5.7	41	
Spark Plugs	25	2.6	18	

2-4 PERIODIC MAINTENANCE

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

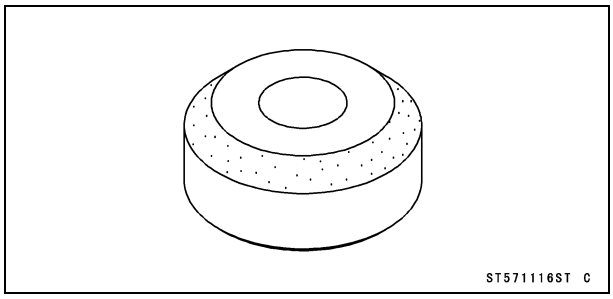
Specifications

Item	Standard
Fuel System (DFI)	
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	Heavy duty type
Pre-cleaner	Primary element
Second-stage cleaner	Secondary element
Cooling System	
Coolant:	
Type (Recommended)	Permanent type of antifreeze
Color	Green
Mixed Ratio	Soft water 50%, coolant 50%
Freezing Point	–35°C (–31°F)
Total Amount	2.7 L (2.8 US qt)
Engine Top End	
Valve Clearance:	
Intake, Exhaust	0.15 mm (0.006 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake, Exhaust	0.5 ~ 1.1 mm (0.020 ~ 0.043 in.)
Lubrication System	
Engine Oil:	
Type	SF, SG, SH, SJ or SL class
Viscosity	SAE 40, SAE 30, SAE 20W-50, SAE 10W-30/SAE 10W-40, or SAE 5W-20
Capacity	1.8 L (1.9 US qt) (When filter is not removed)
	2.0 L (2.1 US qt) (When filter is removed)
Level	Between Upper [H] and Lower [L] level lines
Electrical System	
Spark Plug	NGK BPR5ES
Spark Plug Gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)

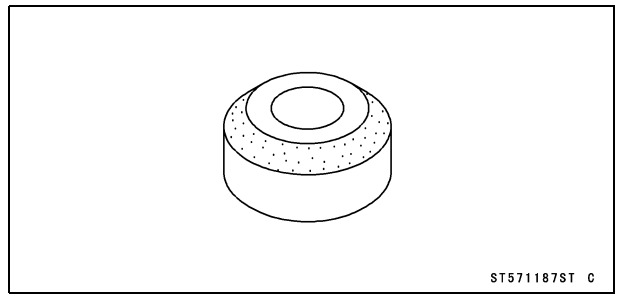
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

Special Tools

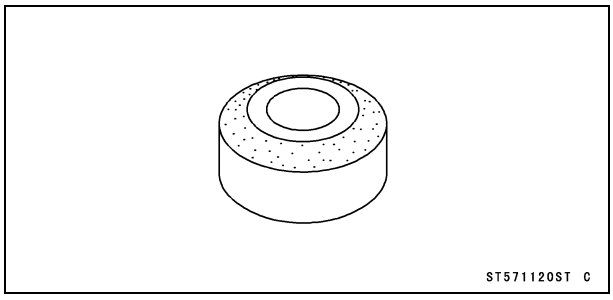
Valve Seat Cutter, 45° - ϕ35:
57001-1116



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



Valve Seat Cutter, 32° - ϕ30:
57001-1120



Valve Seat Cutter, 32° - ϕ33:
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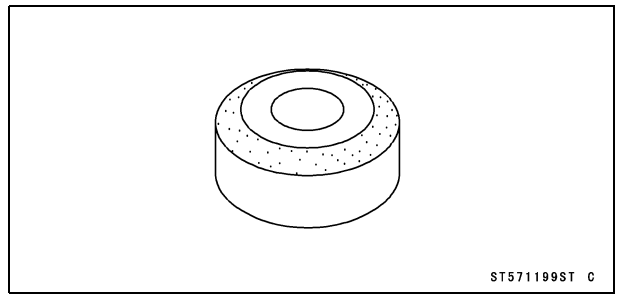
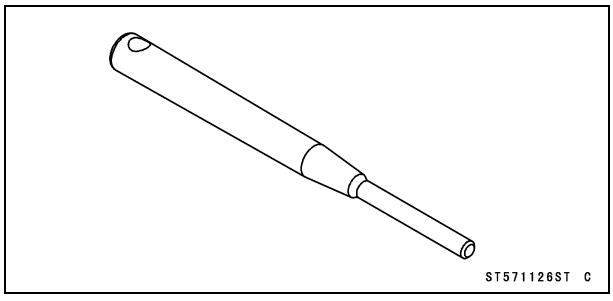
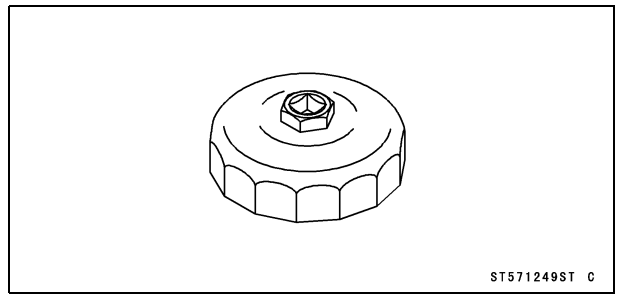


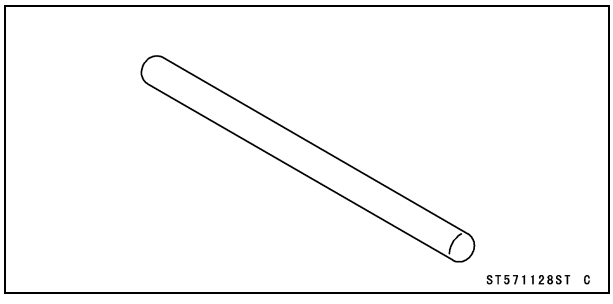
Valve Seat Cutter Holder, ϕ7:
57001-1126



Oil Filter Wrench:
57001-1249



Valve Seat Cutter Holder Bar:
57001-1128



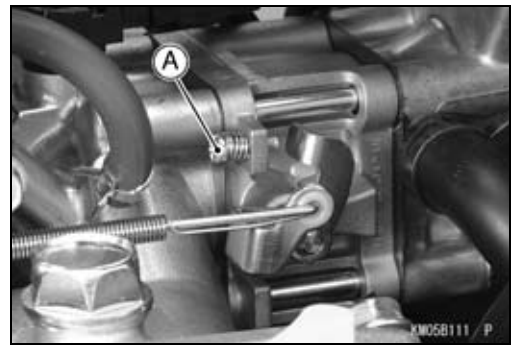
Periodic Maintenance Procedures

Fuel System (DFI)

NOTE

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

Low Idle Speed Adjustment



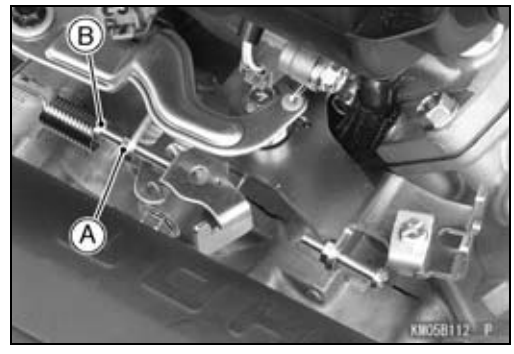
- Disconnect all possible external loads from the engine.
- Start the engine and warm it up thoroughly.

⚠ WARNING

Moving parts can cause severe injury. Keep your hands clear of the moving parts.

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

Low Idle Speed (Throttle body assy idle rpm)
1 450 r/min (rpm)



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

Low Idle Speed (Governor idle rpm)
1 550 r/min (rpm)

- Tighten the locknut.

High Idle Speed Adjustment

NOTE

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

NOTICE

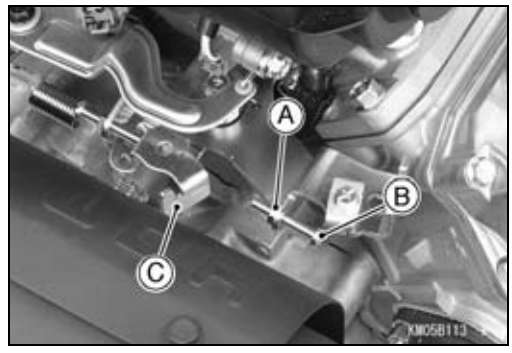
Do not adjust high idle speed with the air cleaner removed.

- Start and warm up the engine thoroughly.

Periodic Maintenance Procedures

⚠ WARNING

Moving parts can cause severe injury. Keep your hands clear of the moving parts.



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

High Idle Speed
3 600 r/min (rpm)

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

NOTICE

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

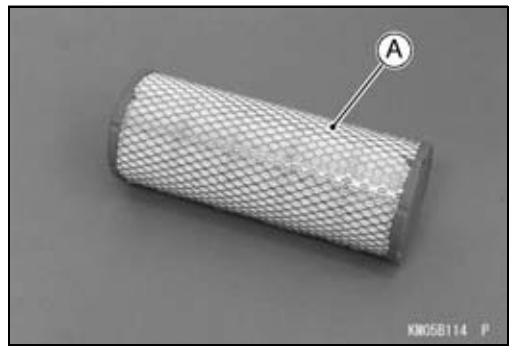
Element Cleaning and Inspection

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

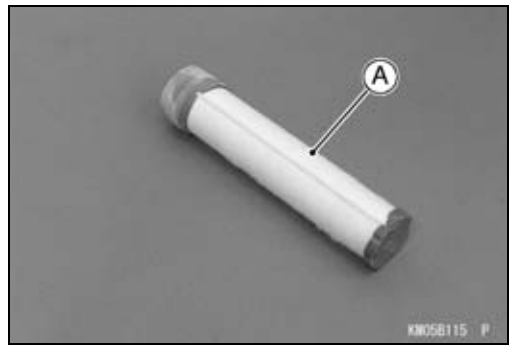
NOTE

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

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



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

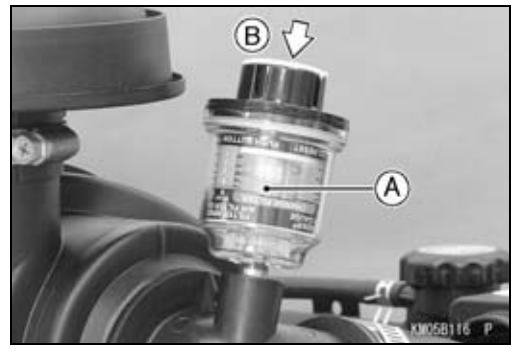


NOTICE

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

Periodic Maintenance Procedures

- Install the elements (see Element Installation in the Fuel System chapter).
- Reset the Air Filter Restriction Gauge [A] (push [B] its reset button).



Air Cleaner Housing (Cap and Body) Inspection

- Remove:
  Elements (see Element Removal in the Fuel System (DFI) chapter)
  Air Cleaner Housing (see Air Cleaner Body and Bracket Removal in the Fuel System (DFI) 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.

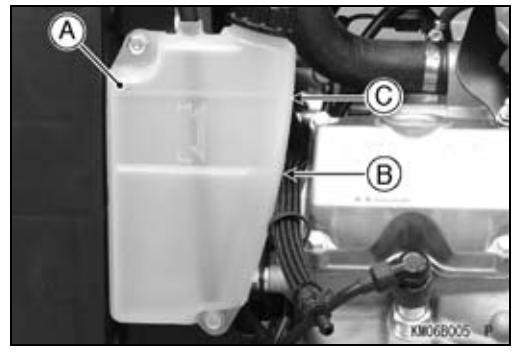
- Check that no foreign material is obstructing the air passage.

Cooling System

Coolant Level Inspection

NOTE

○*Check the level when the engine is cold (room or ambient temperature).*



- Put the engine on a level surface.
- Check the coolant level in the reserve tank [A].

★If the coolant level is lower than the “L” level line [B], remove the reserve tank cap and add coolant to the “H” level line [C].
“L”: Low
“H”: High

NOTICE

For refilling, add the specified mixture of coolant and soft water. Adding water alone dilutes the coolant and degrades its anticorrosion properties. The diluted coolant can attack the aluminum engine parts. In an emergency, soft water alone can be added. But the diluted coolant must be returned to the correct mixture ratio within a few days.
If coolant must be added often or the reservoir tank has run completely dry, there is probably leakage in the cooling system. Check the system for leaks.

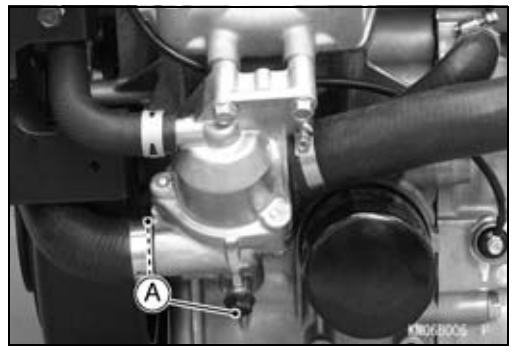
Periodic Maintenance Procedures

Coolant Change

⚠ WARNING

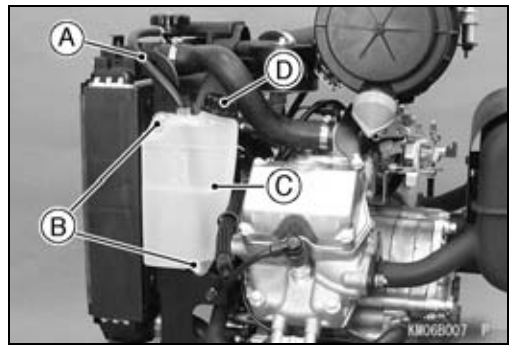
Coolant can be extremely hot and cause severe burns, is toxic and very slippery. Do not remove the radiator cap or attempt to change the coolant when the engine is hot; allow it cool completely. Immediately wipe any spilled coolant from tires, frame, engine or other painted parts. Do not ingest coolant.

- Place a container under the drain plugs [A].
- Drain the coolant from the radiator by removing the drain plugs.



- Remove:
  Radiator Overflow Hose [A]
  Bolts [B]
  Coolant Reserve Tank [C]
  Cap [D]
- Pour the coolant into a container.
- Tighten the coolant reserve tank mounting bolts.
- Tighten the drain plugs with gasket.

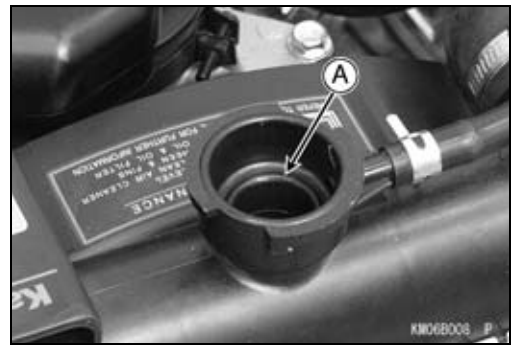
○Replace the drain plug gaskets with new one.



- Remove the radiator cap [A].

○Remove the radiator cap in two steps. First turn the cap counterclockwise to the first stop. Then push and turn it further in the same direction and remove the cap.

Periodic Maintenance Procedures



● Fill the radiator up to the radiator filler neck [A] with coolant, and install the radiator cap.

NOTE

○*Pour in the coolant slowly so that it can expel the air from the engine and radiator.*

● Fill the reserve tank up to the "H" level line with coolant, and install the cap and radiator overflow hose (see Coolant Level Inspection).

NOTICE

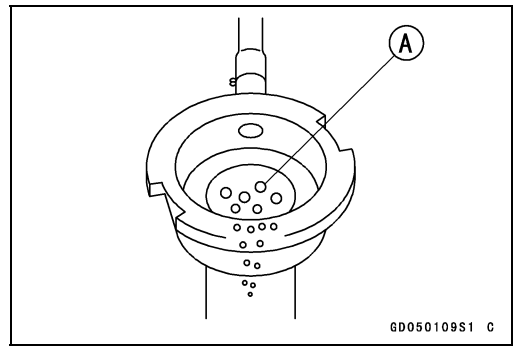
Soft or distilled water must be used with the antifreeze (see below for antifreeze) in the cooling system.
If hard water is used in the system, it causes scales accumulation in the water passages, and considerably reduces the efficiency of the cooling system.

Water and Coolant Mixture Ratio (Recommended)

Soft Water:	**50%**
Coolant:	**50%**
Freezing Point:	**–35°C (–31°F)**
Total Amount:	**2.7 L (2.8 US qt)**

NOTE

○*Choose a suitable mixture ratio by referring to the coolant manufacturer's directions.*



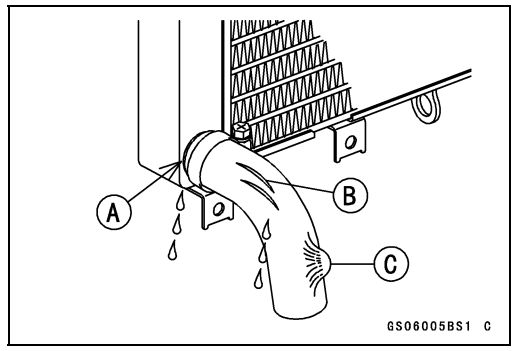
● Bleed the air from the cooling system as follows.
○Start the engine with the radiator cap removed and run it until no more air bubbles [A] can be seen in the coolant.
○Tap the radiator hoses to force any air bubbles caught inside.
○Stop the engine and add coolant up to the radiator filler neck.
● Install the radiator cap.
● Check the coolant level in the reserve tank after the engine cools down.
★If the coolant level is lower than the "L" level line, add coolant to the "H" level line (see Coolant Level Inspection).

NOTICE

Do not add more coolant above the "H" level line.

Periodic Maintenance Procedures

Radiator (Water) Hose Inspection (coolant leak, damage, installation condition)



○The high pressure inside of the water hose can cause coolant to leak [A] or the hose to burst if the line is not properly maintained.

● Visually inspect the hoses for signs of deterioration. Squeeze the hoses. A hose should not be hard and brittle, nor should it be soft or swollen.

★Replace the hose if any fraying, cracks [B] or bulges [C] are noticed.

● Check that the hoses are securely connected and clamps are tightened correctly.

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

Engine Top End

Cylinder Head Cleaning

● Scrape the carbon deposits from the cylinder head and the exhaust port with a suitable tool [A].

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

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

⚠ WARNING

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

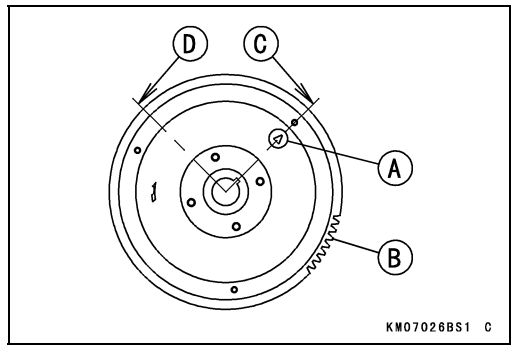
Valve Clearance Inspection

NOTE

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

● Remove the rocker covers (see Cylinder Head Assembly Removal in the Engine Top End chapter).

● Place the piston at the top dead center (TDC) of the compression stroke by turning the crankshaft clockwise facing the flywheel.



No.1 Cylinder:

○Align the triangular mark [A] of the flywheel [B] to the center [C] of the #1 cylinder as shown in the figure.

○Check the intake and exhaust valves are closed completely, if they are not closed, turn the flywheel one turn (360°) clockwise and align the triangular make of the flywheel to the center of the #1 cylinder again.

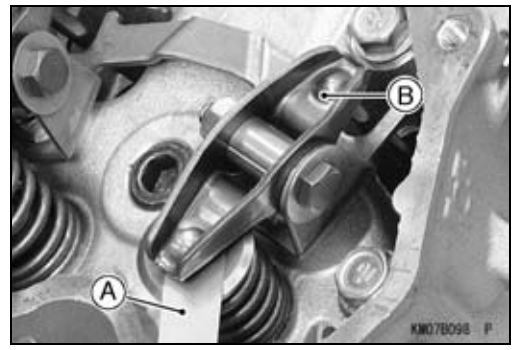
No.2 Cylinder:

○Align the triangular mark of the flywheel to the center [D] of the #2 cylinder. Follow No.1 Cylinder alignment.

Periodic Maintenance Procedures

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

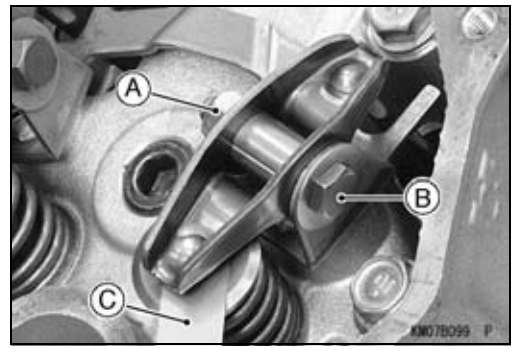
Valve Clearance (when cold)
Intake, Exhaust 0.15 mm (0.006 in.)



Valve Clearance Adjustment

● Since valve repairs change the valve clearance, adjust the valve clearance to the specified.
● 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 0.15 mm (0.006 in.) thickness gauge [C] between the rocker arm and valve stem end, and turn the adjusting bolt until the thickness gauge begin to bind between the rocker arm and valve stem end. Sweep the thickness gauge during this adjustment.

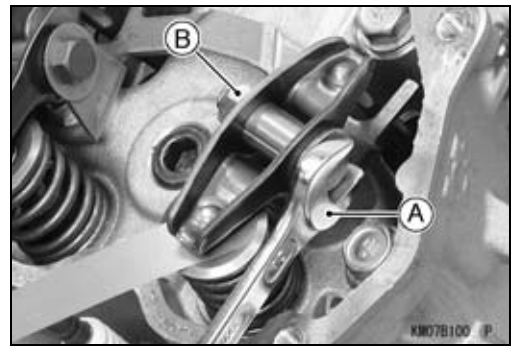
Valve Clearance (when cold)
Intake, Exhaust 0.15 mm (0.006 in.)



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

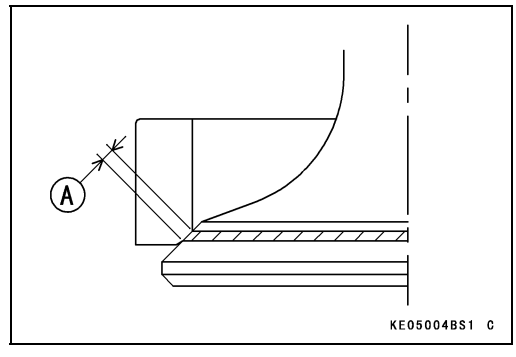
Torque - Valve Clearance Adjusting Locknuts: 11 N·m (1.1 kgf·m, 96 in·lb)

● 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

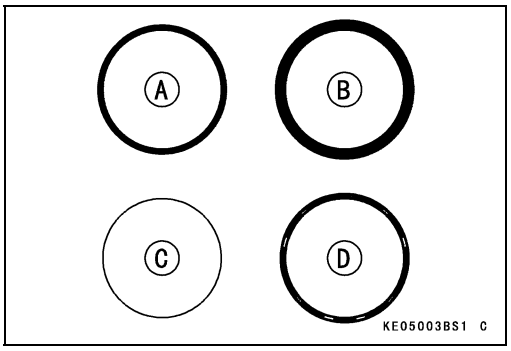
● Remove the valve (see Valve Mechanism Removal/Installation in the Engine Top End chapter).
● Inspect the valve seats for damage.
★If the seats are warped or distorted beyond reconditioning, replace the cylinder head with a new one.
● Pitted or worn valve seats can be refaced. Lap the valves to the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



Periodic Maintenance Procedures

NOTE

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



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

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

Valve Seating Surface Width (STD)
Intake, Exhaust 0.5 ~ 1.1 mm (0.020 ~ 0.043 in.)

Valve Seat Repair

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

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

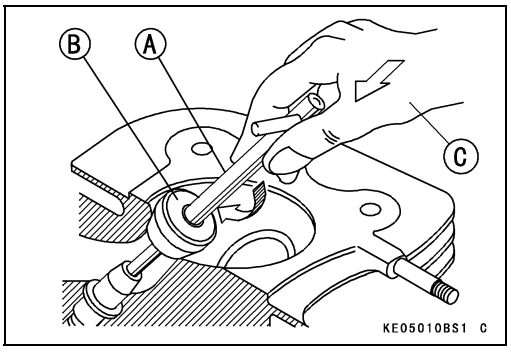
Exhaust Valve
Valve Seat Cutter, 45° - ϕ30: 57001-1187
Valve Seat Cutter, 32° - ϕ30: 57001-1120

Intake Valve
Valve Seat Cutter, 45° - ϕ35: 57001-1116
Valve Seat Cutter, 32° - ϕ33: 57001-1199

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

Seat Cutter Operating Cares

1. This valve seat cutter is designed only for valve seat repair. 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.*

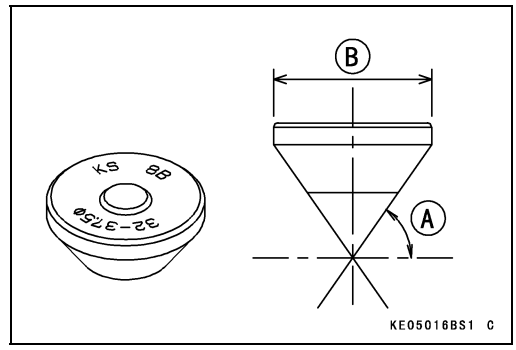
5. After use wash the cutter with washing oil and apply a thin layer of engine oil before storing.

Periodic Maintenance Procedures

Marks Stamped on the Cutter

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

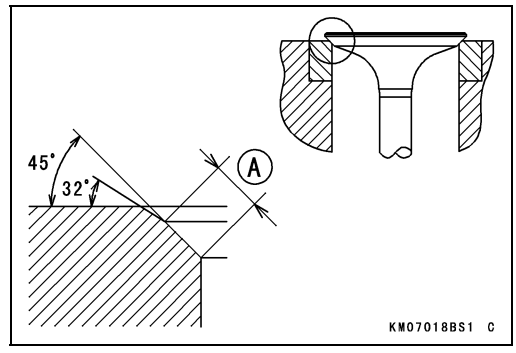
32°	Cutter angle [A]
37.5	Cutter diameter [B]
KS8B	Manufactured lot number



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.



- 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.

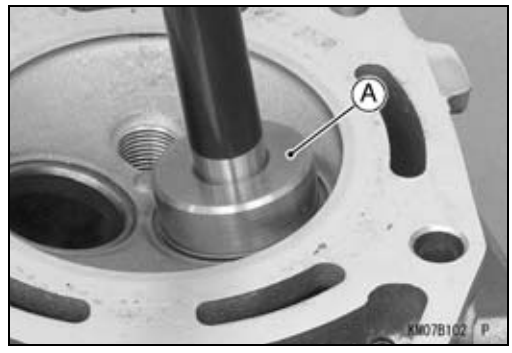
NOTICE

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.

Periodic Maintenance Procedures

● 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.

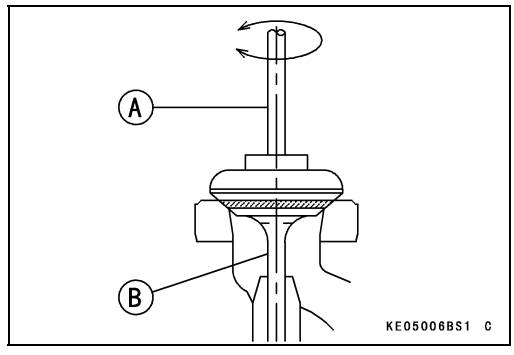
○Apply a machinist's dye to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.

★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 lapper 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.

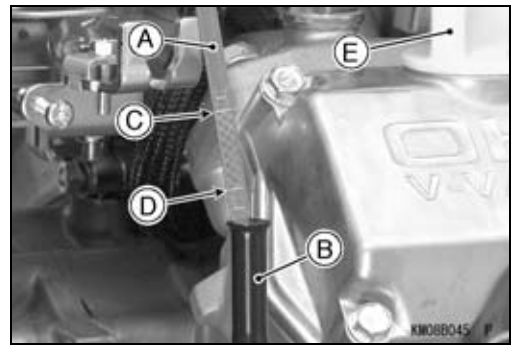
● Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the valve face.

● When the engine is assembled, be sure to adjust the valve clearances (see Valve Clearance Adjustment).

Periodic Maintenance Procedures

Lubrication System

Engine Oil Level Inspection

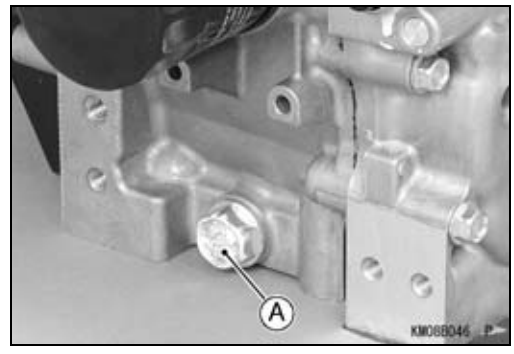


- Place the engine on a level surface and check the oil level.
- Clean the area around the oil gauge [A] before removing it.
- Remove the oil gauge and wipe it with a clean cloth.
- Insert the oil gauge into tube [B] following the tube bend and let it's plug firmly fit into the tube, then check the oil level.
- The oil level should be between the "H" [C] and "L" [D] marks on the oil gauge.

★If the oil level is near or below the "L" mark, remove the oil filler cap [E] and add enough engine oil to bring oil level to the "H" mark.

NOTICE
Do not fill above the "H" mark. Excess oil will cause a smoking condition, and may cause the engine to overheat.

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



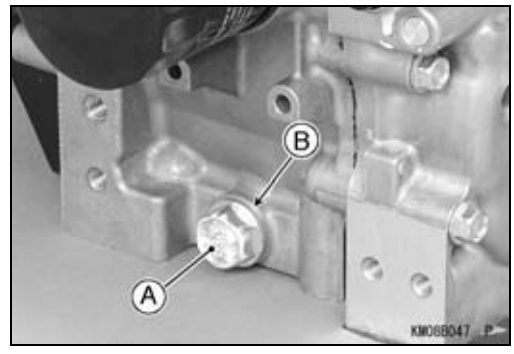
NOTICE
Before starting the engine for the first time, add oil: The engine is shipped dry. Preoil the engine to force all air from the internal oil passages and the oil filter.

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

NOTE

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

Engine Oil Change



- Change 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 gasket [B] with a new one.
- Install the oil drain plug with the gasket and tighten it.

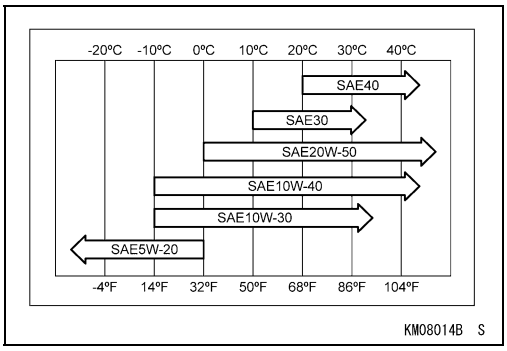
Torque - Engine Oil Drain Plug: 25 N·m (2.5 kgf·m, 18 ft·lb)

Periodic Maintenance Procedures

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

Engine Oil:

Grade:	**SF, SG, SH, SJ or SL Class**
Viscosity:	**SAE40, SAE30, 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]
	2.0 L (2.1 US qt)

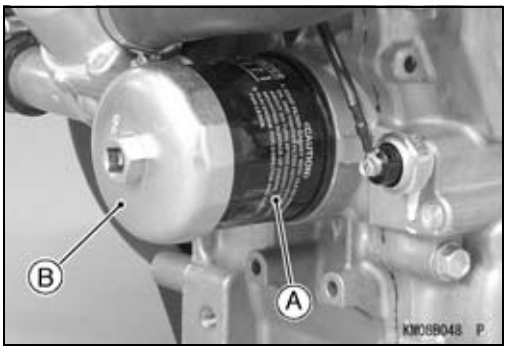


Oil Filter Replacement

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

Special Tool - Oil Filter Wrench: 57001-1249

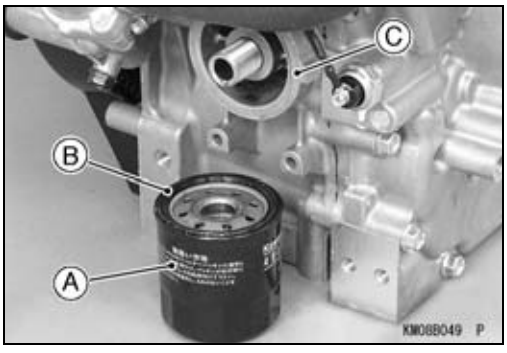
○When unscrewing the oil filter, place a suitable container beneath the oil drip tray to receive oil from the oil filter and oil passages in the engine.



● 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: 17.6 N·m (1.8 kgf·m, 13 ft·lb)

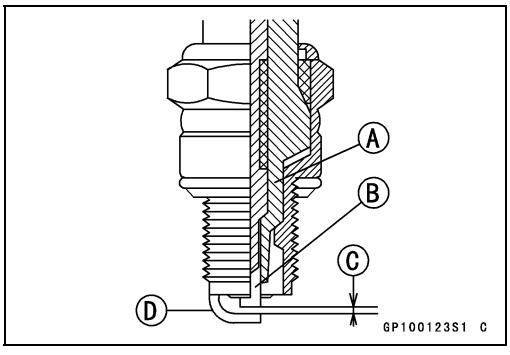
○Turn the filter until the seal contacts mounting surface [C] of the engine. Then turn the filter BY HAND (S) 3/4 turn.
● Run the engine at slow idle speed 3 minutes.
○While running the engine, check for oil leaks around it.
● Stop the engine and check the oil level (see Engine Oil Level Inspection).



Electrical System

Spark Plug Cleaning and Inspection

● Carefully pull the plug cap from the spark plug, and remove the spark plug.
★If the plug is oily or has carbon built up on it, clean the plug using a high-flash point solvent and a wire brush or other suitable tools.
★If the spark plug electrodes are corroded or damaged, or if the insulator is cracked replace the plug with a new one. Use the standard spark plug or its equivalent.
Insulator [A]
Center Electrode [B]
Plug Gap [C]
Side Electrode [D]



Spark Plug Gap Inspection

● Measure the gap with a wire-type thickness gauge.
★If the gap is not correct, carefully bend the side electrode with a suitable tool to obtain the correct gap.

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

Fuel System

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Exploded View

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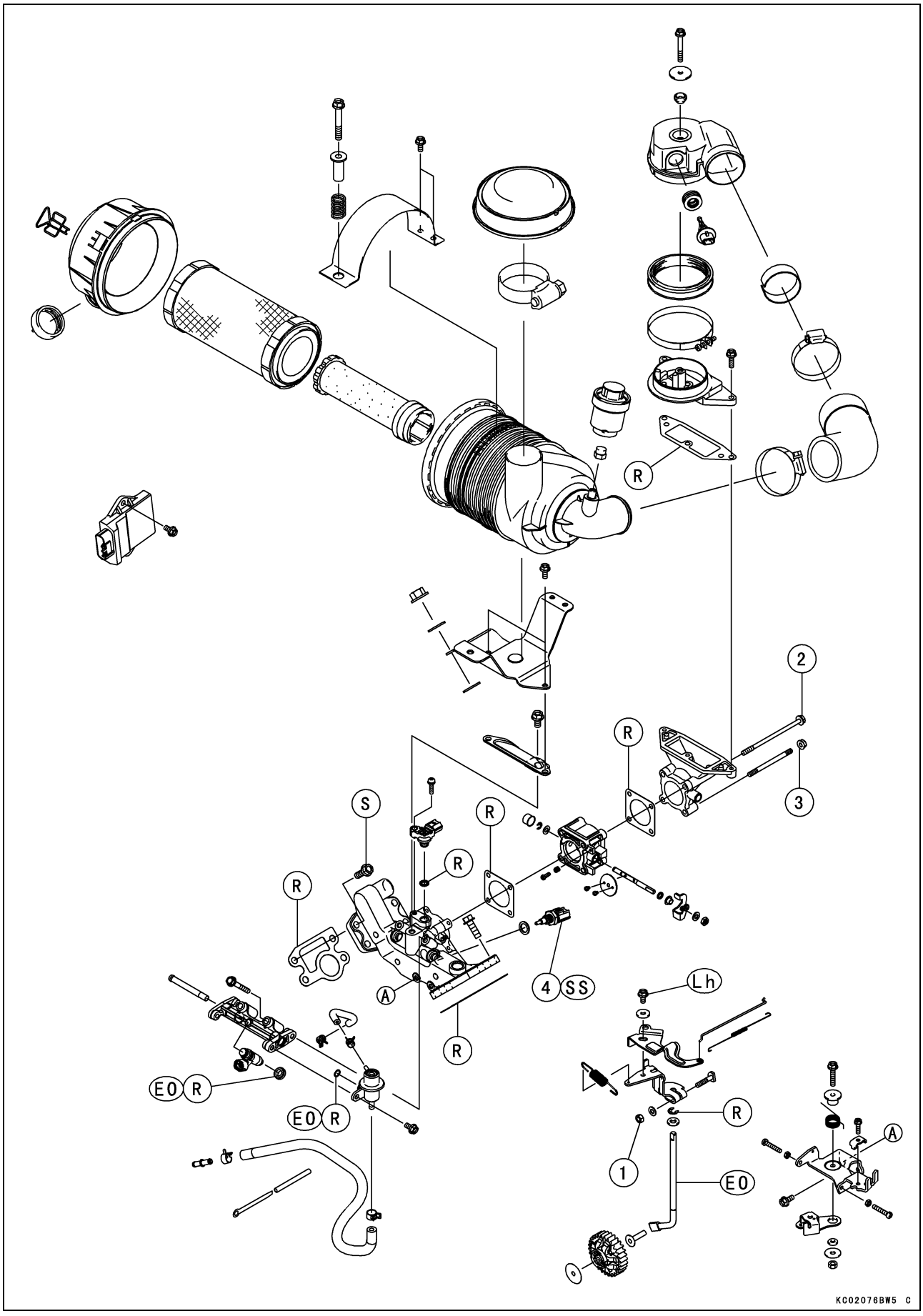
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Governor Arm Clamp Nut	8	0.8	71 in·lb	Lh
2	Throttle Body and Intake Pipe Mounting Bolts	12	1.2	106 in·lb	
3	Throttle Body and Intake Pipe Mounting Nuts	12	1.2	106 in·lb	
4	Water Temperature Sensor	22	2.2	16	SS

EO: Apply engine oil.
Lh: Left-hand threads.
R: Replacement Parts
S: Following the specific tightening sequence.
SS: Apply silicone sealant.

3-6 FUEL SYSTEM

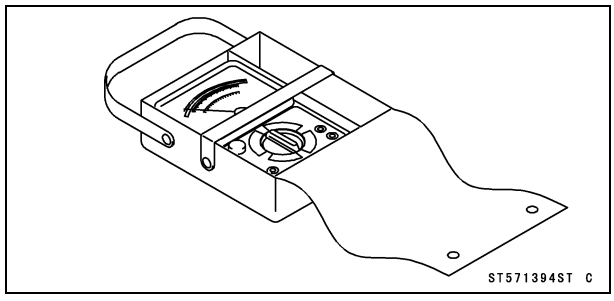
Specifications

Item	Standard
Digital Fuel Injection System	
Throttle Body Assy	
Type	Single barrel type
Bore	30 mm (1.2 in)
ECU (Electronic Control Unit)	
Type	Digital memory type, sealed with resin
Usable Engine Speed	200 ~ 4 450 r/min (rpm)
Pressure Regulator	
Regulated Fuel Pressure	177 kPa (1.80 kgf/cm², 25.7 psi) (for reference)
Intake Air Pressure Sensor:	
Input Voltage	DC 4.75 ~ 5.25 V
Output Voltage	DC 3.26 ~ 4.04 V at standard atmospheric pressure (see this text for details)
Intake Air Temperature Sensor	
Output Voltage	About DC 2.26 ~ 2.50 V at 20°C (68°F)
Resistance	2.21 ~ 2.69 kΩ at 20°C (68°F)
	About 0.322 kΩ at 80°C (176°F) (reference value)
Water Temperature Sensor	
Output Voltage	About DC 2.26 ~ 2.50 V at 20°C (68°F)
Resistance	2.32 ~ 2.59 kΩ at 20°C (68°F)
	0.310 ~ 0.326 kΩ at 80°C (176°F)
	0.140 ~ 0.144 kΩ at 110°C (230°F)
Fuel Injectors	
Nozzle Type	Fine atomizing type with 4 holes
Resistance	12.5 ±0.3Ω at 20°C (68°F)
Fuel Pump	
Type	Electro magnetic pump (in-line type)
Discharge	120 mL or more/3 seconds at high idle speed (3 600rpm)
Idle Speed (1)	
Low Idle Speed	1 550 rpm
High Idle Speed	3 600 rpm
Air Cleaner	
Type	Heavy duty type
Pre-cleaner	Primary element
Second-stage Cleaner	Secondary element
Fuel	
Fuel Requirement	Unleaded regular grade gasoline

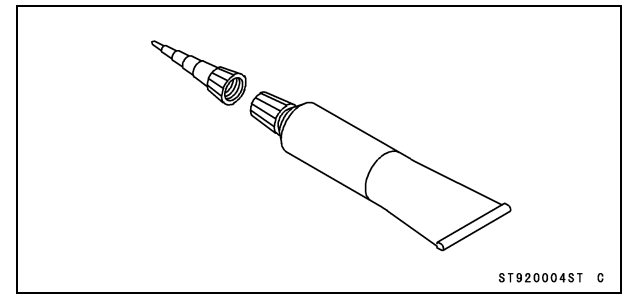
(1) Idle speed may very depending on each equipment. Refer to the equipment specification.

Special Tools and Sealant

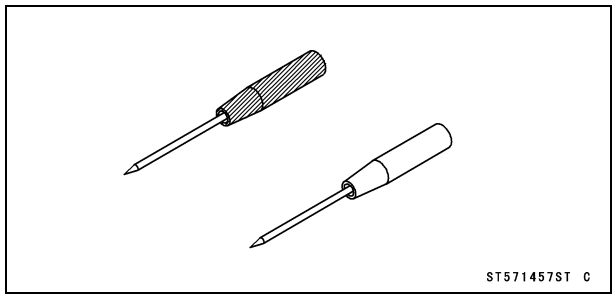
Hand Tester:
57001-1394



Liquid Gasket, TB1211F:
92104-0004

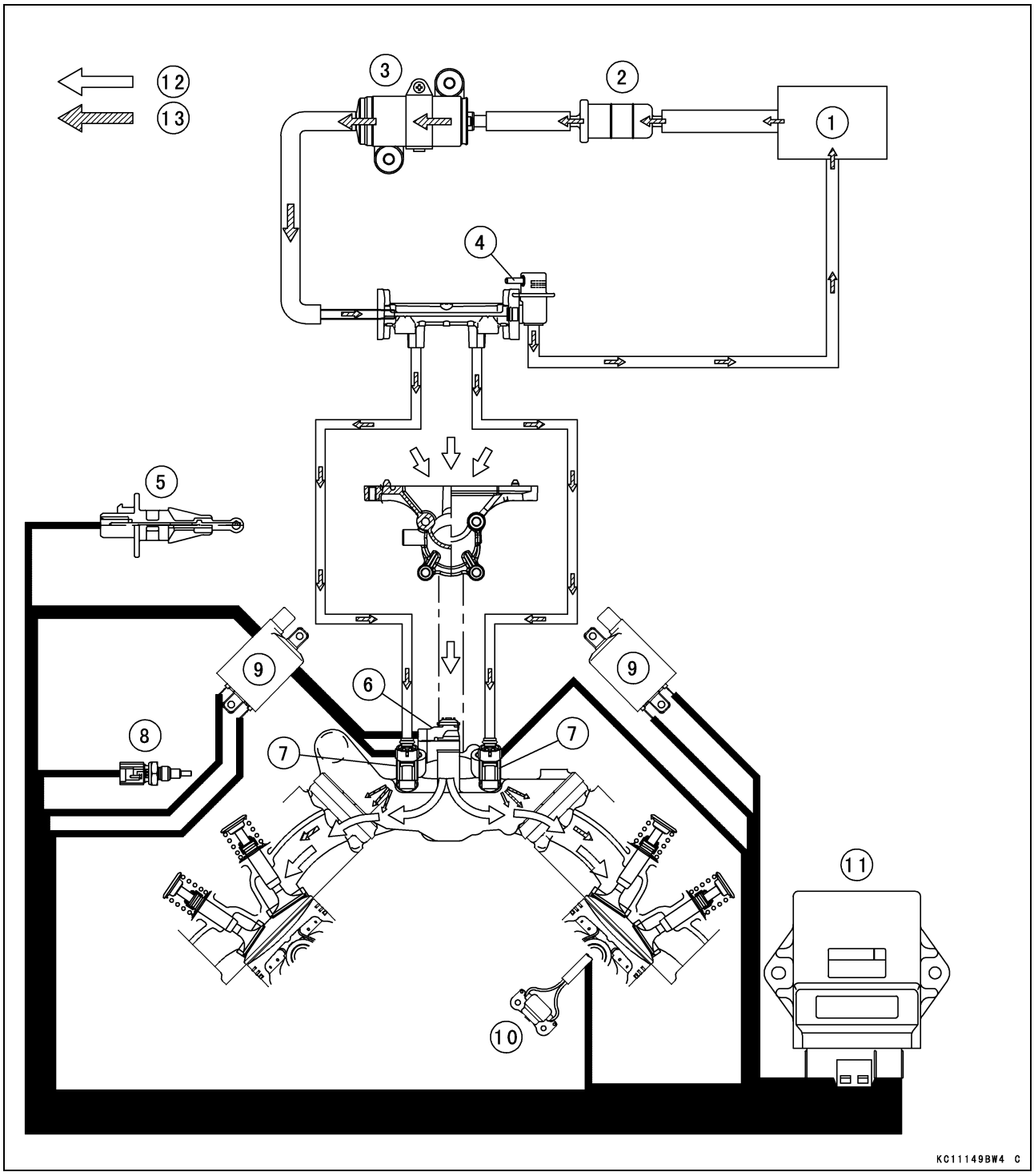


Needle Adapter Set:
57001-1457



Digital Fuel Injection (DFI) System

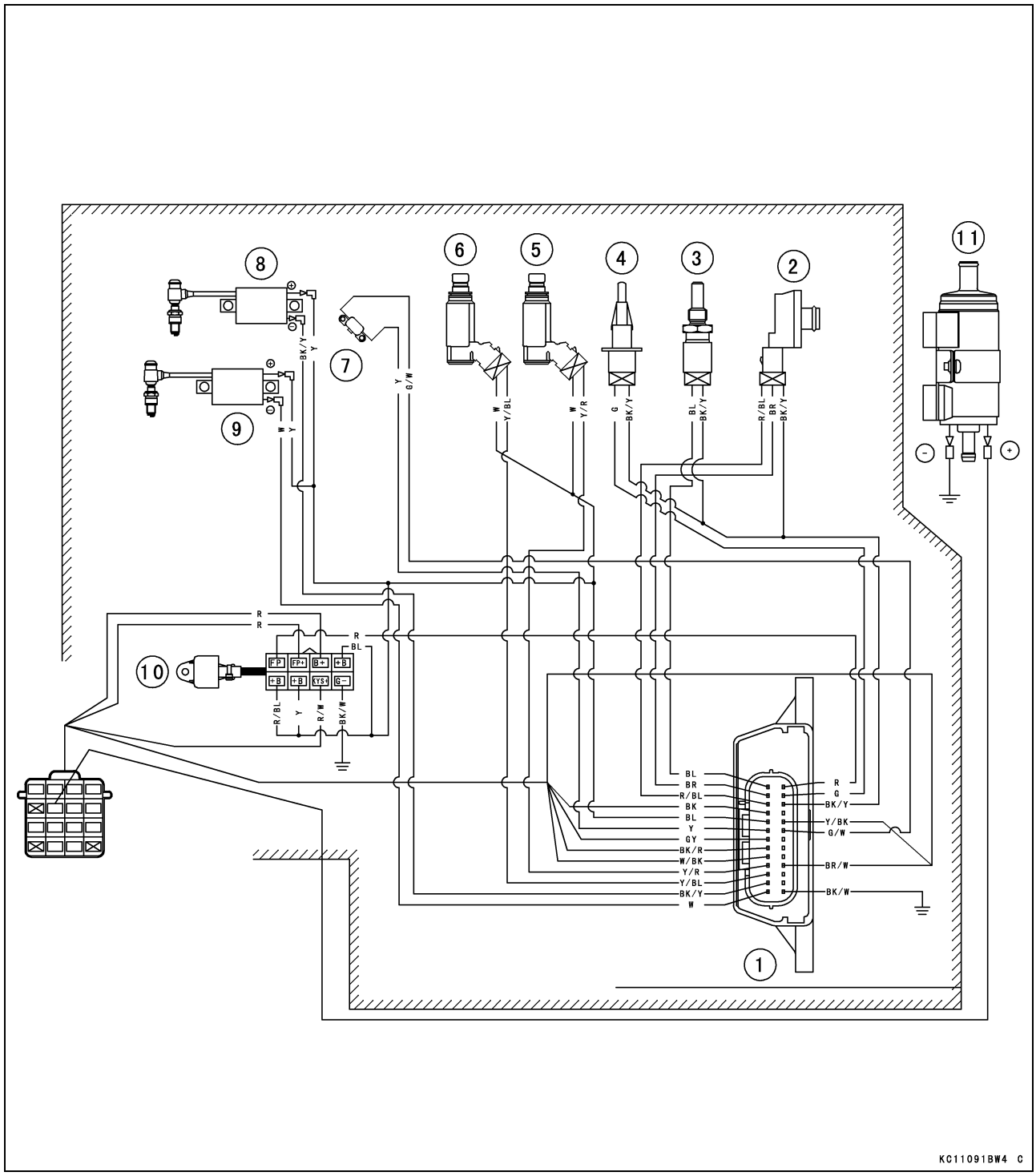
DFI System



1. Fuel Tank
2. Fuel Filter
3. Fuel Pump
4. Fuel Pressure Regulator
5. Intake Air Temperature Sensor
6. Intake Air Pressure Sensor
7. Fuel Injectors
8. Water Temperature Sensor
9. Ignition Coils
10. Crankshaft Sensor
11. ECU (Electronic Control Unit)
12. Air Flow
13. Fuel Flow

Digital Fuel Injection (DFI) System

DFI System Wiring Diagram



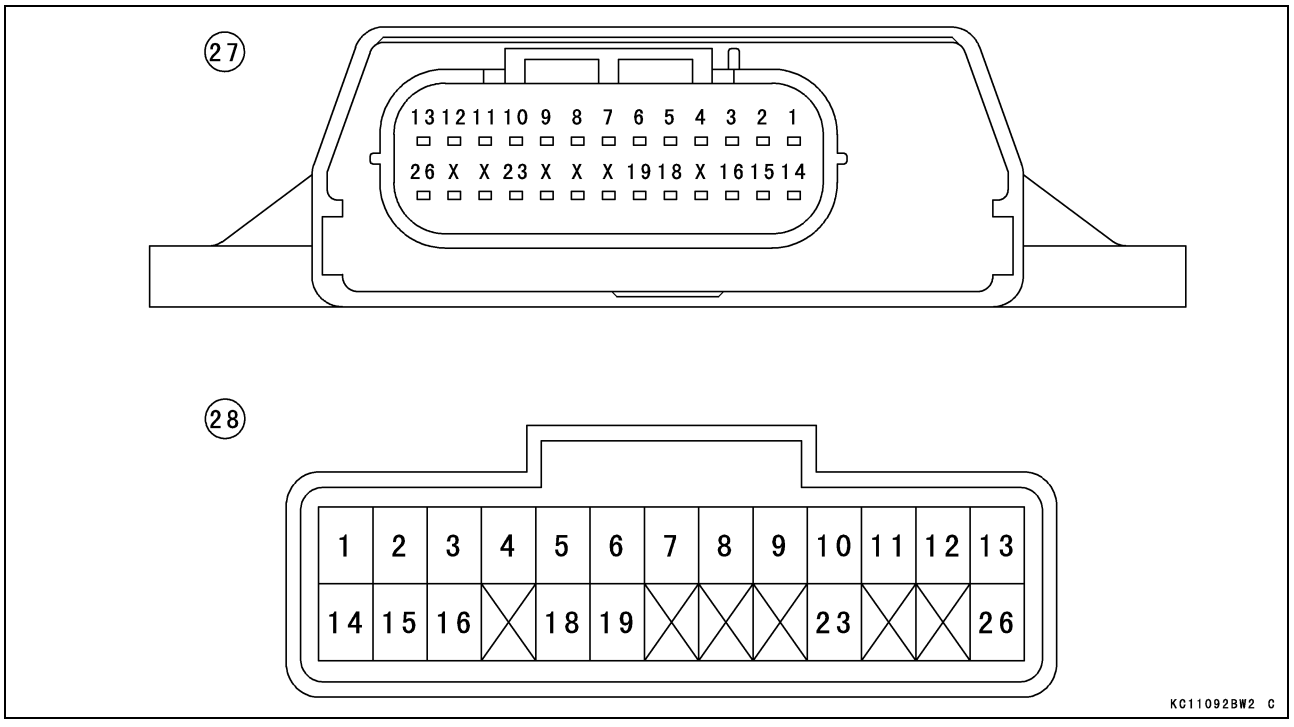
NOTE

○*Portion surrounded by ////// shows KHI procurement pars.*

1. ECU (Electronic Control Unit)
2. Intake Air Pressure Sensor
3. Water Temperature Sensor
4. Intake Air Temperature Sensor
5. Fuel Injector #2
6. Fuel Injector #1
7. Crankshaft Sensor
8. Ignition Coil #2
9. Ignition Coil #1
10. ECU Relay
11. Fuel Pump

Digital Fuel Injection (DFI) System

Terminal Numbers of ECU



1. Water Temperature Sensor
2. Intake Air Pressure Sensor
3. Power Supply to Sensor
4. Ground for Battery
5. Battery 12 V
6. Crankshaft Sensor (+)
7. Map Switch #1
8. Map Switch #2
9. Diagnosis Indicator Light
10. Injector #2
11. Injector #1
12. Ignition Coil #2
13. Ignition Coil #1
14. Fuel Pump Relay
15. Intake Air Temperature Sensor
16. Ground for Sensor
17. Unused
18. Thermo Indicator Light
19. Crankshaft Sensor (–)
20. Unused
21. Unused
22. Unused
23. Seat Switch
24. Unused
25. Unused
26. Ground for Ignition System
27. ECU Side
28. Harness Side

Safety Instruction for DFI System Servicing

There are a number of important precautions that must be observed when servicing the electronic fuel injection system. Failure to observe these precautions can result in serious damage. Learn and observe all the rule listed below.

Electrical System

1. Do not disconnect the battery leads or any other electrical connections when the key switch is on, or while the engine is running. This is to prevent damageing the ECU.

NOTE

○*Whenever electrical connections are to be disconnected, first turn off the key switch, disconnect the lead which connects the fuel injection system harness to the battery positive (+) post and then disconnect the required connection. There are two other leads which are connected to the battery positive post, but these leads can be left connected.*

2. Conversely, make sure that all electrical connections are firmly reconnected before staring the engine.
3. The fuel injection system is designed to be used with a 12 V battery as its power source.

Digital Fuel Injection (DFI) System

4. Always disconnect the battery positive and negative leads from the terminals, and remove the battery from the equipment for charging. This is to prevent the control unit from being damaged by excessive peak voltage.
5. Avoid spraying water with any great pressure on the electric components, connectors, leads, and wiring harness of the electronic fuel injection system.
6. Keep the electronic fuel injection system wiring harness as far apart as possible from the high tension leads of the ignition system. This is to prevent the control unit from malfunctioning due to external electrical noise.
7. If a transceiver is installed on the equipment, make sure that the operation of the fuel injection system is not influenced by electric wave radiated from the antenna. Check operation of the system at the engine idles.

NOTE

○*Locate the antenna as far as possible apart from the control unit. Interference from radio waves can be reduced by grounding the control unit box to the equipment.*

Fuel System

1. Do not operate the fuel pump dry. This is to prevent the pump from running without lubricant at the friction surfaces.
2. Blow the fuel system components with compressed air before removing the parts.

NOTE

○*Any hose clamps on the high pressure fuel line must be replaced with new ones once they are loosened.*

○*Install the hose clamps in the position, and securlly tighten the clamps. Check the fuel system for leaks.*

3. To prevent corrosion and deposits in the fuel system, do not add any antifreeze chemicals.

Air System

1. In order to maintain the correct fuel/air mixture ratio, there should be no air leaks in the system.

Wiring Inspection

- Visually inspect the wiring for signs of burning, fraying, etc.
- Deteriorated wires and bad unstable operation of the DFI system.

★If any wiring is poor, replace the damaged wiring.

- Pull each connector [A] 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.

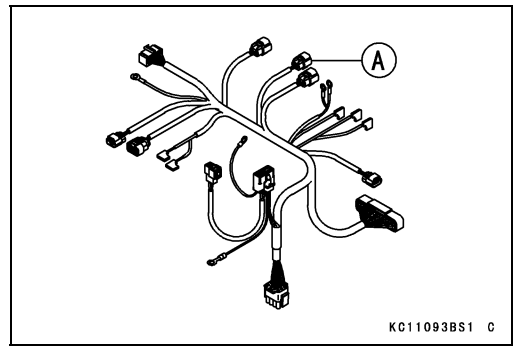
- Check the wiring for continuity.

Special Tool - Hand Tester: 57001-1394

○Use the DFI System Wiring Diagram to find the ends of the lead which is suspected of being a problem.

○Measure the resistance between the ends of the leads.

★If the resistance is not 0 Ω, the wire is defective. Replace the lead or the wiring harness if necessary.



Digital Fuel Injection (DFI) System

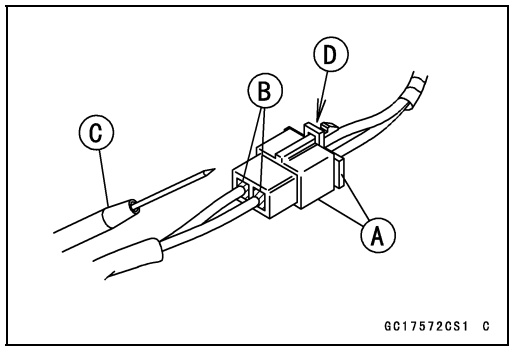
- When checking the DFI parts, use a digital meter which can be read two decimal place voltage or resistance.

○The DFI 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].

Special Tool - Needle Adapter Set: 57001-1457

- Insert the needle adapter inside the seal until the needle adapter reaches the terminal.



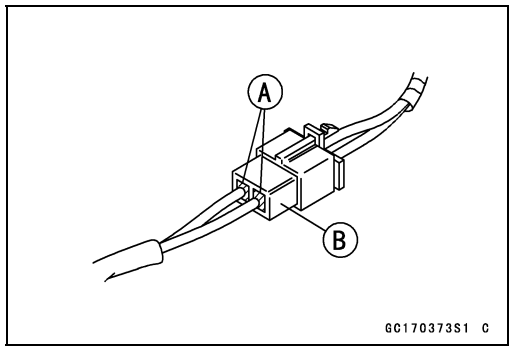
NOTICE
Insert the needle adapter straight along the terminal in the connector to prevent short-circuit between terminals.

- 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 DFI 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 DFI 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



Self-Diagnosis

Self-diagnosis Outline

When an abnormality in the ECU system occurs, the Self -diagnosis light go on to alert the user.

Digital Fuel Injection (DFI) System

Self-diagnosis Procedures

- Turn on the ignition switch. The Self-diagnosis light should go on when the switch is turned on.
- Turn off ignition switch.

★If the bulb does not go on as described above, check the bulb and wiring of the diagnosis light in the chassis side harness.

- Turn on the ignition switch again, the Self-diagnosis light should go on.
- After about five seconds, count the number of blinks of the Self-diagnosis light to read the fault code.

NOTE

○*Use a fully charged battery when conducting Self-diagnosis. Otherwise, the Self-diagnosis light will blink very slowly or not at all.*

How to Read Fault Codes

○Fault codes are shown by a series of long and short blinks of the Self-diagnosis light as shown below.

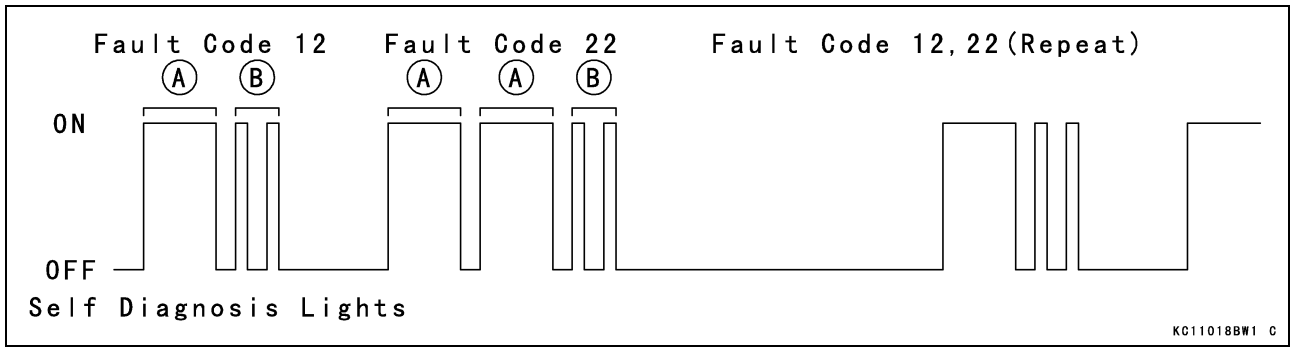
○Read 10th digit and unit digit as the Self-diagnosis light blinks.

○When there are a number of problems, all the fault codes can be stored and the display will begin starting from the lowest number fault code in the numerical order. Then after completing all codes, the display is repeated until the ignition switch is turned OFF.

○If there is no problem, no code is shown.

○For example, if the problems 12 and 22 occur, the fault codes 12 and 22 are shown as follows.

(12 → 22) → (12 →22) → · · · · ·(repeated)



[A]: 10th digit
[B]: Unit digit

Fault Code	Self-diagnoss Light	Problems (1)
12	ON / OFF	Intake air temperature sensor malfunction, wiring open or short
13		Water temperature sensor malfunction, wiring open or short
21		Intake air pressure sensor malfunction, wiring open or short
51		Ignition coil #1 malfunction, wiring open or short
52		Ignition coil #2 malfunction, wiring open or short

Footnotes:

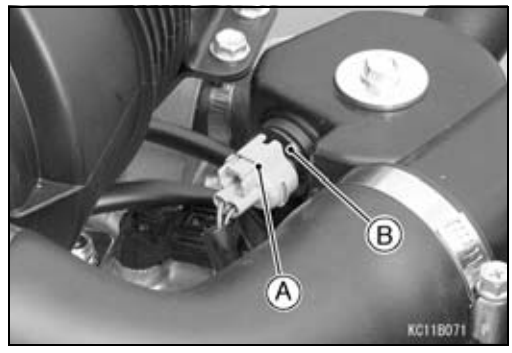
1. The ECU may be involved in these problems. If all the parts, circuits and wiring are good, replace the ECU.

Intake Air Temperature Sensor (Fault Code 12)

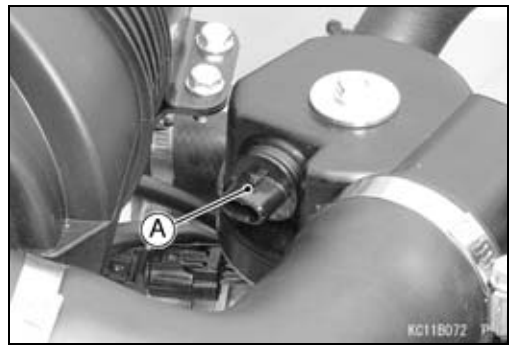
NOTICE
Never drop the intake air temperature sensor, especially on a hard surface. Such a shock to the sensor can damage it.

Intake Air Temperature Sensor Removal

- Disconnect the connector [A] from the intake air temperature sensor [B].

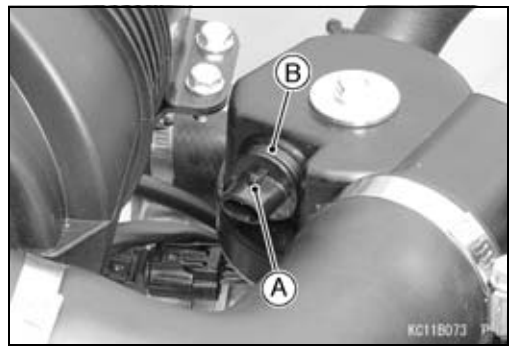


- Pull out the intake air temperature sensor [A].

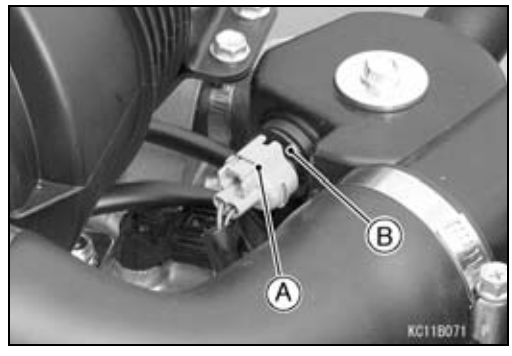


Intake Air Temperature Sensor Installation

- Install the intake air temperature sensor [A] in the grommet [B].

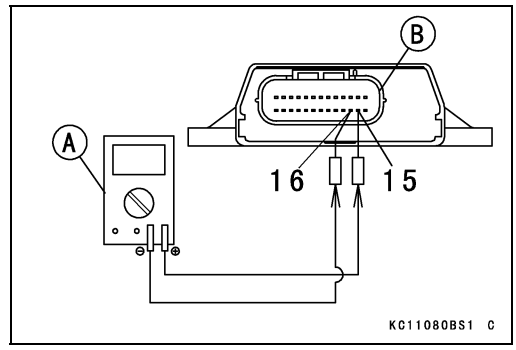


- Connect the connector [A] to the intake air temperature sensor [B].



Digital Fuel Injection (DFI) System

Intake Air Temperature Sensor Output Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Remove the ECU (see ECU Removal).

○Do not disconnect the ECU connector.

- Connect a digital meter [A] to the ECU connector [B], using needle adapter set.

Special Tool - Needle Adapter Set: 57001-1457

- Set the digital meter to the DC 10 V range.

Connections:
Digital Meter (+) → G Lead (ECU terminal 15)
Digital Meter (–) → BK/Y Lead (ECU terminal 16)

- Measure the output voltage with the engine stopped and the connector joined.
- Turn the ignition switch ON.

Intake Air Temperature Sensor Output Voltage
Standard: about 2.26 ~ 2.50 V at 20°C (68°F)

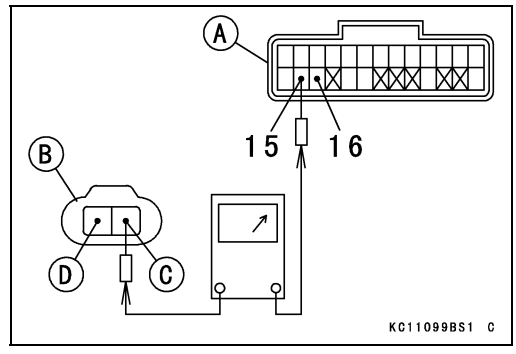
NOTE

○*The output voltage changes according to the intake air temperature.*

- Turn the ignition switch OFF.

★If the reading is within the standard, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).



★If the reading is out of the standard, check the wiring for continuity between main harness connectors with the hand tester and suitable leads.

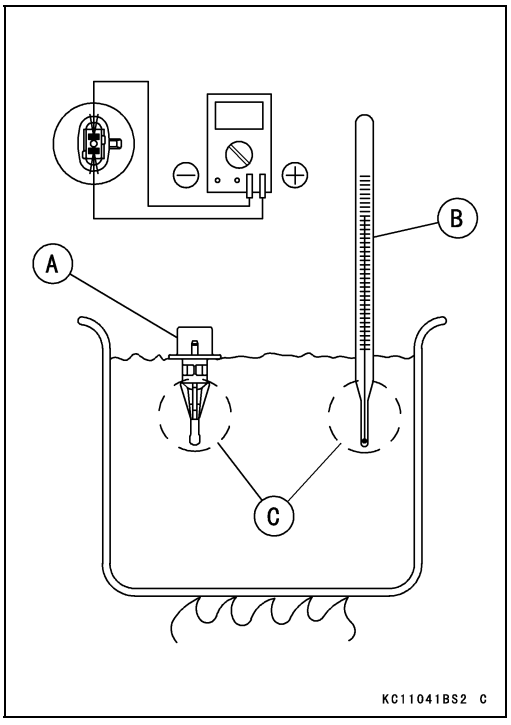
Special Tool - Hand Tester: 57001-1394

- Disconnect the ECU and sensor connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→
Intake Air Temperature Sensor Connector [B]
G lead (ECU terminal 15) [C]
BK/Y lead (ECU terminal 16) [D]

★If the wiring is good, check the intake air temperature sensor resistance (see Intake Air Temperature Sensor Resistance Inspection).

Intake Air Temperature Sensor Resistance inspection



- Remove the intake air temperature sensor (see Intake Air Temperature Sensor Removal).
- Suspend the sensor [A] in a container of machine oil so that 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.*

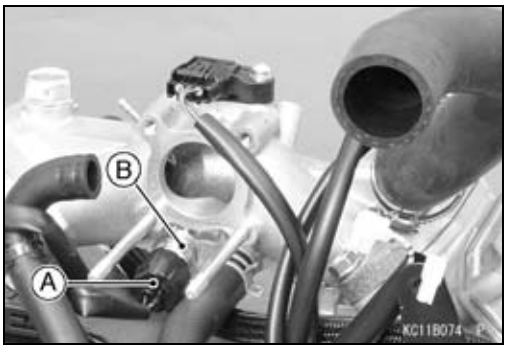
- Place the container over a source of heat and gradually raise the temperature of the oil while stirring the oil gently for even temperature.
- Using a digital meter, measure the internal resistance of the sensor across the terminals at the temperatures shown in the following.

Intake Air Temperature Sensor Resistance
Standard: 2.21 ~ 2.69 kΩ at 20°C (68°F)
About 0.322 kΩ at 80°C (176°F) (reference valve)

★If the reading is out of the standard, replace the intake air temperature sensor
★If the reading is within the standard, replace the ECU (see ECU removal).

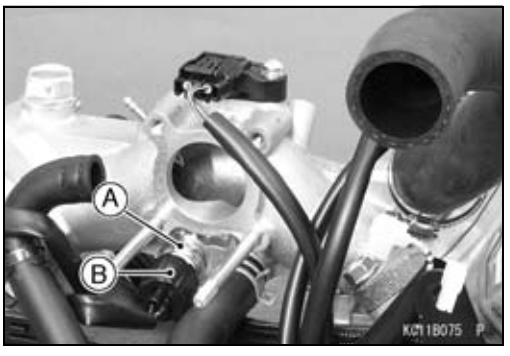
Water Temperature Sensor (Fault Code 13)

Water Temperature Sensor Removal



- Drain the coolant (see Coolant Change in the Periodic Maintenance chapter).
- Remove:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal)
  Radiator (see Radiator Removal in the Cooling System chapter)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal in the Cooling System chapter)
  Throttle Body Assy (see Throttle Body Assy Removal)
  Connector [A]
  Water Temperature Sensor [B]

Water Temperature Sensor Installation



- Apply silicone sealant to the threads of the water temperature sensor [A] and tighten it.

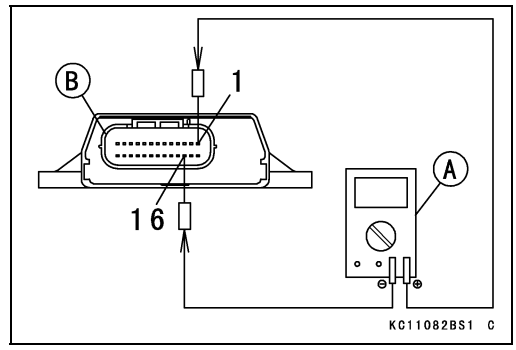
Sealant - Liquid Gasket TB1211: 56019-120

Torque - Water Temperature Sensor: 22 N·m (2.2 kgf·m, 16 ft·lb)

- Connect the connector [B].
- Install the removed parts (see appropriate chapter).
- Fill the engine with coolant and bleed the air from the cooling system (see Coolant Change in the Periodic Maintenance chapter).

Digital Fuel Injection (DFI) System

Water Temperature Sensor Output Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Remove the ECU (see ECU Removal).

○Do not disconnect the ECU connector.

- Connect a digital meter [A] to the connector [B], using needle adapter set.

Special Tool - Needle Adapter Set: 57001-1457

- Set the digital meter to the DC 10 V range.

Connections:

Digital Meter (+) → BL lead (ECU terminal 1)

Digital Meter (–) → BY/K lead (ECU terminal 16)

- Measure the output voltage with the engine stopped and the connector joined.
- Turn the ignition switch ON.

Water Temperature Sensor Output Voltage
Standard: About DC 2.26 ~ 2.50 V at 20°C (68 °F)

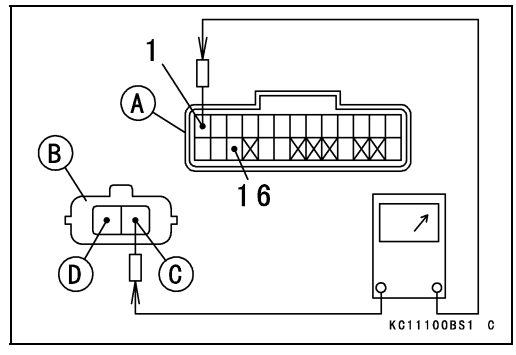
NOTE

○*The output voltage changes according to the coolant temperature in the engine.*

- Turn the ignition switch OFF.

★If the reading is within the standard, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).



★If the reading is out of the standard, check the wiring for continuity between main harness connectors with the hand tester and suitable leads.

Special Tool - Hand Tester: 57001-1394

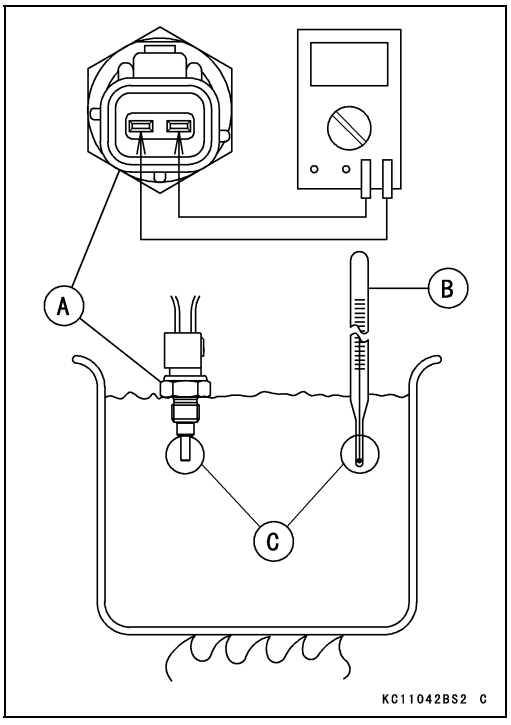
- Disconnect the ECU and sensor connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→
Water Temperature Sensor Connector [B]
BL lead (ECU terminal 1) [C]
BK/Y lead (ECU terminal 16) [D]

★If the wiring is good, check the water temperature sensor resistance (see Water Temperature Sensor Resistance Inspection).

Digital Fuel Injection (DFI) System

Water Temperature Sensor Resistance Inspection



- Remove the water temperature sensor (see Water Temperature Sensor Removal).
- Suspend the sensor [A] in a container of coolant so that the threaded portion are submerged.
- Suspended an accurate thermometer [B] with temperature sensing portions [C] located in almost the same depth.

NOTE

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

- Place the container over a source of heat and gradually raise the temperature of the coolant while stirring the coolant gently.
- Using the hand tester, measure the internal resistance of the sensor.

Special Tool - Hand Tester: 57001-1394

○Measure the resistance across the terminals and the body (for the gauge) at the temperatures shown in the table.

★If the reading is out of the standard, replace the water temperature sensor.

★If the reading is within the standard, replace the ECU (see ECU Removal).

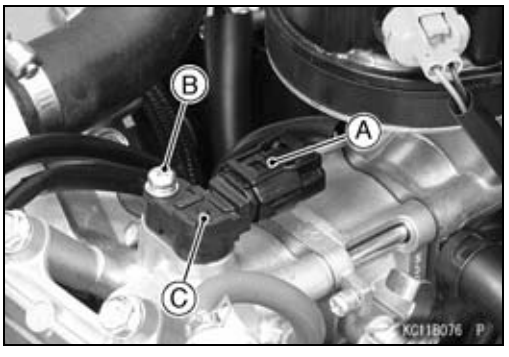
Water Temperature Sensor Resistance

Temperature	Resistance (kΩ)
	Standard
20°C (68°F)	2.32 ~ 2.59
80°C (176°F)	0.310 ~ 0.326
110°C (230°F)	0.140 ~ 0.144

Intake Air Pressure Sensor (Fault Code 21)

NOTICE
Never drop the intake air pressure sensor, especially on a hard surface. Such a shock to the part can damage it.

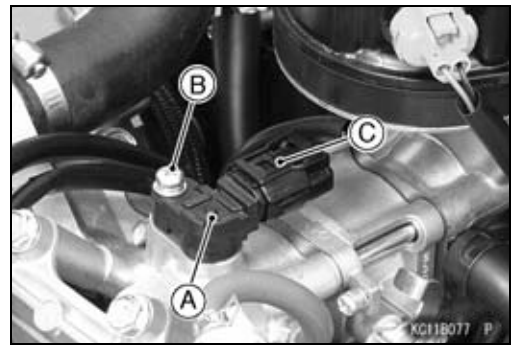
Intake Air Pressure Sensor Removal



- Remove the air cleaner body and bracket (see Air Cleaner Body and Bracket Removal).
- Disconnect the intake air pressure sensor connector [A].
- Remove:
  Screw [B]
  Intake Air Pressure Sensor [C]

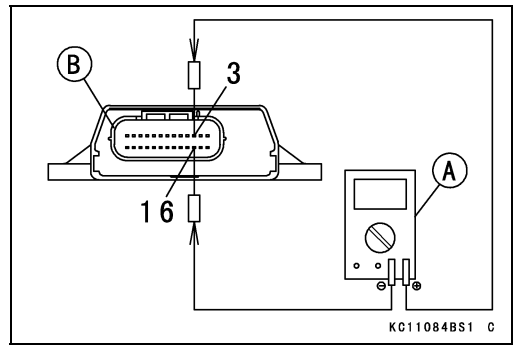
Digital Fuel Injection (DFI) System

Intake Air Pressure Sensor Installation



- Replace the O-ring with a new one.
- Install the intake air pressure sensor [A] and tighten the screw [B].
- Connect the intake air pressure sensor connector [C].
- Install the air cleaner body and bracket (see Air Cleaner Body and Bracket Installation).

Intake Air Pressure Sensor Input Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Remove the ECU (see ECU removal).

○Do not disconnect the ECU connector.

- Connect a digital meter [A] to the ECU connector [B], using needle adapter set.

Special Tool - Needle Adapter Set: 57001-1457

- Set the digital meter to the DC 10 V range.

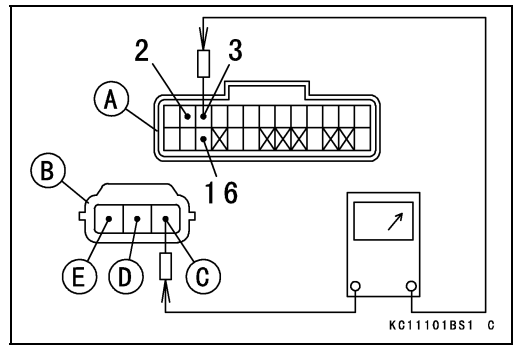
Connections:
Digital Meter (+) → BL Lead (ECU terminal 3)
Digital Meter (–) → BK/Y Lead (ECU terminal 16)

- Measure the input voltage with the engine stopped and the connector joined.
- Turn the ignition switch ON.

Intake Air Pressure Sensor Input Voltage
Standard: DC 4.75 ~ 5.25 V

- Turn the ignitions switch OFF.

★If the reading is within the standard check the output voltage (see Intake Air Pressure Sensor Output Voltage Inspection).



★If the reading is out of the standard, check the wiring for continuity between main harness connectors with the hand tester and suitable leads.

Special Tool - Hand Tester: 57001-1394

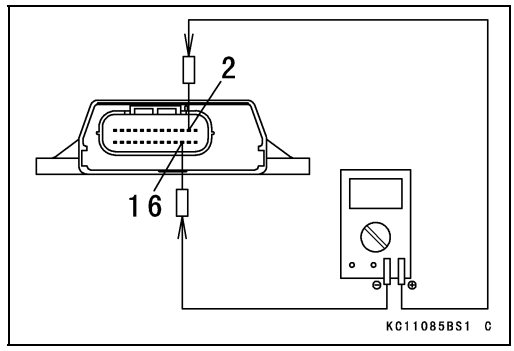
- Disconnect the ECU and sensor connectors.

Wiring Continuity Inspection
ECU Connector [A] ←→
Intake Air Pressure Sensor Connector [B]
R/BL lead (ECU terminal 3) [C]
BR lead (ECU terminal 2) [D]
BK/Y lead (ECU terminal 16) [E]

★If the wiring is not good, replace the main harness.
★If the wiring is good, check the ECU for its ground and power supply (see ECU Power Supply Inspection).
★If the ground and power supply are good, replace the ECU (see ECU Removal).

Digital Fuel Injection (DFI) System

Intake Air Pressure Sensor Output Voltage Inspection



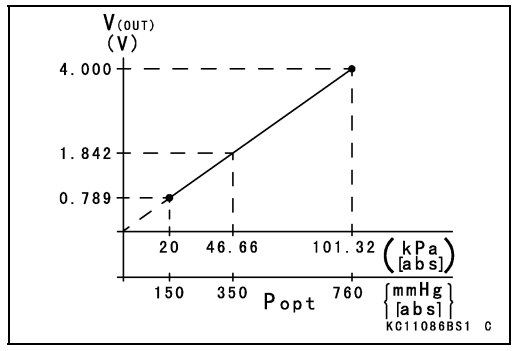
- Measure the output voltage at the intake air pressure sensor in the same way as input voltage inspection. Note the following.

Connections:

Digital Meter (+) → BR Lead (ECU terminal 2)

Digital Meter (–) → BK/Y Lead (ECU terminal 16)

- Measure the output voltage with the engine stopped and the connector joined.
- Turn the ignition switch ON.



Intake Air Pressure Sensor Output Voltage

Usable Range: 3.26 ~ 4.04 V DC at the standard atmospheric

Puressure (101.32 kPs, 76 cmHg abs.)

NOTE

○*Depending on the local atmospheric pressure, the output voltage should be changed according to the chart.*

[Vout]: Output Voltage
[Popt]: Local Atmospheric Pressure

- Turn the ignition switch OFF.

★If the reading is out of the usable range, replace the sensor.

★If the reading is within the usable range, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).

Ignition Coil (Fault Code 51, 52)

Ignition Coil #1: (Fault Code 51)
Ignition Coil #2: (Fault Code 52)

NOTICE
Never drop the ignition coils, especially on a hard surface. Such a shock to the ignition coil can damage it.

Ignition Coil Removal/Installation

- Refer to the Ignition Coil Removal/Installation in the Electrical System chapter.

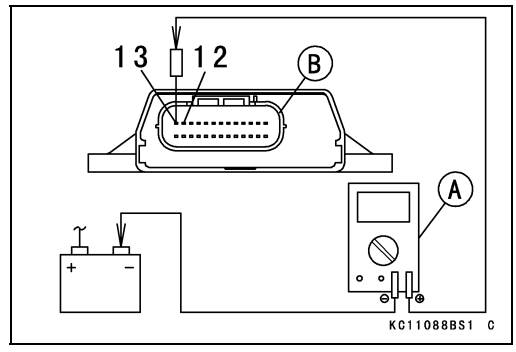
Ignition Coil Primary Winding Resistance Inspection

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

★If the reading is within the standard, check the input voltage (see Ignition Coil Input Voltage Inspection).

Digital Fuel Injection (DFI) System

Ignition Coil Input Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Remove the ECU (see ECU Removal).

○Do not disconnect the ECU connector.

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

Special Tool - Needle Adapter Set: 57001-1457

Connections:

For Ignition Coil #1

Digital Meter (+) → W lead (ECU terminal 13)

Digital Meter (–) → Battery (–) Terminal

For Ignition Coil #2

Digital Meter (+) → BK/Y lead (ECU terminal 12)

Digital Meter (–) → Battery (–) Terminal

- Measure the input voltage to each primary winding of the ignition coils with the engine stopped, and with the connectors joined.
- Turn the ignition switch ON.

Ignition Input Voltage
Standard: Battery Voltage

- Turn the ignition switch OFF.

★If the input voltage is out of the standard, check the wiring (see Wiring Inspection).

★If the wiring is good, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).

★If the input voltage is within the standard, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

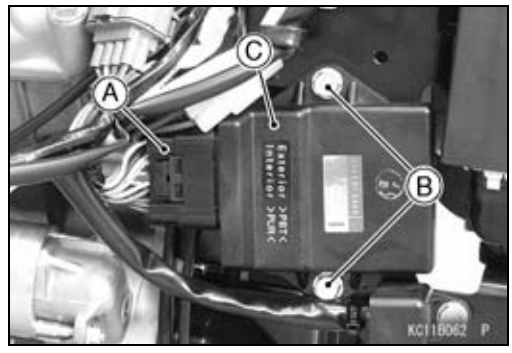
★If the ground and power supply are good, replace the ECU (see ECU Removal).

Electrical Control Unit (ECU)

NOTICE
Never drop the ECU, especially on a hard surface. Such a shock to the ECU can damage it.

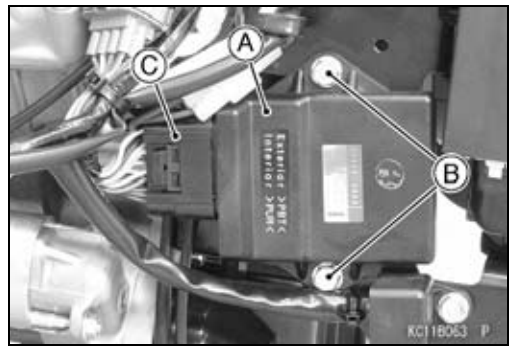
Digital Fuel Injection (DFI) System

ECU Removal



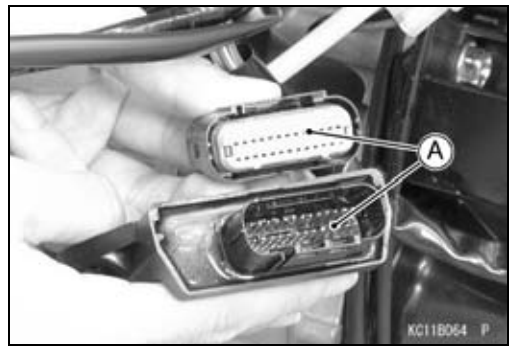
- Disconnect the ECU connector [A].
- Remove:
  Bolts [B]
  ECU [C]

ECU Installation



- Install the ECU [A] and tighten the bolts [B].
- Apply grease to the ECU terminals.
- Connect the ECU connector [C].

ECU Power Supply Inspection



- Visually inspect the connection of the ECU connector.

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

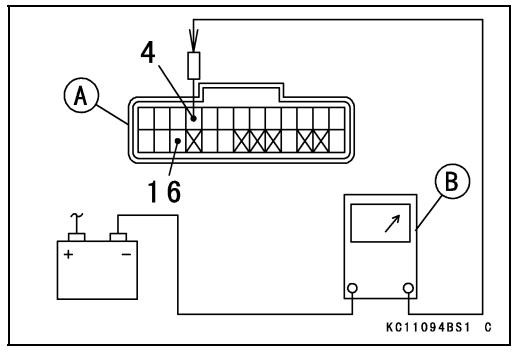
- Disconnect the ECU connector and then visually inspect the connectors.

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

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

○Disconnect the ECU connector.

- Set the hand tester [B] to the × 1 Ω range and check the harness wiring for continuity with the hand tester and suitable lead.



Special Tool - Hand Tester: 57001-1394

ECU Grounding Inspection (Harness Side)

BK/Y lead (ECU terminal 16)	**←→ Battery (–) Terminal: 0 Ω**
BK lead (ECU terminal 4)	**←→ Battery (–) Terminal: 0 Ω**
Engine Ground	**←→ Battery (–) Terminal: 0 Ω**

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

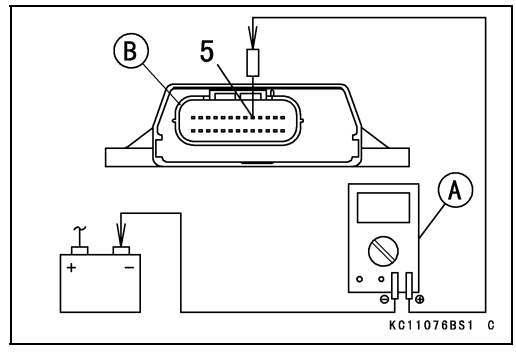
★If the wiring is good, check the power source voltage of the ECU.

- Connect the ECU connector.

NOTE

○*Be sure the battery is fully charged.*

Digital Fuel Injection (DFI) System



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

Special Tool - Needle Adapter Set: 57001-1457

ECU Power Supply Inspection
Connections:
Digital Meter (+) → BL lead (ECU terminal 5)
Digital Meter (–) → Battery (–) terminal
Ignition Switch OFF:
BL lead (ECU terminal 5): 0 V
Ignition Switch ON:
Both: Battery Voltage

★If the reading is out of the specification, check the following.
Fuse 10 A
Power Source Wiring (see Wiring Inspection)
★If the fuse and wiring are good, replace the ECU (see ECU Removal).

Fuel Pump

Fuel Pump Operation Inspection

NOTE

○*Be sure the battery is fully charged.*

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

★If the pump does not work as described above, inspect the operating voltage.

Operating Voltage Inspection

NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Connect the hand tester (25 V DC) to the fuel pump connectors.

Special Tool - Hand Tester: 57001-1394

Digital Fuel Injection (DFI) System

○Measure the operating voltage with the engine stopped, and with the connector joined.
● Turn the ignition switch RUN position.
○The tester needle should indicate battery voltage for 3 seconds, and then 0 V.

Pump Operating Voltage at Pump Connections to Pump Connectors

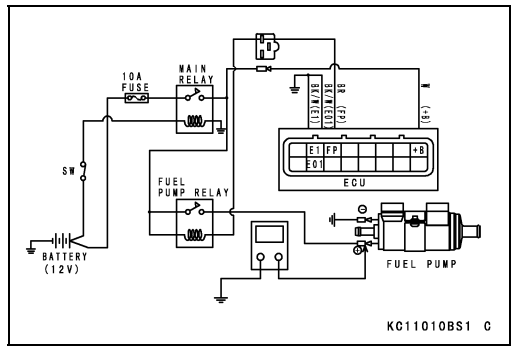
Tester (+) → Pump (+) Terminal

Tester (–) → Engine Ground

Operating Voltage at Pump Connector

Standard: Battery Voltage (12.5 V or more) for 3 seconds, and then 0 V.

★If the reading stays on battery voltage, and never shows 0 V. Check the ECU and fuel pump relay.
★If the voltage is in specification, but the pump doesn't work , replace the pump.
★If there is still no battery voltage, check the pump relay .



Fuel Flow Rate Inspection

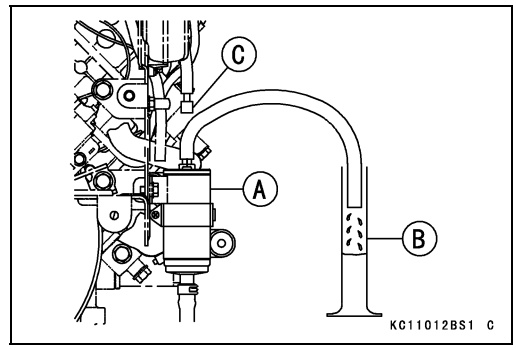
NOTE

○*Be sure the battery is fully charged.*

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions, creating the potential for serious burns. Make sure the area is well-ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light. Do not smoke. Turn the ignition switch OFF. Be prepared for fuel spillage; any spilled fuel must be completely wiped up immediately.

Digital Fuel Injection (DFI) System



- Prepare a measuring cylinder.
- Disconnect the fuel hose from the fuel pump out let pipe [A].
- Connect the appropriate hose and measuring cylinder [B] as shown.
- Quickly plug the fuel hose with a plug [C].

⚠ WARNING

Wipe off spilled out fuel immediately. Be sure to hold the measuring cylinder vertical.

- Turn the ignition switch to the RUN position. The fuel pump should operate for 3 seconds, and then stop.

○Measure the fuel flow rate so that the appropriate hose filled with fuel.

Amount of Fuel Flow
Standard: 120 mL or more for 3 seconds

★If the fuel flow is much less than the specified, check the following:
Fuel Pump
Fuel Filter
Fuel Tank

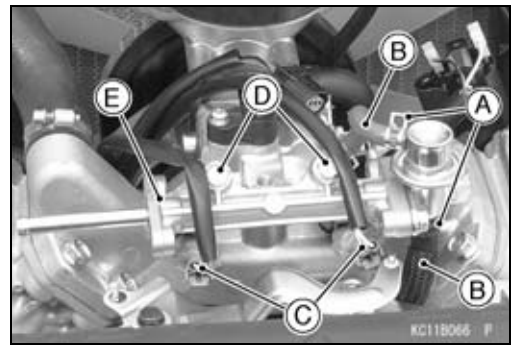
- After inspection, connect the fuel hoses. (see Fuel Tank Installation).
- Start the engine and check for fuel leakage.

Fuel Injectors (#1, #2)

NOTICE

Never drop the fuel injector, especially on a hard surface. Such a shock to the fuel injector can damage it.

Fuel Injector Removal



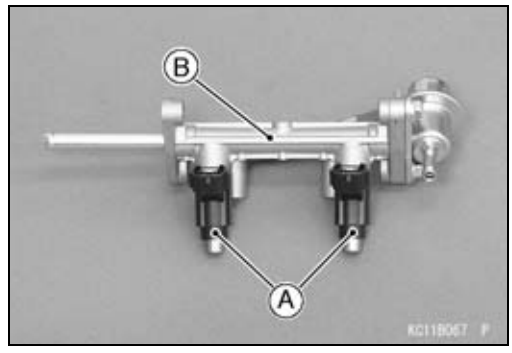
- Remove:
Air Cleaner Body and Bracket (see Air Cleaner and Air Cleaner Body Removal)
Clamps [A]
Hoses [B]
- Disconnect the injector connectors [C].
- Remove the bolts [D] and fuel pipe [E] with fuel injectors.

Digital Fuel Injection (DFI) System

● Pull out the fuel injectors [A] from the fuel pipe [B].

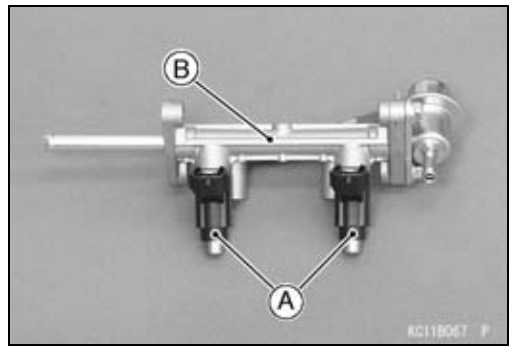
NOTE

○*Take care not to damage the fuel injector inserts when they are pulled from the fuel pipe.*

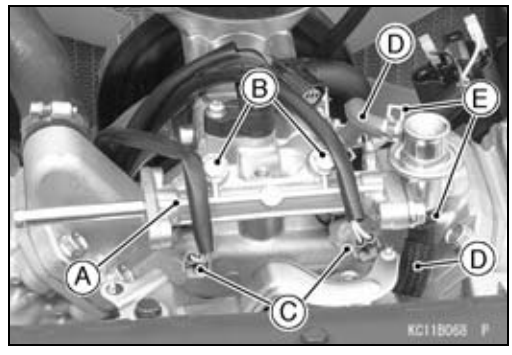


Fuel Injector Installation

● Replace the O-rings with new ones.
● Apply engine oil to the O-rings.
● Install the fuel injectors [A] to the fuel pipe [B].



● Replace the seals with new ones.
● Apply engine oil to the seals.
● Install the fuel pipe [A] with fuel injectors and tighten the bolts [B].
● Connect the injector connector [C].
● Install:
Hoses [D]
Clamps [E]
Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal)

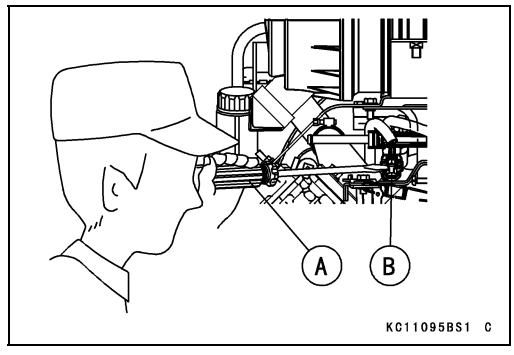


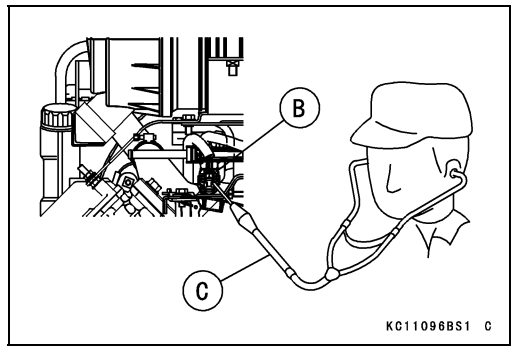
Audible Inspection

NOTE

○*Be sure the battery is fully charged.*

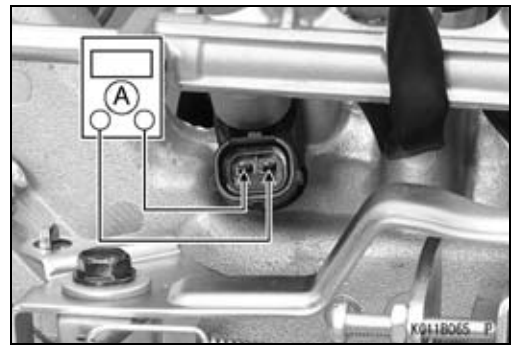
● Start the engine and let it idle.
● Apply the tip of a screwdriver [A] to the fuel injector [B]. Put the grip end onto your ear, and listen whether the fuel injector is clicking or not.
○A sound scope [C] can also be used.
○The click interval becomes shorter as the engine speed rises.
● Do the same for the other fuel injector.
★If all the fuel injectors click at a regular intervals, the fuel injectors are good.
● Turn the ignition switch OFF.
★If any fuel injector does not click, check the fuel injector resistance (see Fuel Injector Resistance Inspection).





Digital Fuel Injection (DFI) System

Fuel Injector Resistance Inspection



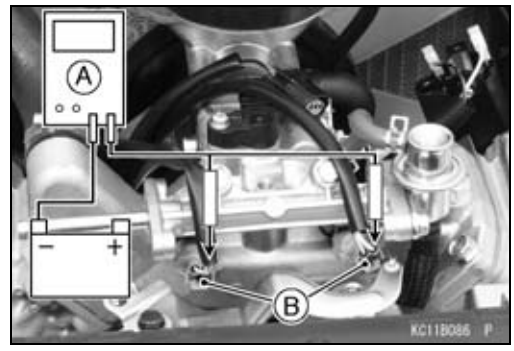
- Disconnect the fuel injector connectors (see Fuel Injector Removal).
- Measure the fuel injector resistance with hand tester [A].

Special Tool - Hand Tester: 57001-1394

Fuel Injector Resistance
Standard: 12.5 ±0.3 Ω at 20°C (68°F)

★If the reading is out of the standard, replace the fuel injector.

Fuel Injector Power Source Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Connect a digital meter [A] to the fuel injector connector [B] with the needle adapter set.

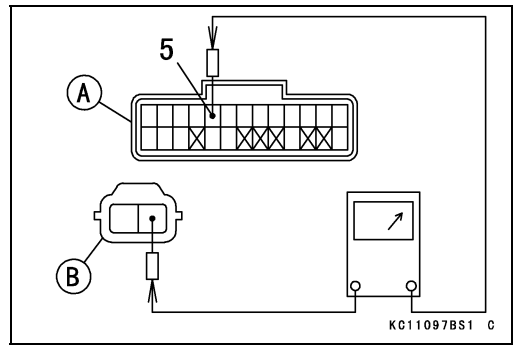
Special Tool - Needle Adapter Set: 57001-1457

Fuel Injector Power Source Voltage
Connections to Fuel Injector #1, #2 Connector
Digital Meter (+) → W lead of Main Horness
Digital Meter (–) → Battery (–) terminal

- Measure the power source voltage with the engine stopped and with the connector joined.
- Turn the ignition switch ON.

Power Source Voltage
Standard: Battery Voltage

- Turn the ignition switch OFF.



★If the reading is not battery voltage, check the power source wiring for continuity between main harness connector with the hand tester and suitable leads.

Special Tool - Hand Tester: 57001-1394

- Disconnect the ECU connector and fuel injector connector.

Wiring Continuity Inspection
Connections to Fuel Injector #1 or #2 Connector

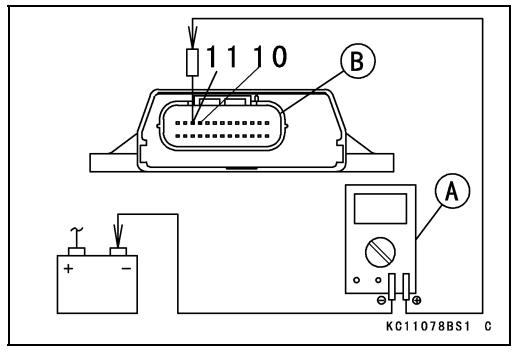
ECU Connector [A] ←→ Fuel Injector #1, #2 Connectors [B]

W lead (ECU terminal 5)

★If the wiring is good, check the ECU for its ground and power supply (see ECU Power Supply Inspection).
★If the ground and power supply are good, replace the ECU (see ECU Removal).
★If the reading is in specification, check the output voltage (see Fuel Injector Output Voltage Inspection).

Digital Fuel Injection (DFI) System

Fuel Injector Output Voltage Inspection



NOTE

○*Be sure the battery is fully charged.*

- Turn the ignition switch OFF.
- Remove the ECU (see ECU Removal).

○Do not disconnect the ECU connector.

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

Special Tool - Needle Adapter Set: 57001-1457

Fuel Injector Output Voltage
Connections to ECU Connector:
For Fuel Injector #1
Digital Meter (+) → Y/BL lead (ECU terminal 12)
Digital Meter (–) → Battery (–) terminal
For Fuel Injector #2
Digital Meter (+) → Y/R lead (ECU terminal 11)
Digital Meter (–) → Battery (–) terminal

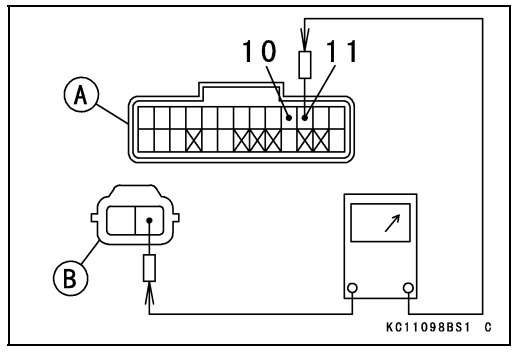
- Measure the output voltage with the engine stopped and with the connector joined.
- Turn the ignition switch ON.

Output Voltage
Standard: Battery Voltage

- Turn the ignition switch OFF.

★If the reading is in specification, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).



★If the reading is out of the specification, check the wiring for continuity between main harness connector with the hand tester and suitable leads.

Special Tool - Hand Tester: 57001-1394

- Disconnect the ECU and injector connector.

Wiring Continuity Inspection
ECU Connector [A] ←→ Fuel Injector Connector [B]
For Fuel Injector #1
Y/BL lead (ECU terminal 11) [C]
For Fuel Injector #2
Y/R lead (ECU terminal 10) [D]

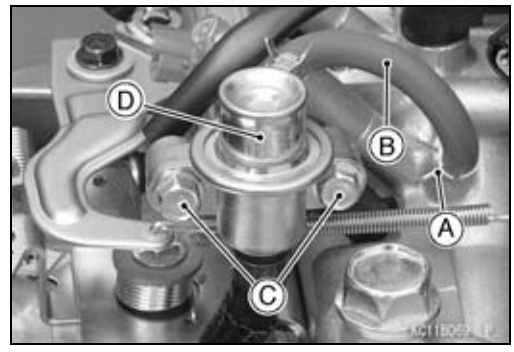
★If the wiring is good, check the ECU for its ground and power supply (see ECU Power Supply Inspection).

★If the ground and power supply are good, replace the ECU (see ECU Removal).

Digital Fuel Injection (DFI) System

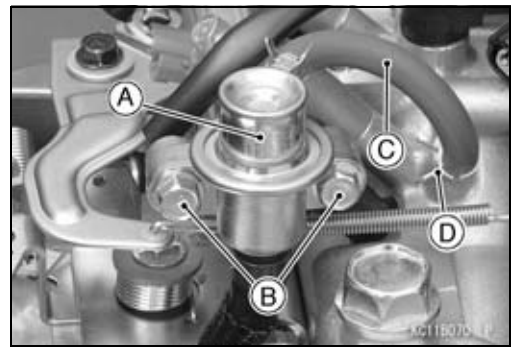
Fuel Pressure Regulator

Fuel pressure Regulator Removal



- Remove:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal)
  Clamp [A]
  Vacuum Hose [B]
  Bolts [C]
  Fuel Pressure Regulator [D]
- Carefully remove the regulator.

Fuel Pressure Regulator Installation

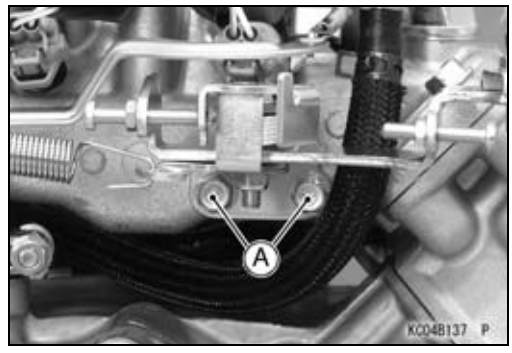


- Check the vacuum tube, fuel hose and O-ring for brittleness, cracks, diformation or damaged, and replace, if necessary.
- Apply engine oil to the O-ring.
- Install the fuel pressure regulator [A] and tighten the bolts [B].
- Install the vacuum hose [C] and clamp [D].

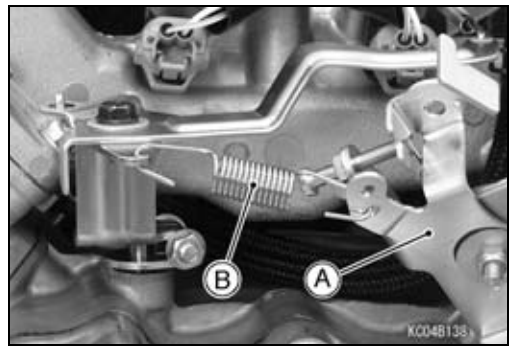
Governor Link Mechanism

Control Panel Assembly Removal

- Remove:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Removal)
  Muffler Assembly (see Muffler Assembly Removal in the Engine Top End chapter)
  Control Panel Mounting Bolts [A]



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

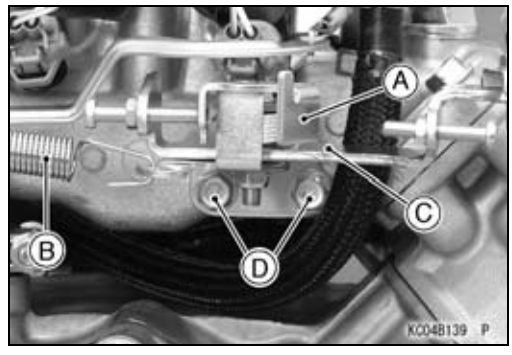


Control Panel Assembly Installation

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

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

- Install the governor spring [B] and control panel assembly [C].
- Tighten the control panel mounting bolts [D].
- Install:
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Installation)
  Muffler Assembly (see Muffler Assembly Installation in the Engine Top End chapter)
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low/High Idle Speed Adjustment in the Periodic Maintenance chapter).

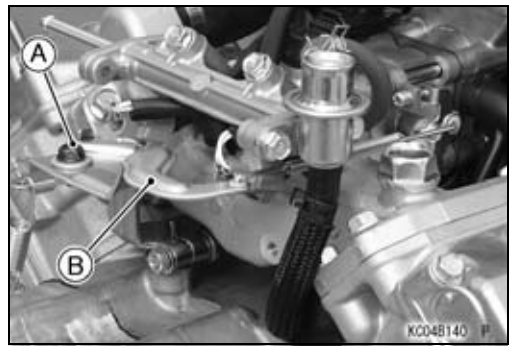


Governor Arm Removal

- Remove the control panel assembly (see Control Panel Removal).
- Remove the governor arm bolt [A] and separate the governor arm [B].

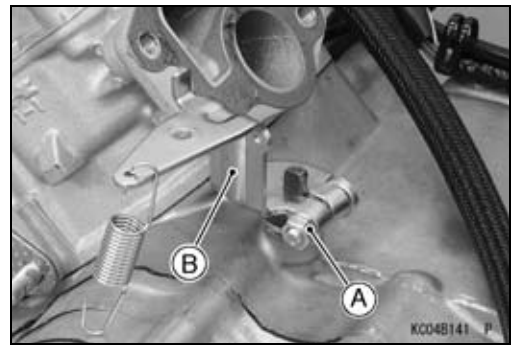
○Governor arm bolt is left-hand threads.

- Clear the throttle link rod from the governor arm.



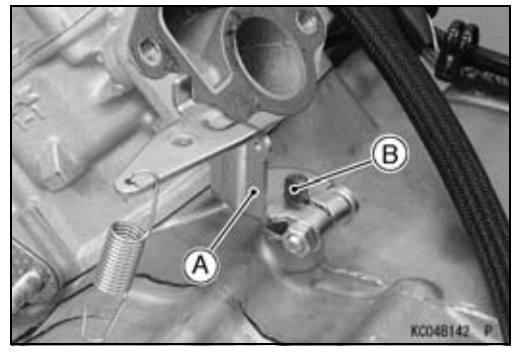
Governor Link Mechanism

- Remove:
  Intake Manifold (see Intake Manifold Removal)
  Cramp Nut [A]
  Governor Arm [B]



Governor Arm Installation

- Install the governor arm bracket [A] onto the governor shaft [B] temporarily.
- Install the intake manifold (see Intake Manifold Installation).

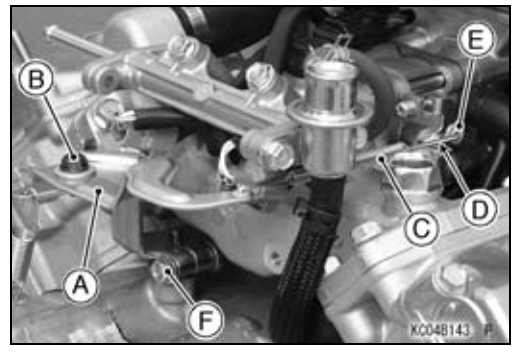


- Install the governor arm [A] and tighten the governor arm joint bolt [B].

○Governor arm bolt joint bolt is left-hand threads.

- Be sure the link spring [C] around the throttle link rod [D] is in place and that it pulls the governor arm and throttle lever [E] toward each other.
- Turn the top end of the governor arm bracket counterclockwise to fully open the throttle body assy valve and hold it there.
- Turn the governor shaft counterclockwise, fully turn the shaft to end of its travel.
- Tighten the clamp nut [F].

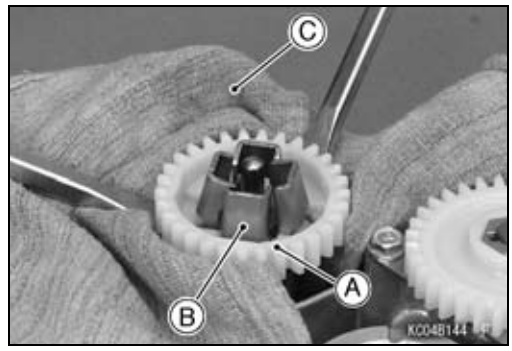
Torque - Governor Arm Clamp Nut: 8 N·m (0.80 kgf·m, 69 in·lb)



- Install:
  Control Panel Assembly (see Control Panel Assembly Installation)
  Air Cleaner Body and Bracket (see Air Cleaner Body and Bracket Installation)
  Muffler Assembly (see Muffler Assembly Installation in the Engine Top End chapter)

Governor Link Mechanism

Governor Assembly Removal



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

NOTE

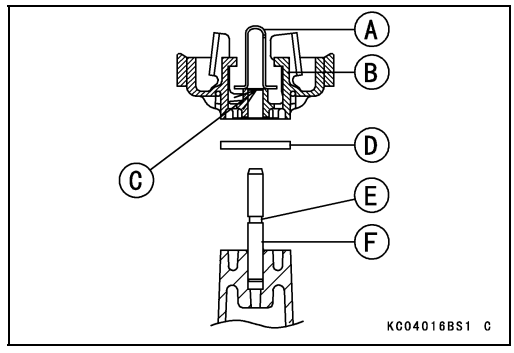
○*To avoid damage to the surface of crankcase cover, use a suitable soft mats [C] as shown.*

NOTICE

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

- Remove the thrust washer.

Governor Assembly Installation



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

NOTE

○*The sleeve and the governor assembly cannot be installed separately.*

○*Push the set onto the shaft until inner flange snaps into the groove securely.*

Sleeve [A]
Governor Assembly [B]
Inner Flange [C]
Thrust Washer [D]
Groove [E]
Shaft [F]

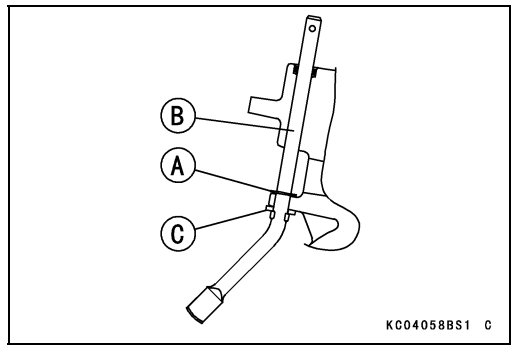
- Spin the governor assembly by hand and check that the flyweights operate freely and the center sleeve moves outward.

Governor Assembly Inspection

○Visually check the assembly for wear and damage.

★If any parts is worm or damaged, replace the assembly.

Governor Shaft Removal



- Remove the camshaft (see Camshaft Removal in the Camshaft/Crankshaft chapter).
  Camshaft (see Camshaft/Crankshaft chapter)
  Governor Arm (see Governor Arm Removal)
- Remove the circlip [B] on the governor shaft [C], and remove the governor shaft and washer [A].

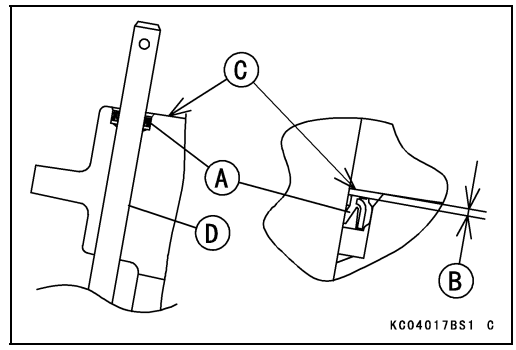
NOTE

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

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

Governor Link Mechanism

- The oil seal [A] must be assembled with seal lip towards inside of the engine.
- Press in the oil seal as shown.
  0 ~ 5 mm (0 ~ 0.04 in.) [B]
  Crankcase Surface [C]
  Governor Shaft [D]

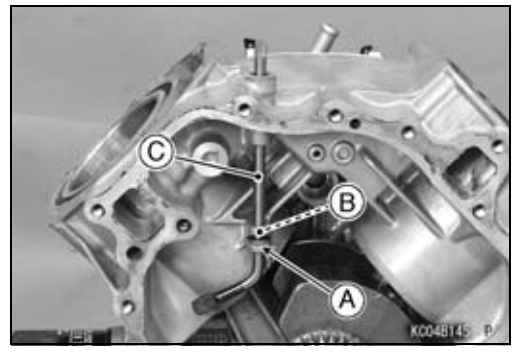


Governor Shaft Installation

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

NOTE

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



Throttle Body Assy

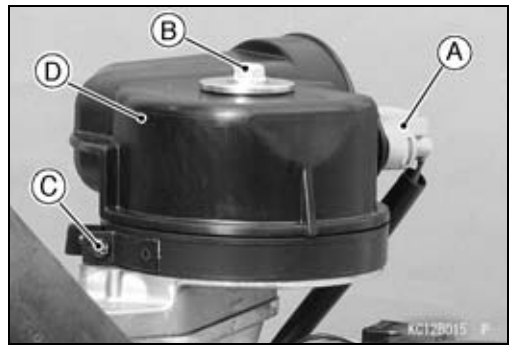
Low Idle Speed Adjustment

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

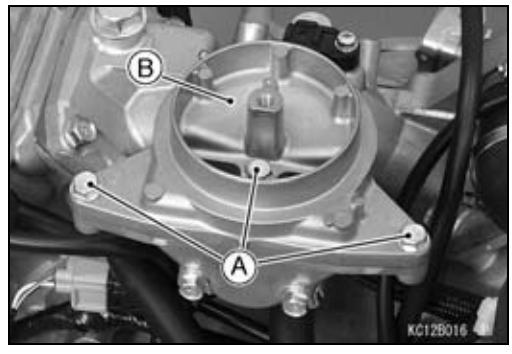
High Idle Speed Adjustment

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

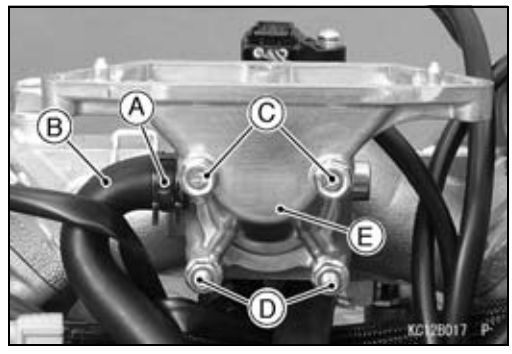
Throttle Body Assy Removal



- Remove:
  Muffler
  Air Cleaner (see Air Cleaner Body and Bracket Removal)
  Control Panel Assembly (see Control Panel Assembly Removal)
  Radiator (see Radiator Removal in the Cooling System chapter)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal in the Cooling System chapter)
  Radiator Bracket (see Cylinder Head Removal in the Engine Top End chapter)
  Intake Air Temperature Sensor Connector [A]
  Upper Duct Mounting Bolt [B]
  Upper Duct Clamp Screw [C]
  Upper Duct [D]



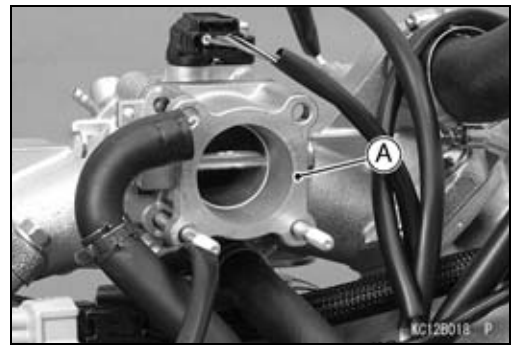
- Remove:
  Lower Duct Mounting Bolts [A]
  Lower Duct [B]



- Remove:
  Clamp [A]
  Breather Hose [B]
  Throttle Body and Intake Pipe Mounting Bolts [C] and Nut [D]
  Intake Pipe [E] and Gasket

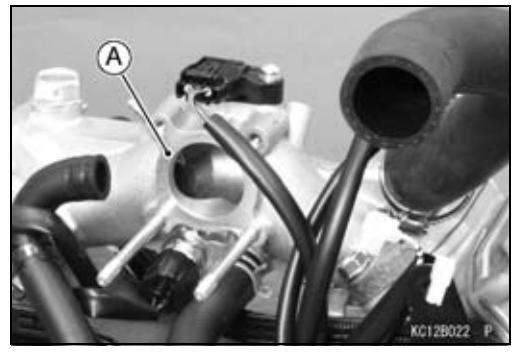
Throttle Body Assy

- Remove the throttle body assy [A] and gasket.



Throttle Body Assy Installation

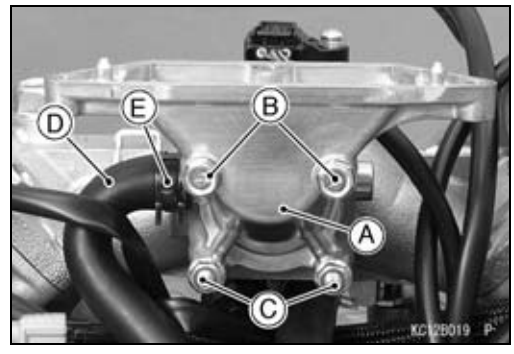
- Clean the mating surface of the intake manifold [A], throttle body assy and intake pipe.
- Replace the gaskets with new ones.
- Install the throttle body assy and new gasket.



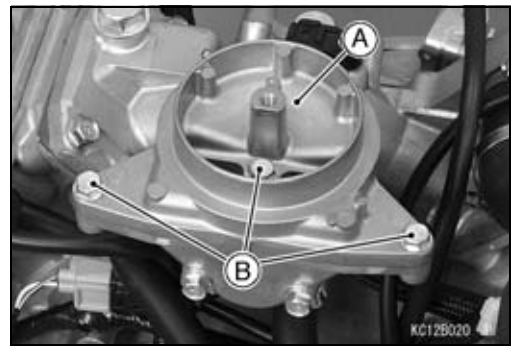
- Install the intake pipe [A] and new gasket.
- Tighten:

Torque - Throttle Body and Intake Pipe Mounting Bolts [B]: 12 N·m (1.2 kgf·m, 8.9 in·lb)
Throttle Body and Intake Pipe Mounting Nuts [C]: 12 N·m (1.2 kgf·m, 8.9 in·lb)

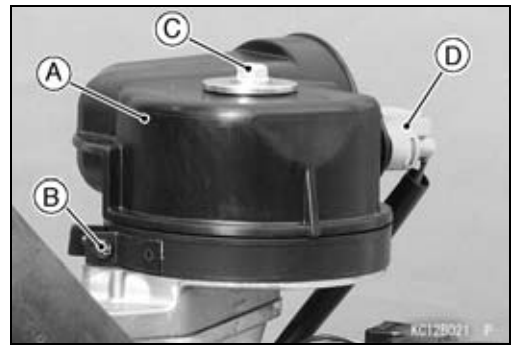
- Install the breather hose [D] and clamp [E].



- Install the lower duct [A] and tighten the lower duct mounting bolts [B].



- Install the upper duct [A].
- Tighten the upper duct clamp screw [B] and upper duct mounting bolt [C].
- Install the intake air temperature sensor [D].

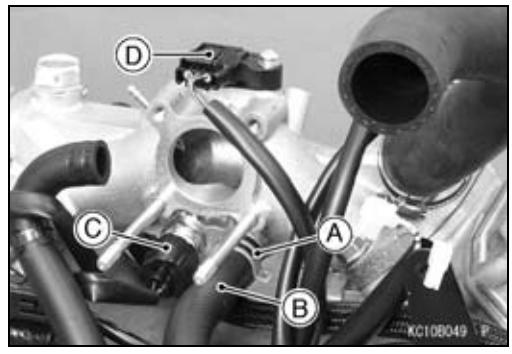


- Install the removed parts (see appropriate chapters).

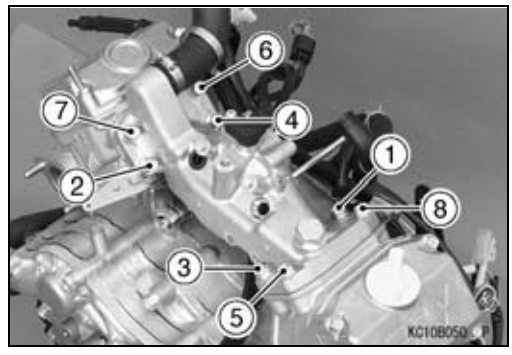
Intake Manifold

Intake Manifold Removal

- Drain the coolant (see Coolant Change in the Periodic Maintenance chapter).
- Remove:
  Throttle Body Assy (see Throttle Assy Removal)
  Fuel Injector (see Fuel Injector Removal)
  Clamp [A]
  Water Hose [B]
  Water Temperature Sensor Connector [C]
  Intake Air Pressure Sensor Connector [D]

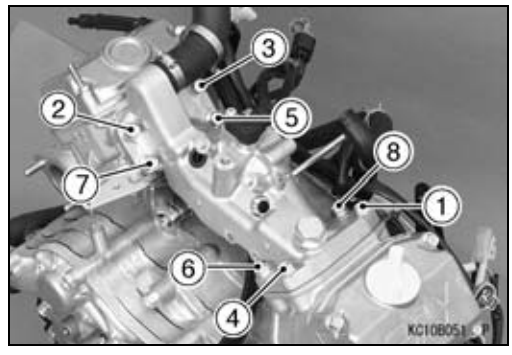


- Unscrew the intake manifold bolts in the order shown [1 ~ 8], 1/4 turn at a time, until all bolts are loose.
- Remove the intake manifold [A] and gasket.

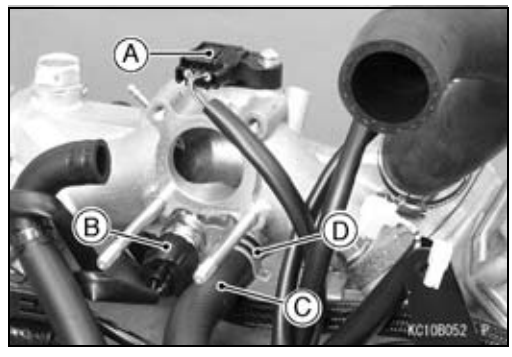


Intake Manifold Installation

- Replace the intake manifold gasket with new ones.
- Clean the mating surfaces of the cylinders and intake manifold.
- Install the intake manifold gasket and intake manifold.
- Tighten the intake manifold mounting bolts follow the tightening sequence.



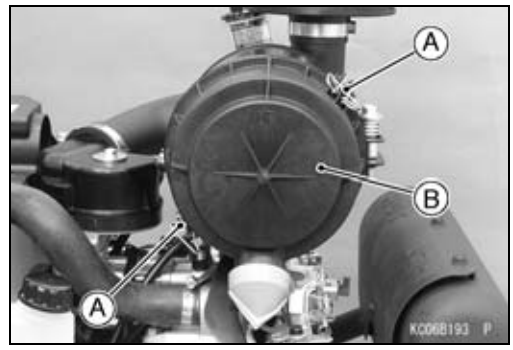
- Install:
  Intake Air Pressure Sensor Connector [A]
  Water Temperature Sensor Connector [B]
  Water Hose [C]
  Clamp [D]



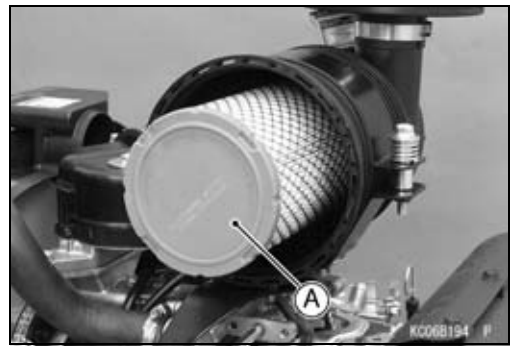
Air Cleaner

Element Removal

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



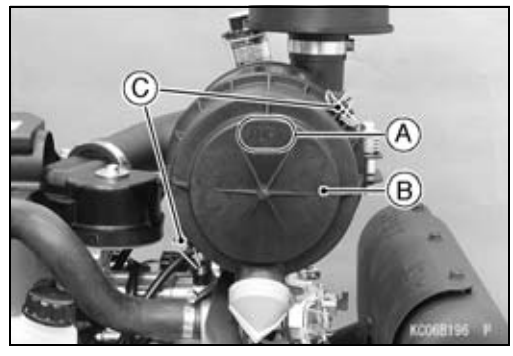
- Remove the primary element [A].



- Remove the secondary element [A].

Element Installation

- Slide the secondary element and primary element into place in the air cleaner body.
- Turn the “UP” mark [A] of the cap to the top, and install the cap [B] to the air cleaner body.
- Fasten the two retaining clamps [C].



Element Cleaning and Inspection

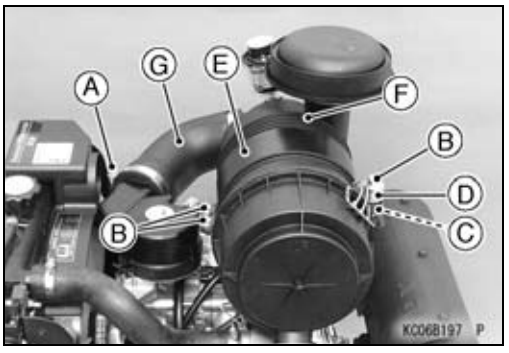
Air cleaner elements are not recommended to be cleaned, and each air cleaner element should be replaced with new ones.

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

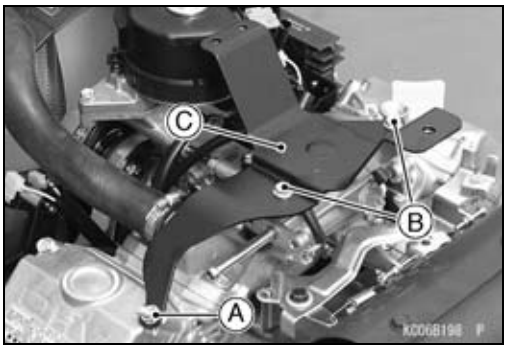
Air Cleaner

Air Cleaner Body and Bracket Removal

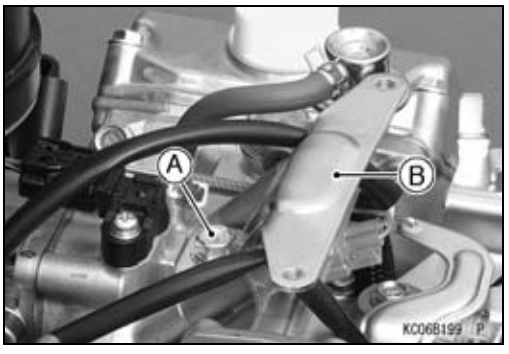
- Remove the air cleaner elements, if necessary (see Element Removal).
- Loosen the clamp screw [A].
- Remove:
  Bolts [B]
  Color [C]
  Spring [D]
  Air Cleaner Bracket [E]
- Take out the air cleaner body [F] together with the intake hose [G].



- Remove:
  Nut [A]
  Bolts [B]
  Air Cleaner Mounting Bracket [C]

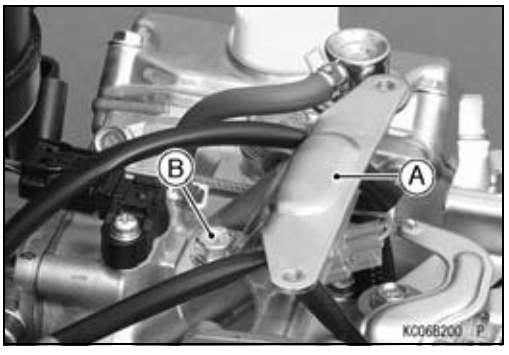


- Remove:
  Bolt [A]
  Bracket [B]

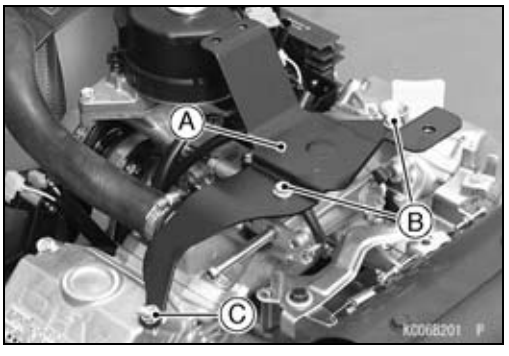


Air Cleaner Body and Bracket Installation

- Install the bracket [A] and tighten the bolt [B].

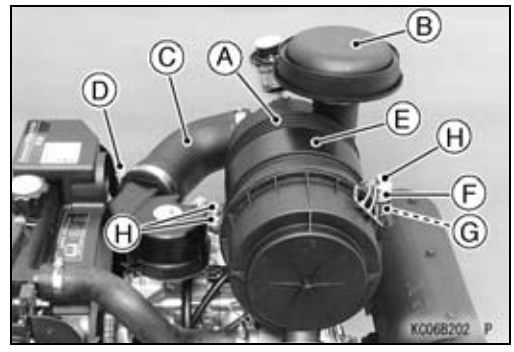


- Install the air cleaner mounting bracket [A].
- Tighten the bolts [B] and nut [C].



Air Cleaner

- Set the air cleaner body [A] onto the air cleaner mounting bracket so that intake duct [B] is facing upward.
- Install the intake hose [C] and tighten the clamp screw [D].
- Install air cleaner bracket [E], spring [F] and color [G].
- Tighten the bolts [H].



Cooling System

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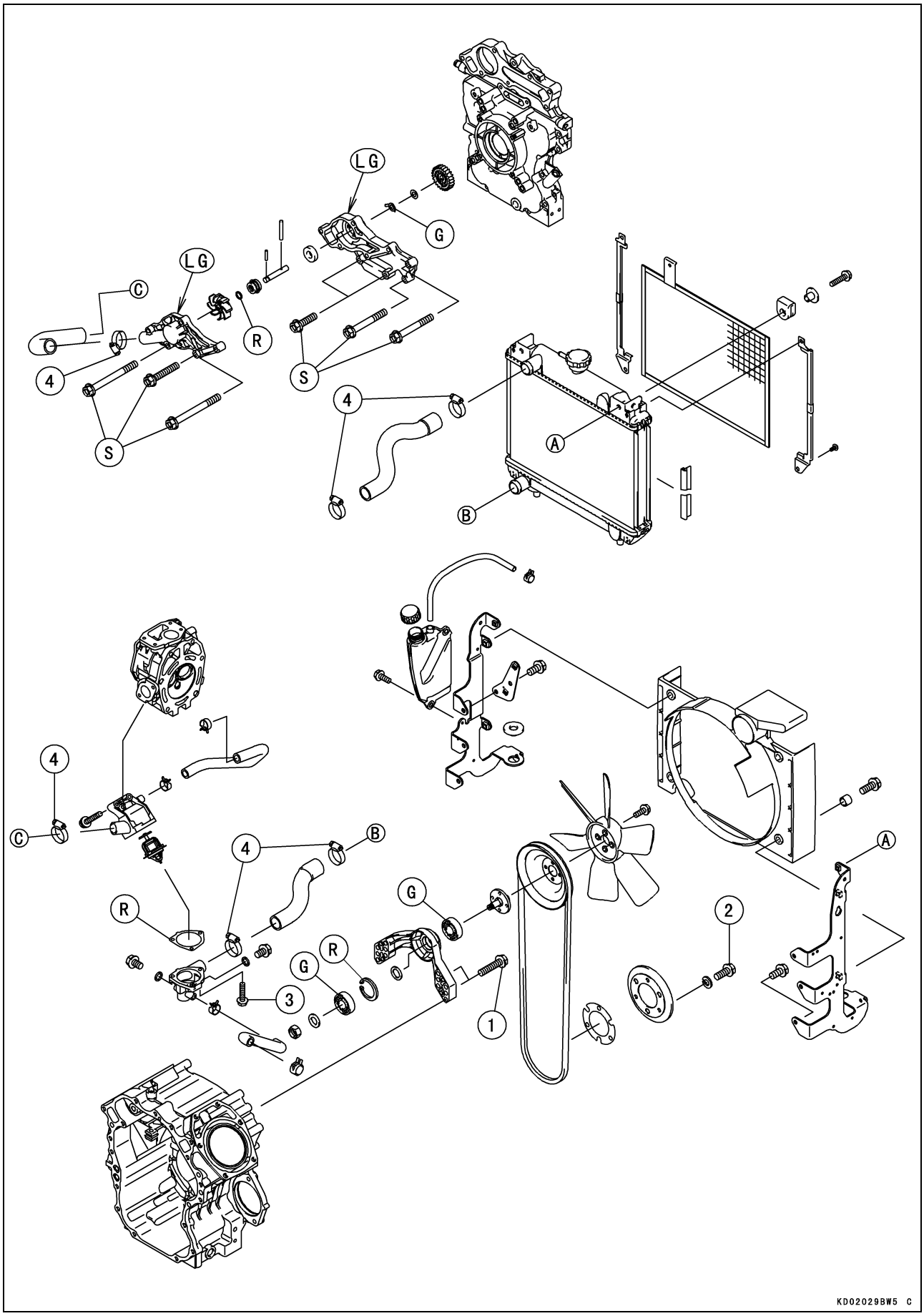
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Cooling Fan Mounting Bracket Bolts	20	2.0	15	
2	Cooling Fan Belt Pulley Mounting Bolts	20	2.0	15	
3	Thermostat Tightening Bolts	10	1.0	89 in·lb	
4	Water Hose Clamp Screws	1.3	0.13	12 in·lb	

R: Replacement Parts
S: Following the specific tightening sequence.

4-4 COOLING SYSTEM

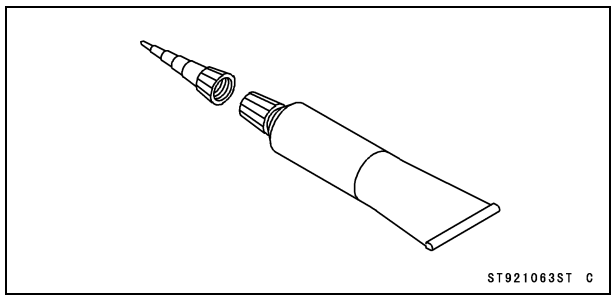
Specifications

Item	Standard	Service Limit
***Coolant**		
Type	Permanent type of antifreeze (Soft water and ethylene glycol plus corrosion and rust inhibitor chemicals for aluminum engines and radiators)	– – –
Color	Green	– – –
Mixed Ratio	Soft water 50%, coolant 50%	– – –
Freezing Point	–35°C (–31°F)	– – –
Total Amount	2.7 L (2.9 US qt)	– – –
Water Pump		
Water Pump Shaft Diameter	9.975 ~ 9.990 mm (0.3927 ~ 0.3933 in.)	9.94 mm (0.391 in.)
Water Pump Shaft Bearing Inside Diameter	10.020 ~ 10.058 mm (0.3945 ~ 0.3960 in.)	10.09 mm (0.397 in.)
Radiator Cap		
Relief Pressure	78 ~ 98 kPa (0.80 ~ 1.00 kgf/cm², 11.3 ~ 14.2 psi)	– – –
Thermostat		
Valve Opening Temperature	81 ~ 84°C (178 ~ 183°F)	– – –
Valve Full Opening Lift	8 mm (0.31 in.) or more at 95°C (203°F)	– – –

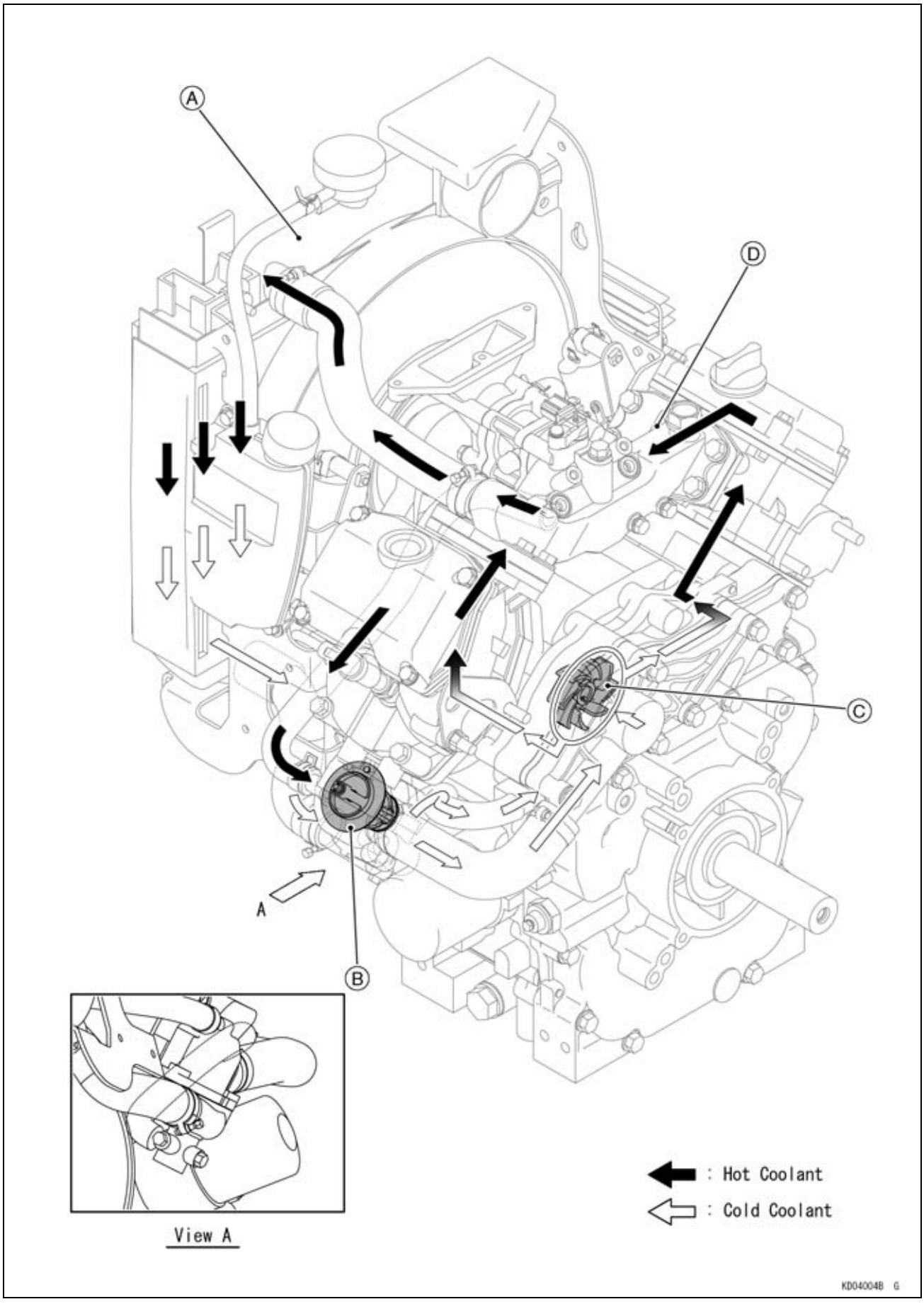
*A permament type of antifreeze is not in the cooling system with shipped.

Sealant

Liquid Gasket, TB1207B:
92104-2068



Cooling System



View A

Cooling System

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

Radiator [A]
Thermostat [B]
Water Pump (Impeller) [C]
Intake Manifold [D]

⚠ WARNING

Hot engine coolant can cause severe burns. To prevent burns, allow the engine and coolant to completely cool before draining the coolant and disassembling any cooling system parts (radiator, pump, sensor, etc.).

NOTICE

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

Coolant

Coolant Deterioration

- Visually inspect the coolant in the reserve tank.

★If whitish cotton-like wafts are observed, aluminum parts in the cooling system are corroded. If the coolant is brown, iron or steel parts are rusting. In either case, flush the cooling system.

★If the coolant gives off an abnormal smell check for a cooling system leak. It may be caused by exhaust gas leaking in to the cooling system.

Coolant level Inspection

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

Coolant Draining

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

Coolant Filling

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

Pressure Testing

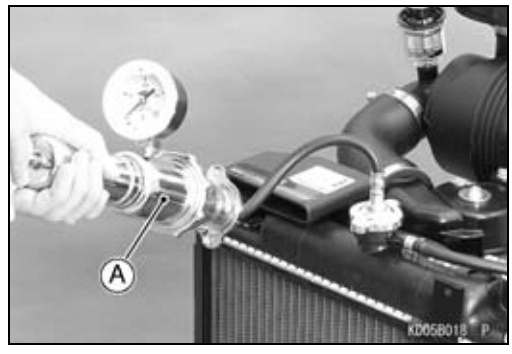
- Remove the radiator cap [A].

○Remove the radiator cap in two steps. First turn the cap counterclockwise to the first stop. Then push and turn it further in the same direction and remove the cap.

- Install the cooling system pressure tester [A] on the filler neck.

NOTE

○*Wet the cap sealing surfaces with water or coolant to prevent pressure leaks.*



- Build up pressure in the system carefully until the pressure reaches 60 kPa (0.61 kgf/cm², 8.7 psi).

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

Watch the pressure gauge for at least 6 seconds.

★If the pressure holds steady, the system is all right.

★If the pressure drops and no external source is found, check for internal leaks. Droplets in the engine oil indicate internal leakage. Check the cylinder head gaskets and the water pump.

- Remove the pressure tester, replenish the coolant, and install the cap.

Coolant

Cooling System Flushing

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

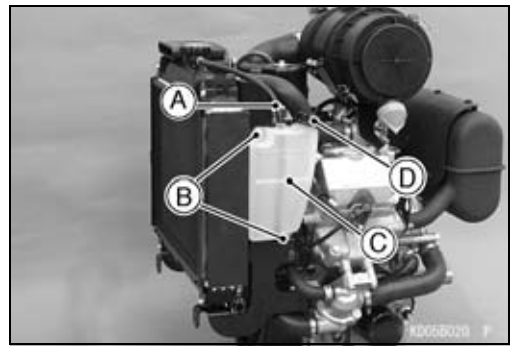
- Drain the cooling system.
- Fill the cooling system with fresh water mixed with a flushing compound.

NOTICE
Do not use a flushing compound which is harmful to the aluminum engine and radiator. Carefully follow the instructions supplied by the manufacturer of the cleaning product.

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

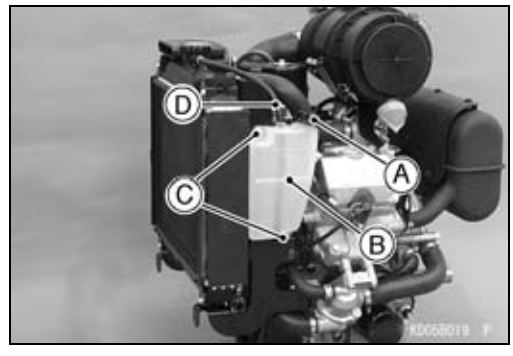
Coolant Reserve Tank Removal

- Remove:
  Radiator Overflow Hose [A]
  Bolts [B]
  Coolant Reserve Tank [C]
- Remove the cap [D] and pour the coolant into a container.



Coolant Reserve Tank Installation

- Install the cap [A].
- Tighten the mounting bolts [B].
- Install the radiator overflow hose [C].
- Fill the coolant reserve tank with coolant (see Coolant Change in the Periodic Maintenance chapter).

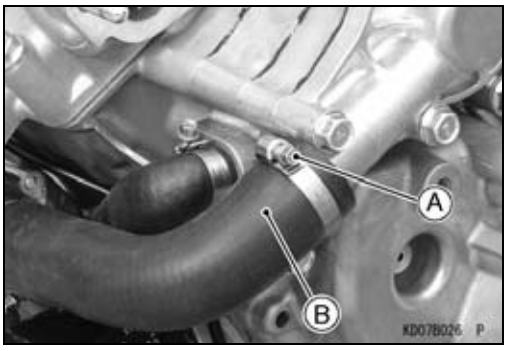


Water Pump

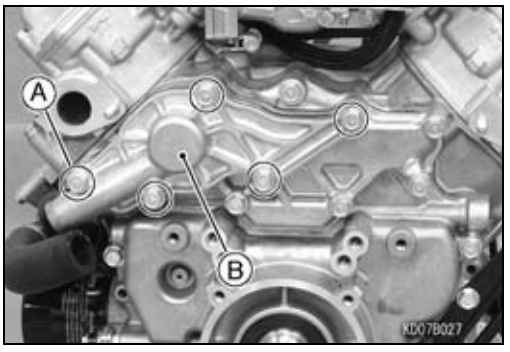
Water Pump Removal

- Drain the coolant (see Coolant Change in the Periodic Maintenance chapter).
- Remove the Muffler Assembly (see Muffler Assembly Removal in the Engine Top End chapter).

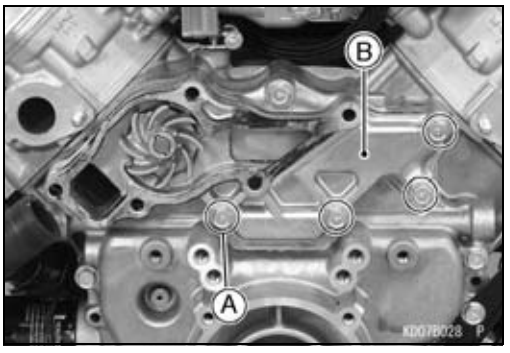
- Loosen the water hose clamp [A].
- Remove the water hose [B].



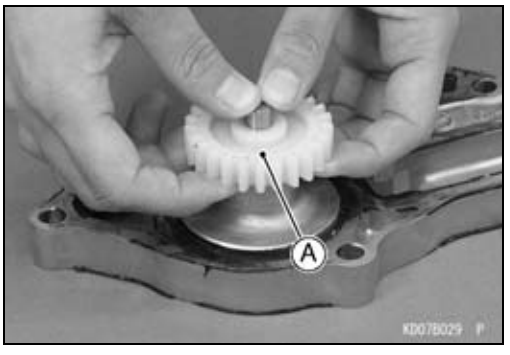
- Remove:
  Water Pump Cover Bolts [A]
  Water Pump Cover [B]



- Remove:
  Water Pump Housing Bolt [A]
  Water Pump Housing [B]

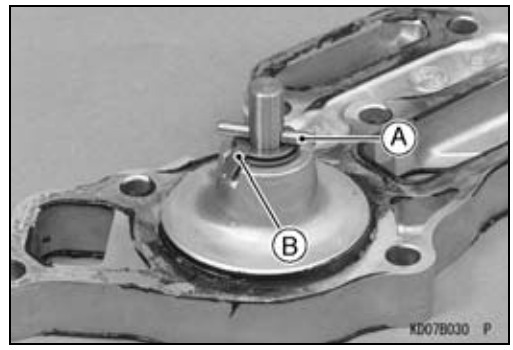


- Remove:
  Water Pump Drive Gear [A]

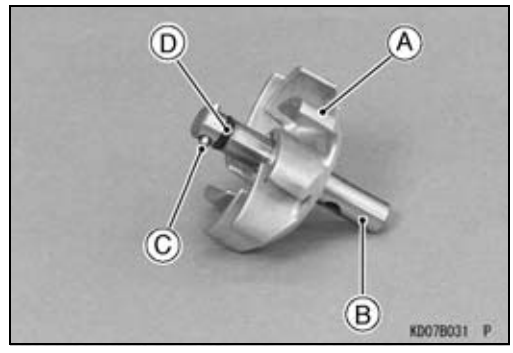


Water Pump

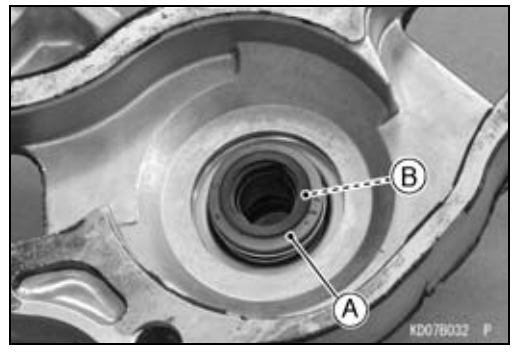
- Remove:
  Pin [A]
  Washer [B]



- Remove:
  Water Pump Impeller [A]
  Shaft [B]
  Pin [C] and O-ring [D]

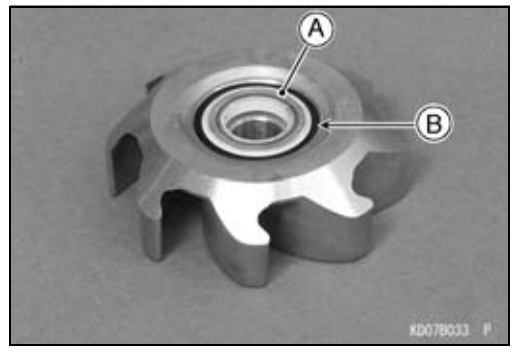


- Remove:
  Mechanical Seal [A]
  Oil Seal [B]

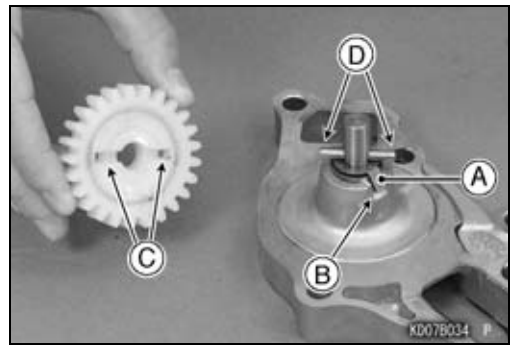


Water Pump Installation

- Clean the sliding surface of a new mechanical seal with a high-flash point solvent, and apply a little coolant to the sliding surface to give the mechanical seal initial lubrication.
- Apply coolant to the surfaces of the rubber seal and sealing seat [A], and press the rubber seal [B] and sealing seat into the impeller by hand until the seat bottoms out.



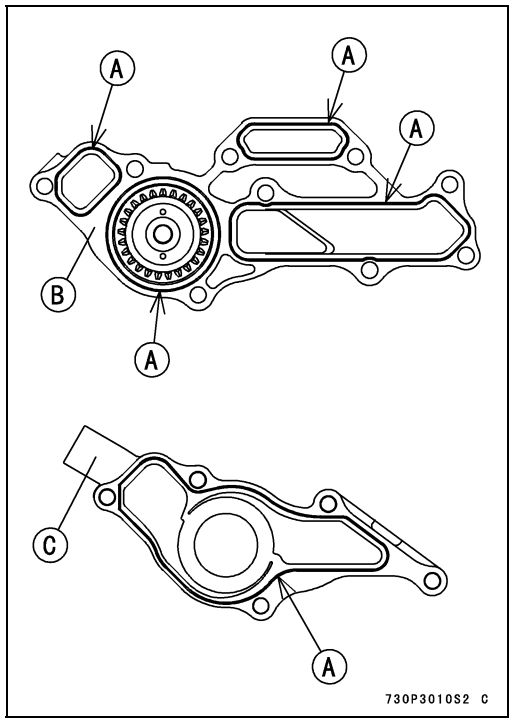
- Fit the washer tab [A] to the notch [B] of the housing.
- Fit the drive gear notches [C] to the pin [D].



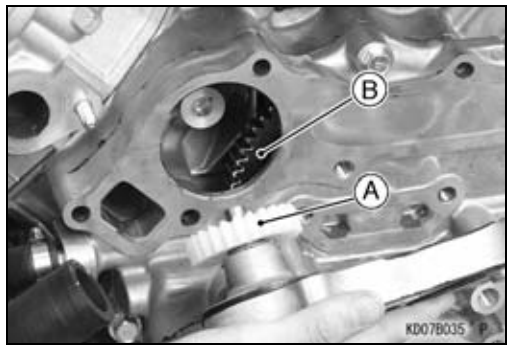
Water Pump

- Apply liquid gasket to the mating surface [A] of the water pump housing [B] and water pump cover [C].

  Sealant - Liquid Gasket, TB1207B: 92104-2068

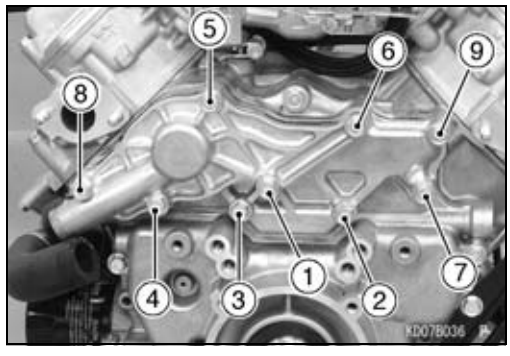


- Install the water pump housing turning the impeller so that the drive gear [A] engages with the camshaft gear [B].



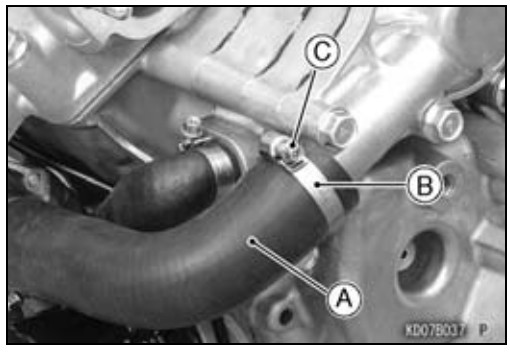
- Tighten the water pump cover bolts and housing bolt in accordance with the order shown.
  M8, L = 45 mm (1.77 in.) [1]
  M8, L = 30 mm (1.18 in.) [2.3]
  M8, L = 80 mm (3.15 in.) [4.5.6.8]
  M8, L = 60 mm (2.36 in.) [7.4]

  Torque - Water Pump Cover Bolts [2.3.7.9]: 20 N·m (2.0 kgf·m, 15 ft·lb)
  Water Pump Housing Bolt [1.3.4.5.6.8]: 20 N·m (2.0 kgf·m, 15 ft·lb)



- Install the water hose [A] and water hose clamp [B].
- Tighten:

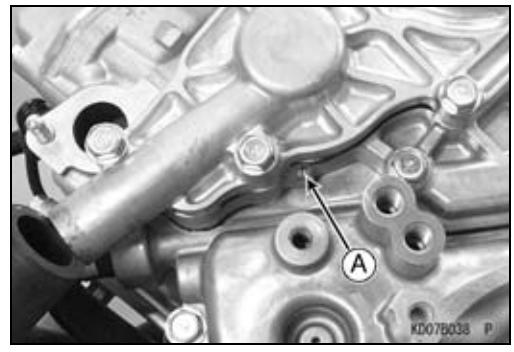
  Torque - Water Hose Clamp Screw [C]: 1.3 N·m (0.13 kgf·m, 12 in·lb)



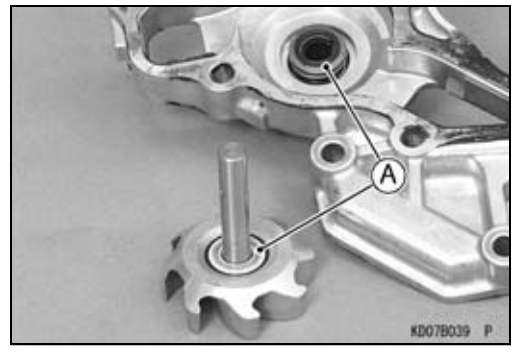
Water Pump

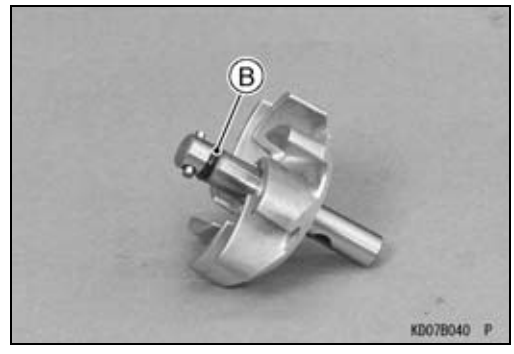
Water Pump Inspection

● Check the drainage outlet passage [A] at the bottom of the water pump body for coolant leakage.



★If the mechanical seal is damaged, the coolant leaks through the seal and drains through the passages. Replace the mechanical seal [A] or O-ring [B].





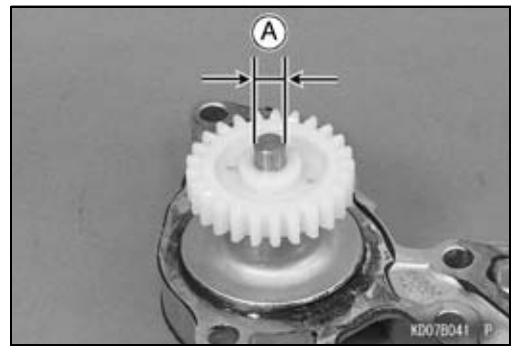
● Measure the diameter [A] of the water pump shaft.

★If the shaft has worn past the service limit, replace the shaft with a new one.

Water Pump Shaft Diameter

Standard: 9.975 ~ 9.990 mm (0.3927 ~ 0.3933 in.)

Service Limit: 9.94 mm (0.391 in.)



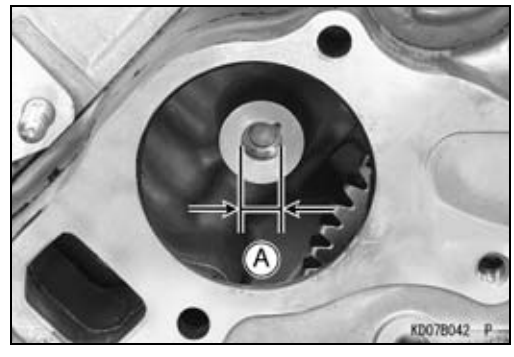
● Measure the inside diameter [A] of the water pump shaft bearing.

★If the bearing has worn past the service limit, replace the crankcase with a new one.

Water Pump Shaft Bearing Inside Diameter

Standard: 10.020 ~ 10.058 mm (0.3945 ~ 0.3960 in.)

Service Limit: 10.09 mm (0.397 in.)

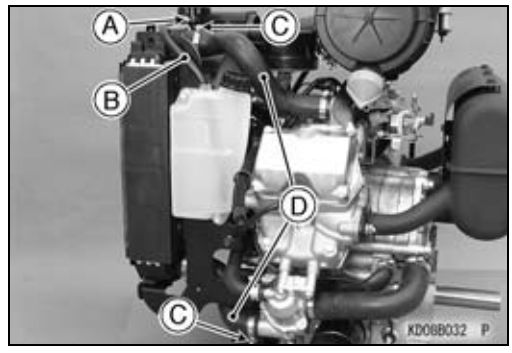


Radiator

Radiator Removal

⚠ WARNING

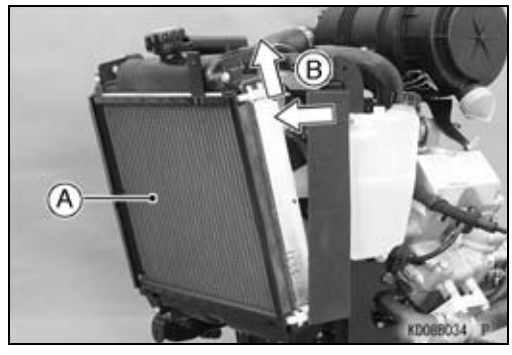
Hot engine coolant can cause severe burns. To prevent burns, allow the engine and coolant to completely cool before removing the radiator cap. Then turn it slowly to release any pressure before actually removing the cap.



- Remove the radiator cap and drain the coolant in the radiator (see Coolant Change in the Periodic Maintenance chapter).
- Remove the clamp [A] and radiator overflow hoses [B].
- Loosen the water hose clamp screws [C], and disconnect the water hoses [D].

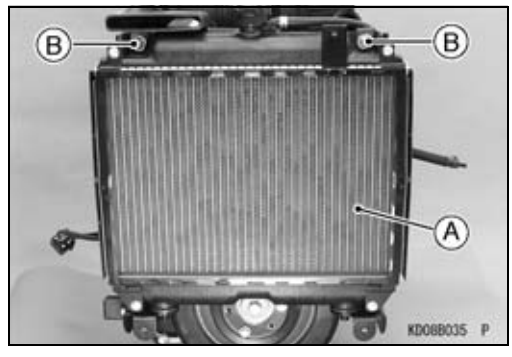
- Unscrew the radiator mounting bolts [A].

- Remove the radiator [A] pulling toward you and up [B].



Radiator Installation

- Install the radiator [A] and tighten the radiator mounting bolts [B].

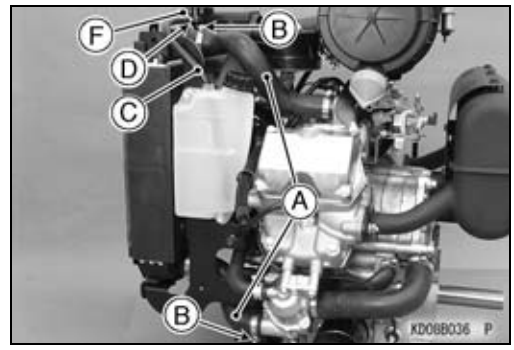


Radiator

- Install the water hose [A] and tighten the water hose clamp screws [B].

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

- Install the radiator overflow hose [C] fully so that the clamp knob [D] faces the downward.
- Install the radiator cap [E].



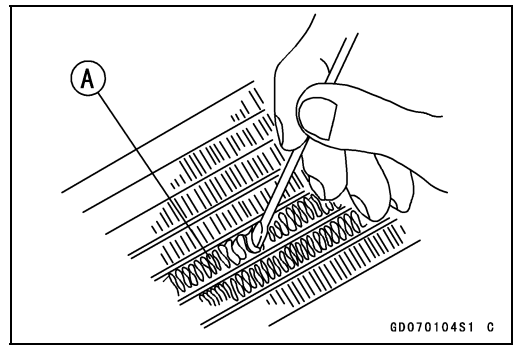
Radiator Inspection

- Remove the radiator (see Radiator Removal).
- Check the radiator core.

★If there are obstructions to air flow, remove them.

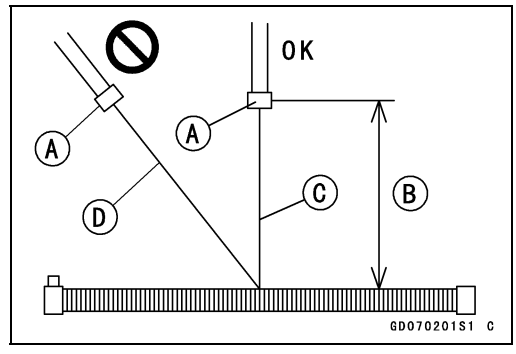
★If the corrugated fins [A] are deformed, carefully straighten them.

★If the air passages of the radiator core are blocked more than 20% by unremovable obstructions or irreparably deformed fins, replace the radiator with a new one.



NOTICE

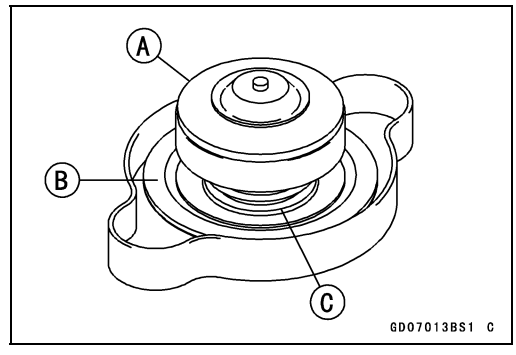
When cleaning the radiator with steam cleaner, be careful of the following to prevent radiator damage:
Keep the steam gun [A] away more than 0.5 m (1.6 ft) [B] from the radiator core.
Hold the steam gun perpendicular [C] (not oblique [D]) to the core surface.
Run the steam gun, following the core fin direction.



Radiator Cap Inspection

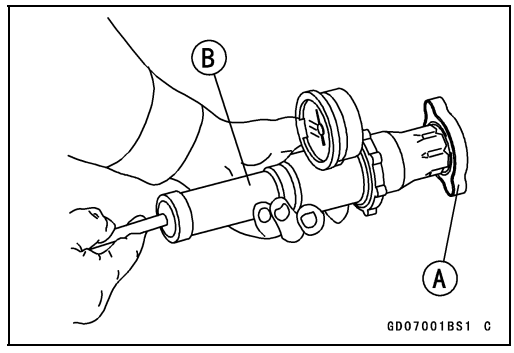
- Remove the radiator cap (see Pressure Testing).
- Check the condition of the bottom [A] and top [B] valve seals and valve spring [C].

★If any one of them shows visible damage, replace the cap with a new one.



Radiator

- Install the cap [A] on a cooling system pressure tester [B].



NOTE

○*Wet the cap sealing surfaces with water or coolant to prevent pressure leaks.*

- Watching the pressure gauge, pump the pressure tester to build up the pressure until the relief valve opens: the gauge needle flicks downward. Stop pumping and measure leak time at once. The relief valve must open within the specified range in the table below and the gauge hand must remain within the same range at least 6 seconds.

Radiator Cap Relief Pressure

Standard: 78 ~ 98 kPa (0.80 ~ 1.00 kgf/cm², 11.3 ~ 14.2 psi)

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

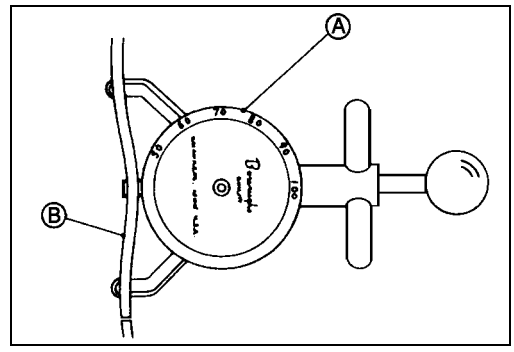
Radiator Filler Neck Inspection

- Remove the radiator cap (see Pressure Testing).
- Check the radiator filler neck for signs of damage.
- Check the condition of the top and bottom sealing seats [A] in the filler neck. They must be smooth and clean for the radiator cap to function properly.

Cooling Fan and Fan Belt

The only service on the cooling fan is to be srue the fan blades are not deformed, and the blade tips are far enough from the air duct to not strike the duct. The fan belt should be neither too tight nor too loose.

Belt Tension Inspection

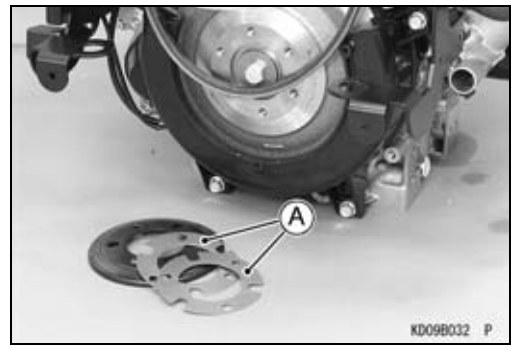


- Remove:
  Radiator (see Radiator Removal)
- Measure the belt tension using a proper belt tension gauges [A]. Follow the manufacturer's instructions for use of the belt tension gauge. The belt tension is adjusted between 25 kg (55 lb) and 40 kg (88 lb) in the factory for the manufacturing standard.

★If the belt tension is less than specified limit, adjust or replace the belt [B].

Belt Tension Service Limit
18 kg (40 lb)

Belt Replacement



- Remove the pully (see Cooling Fan and Fan Belt Removal)
- When replacing the fan belt, use only factory recommended belt with the proper length. To compensate for the belt length allowance, select appropriately sized shim(s) [A] from the table to obtain proper level of the belt tension (25 ~ 40 kg).

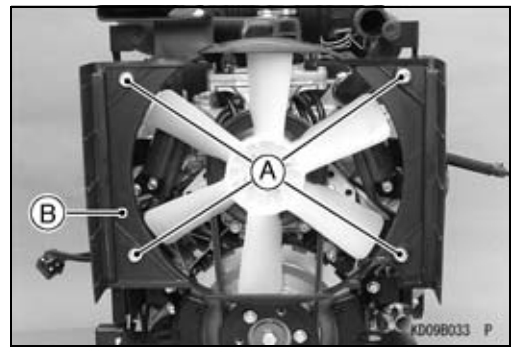
Fan Belt		A	B	C	D	E	F
No of shim	92180-2013*	1	1	2	1	2	2
	t = 0.6 mm						
	92180-2014*	—	—	—	1	1	1
	t = 1.2 mm						

*Part Number A Belt: smaller allowance
t = Thickness of shim F Belt: Bigger allowance

- Install the belt pully (see Cooling Fan and Fan Belt Removal).

Drive Belt Specification
MITSUBOSHI — 59011-2058

Cooling Fan and Fan Belt Removal



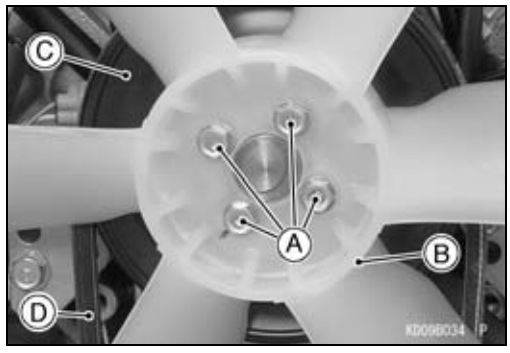
- Remove the radiator (see Radiator Remove).
- Unscrew the mounting bolts [A] and remove the radiator guide [B].

Cooling Fan and Fan Belt

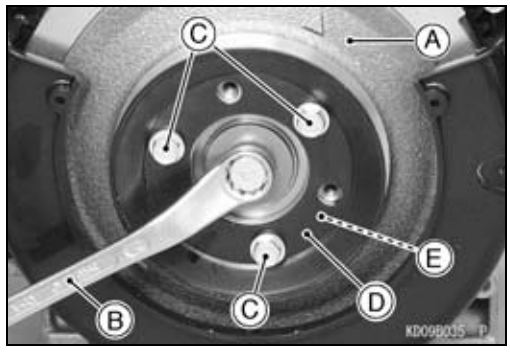
- Unscrew the mounting bolts [A], and take off the cooling fan [B] and fan pully [C] and fan belt [D].

NOTE

○*When removing the fan belt, note the belt so that it may be reinstalled on the pullies to rotate same direction as original installation.*

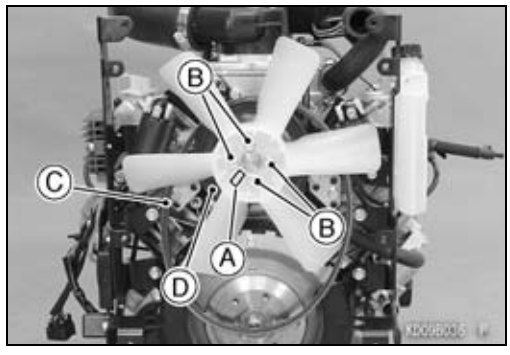


- Hold the flywheel [A] with a suitable spanner [B] to prevent rotating the belt pully.
- Unscrew the belt pully mounting bolts [C], and take off the belt pully [D] and shim(s) [E].



Cooling Fan and Fan Belt Installation

- Install the cooling fan as “AISKIN” raised lettering [A] on the fan boss facing toward the radiator.
- Tighten the cooling fan mounting bolts [B] by the hand.
- Clean the drive belt by wiping with a clean cloth. Immediately wipe off any spilled oil or grease. Do not use solvent.
- Install the belt [C] on the fan pully [D] to rotate same direction as original installation.

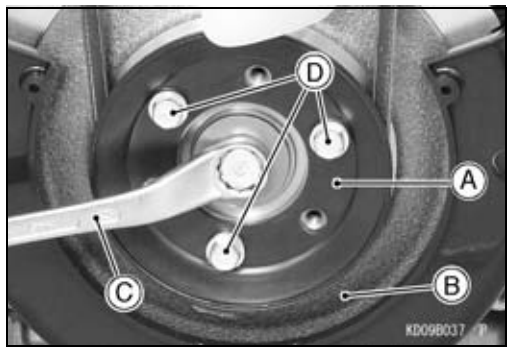


- Install the belt pully [A] and hold the flywheel [B] with suitable spanner [C] to prevent rotating the belt pully.
- Tighten the belt pully mounting bolts [D].

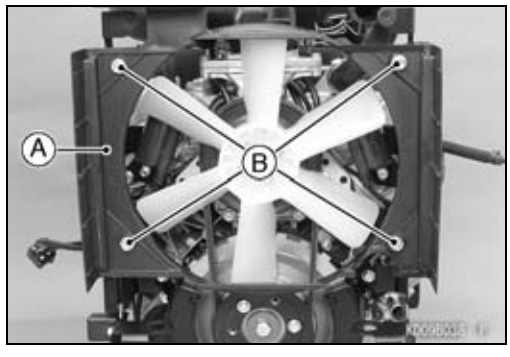
NOTE

○*When tightening the belt pully mounting bolts, rotate the fan in either direction to avoid pinching the belt.*

- Check the Belt tension (see Belt Tension Inspection).

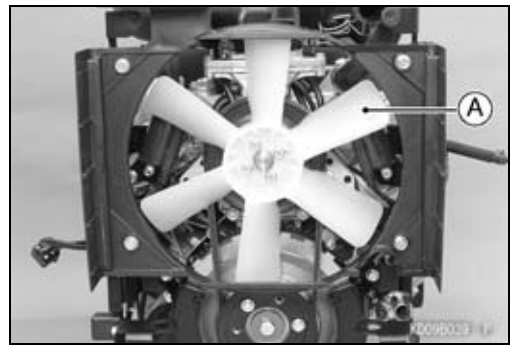


- Install the radiator guide [A] and tighten the bolts [B].
- Install the radiator (see Radiator Installation).



Cooling Fan and Fan Belt

Cooling Fan, Fan Belt Inspection

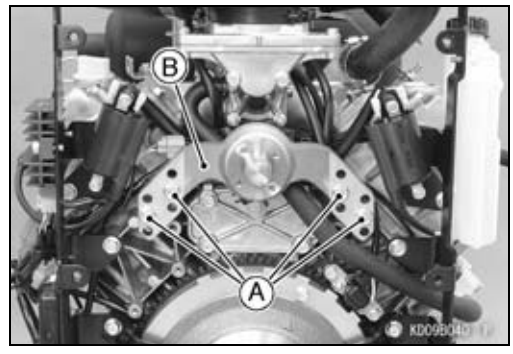


- Be sure the fan blades [A] are straight. Deformed blades reduce the cooling system efficiency and throw the fan out of balance.

Fan Belt Inspection

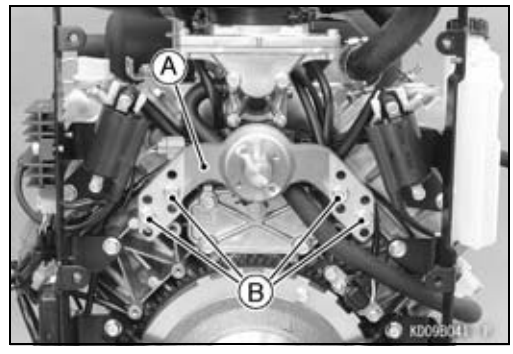
- Check for excessive side wall wear of the sheaves and belt, replace if necessary. The belt and sides of the sheaves should wear evenly.
- Check to be sure dirt has not lodged and packed in the sheave V-grooves.
- Check the belt for swells or lumps, replace if necessary.

Cooling Fan Mounting Bracket Removal



- Remove the cooling fan (see Cooling Fan and Fan Belt Removal).
- Unscrew the cooling fan mounting bracket bolts [A] and remove the cooling fan mounting bracket [B].

Cooling Fan Mounting Bracket Installation

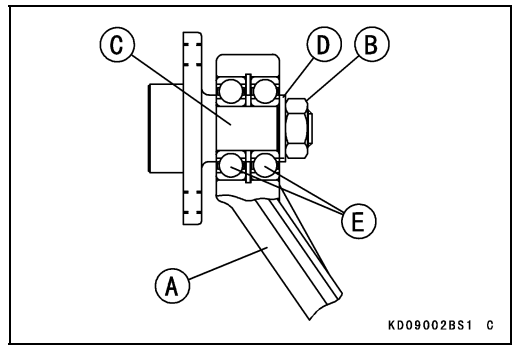


- Install the cooling fan mounting bracket [A] and tighten the cooling fan mounting bracket bolts [B].

  Torque - Cooling Fan Mounting Bracket Bolts: 20 N·m (0.20 kgf·m, 15 in·lb)

- Install the cooling fan (see Cooling Fan and Fan Belt Installation).

Fan Bearing Removal



- Remove the cooling fan mounting bracket [A] (see Cooling Fan Mounting Bracket Removal).
- Unscrew the fan shaft nut [B], and remove the shaft [C] and washer [D].
- To check the ball bearing [E], rotate the bearing slowly by finger; if any roughness is noted, the bearing should be replaced.

⚠ WARNING

Super-heated oil can start a fire and cause serious burns. To prevent fire and burns, do not allow a flame or heating element to directly contact the oil. Heat the oil in a well-ventilated area, and use caution when handling the heated oil to prevent burns.

Cooling Fan and Fan Belt

- To remove the ball bearing, heat the bearing housing in a hot 150°C (320°F) oil.
- Use a heat shield gloves to prevent burns.
- Place the bearing housing on a bench with bearing side up and take off the bearing with a suitable tools.

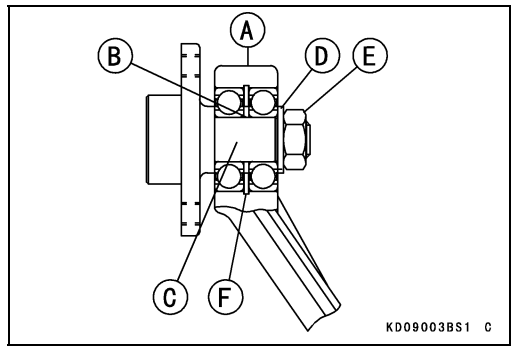
NOTICE
Do not remove the bearing unless it is necessary. Once it has been removed, it must be replaced.

Fan Bearing Installation

- Coat the bearing surfaces with a light film of engine oil.
- Use a bearing driver, press in the fan side bearing flush with the housing [A].
- Install opposite side of bearing using a bearing driver until it stops at the stop (spacer [B]) in hole.
- Install the fan shaft [C], washer [D] and nut [E], then tighten the nut to the specified torque (see Exploded View).

  Circlip [F]

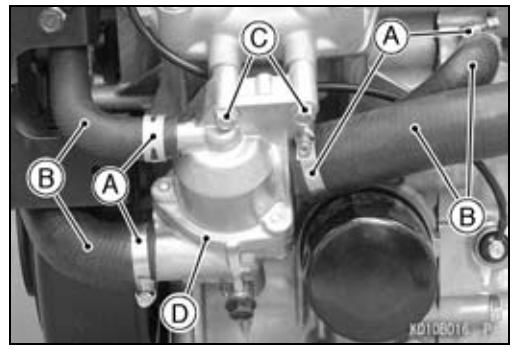
  Torque - Cooling Fan Shaft Nut: 20 N·m (2.0 kgf·m, 15 ft·lb)
- Install the cooling fan mounting bracket (see Cooling Fan Mounting Bracket Installation).



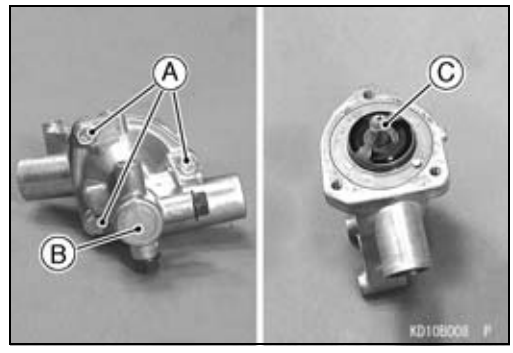
Thermostat

Thermostat Removal and Installation

- Drain the coolant (see Coolant Change in the Periodic Maintenance chapter).
- Loosen the hose clamps [A], and pull off the three coolant hoses [B].
- Unscrew the mounting bolts [C], and remove the thermostat-body [D].

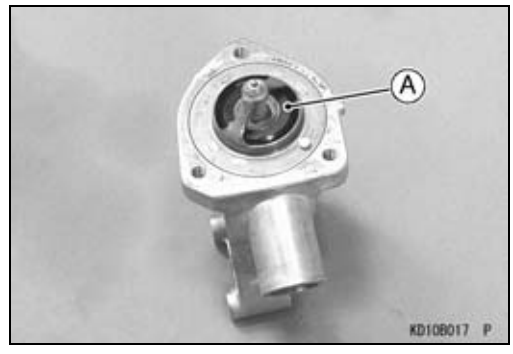


- Unscrew the bolts [A], and remove the cover [B].
- Take off the thermostat [C].



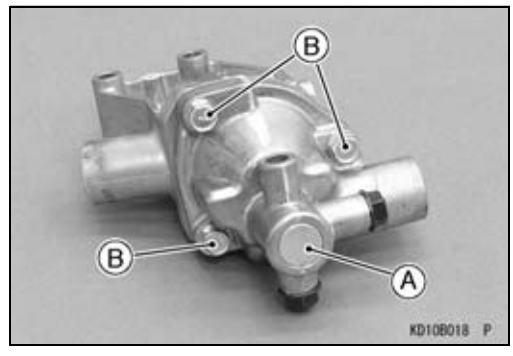
Thermostat Installation

- Replace the gasket with a new one.
- Install the thermostat [A] in the thermostat body.



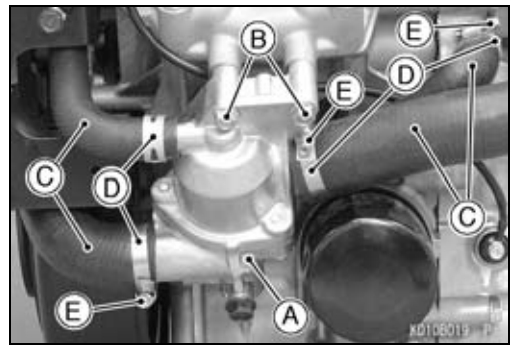
- Install:
  Gasket
  Thermostat Cover [A]
- Tighten:

Torque - Thermostat Body Tightening Bolt [B]: 10 N·m (1.0 kgf·m, 87 in·lb)



- Install the thermostat body [A] and tighten the mounting bolts [B].
- Install the water hoses [C] and clamps [D].
- Tighten:

Torque - Water Hose Clamp Screw [E]: 1.3 N·m (0.13 kgf·m, 12 in·lb)

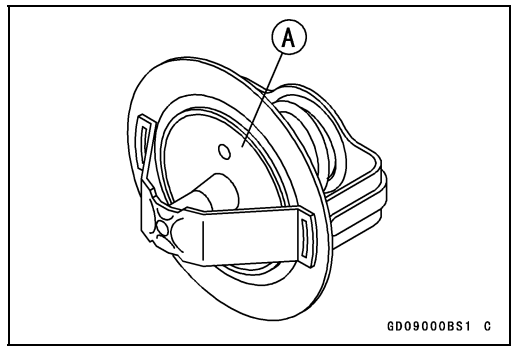


Thermostat

Thermostat Inspection

- Remove the thermostat (see Thermostat Removal).
- Inspect the thermostat valve [A] at room temperature.

★If the valve is open, replace the thermostat with a new one.

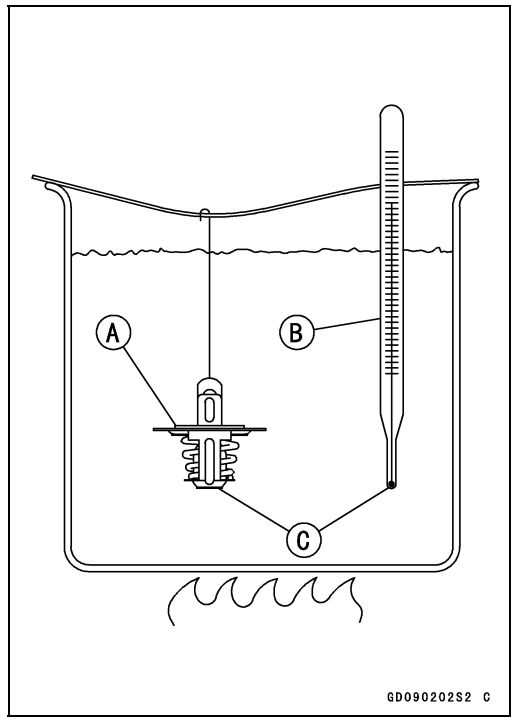


- To check valve opening temperature, suspend the thermostat [A] in a container of water and raise the temperature of the water.

○The thermostat must be completely submerged and must not touch the container sides or bottom. Suspend an accurate thermometer [B] in the water so that the heat sensitive portions [C] are located in almost the same depth. It must not touch the container, either.

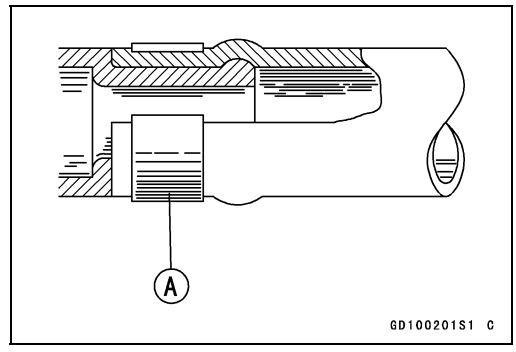
★If the measurement is out of the specified range, replace the thermostat with a new one.

Thermostat Valve Opening Temperature
58 ~ 62°C (136 ~ 144°F)



Hoses and Pipes

Hose Installation



- Install the hoses and pipes, being careful to follow bending direction. Avoid sharp bending, kinking, flattening or twisting.
- Run the hoses (see Cable, Wire, and Hose Routing section in the Appendix chapter).
- Install the clamp [A] as near as possible to the hose end to clear the raised rib of the fitting. This will prevent the hoses from working loose.

○The clamp screws should be positioned correctly to prevent the clamps from contacting the other parts.

○Tighten:

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

Hose Inspection

- Refer to the Radiator Hose and Pipe Inspection in the Periodic Maintenance chapter.

Engine Top End

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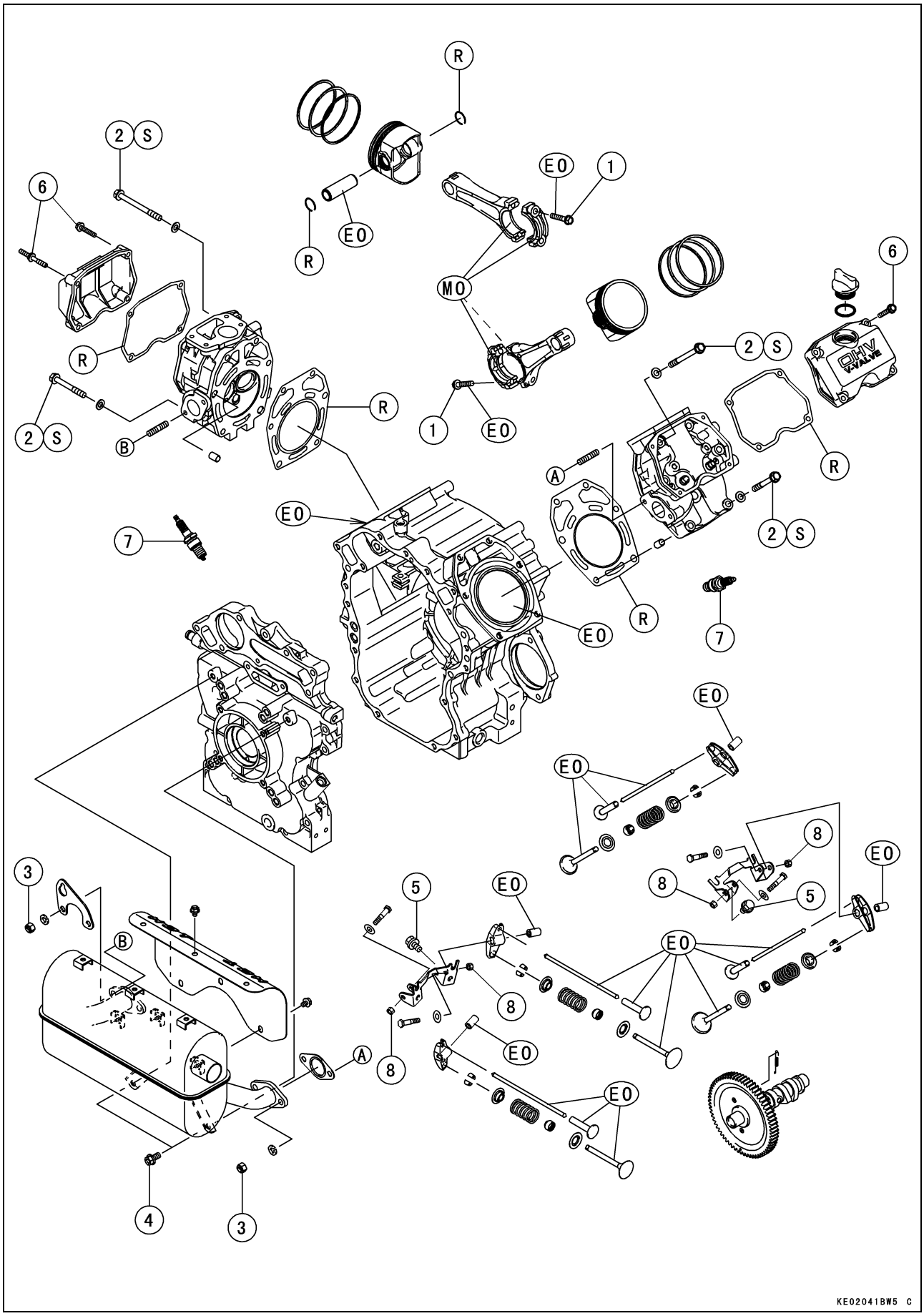
5-2 ENGINE TOP END

Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Connecting Rod Big End Cap Bolts	21	2.1	15	EO
2	Cylinder Head Bolts	27	2.8	20	S
3	Exhaust Pipe Nuts	20	2.0	15	
4	Muffler Bracket Bolts	20	2.0	15	
5	Rocker Arm Bracket Bolts	22	2.2	16	
6	Rocker Cover Bolts	10	1.0	12 in·lb	
7	Spark Plugs	25	2.6	18	
8	Valve Clearance Adjusting Locknuts	11	1.1	96 in·lb	

EO: Apply engine oil.
MO: Apply molybdenum disulfide oil.
R: Replacement Parts
S: Following the specific tightening sequence.

Specifications

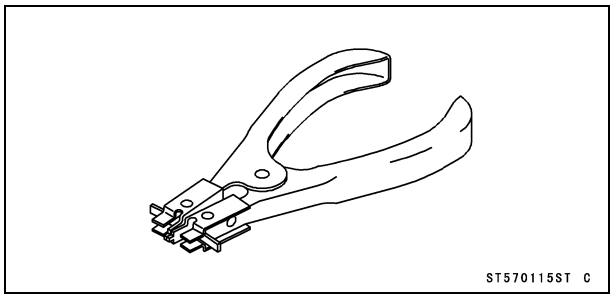
Item	Service Limit
Cylinder Head	
Cylinder Compression (MIN)	853 kPa (8.70 kgf/cm²124 psi)
Cylinder Head Warp	0.05 mm (0.002 in.)
Valves	
Valve Head Thickness	
Intake, Exhaust	0.6 mm (0.024 in.)
Valve Stem Runout	
Intake, Exhaust	TIR 0.05 mm (0.002 in.)
Valve Stem Diameter	
Intake, Exhaust	6.94 mm (0.273 in.)
Valve Guide Inside Diameter	
Intake, Exhaust	7.08 mm (0.279 in.)
Valve Spring Free Length	
Intake, Exhaust	31.0 mm (1.22 in.)
Rocker Arm Push Rod Runout	
Intake, Exhaust	0.5 mm (0.02 in.)
Rocker Arm Collar Outside Diameter	
Intake, Exhaust	10.914 mm (0.4297 in.)
Rocker Arm Inside Diameter	
Intake, Exhaust	11.132 mm (0.4382 in.)
Cylinder, Piston	
Piston Diameter	81.80 mm (3.220 in.)
Piston Ring/Groove Clearance:	
Top, Second	0.15 mm (0.0059 in.)
Piston Ring Thickness	
Top, Second	1.40 mm (0.0551 in.)
Piston Ring End Gap:	
Top	0.7 mm (0.028 in.)
Second	0.8 mm (0.031 in.)
Oil	1.0 mm (0.039 in.)
Piston Pin Outside Diameter	18.96 mm (0.746 in.)
Piston Pin Hole Inside Diameter	19.08 mm (0.751 in.)
Connecting Rod Small End Inside Diameter	19.06 mm (0.756 in.)
Cylinder Inside Diameter:	
Standard Cylinder	82.09 mm (3.232 in.)
Cylinder Inside Diameter Out Round	0.056 mm (0.0022 in.)

Specifications

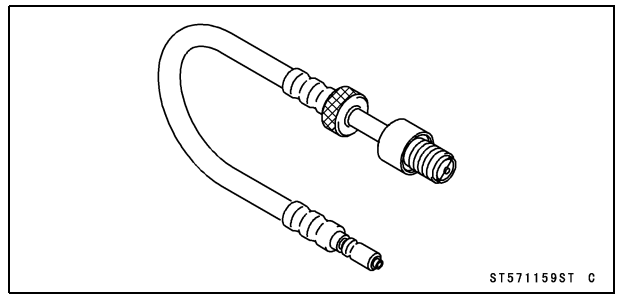
Item	Standard
Valve Clearance:	
Intake, Exhaust	0.15 mm (0.006 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake, Exhaust	0.5 ~ 1.1 mm (0.020 ~ 0.043 in.)
Valves Guide Inside Diameter:	
Intake, Exhaust	7.000 ~ 7.015 mm (0.2756 ~ 0.2762 in.)
Cylinder Inside Diameter:	
Standard Cylinder	81.97 ~ 81.99 mm (3.227 ~ 3.228 in.)

Special Tools

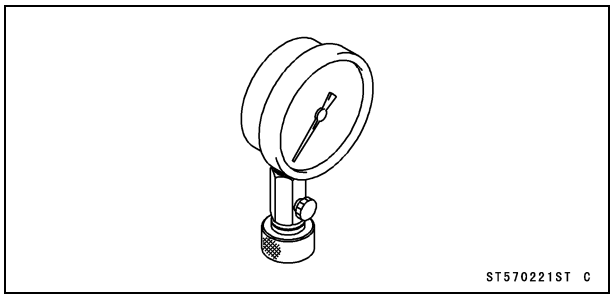
Piston Ring Pliers:
57001-115



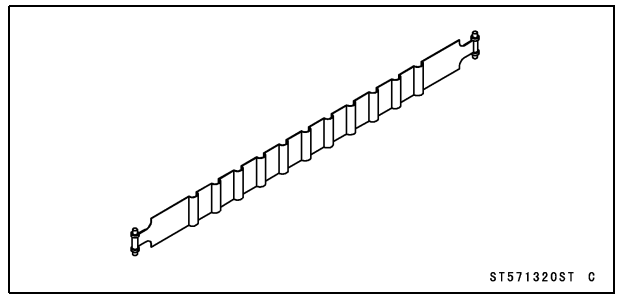
Compression Gauge Adapter, M14 × 1.25:
57001-1159



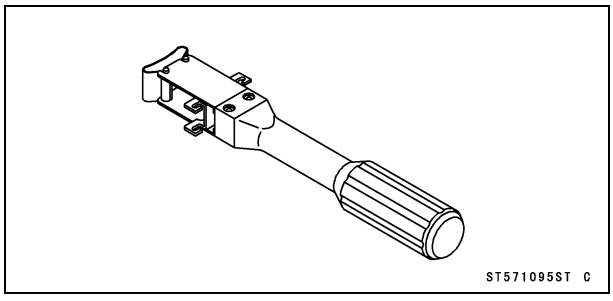
Compression Gauge, 20 kgf/cm²:
57001-221



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



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

● 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) 853 kPa (8.70 kgf/cm², 124 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 450 rpm

● 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.

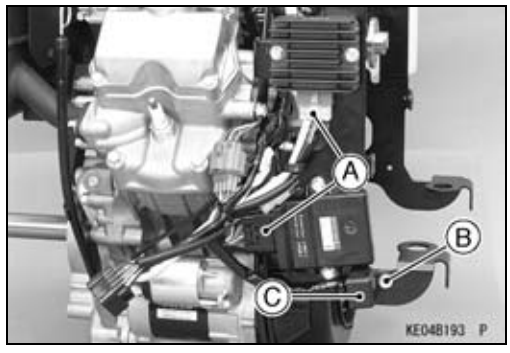
★If the cylinder compression is lower than the (MIN), check the following.
1. Gas leakage around the cylinder head - replace the damaged gasket with a new one and check the cylinder head warp.
2. Condition of the valve seating.
3. Valve clearance.
4. Piston/cylinder wear, piston seizure.
5. Piston ring,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

Cylinder Head

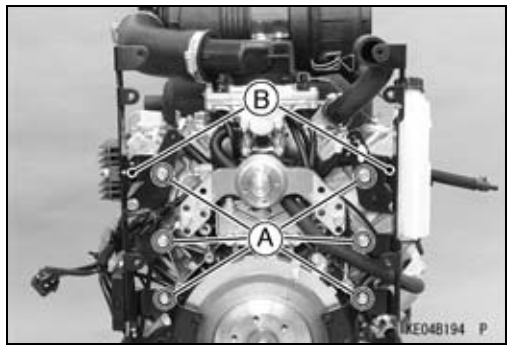
Cylinder Head Assembly Removal

● Remove:
Radiator (see Radiator Removal in Cooling System chapter)
Cooling Fan and Fan Belt (see Cooling Fan Removal and Fan Belt Removal in Cooling System chapter)
Ignition Coil (see Ignition Coil Removal/Installation in the Electrical System chapter)

● Disconnect the connectors [A].
● Remove the bolt [B] and relay [C].

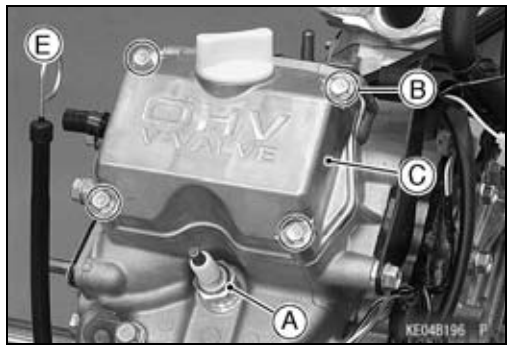


● Remove:
Bolts [A]
Radiator Bracket [B]
Muffler Assembly (see Muffler Assembly Removal)
Intake Manifold (see Intake Manifold Removal in the Fuel System (DFI) chapter)



● Remove the spark plug [A].
● Unscrew the rocker cover bolts [B], and remove the covers, [C] and gaskets.
#1 Cylinder [D]
#2 Cylinder [E]

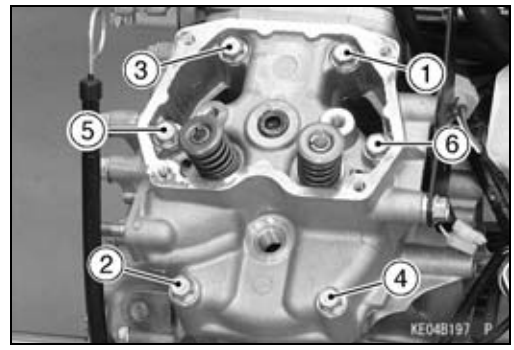
○When removing the #1, #2 cylinder head, set each piston at the top dead center (T.D.C) of the compression stroke (see Valve Clearance Inspection in the Periodic Maintenance chapter).



● Remove:
Rocker Arms (see Valve Mechanism Removal/Installation)
Push Rods (see Push Rod Removal)
Rocker Arm Bracket (see Valve Mechanism Removal/Installation)

Cylinder Head

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



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

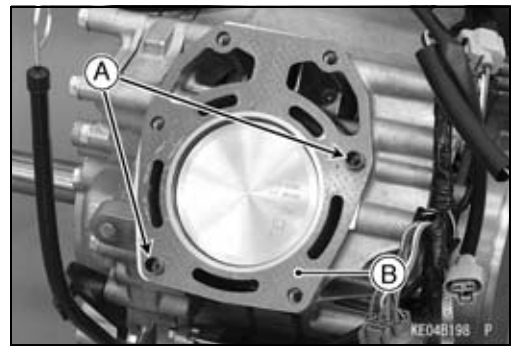
- Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.

NOTE

○*Mark 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 gaskets with new ones.
- Install the dowel pins [A].
- When installing the #1, #2 cylinder head, set each piston at the top dead center (T.D.C) of the compression stroke (see Valve Clearance Inspection in the Periodic Maintenance chapter).
- Put new gaskets [B] and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms.

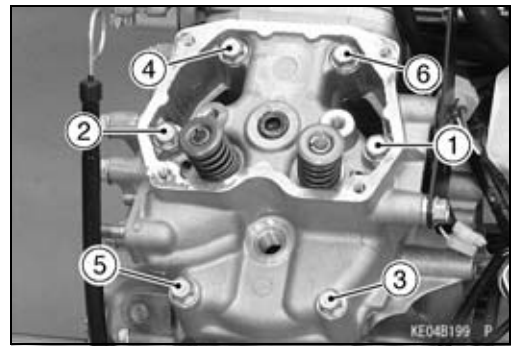


NOTE

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

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

Torque - Cylinder Head Bolts: 27 N·m (2.8 kgf·m, 20 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.

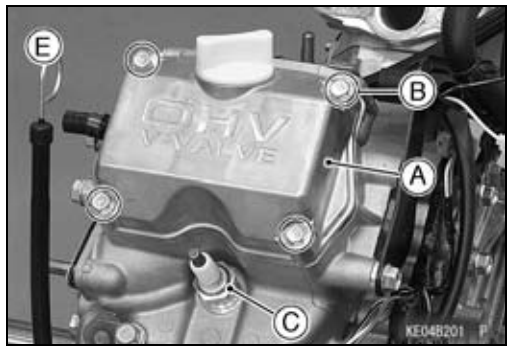
- Install:
  Rocker Arm Bracket (see Valve Mechanism Removal/Installation)
  Push Rods (see Push Rod Installation)
  Rocker Arms (see Valve Mechanism Removal/Installation)

Cylinder Head

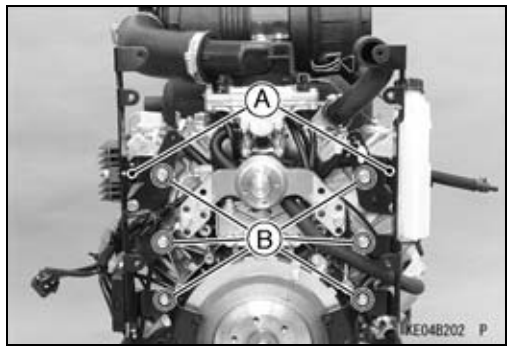
- Install the new gaskets and rocker covers [A].
- Tighten:

Torque - Rocker Cover Bolts [B]: 10 N·m (1.0 kgf·m, 88 in·lb)

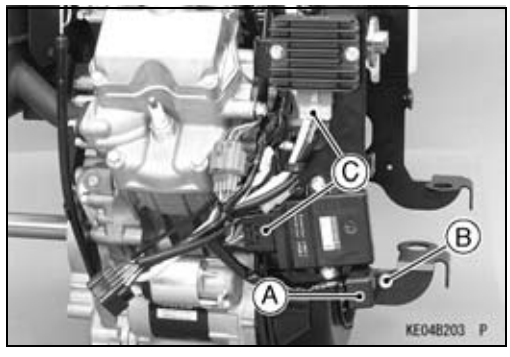
- Install the spark plug [C] (see Spark Plug Installation in the Electrical System chapter).
  #1 Cylinder [D]
  #2 Cylinder [E]



- Install:
  Intake Manifold (see Intake Manifold Installation in the Fuel System (DFI) chapter)
  Muffler Assembly (see Muffler Assembly Installation)
  Radiator Bracket [A]
  Bolts [B]



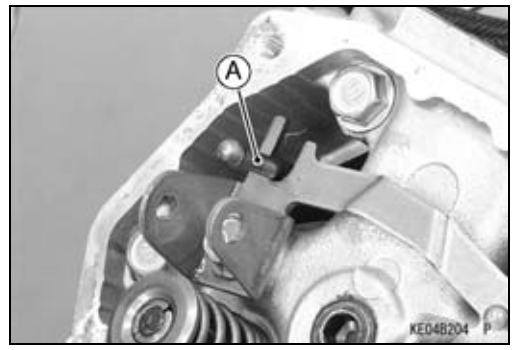
- Install the relay [A] and bolt [B].
- Connect the connectors [C].



- Install the removed parts (see appropriate chapters).

Cylinder Head

Push Rod Removal

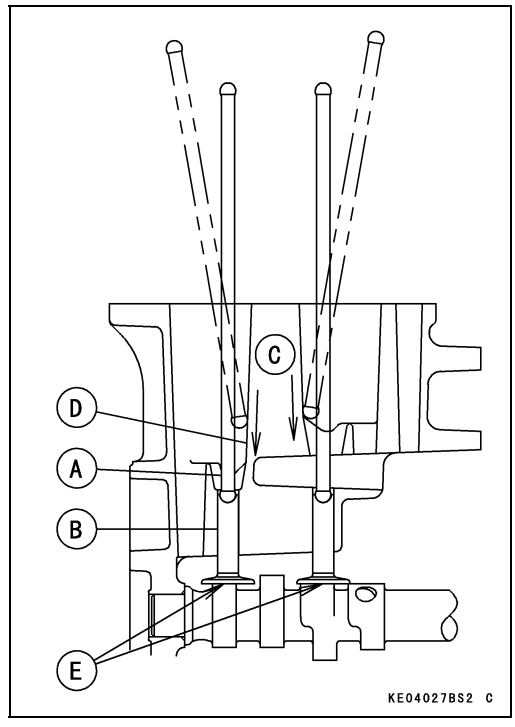


- Set each piston at the T.D.C of the compression stroke.
- Remove the rocker arms (see Cylinder Head Assembly Removal).
- Pull out the push rods [A].

NOTE

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

Push Rod Installation

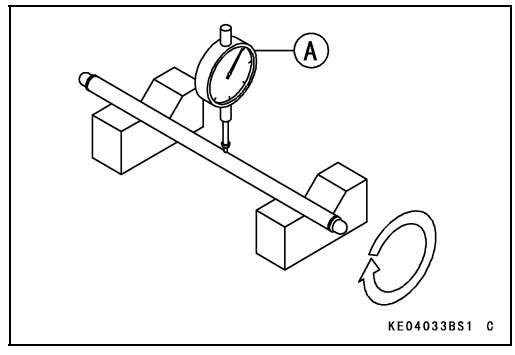


- Set each piston at the T.D.C of the compression stroke.
- Apply engine oil to the both ends and shaft of the push rod.
- Install the push rods in their original positions of the tappet hollow [A].

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

- 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 T.D.C of the compression stroke, turn the flywheel clockwise one turn (360°) and reset each piston at the T.D.C of the compression stroke.
- Be sure the end of the push rods are correctly seated on the tappets.
- Install the rocker arm (see Valve Mechanism Removal/Installation).
- Check and adjust the valve clearance (see Valve Clearance Inspection in the Periodic Maintenance chapter).

Push Rod Inspection

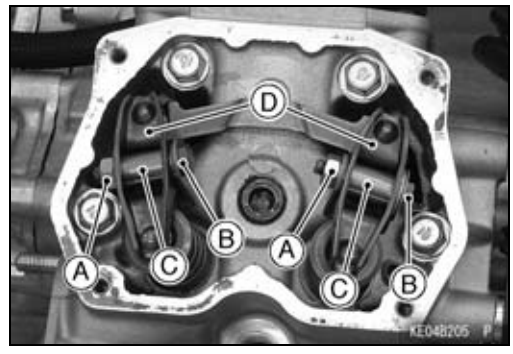


- Place the push rod on V blocks as far apart as possible, and set a dial gauge [A] on the rod at a halfway point between the blocks. Turn the rod to measure the runout. The difference between the highest and the lowest dial readings is amount of runout.

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

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

Valve Mechanism Removal



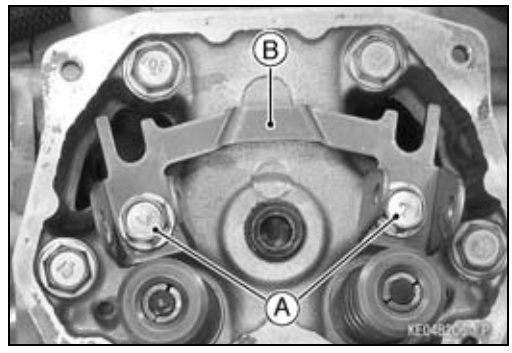
NOTE

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

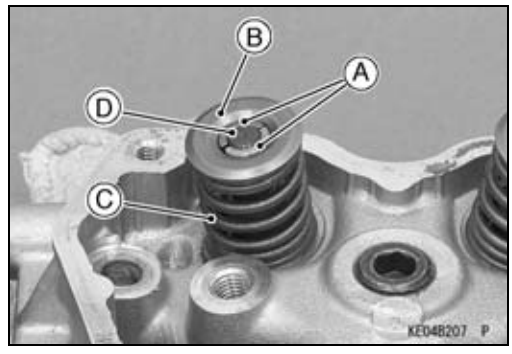
- Remove:
  Valve Clearance Adjusting Locknuts [A]
  Valve Clearance Adjusting Bolts [B] and Washer
  Collars [C]
  Rocker Arms [D]

Cylinder Head

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



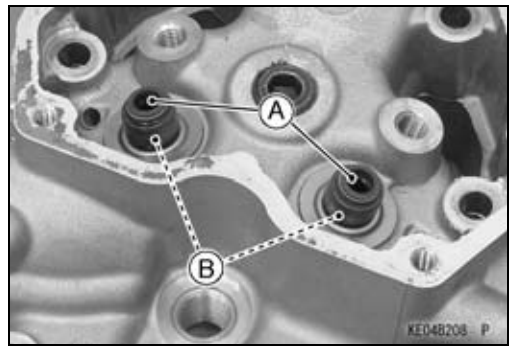
- Remove the cylinder head assembly (see Cylinder Head Assembly Removal)
- Support the valve head in the combustion chamber with a suitable block.
- To remove the collets [A], push down the valve retainer [B] with suitable tool and remove the collets.
- Remove the valve retainer, spring [C] and valve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



- Remove the stem seals [A].

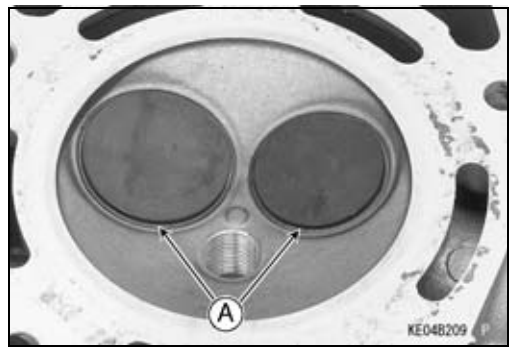
NOTE

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

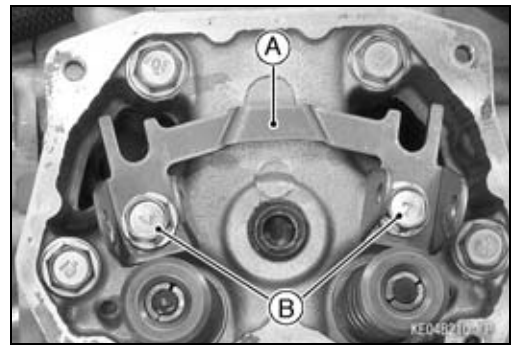


Valve Mechanism Installation

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



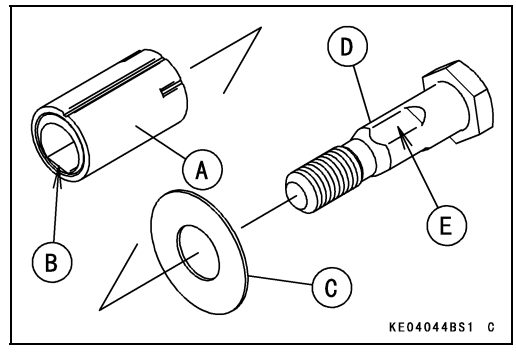
Cylinder Head



- Install the bracket [A] on the cylinder head.
- Tighten:

Torque - Rocker Arm Bracket Mounting Bolt [B]: 22 N·m (2.2 kgf·m, 16 ft·lb)

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



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

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

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

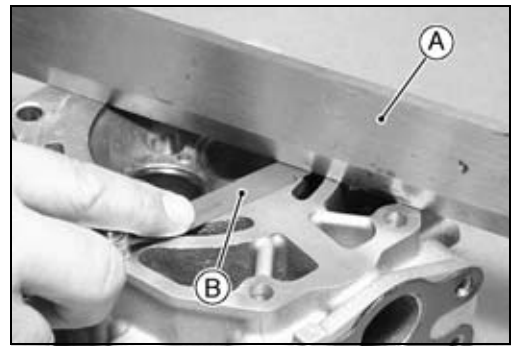
○Align the flatten surface of the collars with the flatten surface of the valve clearance adjusting bolts.

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

Cylinder Head Cleaning

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

Cylinder Head Inspection



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

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

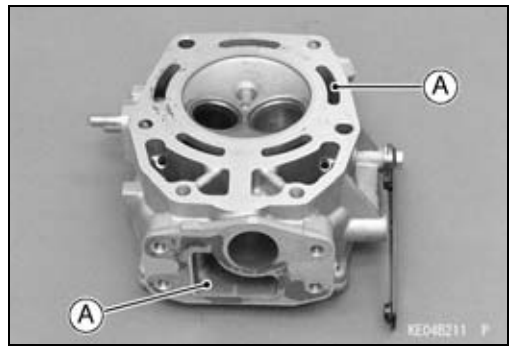
Cylinder Head Warp
Service Limit: 0.03 mm (0.001 in.)

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

Cylinder Head

- Inspect the cylinder head for accumulation of rust, scale and lime in the water jacket [A].

★If this accumulation is observed, flush the cooling system (see Cooling System chapter).

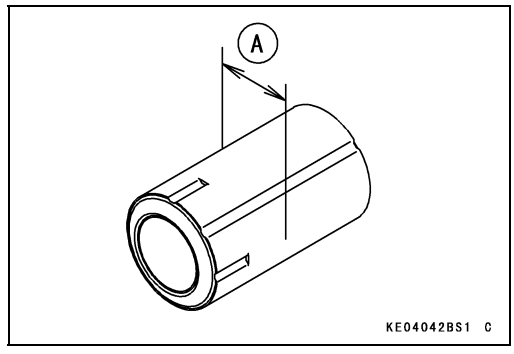


Rocker Arm Inspection

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

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

Rocker Arm Collar Outside Diameter
Service Limit:
Intake Exhaust 10.914 mm (0.4297 in)



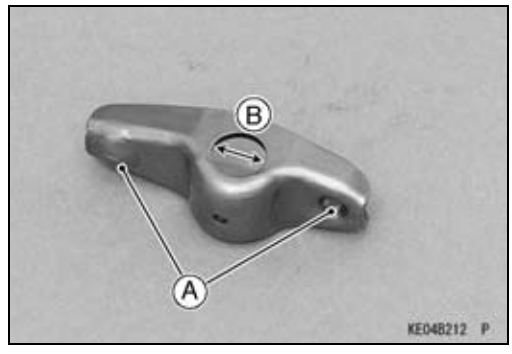
- Clean and inspect the rocker arm where it touches the push rod and valve stem.

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

- Measure the inside diameter [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 Bearing Inside Diameter
Service Limit:
Intake Exhaust 11.132 mm (0.4382 in)



Valves

Valve Clearance Inspection

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

Valve Clearance Adjustment

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

Valve Seat Inspection

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

Valve Seat Repair

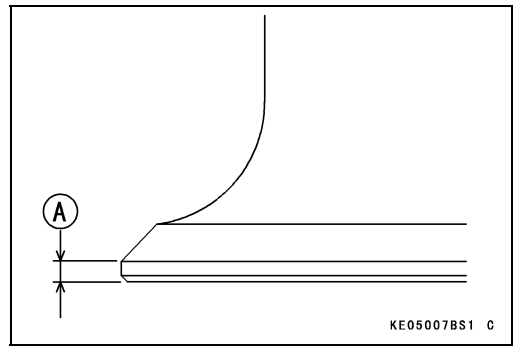
- Refer to the Valve Seat Repair in the Periodic Maintenance chapter.

Valve Head Thickness

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

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

Valve Head Thickness
Service Limit:
Intake, Exhaust 0.6 mm (0.24 in)

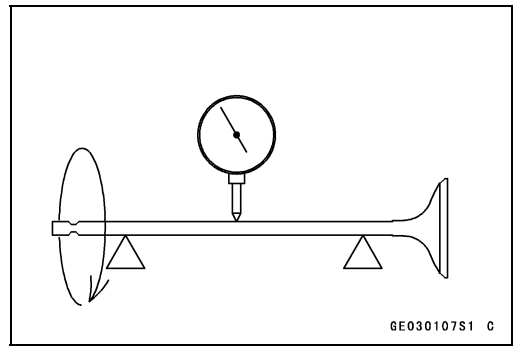


Valve Stem Runout

- 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 with a new one.

Valve Stem Runout
Service Limit :
Intake, Exhaust TIR 0.05 mm (0.002 in.)

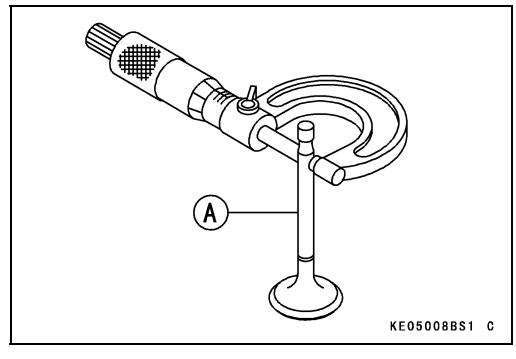


Valve Stem Diameter

- 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, Exhaust: 6.94 mm (0.273 in.)



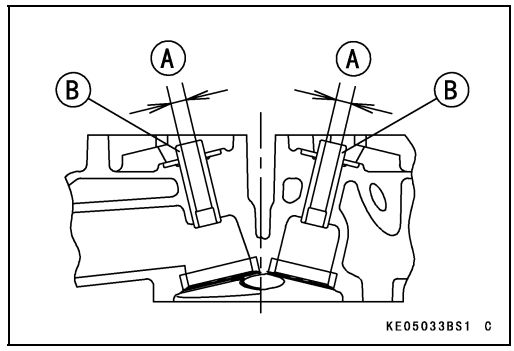
Valves

Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter [A] of the valve guide [B] a 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: 7.08 mm (0.2787 in.)

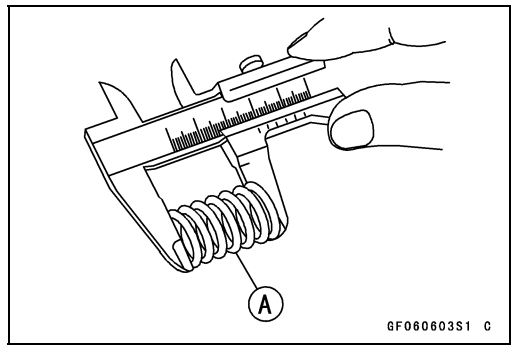


Valve Spring Inspection

- Inspect the valve spring for pitting, cracks, rusting, and burrs. Replace the spring if necessary.
- Measure the free length [A] of the spring.

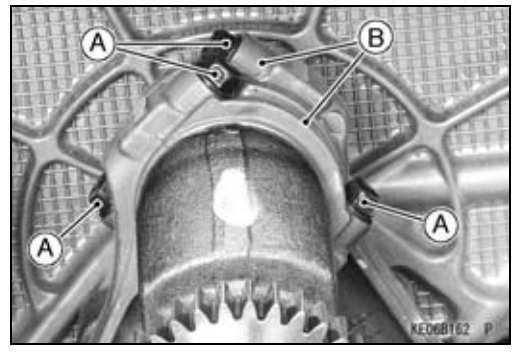
★If the measurement is less than the service limit, replace the spring with a new one.

Valve Spring Free Length
Service Limit: 31.0 mm (1.22 in.)



Cylinder, Piston

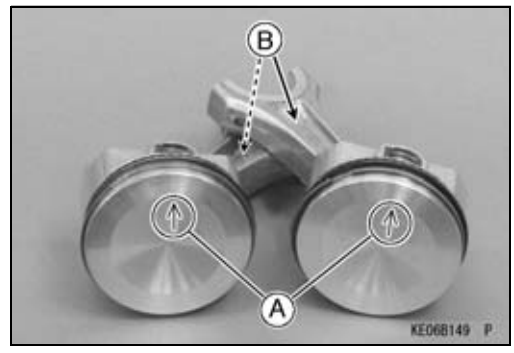
Piston Removal



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

NOTE

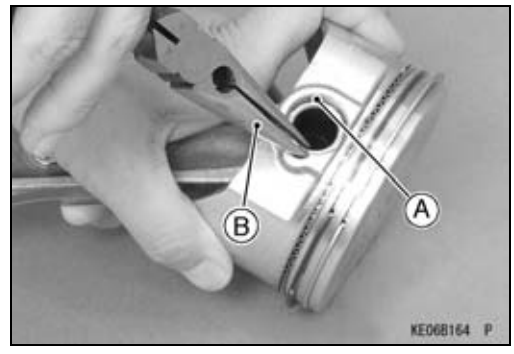
○*Note the positions of the connecting rod caps for reinstalling the caps.*



- Scrape the carbon depsits from the cylinder head with a suitable tool before the piston and connecting rod are pulled out.
- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.

NOTICE

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



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

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

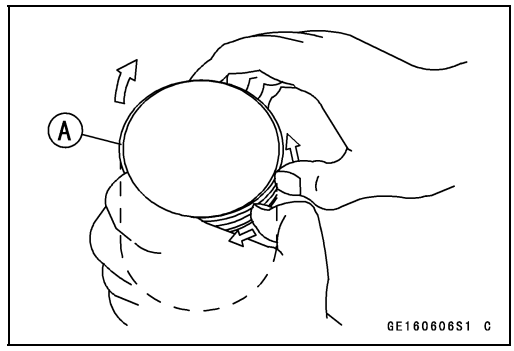
Cylinder, Piston

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

Special Tool - Piston Ring Pliers: 57001–115

★If the special tool is not available, carefully spread the ring opening with your thumbs, then push up on the opposite side of the ring [A] to remove it.

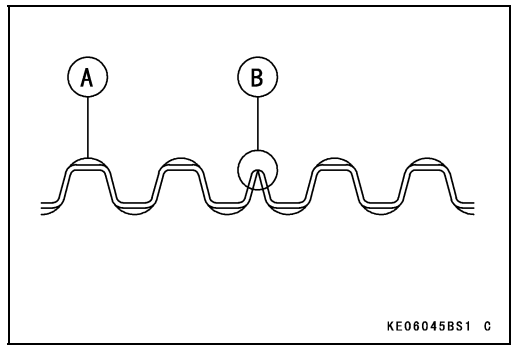
● Remove the 3-piece oil ring with your thumbs in the same manner.



Piston Installation

● Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap them.

● Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.

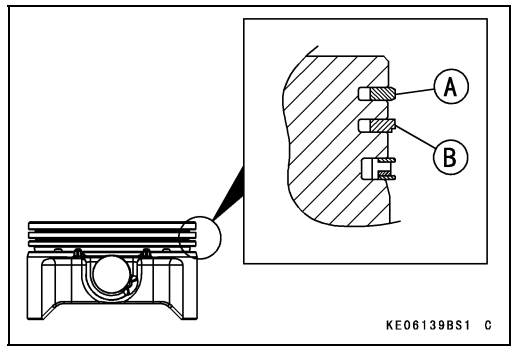


● Do not mix up the top and second rings.

● With the notched side facing down, install the second ring [A] and top ring [B] in that order.

○The top ring have no “top” or “bottom”.

● The rings should turn freely in the grooves.



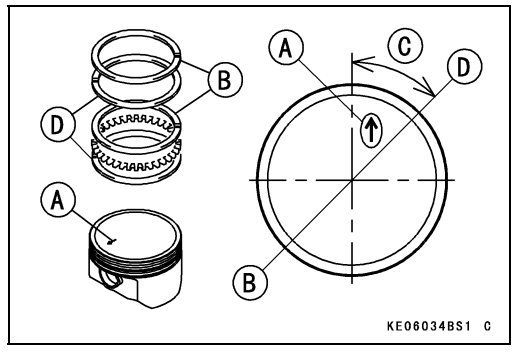
● Align the piston and rings with the piston ring end gap as shown.

[A]: Arrow Match Marks

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

[C]: 30° ~ 45°

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



● Apply engine oil to the piston pins.

● Assemble the pistons onto the connecting rods as follow.

○No.1 Cylinder Piston is oil filter side.

○No.1 Cylinder Piston; piston, align the arrow match mark on the piston head with the raised letters (MADE IN JAPAN) on the connecting rod.

○No.2 Cylinder Piston; align the arrow match mark on the piston head with opposite MADE IN JAPAN on the connecting rod.

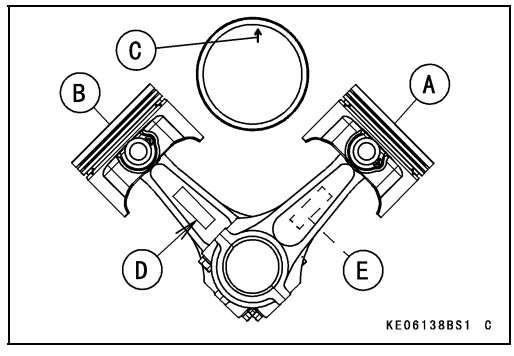
[A]: No.1 Cylinder Piston

[B]: No.2 Cylinder Piston

[C]: Arrow Match Marks

[D]: MADE IN JAPAN

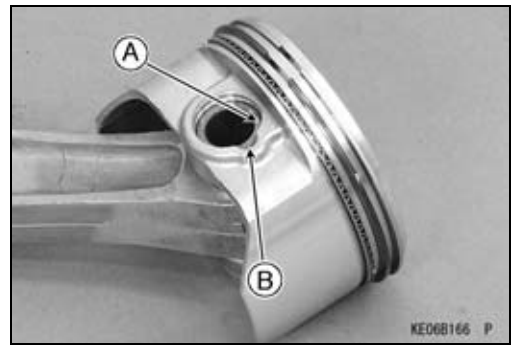
[E]: Opposite MADE IN JAPAN



Cylinder, Piston

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

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



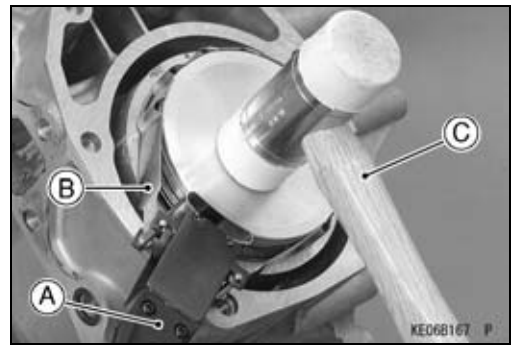
NOTICE

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

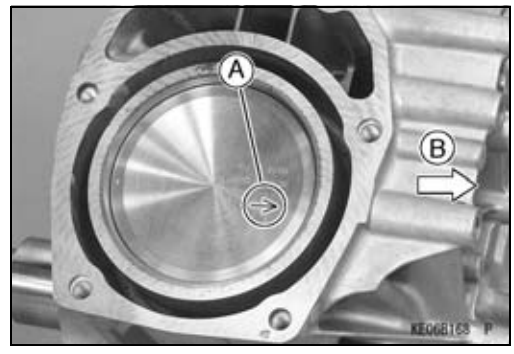
● Apply engine oil to the piston skirt and the cylinder bore.

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

Special Tools - Piston Ring Compressor Grip: 57001-1095
Piston Ring Compressor Belt, ϕ67 ~ ϕ79: 57001-1057



● Insert the piston and connecting rod so that the arrow mark [A] on the top of the piston is facing the flywheel side [B].



NOTICE

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

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

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

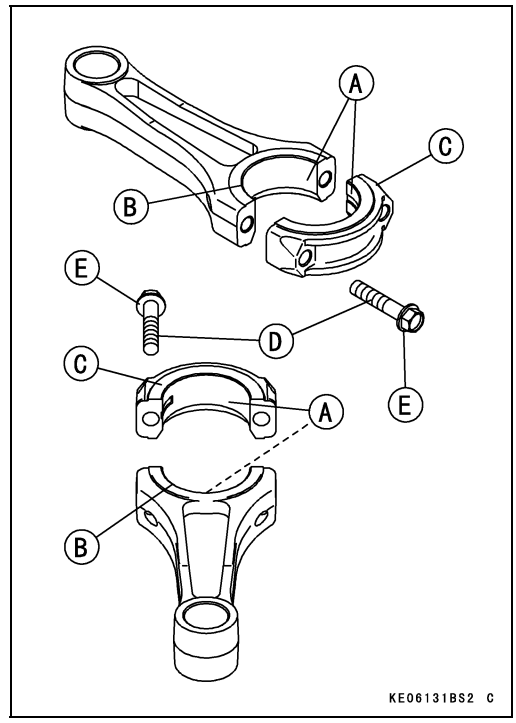
● Install the connecting rod big end caps on their original position on each connecting rod big ends.

● Apply a thin layer of engine oil to the thread [D] and seating surface [E] of the cap bolts.

● Tighten:

Torque - Connecting Rod Big End Cap Bolts: 21 N·m (2.1 kgf·m, 15 ft·lb)

● Install the removed parts (see appropriate chapters).



Cylinder, Piston

Piston/Cylinder Seizure

- In case of seizure, remove the pistons (see Piston Removal).
- Visually inspect the cylinder and pistons for damage.

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

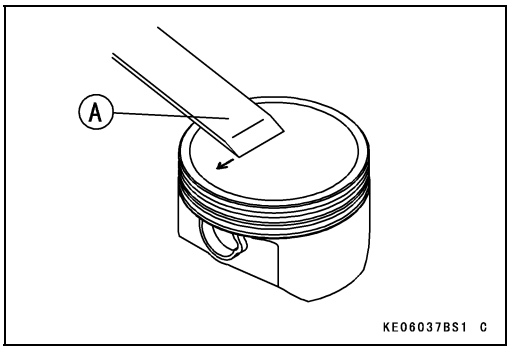
★If the damage is severe, replace the crankcase and pistons.

Piston Cleaning

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

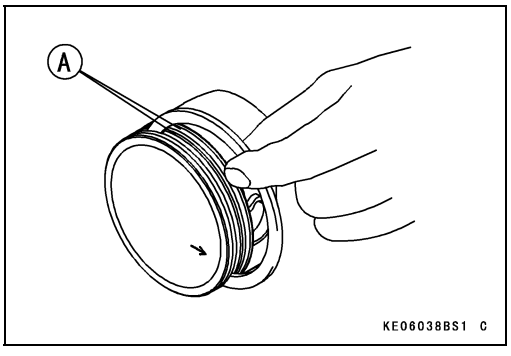
NOTICE
Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.

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



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

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



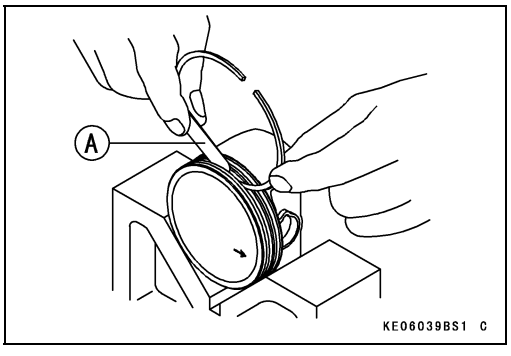
Piston Ring and Ring Groove Wear

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

★If the piston rings are worn unevenly or damaged, replace them with new ones.

★If the ring grooves are worn unevenly or damaged, replace both the piston and piston rings with new ones.

- Check ring grooves for wear by inserting a new ring in the proper groove at several points around the piston.
- Measure the clearance between the top and second rings and their grooves using a thickness gauge [A] as shown in the figure.



Cylinder, Piston

★If the piston ring/groove clearance is greater than the service limit, replace the piston.

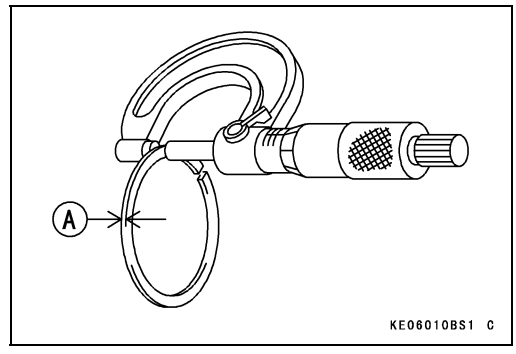
Piston Ring/Groove Clearance
Service Limit:

Top, Second	**0.15 mm (0.0059 in.)**

NOTE

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

● 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:

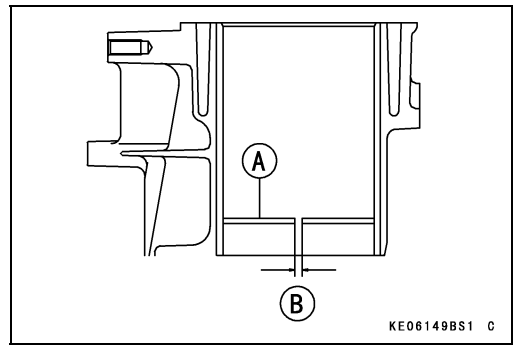
Top, Second	**1.40 mm (0.055 in.)**

NOTE

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

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.

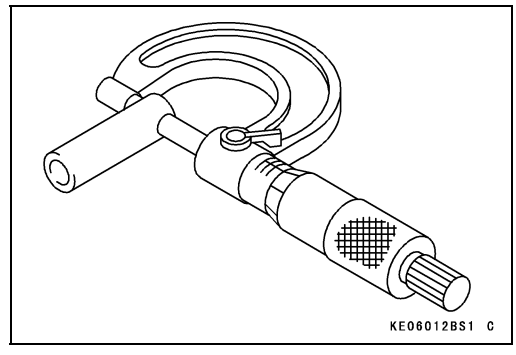


Piston Ring End Gap
Service Limit

Top	**0.7 mm (0.0284 in.)**
Second	**0.8 mm (0.031 in.)**
Oil	**1.0 mm (0.039 in.)**

Piston Pin, Piston Pin Hole, and Connecting Rod Wear

● Remove the piston pin (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 ones.



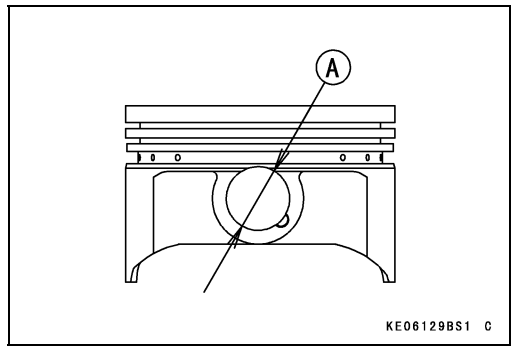
Piston Pin Outside Diameter

Service Limit:	**18.96 mm (0.746 in.)**

Cylinder, Piston

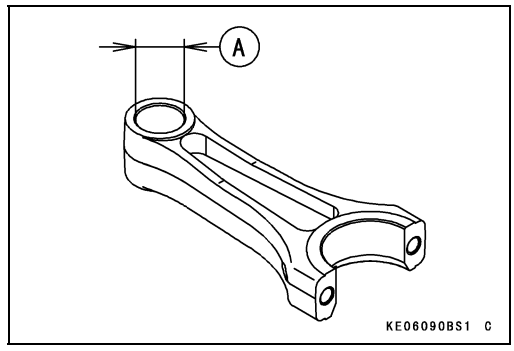
● Measure the inside diameter [A] of the piston pin hole at several points on both side. Use a dial bore gauge.
★If the inside diameter is greater than the service limit, replace the piston with a new one.

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



● Measure the inside diameter [A] of the connecting rod the 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.

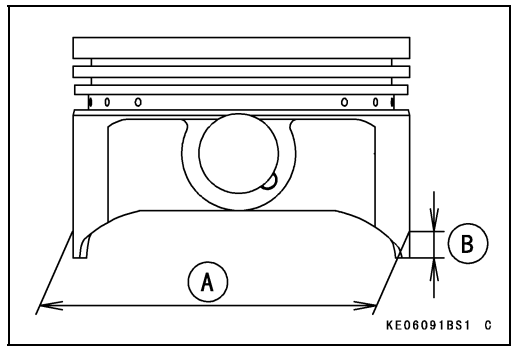
Connecting Rod Small End Inside Diameter
Service Limit: 19.06 mm (0.750 in.)



Piston Diameter

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

Piston Outside Diameter
Service Limit: 81.80 mm (3.220 in.)

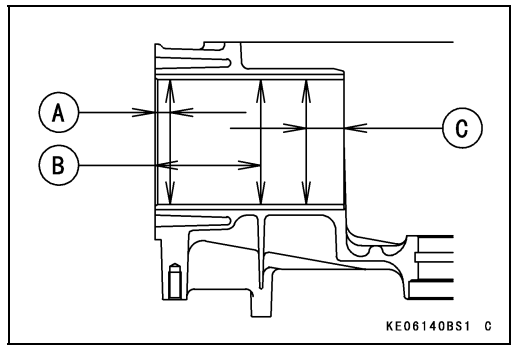


Cylinder Inside Diameter

● Clean and measure the cylinder inside diameter.
○Use a dial bore gauge to measure front-to-back and side -to-side at the points shown in the figure.
★If any of the cylinder bore measured valve is greater than the service limit, replace crankcase with a new one.
10 mm [A]
55 mm [B]
25 mm [C]

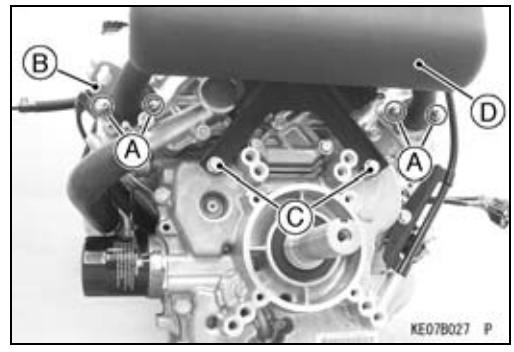
Cylinder Inside Diameter
Standard: 81.97 ~ 81.99 mm (3.227 ~ 3.228 in.)
Service Limit: 82.09 mm (3.232 in.)

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



Muffler

Muffler Assembly Removal



- Unscrew the flange nuts [A], and remove the spring washers and engine hook [B] (Only No.1 Cylinder side). Use a penetrating oil if necessary to break threads loose.
- Remove the bolts [C] on the muffler bracket and take off the muffler assembly [D].
- Remove the gaskets.
- Do not use unnecessary force on the exhaust pipes when removing the muffler assembly, or they could become damaged or distored.

Muffler Assembly Installation

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

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

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

Muffler Assembly Inspection

- Inspect the exhaust pipe or muffler for dents, cracks, rust and holes.

★If the exhaust pipe or muffler is damaged, it should be replaced for best performance and least noise.

- Check the muffler for distortion and/or loose internal components. Loss of power could develop if the muffler loose the internal components restricting the exhaust flow.
- Check for breaks in the seams and check weld at the junction of the exhaust pipes and muffler.
- Tap the muffler with a plastic hammer to decarbonize.

Lubrication System

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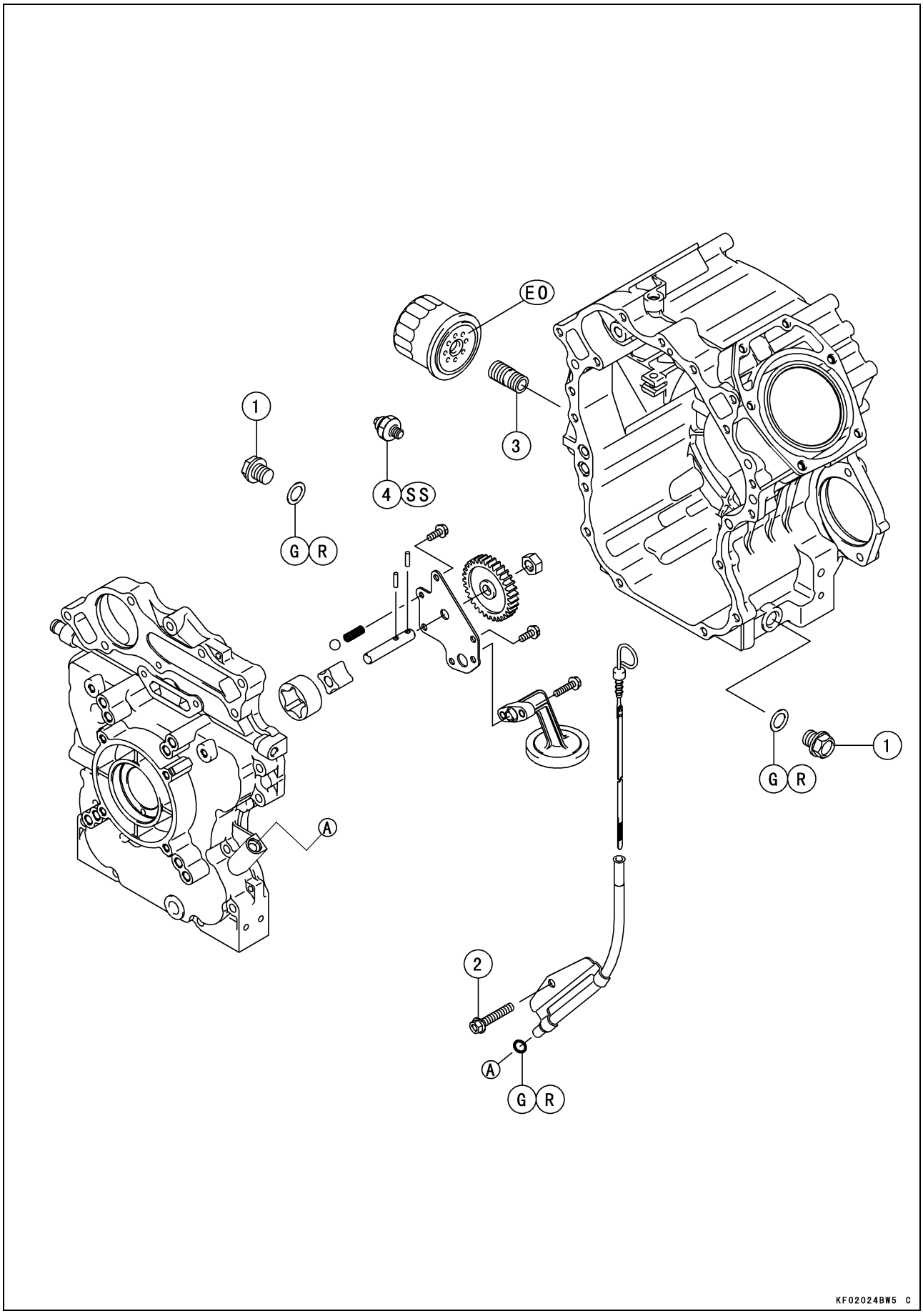
Exploded View

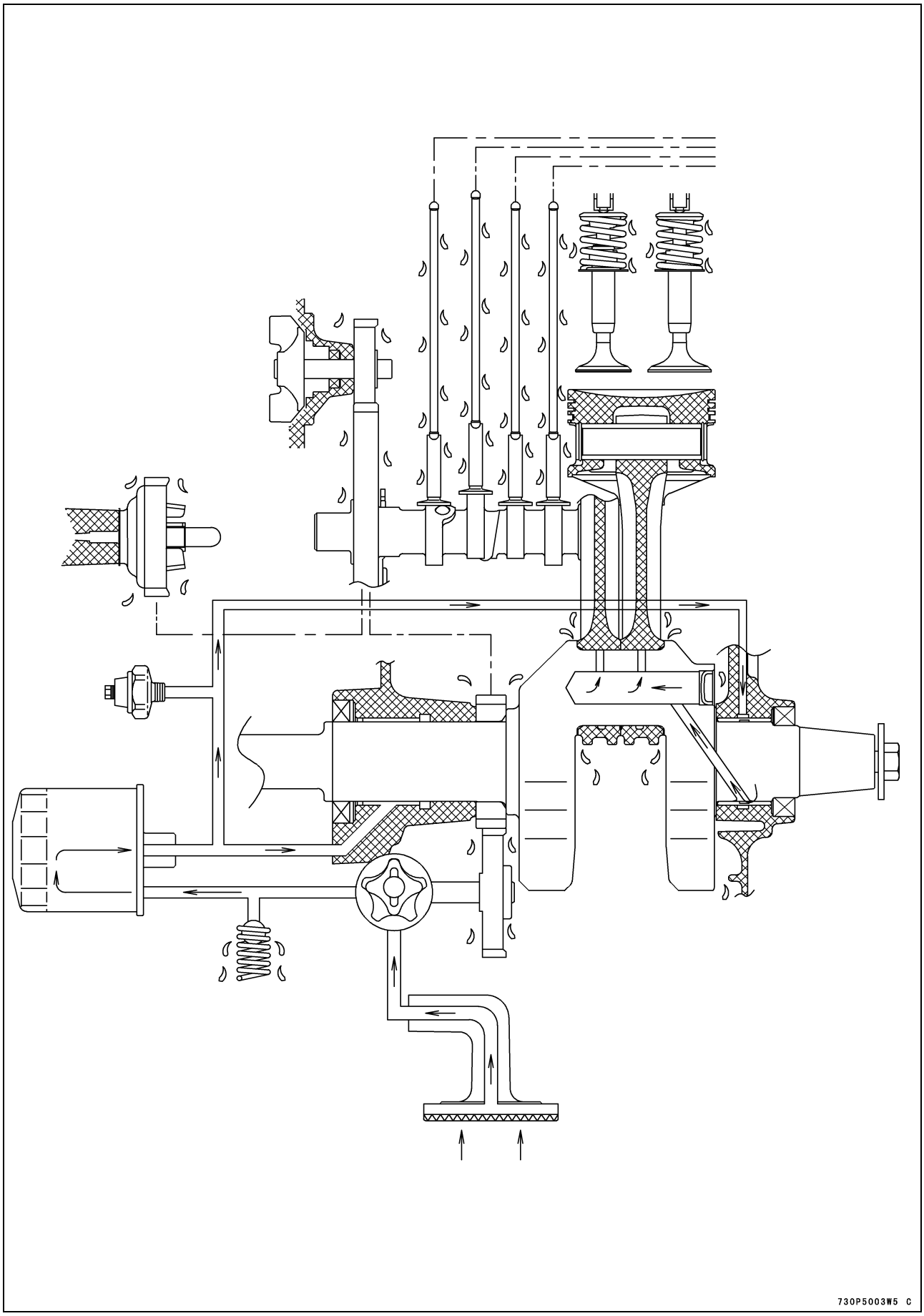


Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Engine Oil Drain Plug	25	2.5	18	
2	Oil Filler Level Gauge Bolt	22	2.2	16	
3	Oil Filter Joint Pipe	27	2.8	20	
4	Oil Pressure Switch	15	1.5	11	SS

EO: Apply engine oil.
G: Apply grease.
R: Replacement Parts
SS: Apply silicone sealant.

Engine Oil Flow Chart



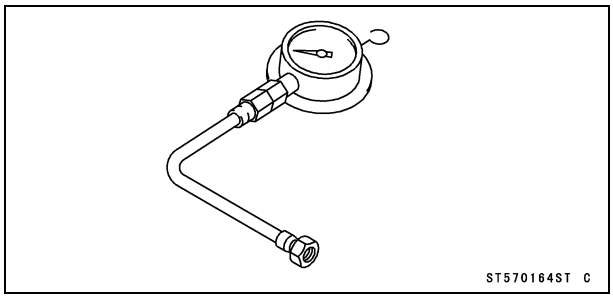
Specifications

Item	Standard
Engine Oil	
Grade	SF, SG, SH, 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 filter is not removed)
	2.0 L (2.1 US qt) (When filter is removed)
Level	Between upper [H] and lower [L] level lines
Oil Pressure	276 kPa (40 psi): Engine oil temperature 120°C
	294 ~ 686 kPa (3.0 ~ 7.0 kgf/cm^2, 42.6 ~ 99.5 psi): Engine oil temperature 50 ~ 60°C
Oil Pressure Switch	
Detect pressure	68.6 ~ 127.4 kPa (0.7 ~ 1.3 kgf/cm^2, 9.9 ~ 18.5 psi)
Screw	PT 1/8 pipe thread
Oil Filter By-pass Valve Openning	
Pressure	78.5 ~ 117.5 kPa (11.4 ~ 17.1 psi)

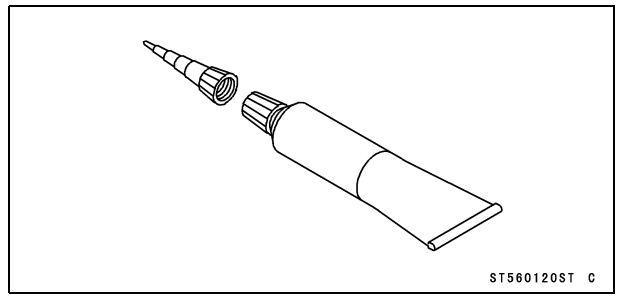
Item	Service Limit
Oil Pump:	
Inner and outer rotor clearance	0.3 mm (0.012 in.)
Outer rotor outside diameter	40.47 mm (1.5933 in.)
Outer rotor thickness	19.83 mm (0.7807 in.)
Pump housing inside diameter	40.801 mm (1.606 in.)
Pump housing depth	20.23 mm (0.7965 in.)
Pump shaft outside diameter	10.923 mm (0.4300 in.)
Pump shaft bearing inside diameter	11.072 mm (0.4359 in.)
Relief valve spring free length	19.5 mm (0.77 in.)

Special Tools and Sealant

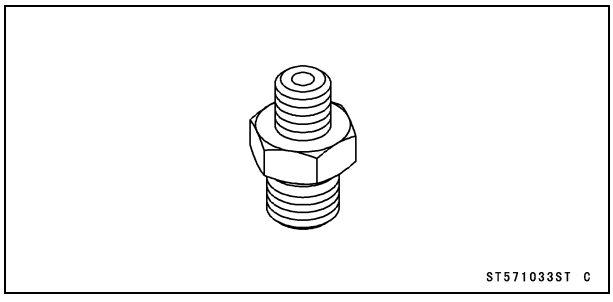
Oil Pressure Gauge, 10 kgf/cm²:
57001-164



Liquid Gasket, TB1211:
56019-120



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

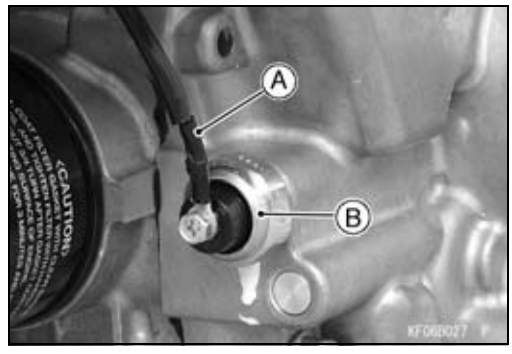
- Refer to the Oil Filter Replacement in the Periodic Maintenance chapter.

Pressurized Lubrication System

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

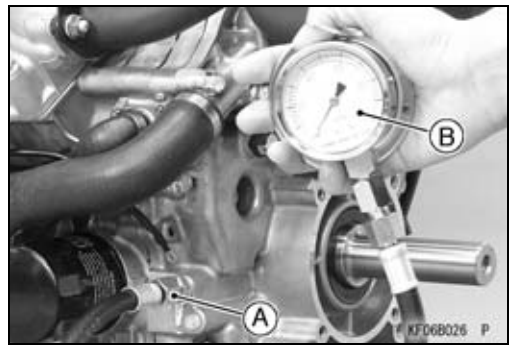
Oil Pressure Measurement

- Remove the oil pressure switch lead [A] and oil pressure switch [B] from the crankcase cover.



- 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 high idle speed and read the oil pressure gauge.

★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.

Oil Pressure
294 ~ 686 kPa (3.0 ~ 7.0 kgf/cm², 43 ~ 99 psi)

Measurement Condition
Engine Oil Temperature: 50 ~ 60°C (122 ~ 144°F)

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 (pipe threads)**

- Stop the engine.
- Remove the oil pressure gauge and adapter.

⚠ WARNING

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

- Apply silicone sealant to the taper threads of the oil pressure switch, and tighten it.

Sealant - Liquid Gasket, TB1211: 56019-120

Torque - Oil Pressure Switch: 15 N·m (1.5 kgf·m, 11 ft·lb)

Pressurized Lubrication System

Oil Pressure Switch Inspection

When the oil pressure falls below 98 kPa (1.0 kgf/cm^2, 14.2 psi), the oil pressure switch activates the oil warning lamp to alert the operator or lubricating problem.

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

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

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

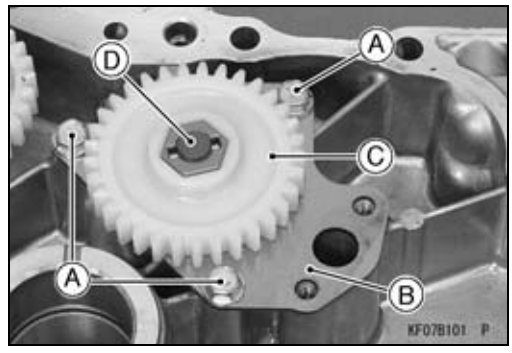
★If the warning light is on in the started engine in spite of adequate oil level, check the lead from the pressure switch to the warning light for short circuit and/or check the pressure switch and replace damaged part.

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

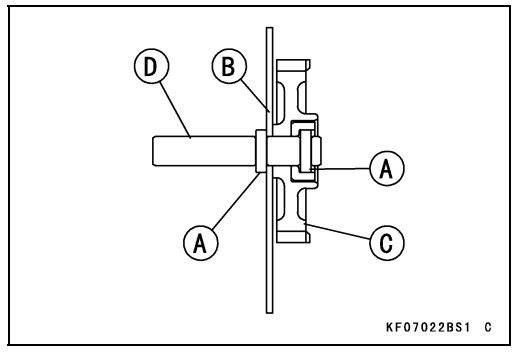
Oil Pump, Relief Valve

Oil Pump, Relief Valve Removal

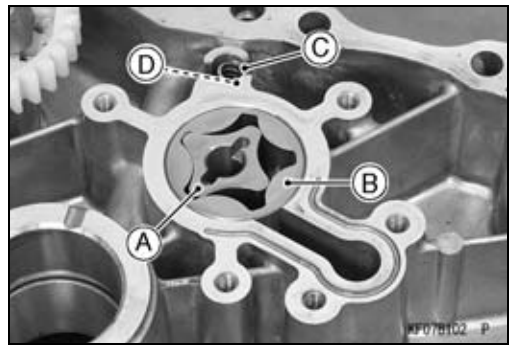
- Remove:
  Crankcase Cover (see Crankcase Cover Removal in the Camshaft/Crankshaft chapter)
  Oil Screen (see Oil Screen Removal)
  Bolts [A]
- Take out the pump cover plate [B] , pump gear [C] and pump shaft [D] as a set.



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

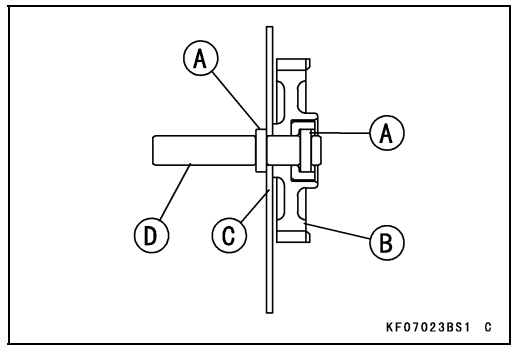


- Remove:
  Inner Rotor [A]
  Outer Rotor [B]
  Spring [C]
  Relief Valve Ball [D]



Oil Pump , Relief Valve Installation

- Assemble the following parts as shown in the figure.
  Pins [A]
  Oil Pump Gear [B]
  Oil Pump Cover Plate [C]
  Pump Shaft [D]

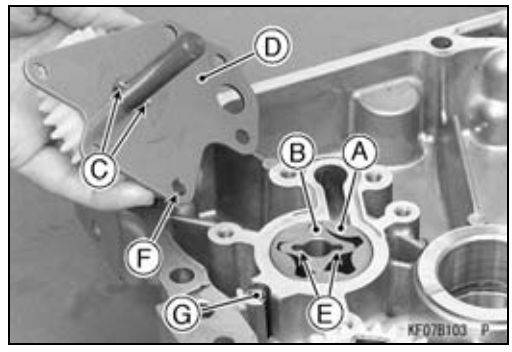


- Fill the rotor housing with engine oil for initial lubrication.
- Install the outer [A] and inner rotor [B].
- Install the relief valve ball and spring in position.
- Fit the pin [C] of the oil pump parts assembly [D] into the slots [E] in the inner rotor.

NOTE

○*When installing the pump parts assembly align the ϕ6 mm (ϕ0.2 in.) hole [F] on the cover plate with center of the relief valve [G].*

- Tighten the oil pump cover plate bolts.



Oil Pump, Relief Valve

Oil Pump, Relief Valve Inspection

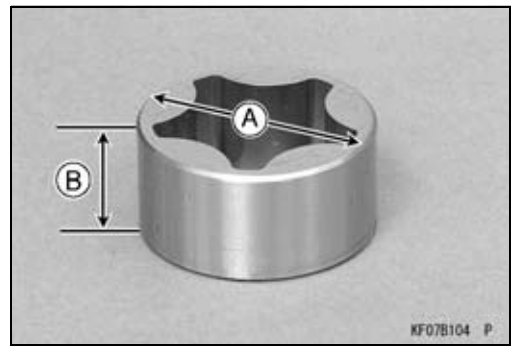
- Remove the oil pump parts assembly (see Oil Pump, Relief Valve Removal).
- Visually inspect the pump gear, outer and inner rotor, and cover plate.

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

○Check the clearance [A] between the inner and outer rotor with a feeler gauge. Measure the clearance between the 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: 0.3 mm (0.012 in.)



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

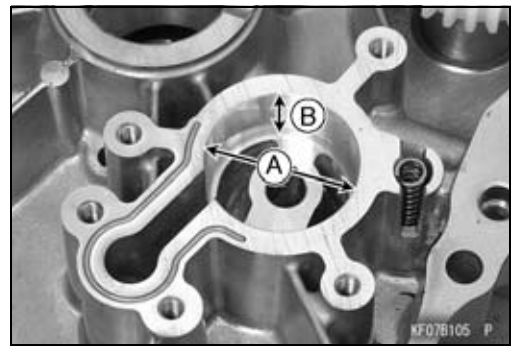
★If the rotor diameter is less than the service limit, replace both the inner and outer rotor with new ones.

Outer Rotor Outside Diameter
Service Limit: 40.47 mm (1.5933 in.)

- Measure the thickness [B] of the outer rotor with a micrometer at several points

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

Outer Rotor Thickness
Service Limit: 19.83 mm (0.7807 in.)



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

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

Pump Housing Inside Diameter
Service Limit: 40.801 mm (1.6063 in.)

- Measure the depth [B] of the pump housing with a depth micrometer at several points.

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

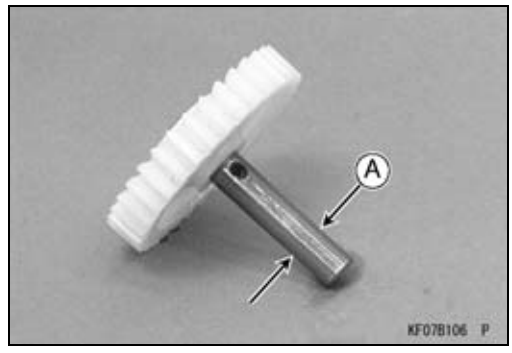
Pump Housing Depth
Service Limit: 20.23 mm (0.7965 in.)

Oil Pump, Relief Valve

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

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

Pump Shaft Outside Diameter
Service Limit: 10.923 mm (0.4300 in.)



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

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

Inside Diameter of Pump Shaft Bearing
Service Limit: 11.072 mm (0.4359 in.)

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

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

⚠ WARNING

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

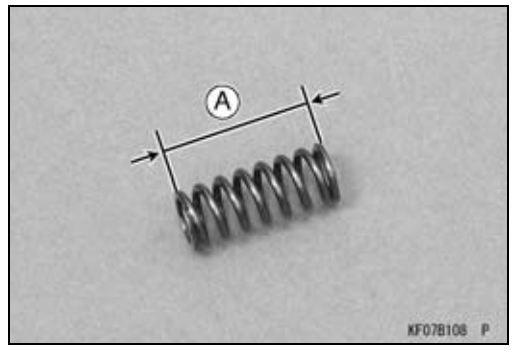
★If cleaning does not solve the problem, replace the relief valve parts with new ones.

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

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

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

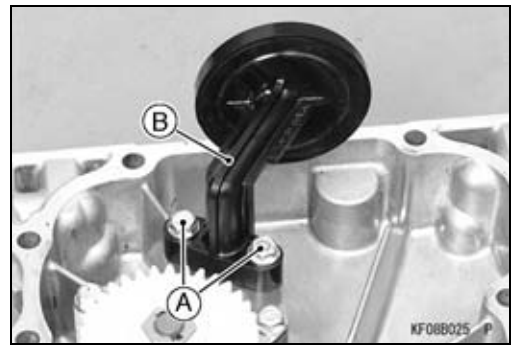
Relief Valve Spring Free Length
Service Limit: 19.5 mm (0.768 in.)



Oil Screen

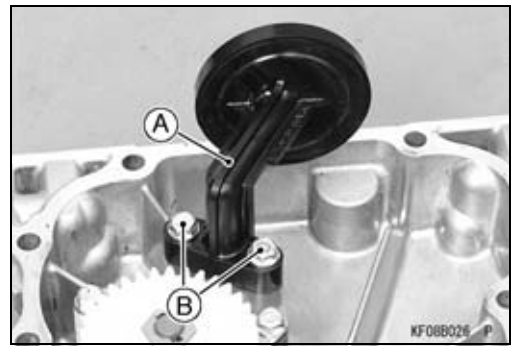
Oil Screen Removal

- Remove the oil pump parts assembly (see Oil Pump, Relief Valve Removal).
- Unscrew the bolts [A] and remove the oil screen [B].



Oil Screen Installation

- Clean the oil screen thoroughly whenever it is removed for any reason (see Cleaning and Inspection).
- Install the oil screen [A] and tighten the bolts [B].
- Install the oil pump parts assembly (see Oil Pump, Relief Valve Installation).

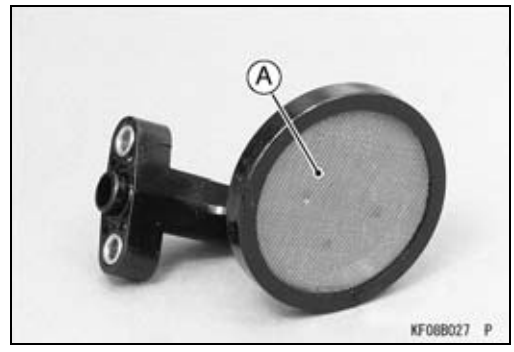


Cleaning and Inspection

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

⚠ WARNING

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



NOTE

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

- Check the screen carefully for any damage: holes and broken wire.

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

Camshaft/Crankshaft

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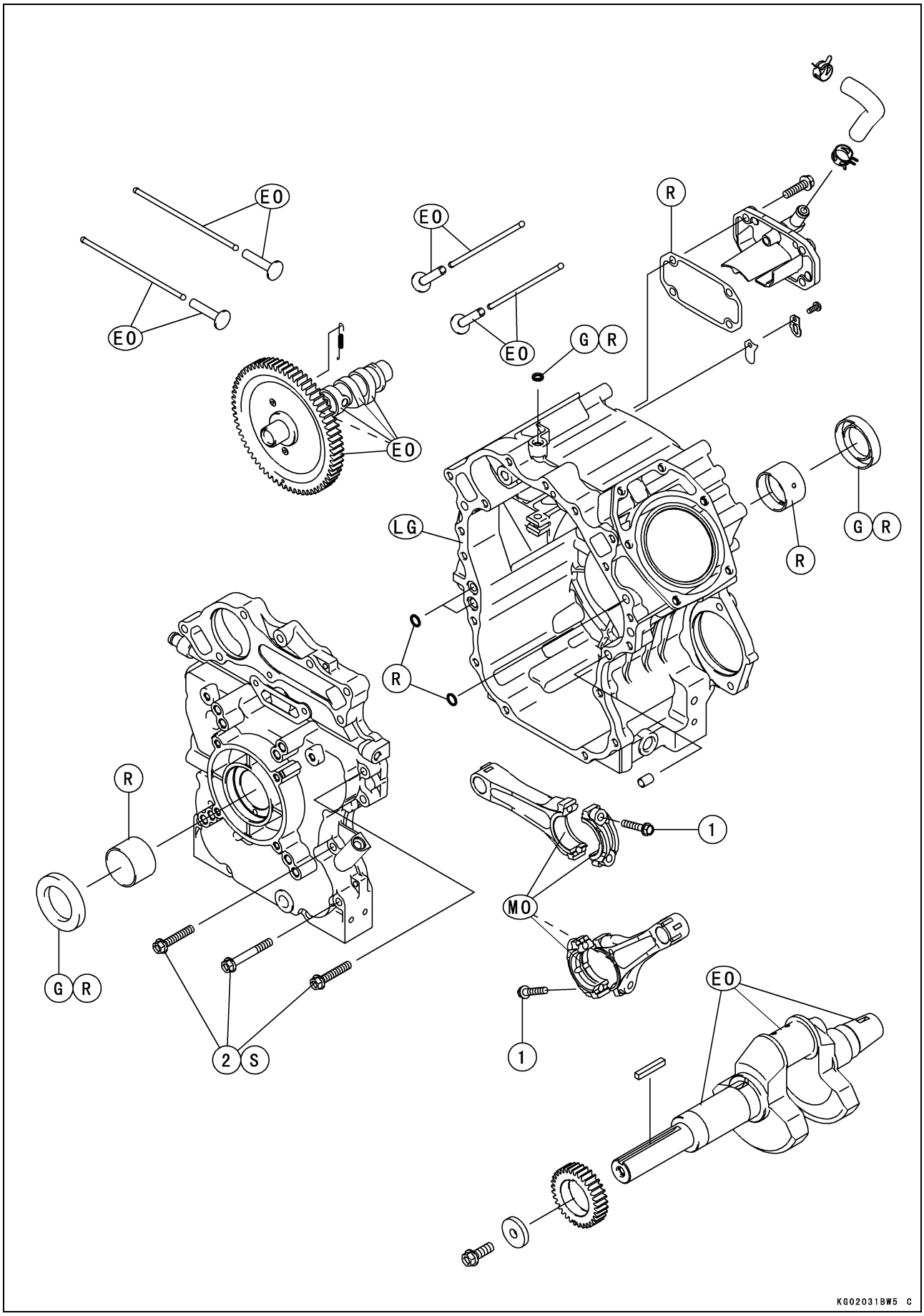
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Connecting Rod Big End Cap Bolts	21	2.1	15	EO
2	Crankcase Cover Bolts	22	2.2	16	S

EO: Apply engine oil.
G: Apply grease.
R: Replacement Parts
S: Following the specific tightening sequence.
LG: Apply liquid gasket.

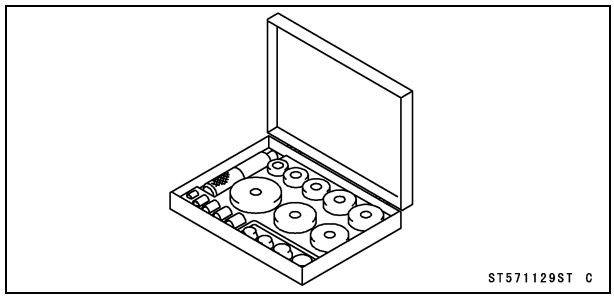
7-4 CAMSHAFT/CRANKSHAFT

Specifications

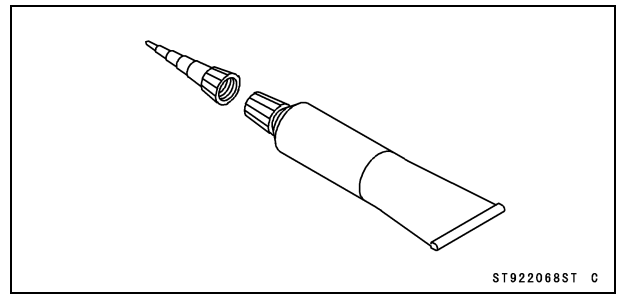
Item	Service Limit
Camshaft, Tappet:	
Cam Lobe Height:	
Intake, Exhaust	33.59 mm (1.322 in.)
Camshaft Journal Diameter:	
PTO Side	19.93 mm (0.785 in.)
Flywheel Side	19.93 mm (0.785 in.)
Camshaft Bearing Inside Diameter:	
Crankcase	20.08 mm (0.791 in.)
Crankcase Cover	20.08 mm (0.791 in.)
Crankshaft, 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	22.35 mm (0.88 in.)
Crankpin Width	46.5 mm (1.83 in.)
Connecting Rod Big End Inside Diameter	40.06 mm (1.58 in.)
Crankpin Outside Diameter	39.95 mm (1.57 in.)
Crankshaft Runout	TIR 0.05 mm (0.002 in.)
Crankshaft Journal Diameter	
PTO Side	41.94 mm (1.65 in.)
Flywheel Side	41.94 mm (1.65 in.)
Crankcase:	
Crankshaft Bearing Inside Diameter:	
Crankcase	42.13 mm (1.659 in.)
Crankshaft Journal Bearing Inside Diameter:	
Crankcase Cover	42.13 mm (1.659 in.)

Special Tools and Sealant

Bearing Driver Set:
57001-1129

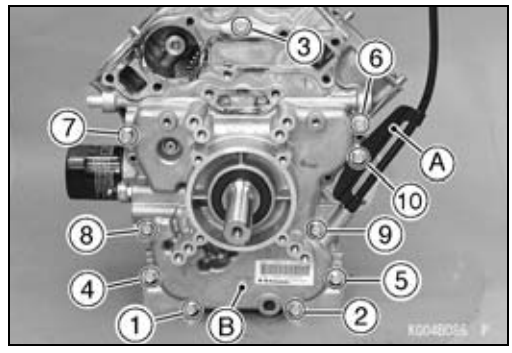


Liquid Gasket, TB1207B:
92104-2068



Crankcase

Crankcase Cover Removal

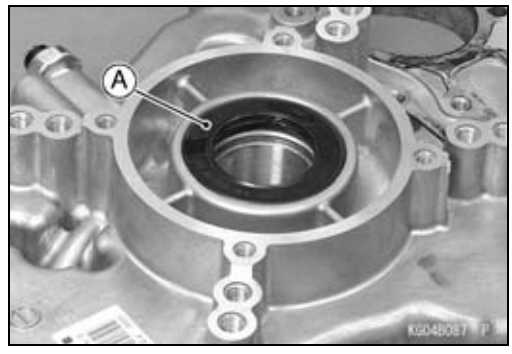


- Set the engine on a clean surface while parts are being removed.
- Drain the engine oil (see Engine Oil Change in the Periodic Maintenance chapter).
- Remove:
  Muffler Assembly (see Muffler Assembly Removal in the Engine Top End chapter)
  Intake Manifold (see Intake Manifold Removal in the Fuel System (DFI) chapter)
  Governor Arm (see Governor Arm Removal in the Fuel System (DFI) chapter)
  Ignition Coils (see Ignition Coil Removal in the Electrical System chapter)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal in the Cooling System chapter)
  Cylinder Head Assembly (see Cylinder Head Assembly Removal in the Engine Top End 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)
  Water Pump (see Water Pump Removal in the Cooling System chapter)
- Unscrew the mounting bolts in the order shown.
- Remove the oil level gauge [A] and crankcase cover [B].

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

Crankcase Cover Disassembly

- Remove:
  Crankcase Cover (see Crankcase Cover Removal)
  Oil Pump and Relief Valve (see Oil Pump, Relief Valve Removal in the Lubrication System chapter)
  Goveror Assembly (see Goveror Assembly Removal in the Fuel System (DFI) chapter)



- Pry the crankshaft oil seal [A] with the suitable tool, and remove it.

Crankcase Cover Assembly

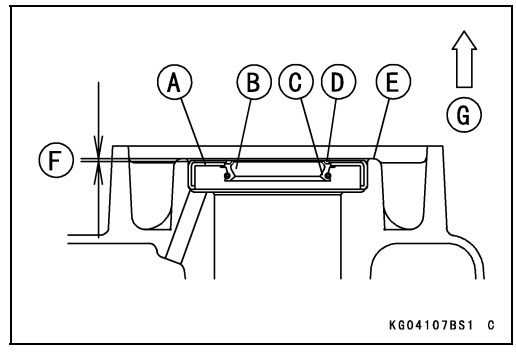
- Chip off the old gasket from the mating surfaces of the crankcase and cover.
- Using compressed air, blow out the oil passage in the crankcase cover.
- With a high flash-point solvent, clean off the mating surfaces of the crankcase and cover, and wipe them dry.

Crankcase

⚠ 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.
○Install the oil seal so that the marks [A] face out.
○Thoroughly pack high-temperature grease to 60% volume into the space [B] between the seal lip [C] and dust lip [D]. Press in the new oil seal using a press or suitable tools until it is flush with flange surface [E] or maximum 0.5 mm (0.02 in.) [F] lower than the flange surface. Do not damage the seal lip.
PTO Side [G]



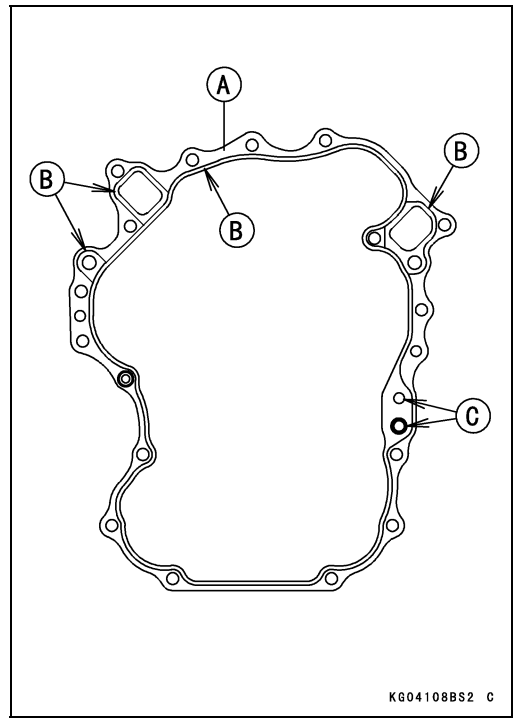
Crankcase Cover Installation

● Apply liquid gasket to the mating surface [A] of the crankcase cover.
Wide 1 ~ 2 mm [B]

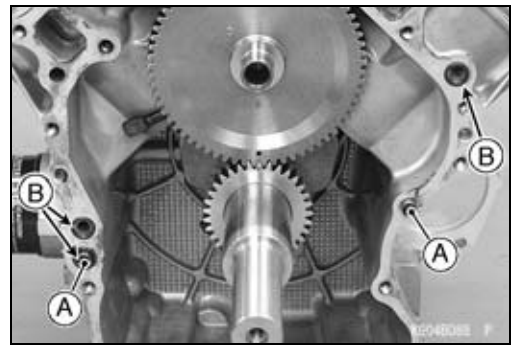
Sealant - Liquid Gasket, TB1207B: 92104-2068

NOTICE

Do not get the sealant into the oil line hole [C] onthe crankcase or crankcase cover.

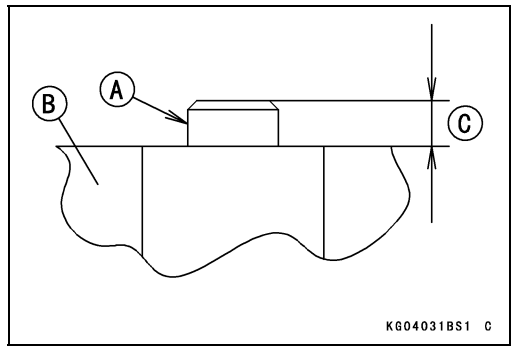


● Check to see that the dowel pins [A] and O-rings [B] are in place on the crankcase.



Crankcase

● Press in the dowel pins [A] into the crankcase [B].
5 mm (0.20 in.) [C]

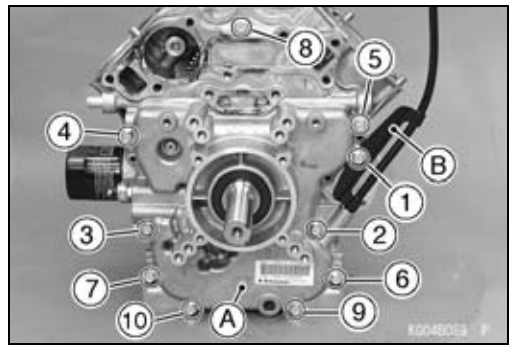


● Install the crankcase cover [A] and oil level gauge [B].
● Tighten the crankcase cover bolts following the tightening sequence as shown in the figure.

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

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

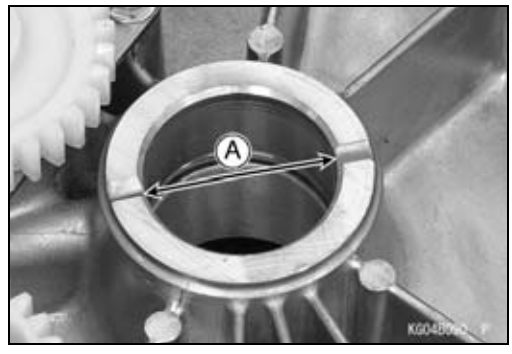
● Install the removed parts (see appropriate chapters).



Crankcase Cover Inspection

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

Crankshaft Journal Bearing Inside Diameter
Service Limit: 42.09 mm (1.657 in.)



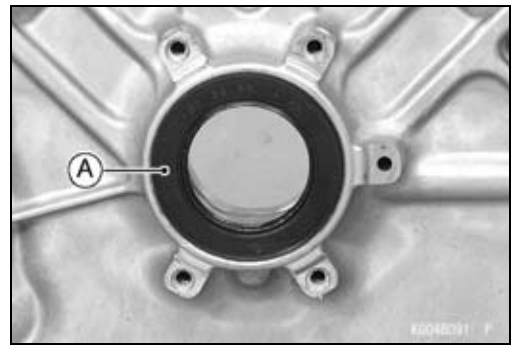
Crankcase Disassembly

● Remove:
Oil Filter (see Oil Filter Replacement in the Periodic Maintenance chapter)
Crankcase Cover (see Crankcase Cover Removal)
Camshaft and Tappets (see Camshaft, Tappet Removal)
Governor Shaft (see Governor Shaft Removal in the Fuel System (DFI) chapter)
Crankshaft (see Crankshaft Removal)
Breather Valve and Cover (see Breather Valve Removal)

● Pry the governor shaft oil seal with the suitable tool, and remove it.

Crankcase

● Pry the crankshaft oil seal [A] with the suitable tool, and remove it.



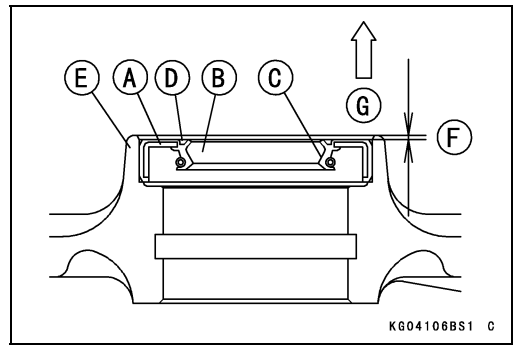
Crankcase Assembly

● 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.

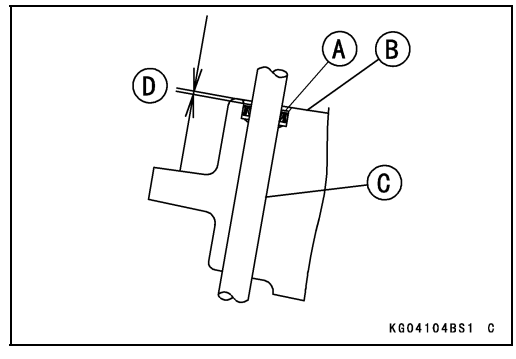
⚠ WARNING

Spark plugs conduct electricity and can give an electrical shock. Do not hold the spark plug, only hold the plug cap. Keep the plug as far away as possible from the plug hole.

● Be sure to replace any oil seal with a new one if removed.
○Install the oil seal so that the marks [A] face out.
○Thoroughly pack high-temperature grease to 60% volume into the space [B] between the seal lip [C] and dust lip [D]. Press in the new oil seal using a press or suitable tools until it is flush with flange surface [E] or maximum 0.5 mm (0.02 in.) [F] lower than the flange surface. Do not damage the seal lip.
Flywheel Side [G]

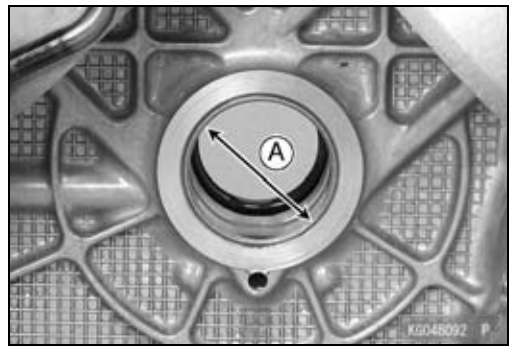


● When replacing the oil seal [A] of the governor shaft, note the following.
○Thoroughly pack high-temperature grease to 60% volume into the space between the dust lip and seal lip. .
○Install the oil seal into the crankcase [B] with a suitable tool after inserted the governor shaft [C] in the crankcase. Do not damage the seal lip.
○The depth is 0 ~ 0.5 mm (0 ~ 0.02 in.) [D].
● Install the removed parts (see appropriate chapters).



Crankcase

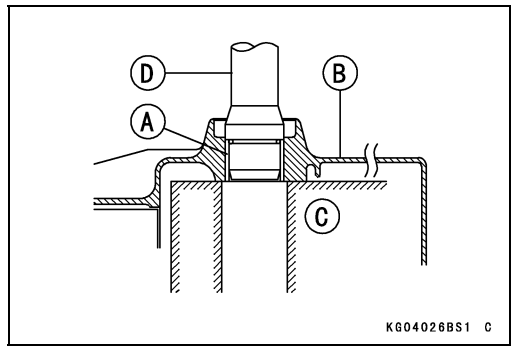
Crankcase Inspection



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

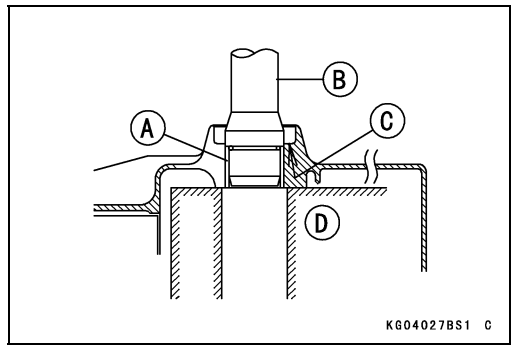
Crankshaft Bearing Inside Diameter
Service Limit: 42.14 mm (1.659 in.)

Journal Bushing Replacement



The journal bushing [A] is press fit into the crankcase [B].

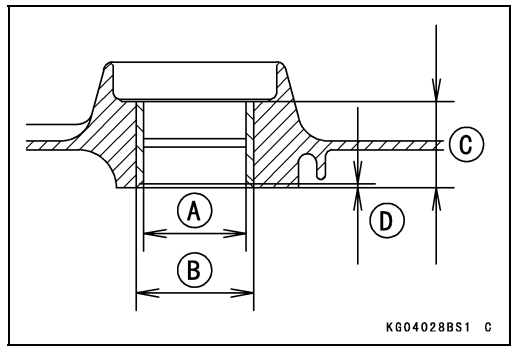
- Remove the oil seal on the crankcase. The oil seal should not be reused once removed.
- Place the crankcase on a support block [C] with the oil seal side up.
- Using a bushing tool [D], drive out the bushing as shown.



- The new bushing [A] is to be reinstalled using a bushing tool [B] as shown.
- Coat the bushing and flange surface [C] with light film of oil, press in the new bushing flush with the flange surface.
- No finish reaming is required.

Support Block [D]

For Designing Bushing Tools



Bushing Inside Diameter (MIN) [A] 41.997 mm (1.6534 in.)

Housing Inside Diameter (MIN) [B] 46.000 mm (1.8110 in.)

Bushing Width [C] 28.5 mm (1.12 in.)

Bushing Counter Sunk [D] 0.5 mm (0.02 in.)

Crankcase

Crankcase and Crankcase Cover Cleaning

- Disassemble:
  Crankcase Cover (see Crankcase Cover Disassembly)
  Crankcase (see Crankcase Disassembly)
- 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

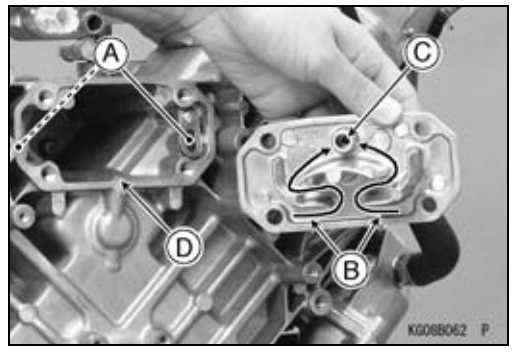
Gasoline and low-flash point solvents can be flammable and/or explosive and cause severe burns. Clean the crankcase and cover in a well-ventilated area, and take care that there is no spark or flame anywhere near the working areas. Do not use gasoline or low-flash point solvents to clean parts.

Breather

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

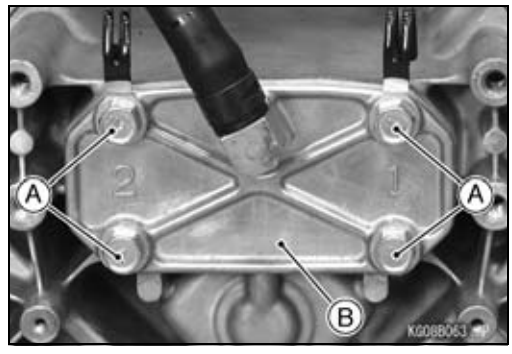
Oil laden air in the crankcase passes through the reed valves and expand into the breather chamber. Here most oil separates from the air and drains back to the crankcase. The air passes through a maze [B] and vents to the intake pipe [C].

Drain Hole [D]

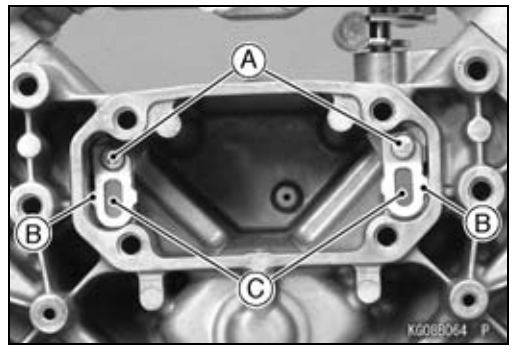


Breather Valve Removal

- Remove:
  Radiator (see Radiator Removal in the Cooling System chapter)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal in Cooling System chapter)
  Cooling Fan Mounting Bracket (see Cooling Fan Mounting Bracket Removal in Cooling System chapter)
  Bolts [A]
  Breather Chamber Cover [B]
  Gasket



- Remove:
  Screws [A]
  Back Plates [B]
  Reed Valves [C]

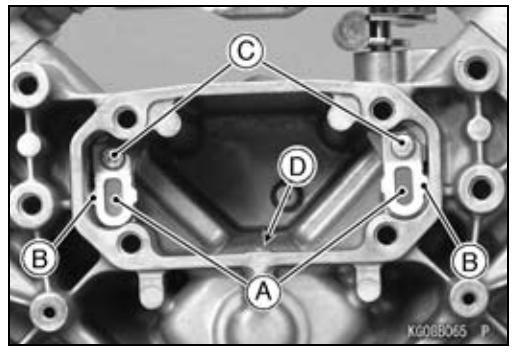


Breather Valve Installation

- Align center of the valve seat with center of the reed valves [A] and back plates [B], then tighten the mounting screws [C].
- Be sure the drain hole [D] on the breather chamber does not accumulate with slugs.

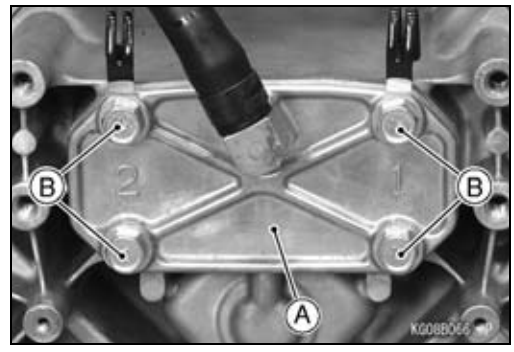
NOTE

○*The mounting screws [C] is a self-tapping one. Be aware that misthreading or overtightening screw will strip the female threads and ruin the hole.*



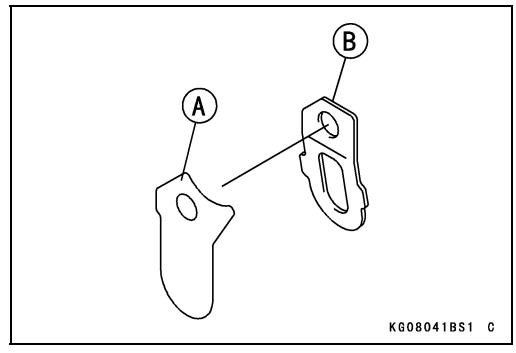
Breather

- Replace the breather chamber cover gasket with a new one.
- Install:
  Gasket
  Breather Chamber Cover [A]
- Tighten the mounting bolts [B].
- Install the removed parts (see appropriate chapters).



Breather Valve Inspection

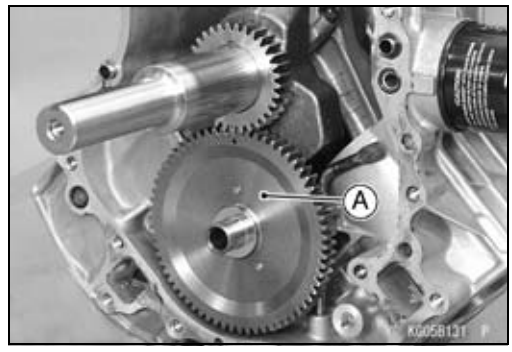
- Inspect the reed valve [A] for breakage, crack or distortion, replace it with a new one if necessary.
- Inspect the back plate [B] for damage or rough contact surface, replace it if with a new one if necessary.
- Inspect the valve seating surface. The surface should be no nicks or burrs.



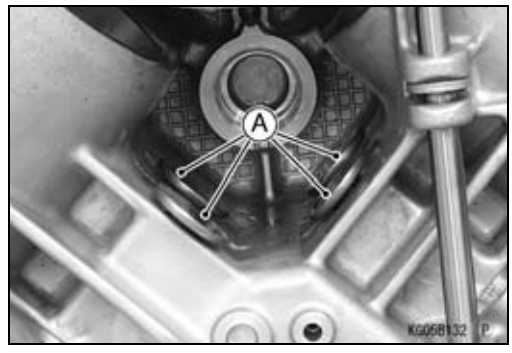
Camshaft, Tappet

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 the crankcase cover (see Crankcase Cover Removal).
- Turn the crankcase upside down so that the tappets will fall away from the cam lobes.
- Pull the camshaft [A] out of the crankcase.

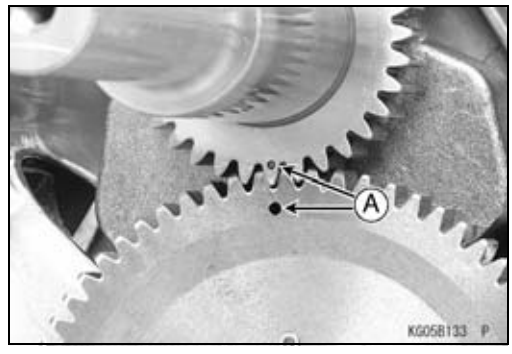


- Remove the tappets [A] and mark them so they can be installed in their original positions during assembly.



Camshaft, Tappet Installation

- Apply engine oil to the following.
  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 (see appropriate chapters).



Camshaft Inspection

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

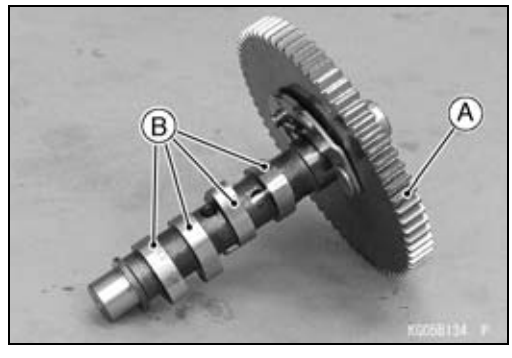
★Replace the shaft if necessary.

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

★Replace the shaft if necessary.

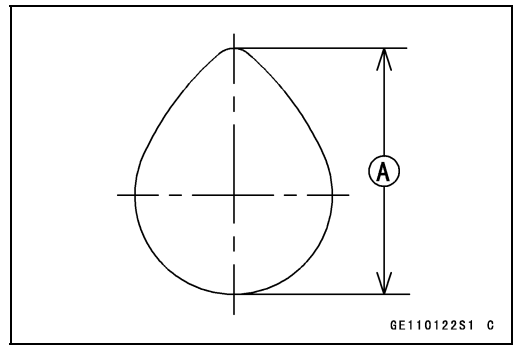
- Remove the spring to make sure if the ACR (automatic compression reduction) moves smoothly.

★If the ACR does not move smoothly, replace the camshaft with a new one.



Camshaft, Tappet

Camshaft Bearing/Journal Wear

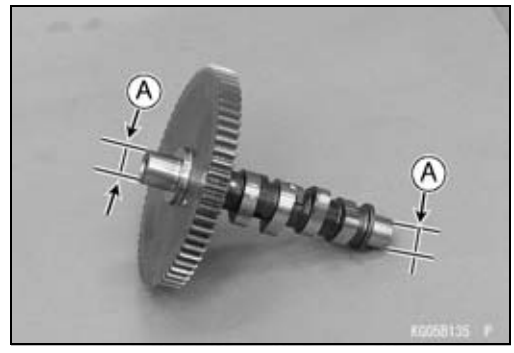


● Measure the height [A] of each cam lobe.

★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, Exhaust	**33.59 mm (1.322 in.)**



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

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

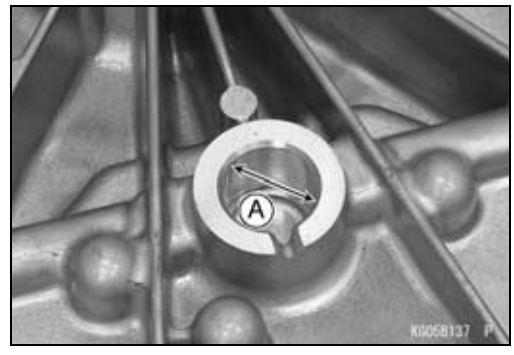
Camshaft Journal Diameter
Service Limit:

PTO Side	**19.93 mm (0.785 in.)**
Flywheel Side	**19.93 mm (0.785 in.)**

● Measure the inside diameter [A] of the camshaft bearing 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: 20.08 mm (0.791 in.)



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

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

Camshaft Bearing Inside Diameter (Crankcase Cover)
Service Limit: 20.08 mm (0.791 in.)

Crankshaft, Connecting Rod

Connecting Rod Removal

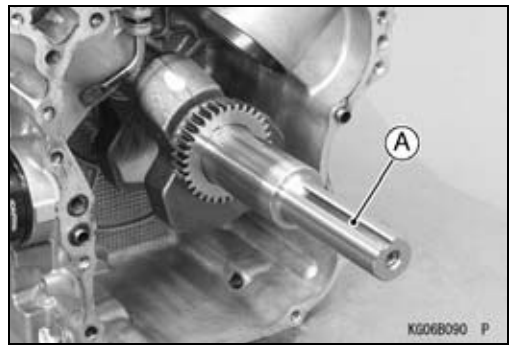
- Remove the piston (see Piston Removal in the Engine Top End chapter).

Connecting Rod Installation

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

Crankshaft Removal

- Remove:
  Camshaft (see Camshaft, Tappet Removal)
  Connecting Rod and Pistons (see Piston Removal in the Engine Top End chapter)
- Pull the crankshaft [A] out of the crankcase. Tap gently with a wooden or plastic mallet if necessary to loosen the crankshaft.



Crankshaft Installation

- Clean up the crankshaft and crankcase thoroughly, especially at the bearing contact surfaces.
- Pack some amount of high-temperature grease into the oil seal on the crankcase.
- Apply engine oil to the crankshaft journal.
- Apply molybdenum disulfide oil solution to the crankpin.

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

- Carefully insert the crankshaft end into the main bearing in the crankcase.

Cleaning/Inspection

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

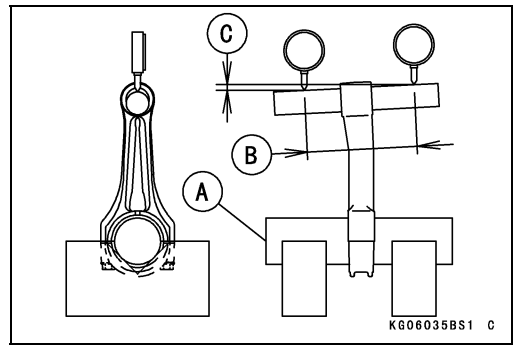
★Replace the crankshaft with a new one if necessary.

- Inspect the crankshaft and connecting rods especially at the bearing surfaces for wear, scratches, any evidence of improper contact or other damages.

★Replace them with new ones if necessary.

Crankshaft, Connecting Rod

Connecting Rod Bend/Twist



● Measure the connecting rod bend.

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

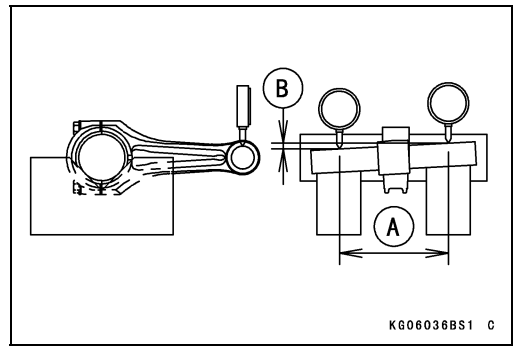
○Select an arbor of the same diameter as the piston pin and at least 100 mm (3.94 in.) long, and insert the arbor through the connecting rod small end.

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

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

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

Connecting Rod Bend
Service Limit: 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 tow different positions and the distance of the two positions is 100 mm (3.94 in.) [A]. Then determine the connecting rod twist from the measured height differences [B].

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

Connecting Rod Twist
Service Limit: 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 dial caliper.

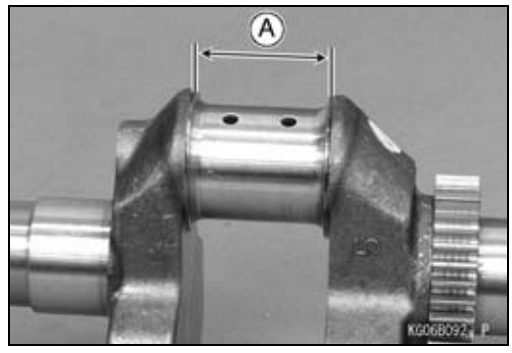
★If the measurement is less than the service limit, replace the connecting rod with a new one.

Connecting Rod Big End Width
Service Limit: 22.35 mm (0.88 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: 46.5 mm (1.83 in.)



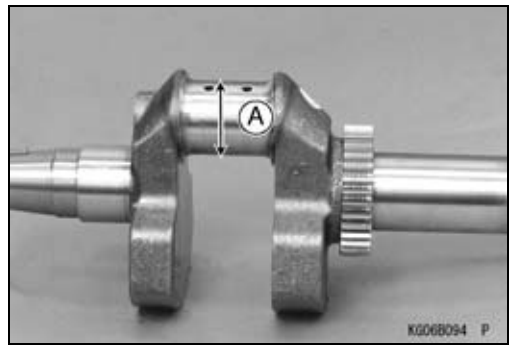
Connecting Rod Big End Bearing/Crankpin Wear

● Apply a light film of oil on the thread of the cap bolts.
● Install the cap bolts and tighten the bolts to the specified torque (see Piston Installation in the Engine Top End chapter).
● Measure the inside diameter [A] of 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: 40.06 mm (1.58 in.)

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

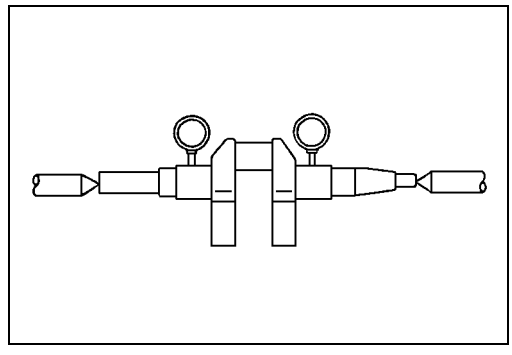
Crankpin Outside Diameter
Service Limit: 39.95 mm (1.57 in.)



Crankshaft Runout

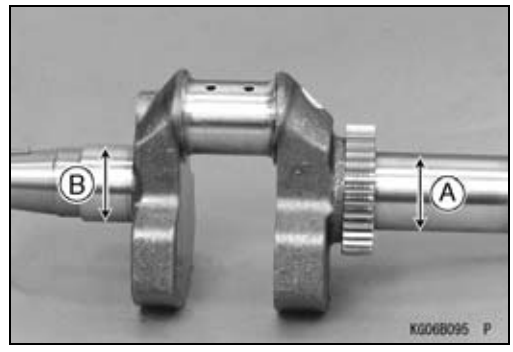
● Measure the crankshaft runout.
○Set the crankshaft in a flywheel alignment jig [A] or on V blocks gauge.
○Set a dial gauge [B] against both bearing journals.
○Turn the crankshaft slowly to measure the runout. The difference between the highest and lowest dial gauge readings (TIR) is the amount of runout.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

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



Crankshaft, Connecting Rod

Crankshaft Main Journal/Wear



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

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

Camshaft Journal Diameter
Service Limit:

PTO Side [A]	**41.94 mm (1.65 in.)**
Flywheel Side [B]	**41.94 mm (1.65 in.)**

Starter System

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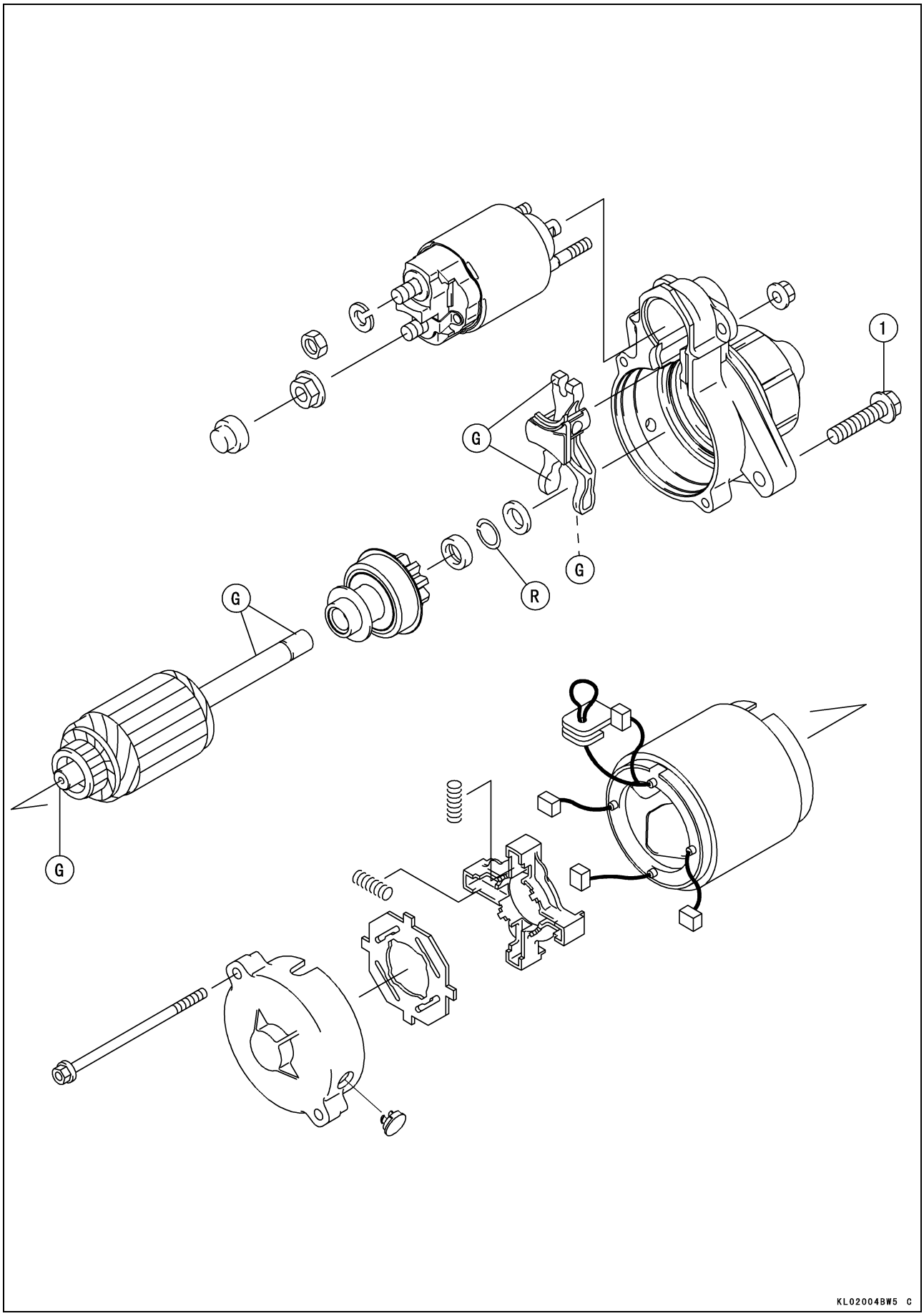
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Starter Motor Mounting Bolts	20	2.0	15	

G: Apply grease.
R: Replacement Parts

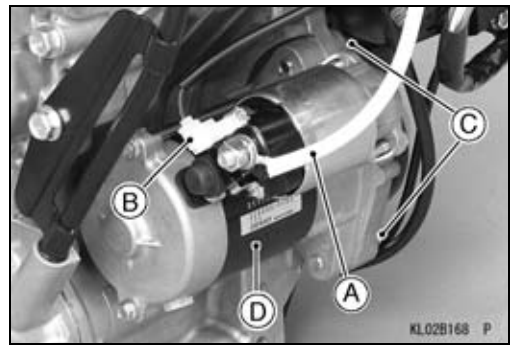
8-4 STARTER SYSTEM

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	0.5 ~ 0.8 mm (0.020 ~ 0.031 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 the wire and the switch lead [B].
- Remove the mounting bolts [C] and pull the starter motor [D] from the engine with the switch lead attached.

Starter Motor Installation

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

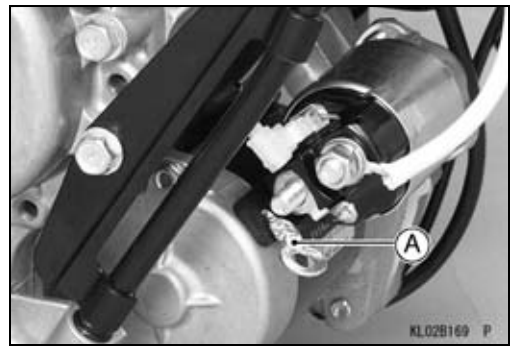
○Install the hook [A] so that the stopper [B] of the hook contacts the crankcase.

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

Starter Solenoid and Circuit Test

NOTE

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



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

- Measure the continuity of the solenoid when activated.

○Set the hand tester selector switch to the R × 1 Ω position and connect the leads across the large terminals [A] as shown in the figure.

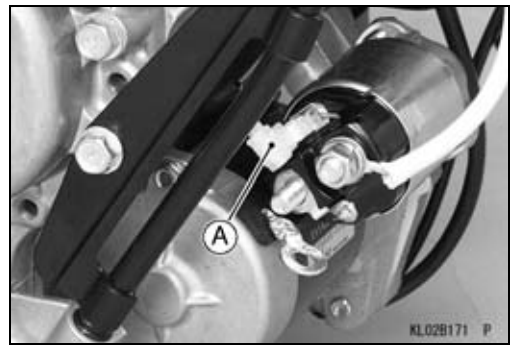
○Turn the engine switch to the START (II) position and read the tester.

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

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

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

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



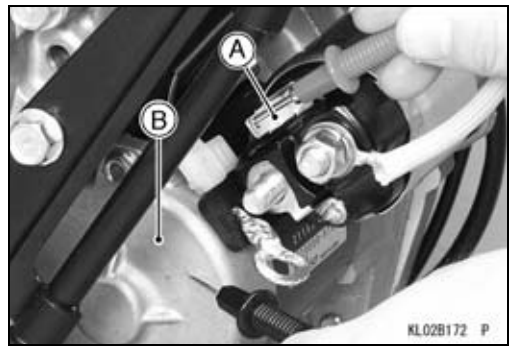
- Disconnect the switch lead [A].

Electric Starter System

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

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

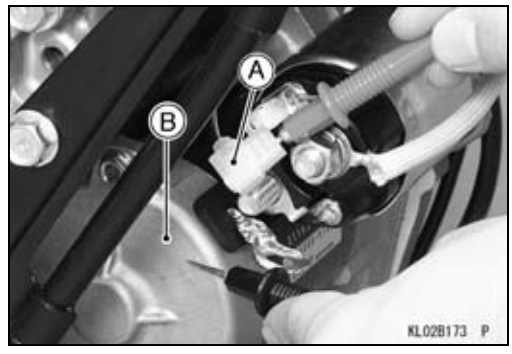
★If the tester reads close to 0 Ω, the solenoid may be good.



- Check the voltage to the solenoid from the engine switch.
- Set the hand tester selector switch to the 25 V DC position and connect it as shown in the figure.
  Switch Lead Connector [A]
  To Ground [B]
- Turn the engine switch to the START (II) position and read the tester.

★If the tester reads battery voltage, the circuit is good.

★If the tester reads much less than battery voltage or no voltage at all, either the wiring or the engine switch is bad. Check the engine switch or the wiring for damaged or broken wires and replace as required.



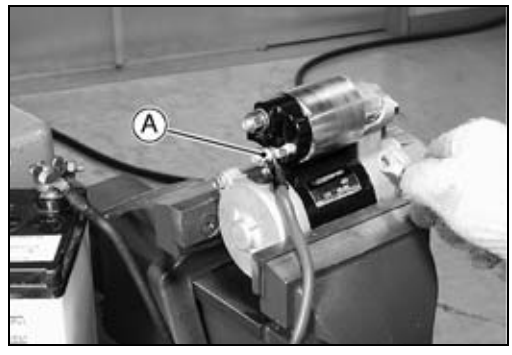
Starter Motor Test

NOTE

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

- Remove the starter motor (see Starter Motor Removal).
- Hold the starter motor with a vice.

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



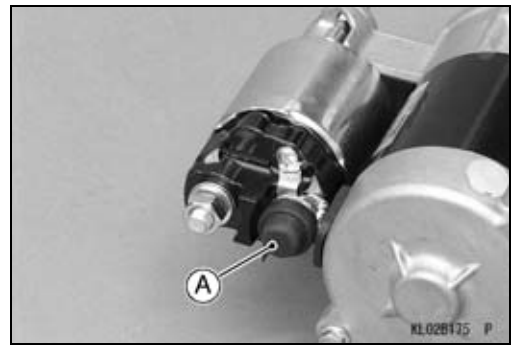
- Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal [A] on the solenoid as shown in the figure.
- Connect the second jumper cable to the battery (–) terminal.
- Touch the switch intermittently for one second intervals.
- The pinion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

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

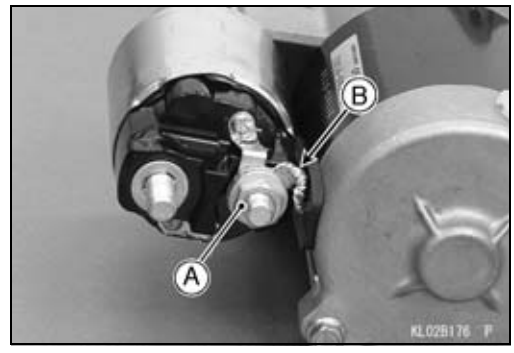
Electric Starter System

Starter Motor Disassembly

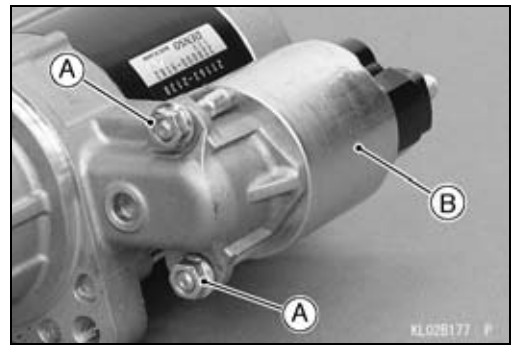
● Remove the rubber boot [A].



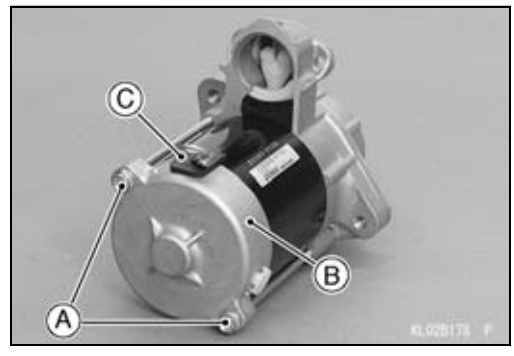
● Loosen the terminal nut [A].
● Remove the lead [B] from the starter motor to the solenoid.



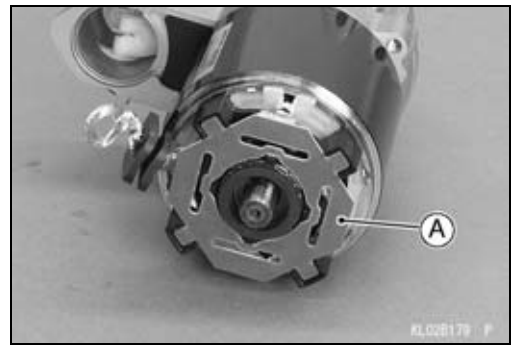
● Unscrew the mounting nuts [A] and remove the solenoid assembly [B].



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

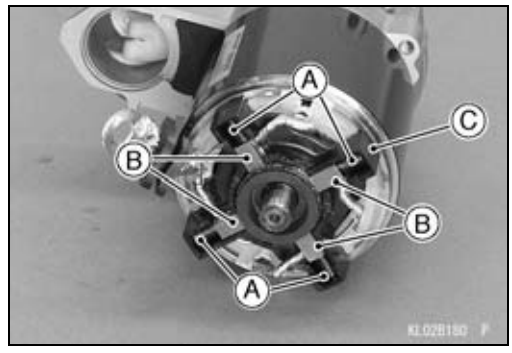


● Remove the insulator [A].

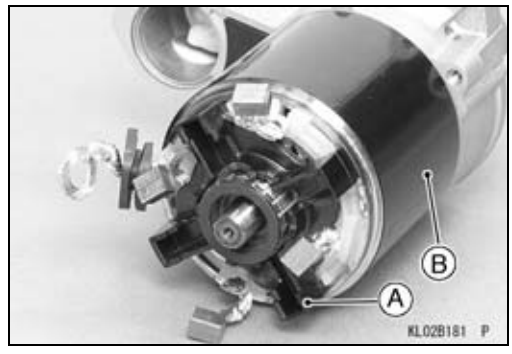


Electric Starter System

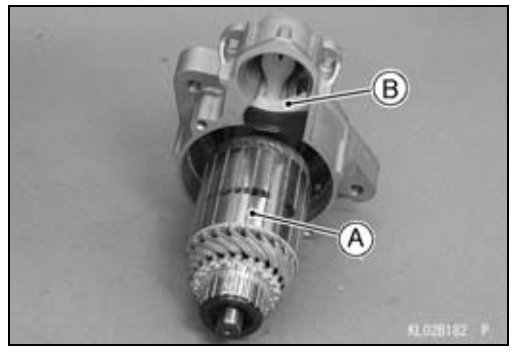
- Remove the springs [A].
- Free the brushes [B] from the brush holder [C].



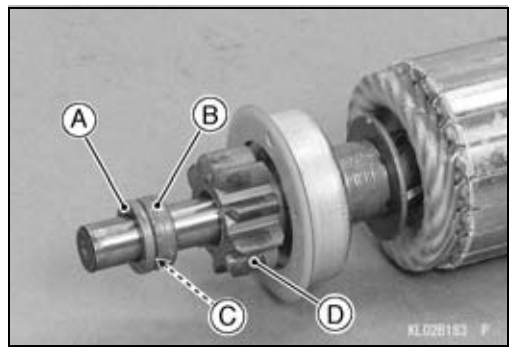
- Remove:
  Brush Holder [A]
  Yoke [B]



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

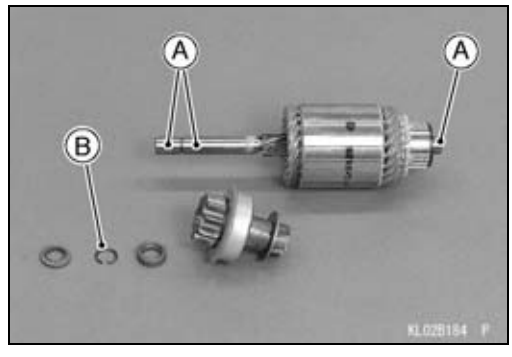


- Remove the front stopper [A].
- Push the rear stopper [B] downward and remove the snap ring [C].
- Pull the rear stopper and pinion clutch [D] from the armature shaft.



Starter Motor Assembly

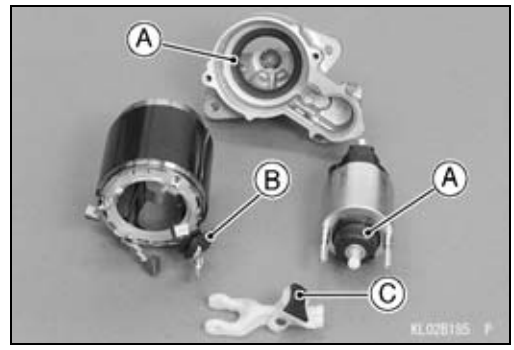
- Apply a small amount of grease to the armature shaft [A] as shown in the figure.
- Do not reuse the snap ring [B]. Replace it with a new one.



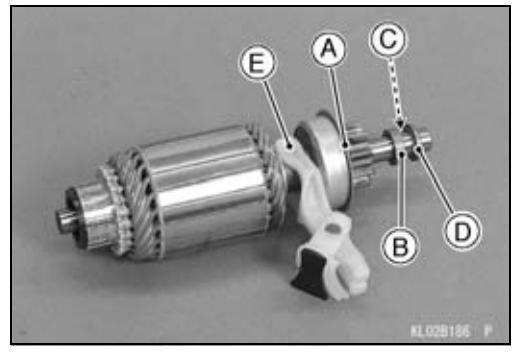
Electric Starter System

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

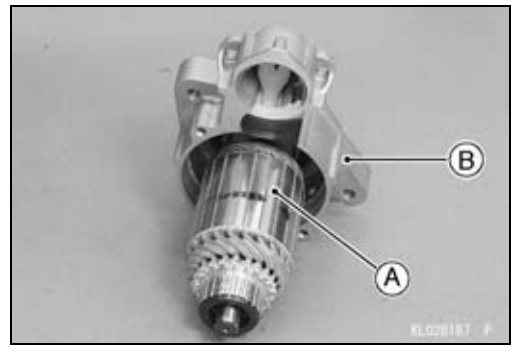
★If it is damaged, replace the related parts.



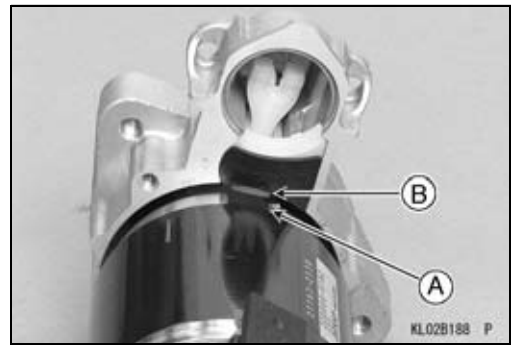
- Install the pinion clutch [A].
- Install the rear stopper [B] so that the hollow side face the outside.
- Install the snap ring [C] to the groove of the shaft.
- Slide the rear stopper until the stopping with the snap ring.
- Install the front stopper [D] so that the smaller diameter face the inside.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



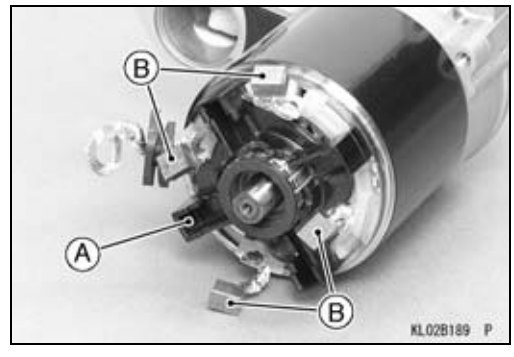
- Install the armature assembly [A] to the pinion gear cover [B].



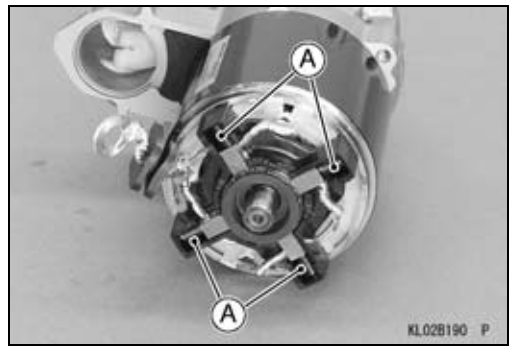
- Install the yoke so that the slit [A] fit the projection [B] of the pinion gear fork.



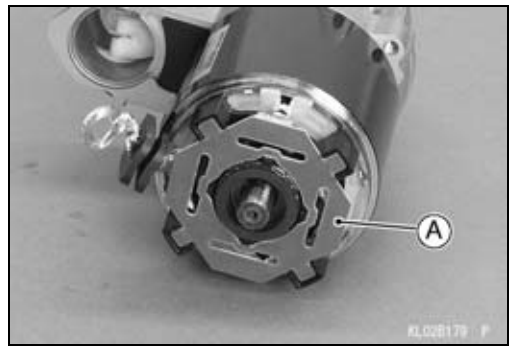
- Install the brush holder [A].
- Install the brushes [B] to the brush holder.



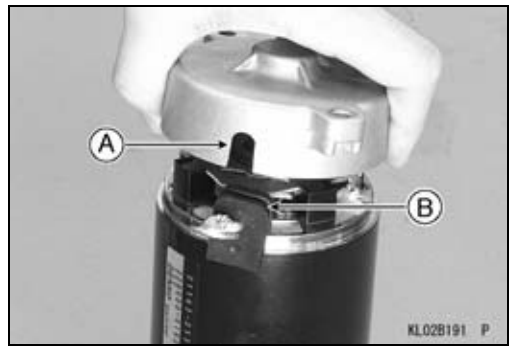
● Install the springs [A].



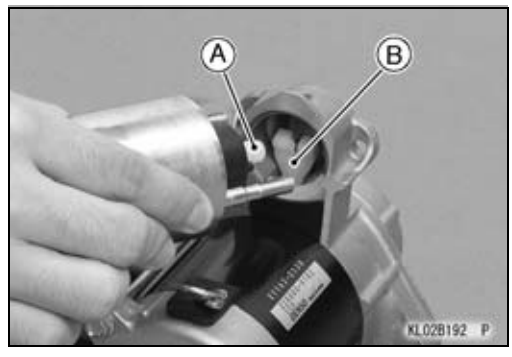
● Install the insulator [A].



● Install the end cover so that the slit [A] fit the groove [B] of the grommet.
● Tighten the through bolts.



● Engage the hook on the starter solenoid with the hook [A] on the pinion gear fork [B].
● Tighten the solenoid mounting nut.

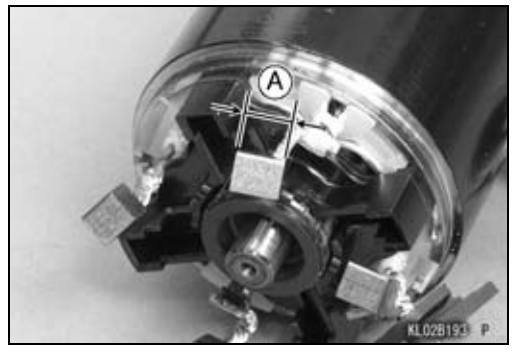


Starter Motor Brush Inspection

● 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.)**



Electric Starter System

Brush Spring Inspection

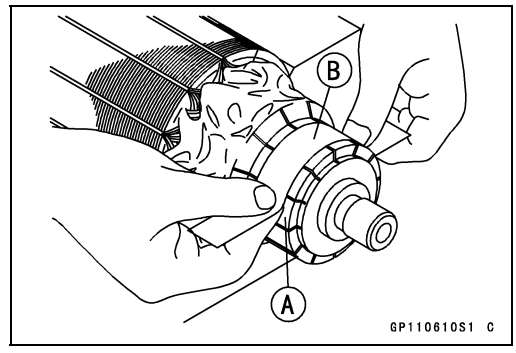
- Inspection the brush springs for pitting, cracks, rusting and burrs. Replace the spring if necessary.
- Inspect the springs for weakened conditions and distortion. Replace the spring if necessary.

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

Armature Inspection

- Inspect the surface of the commutator [A].

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



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

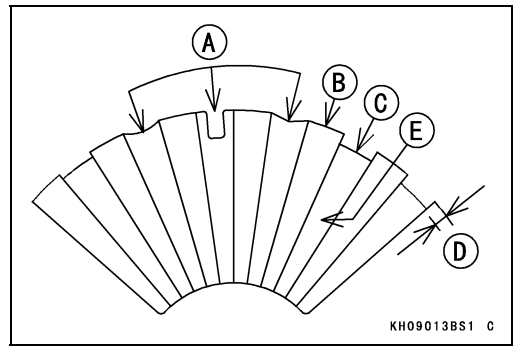
★If the grooves are shallower than the specified limit, replace the armature with a new one.

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

Commutator Groove Depth

Standard:	**0.5 ~ 0.8 mm (0.020 ~ 0.031 in.)**
Service Limit:	**0.2 mm (0.008 in.)**

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

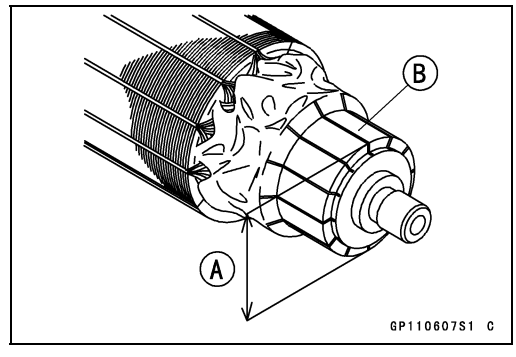


- Measure the outside diameter [A] of the commutator [B] at several points.

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

Commutator Outside Diameter

Standard:	**28.0 mm (1.10 in.)**
Service Limit:	**27.0 mm (1.06 in.)**

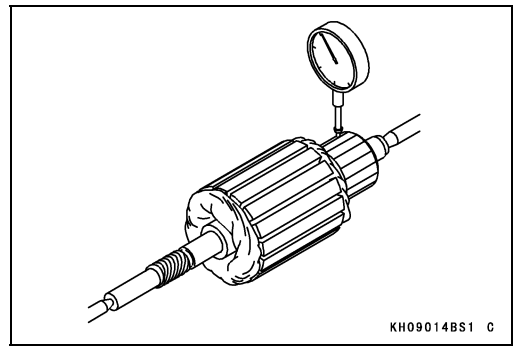


- Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.
- Rotate the armature slowly and read the commutator runout.

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

Commutator Runout

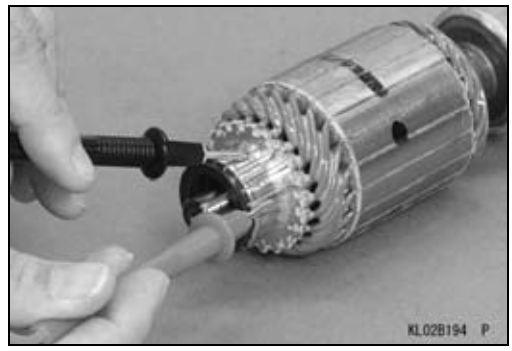
Service Limit:	**0.4 mm (0.016 in.)**



Electric Starter System

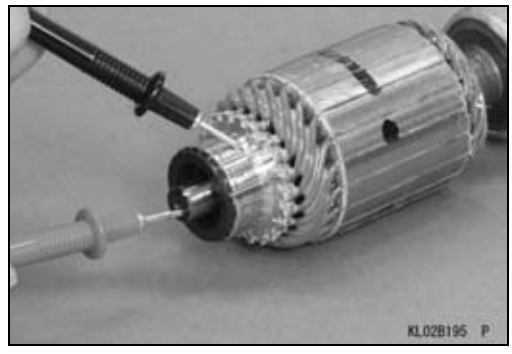
● Measure the armature winding resistance.
○Set the multimeter selector switch to the R × 1 Ω position and check the resistance between each segment and all the others.
★If the resistance it too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

Armature Winding Resistance
Close ~ 0 Ω

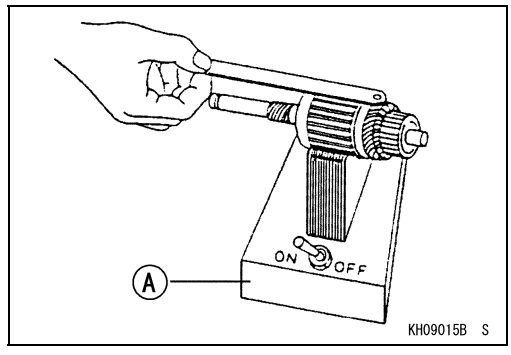


● Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the commutator and the armature shaft.
★If the resistance is less than infinite, the armature is shorted.

Commutator to Shaft Resistance
(∞)



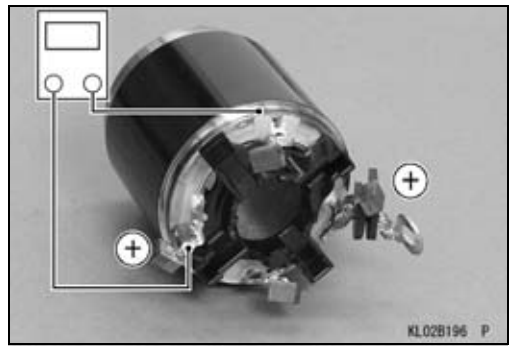
● Test the armature winding for shorts.
○Place the armature on a growler [A].
○Hold a thin metal strip (e.g., hack saw blade) on top of the armature.
○Turn on the growler and rotate the armature one complete turn.
★If the metal strip vibrates, the windings are internally shorted to each other and the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



Yoke Assembly Inspection

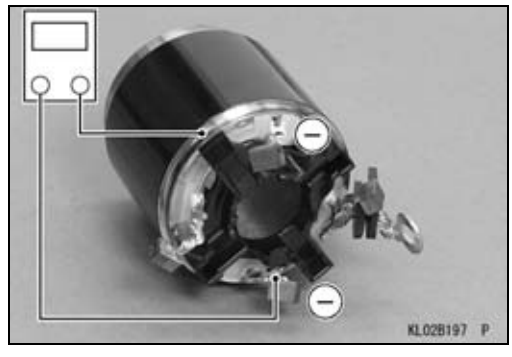
● Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the positive brushes and stator motor yoke.
★If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

Positive Brush to Ground Resistance
(∞)



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

Negative Brush to Ground Resistance
Close ~ 0 Ω

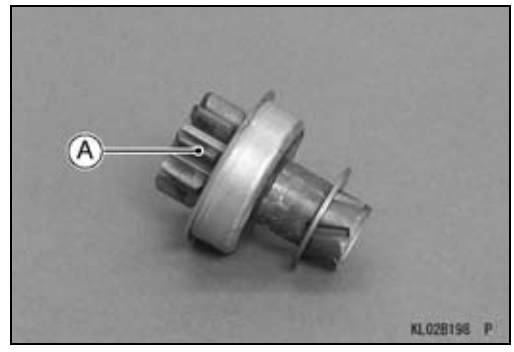


Electric Starter System

Pinion Clutch Inspection

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

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



Electrical System

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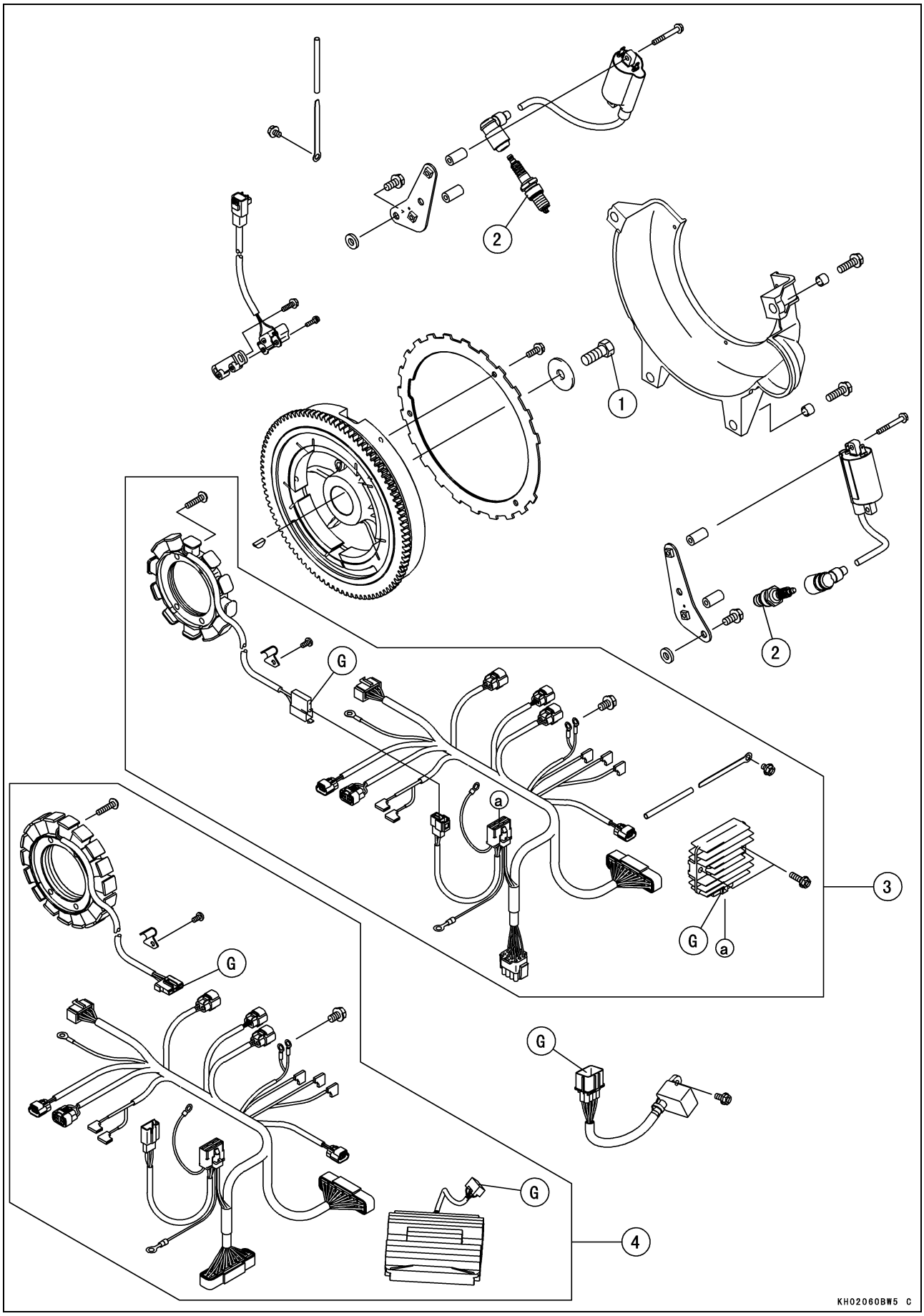
Exploded View



Exploded View

No.	Fastener	Torque			Remarks
		N·m	kgf·m	ft·lb	
1	Flywheel Bolt	56	5.7	41	
2	Spark Plugs	22	2.2	16	

3. 12 V - 20 A Model
4. 12 V - 30 A Model

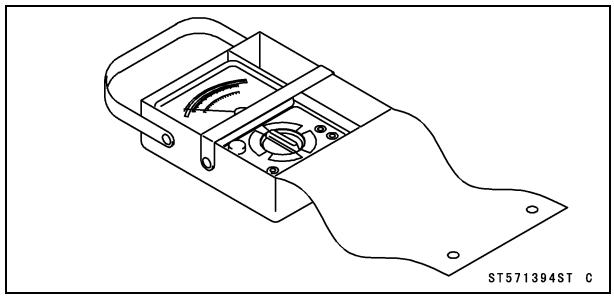
G: Apply grease.

Specifications

Item	Standard	Service Limit
Charging System		
Regulated output voltage	14.0 ~ 15.0 V DC (12 V - 20 A model)	– – –
	14.2 ~ 15.2 V DC (12 V - 30 A model)	– – –
Alternator stator coil resistance	0.15 ~ 0.22 Ω at 20°C (68°F) (12 V - 20 A model)	– – –
	0.16 ~ 0.24 Ω at 20°C (68°F) (12 V - 30 A model)	– – –
Unregulated stator output	– – –	26 VAC/3000 rpm
Regulator resistance	in the text (12 V - 20 A model)	– – –
Ignition System		
Crankshaft Position Sensor		
Air Gap	0.5 ~ 0.9 mm (0.02 ~ 0.04 in.)	– – –
Resistance	88 ~ 132 Ω at 20°C (68°F)	– – –
Ignition coil:		
Primary winding resistance	2.2 ~ 3.6 kΩ	– – –
Secondary winding resistance	13 ~ 21 kΩ	– – –
Spark Plug	NGK BPR2ES	– – –
Plug gap	0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)	– – –

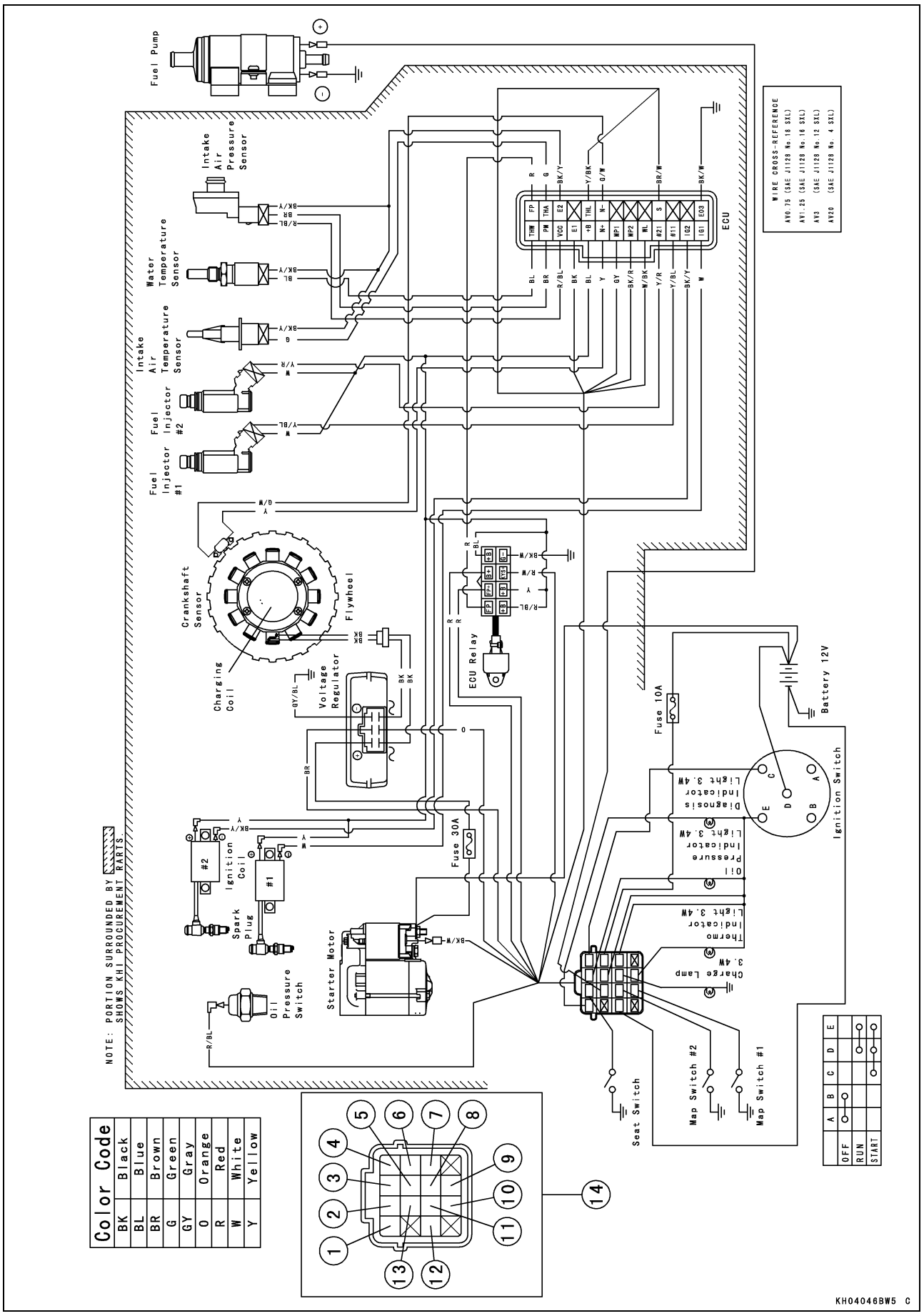
Special Tool

Hand Tester:
57001-1394



Wiring Diagram

12 V - 20 A Model



NOTE

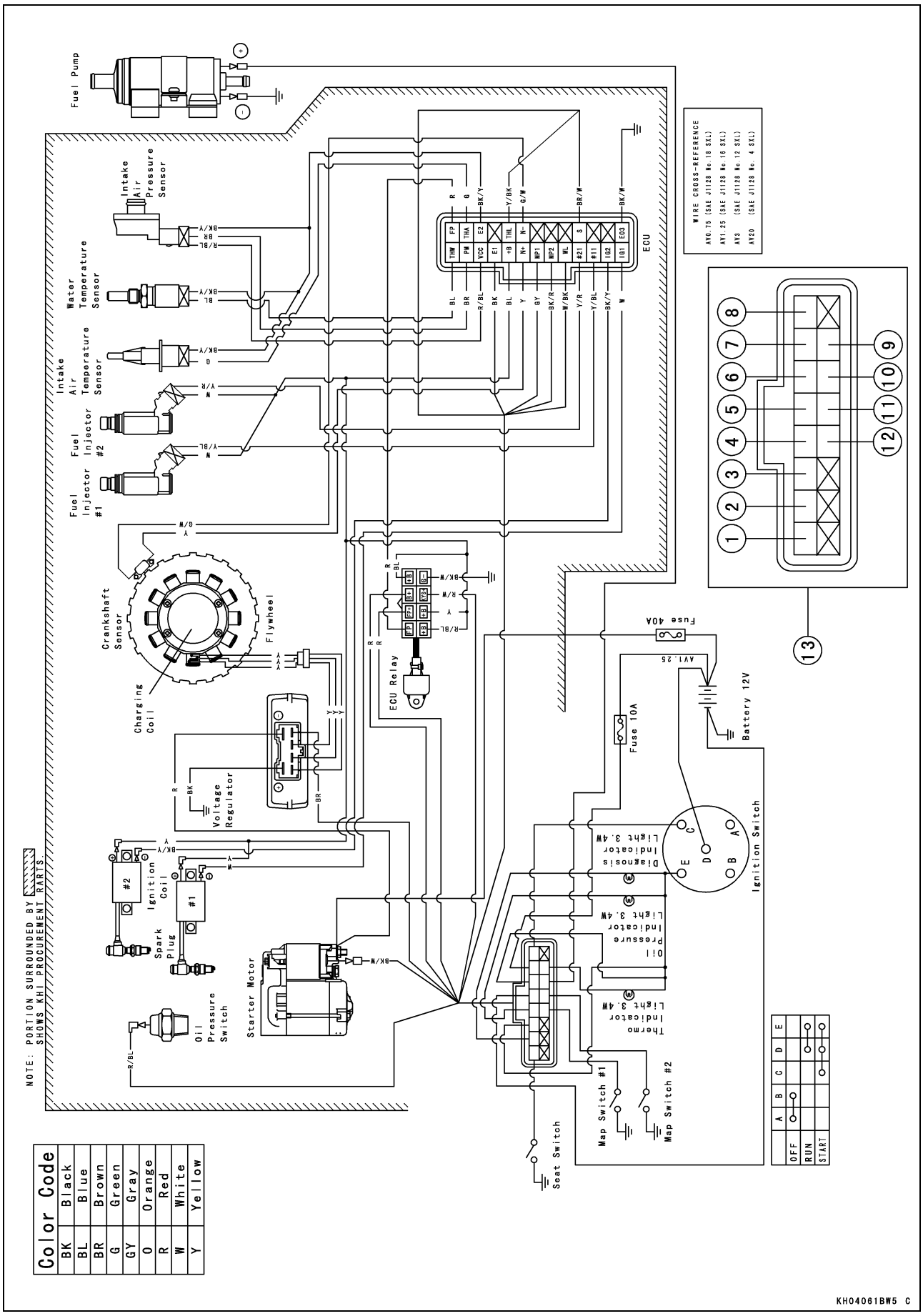
○*Portion surrounded by ∠∠∠ shows KHI procurement parts.*

Wiring Diagram

1. W/BK: Diagnosis Indicator Light 3.4 W
2. BR/W: Seat Switch
3. R/BL: Oil Pressure Indicator Light 3.4 W
4. BK/W: Ignition Switch (terminal C)
5. R/W: Ignition Switch (terminal E)
6. R: Battery (+) Terminal
7. BR: Ignition Switch (terminal E)
8. O: Charge Lamp 3.4 W
9. Y/BK: Thermo Indicator Lamp 3.4 W
10. BK/R: Map Switch #2
11. GY: Map Switch #1
12. BK: Battery (–) Terminal
13. R: Fuel Pump
14. Engine Main Harness Connector

Wiring Diagram

12 V - 30 A Model



NOTE

○*Portion surrounded by ∠∠∠ shows KHI procurement parts.*

Wiring Diagram

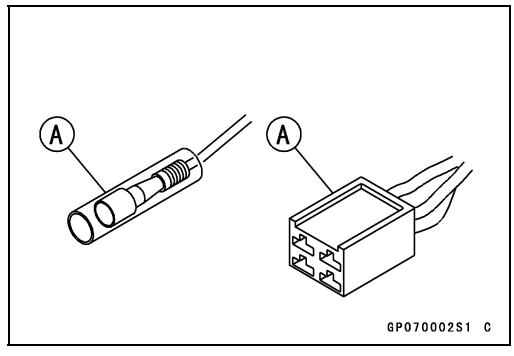
1. BR/W: Seat Switch
2. W/BK: Diagnosis Indicator Light 3.4 W
3. R/W: Ignition Switch (terminal E)
4. R/BL: Oil Pressure Indicator Light 3.4 W
5. BK: Battery (–) Terminal
6. BR: Ignition Switch (terminal E)
7. R: Battery (+) Terminal
8. BK/W: Ignition Switch (terminal C)
9. Y/BK: Thermo Indicator Lamp 3.4 W
10. R: Fuel Pump
11. GY: Map Switch #1
12. BK/R: Map Switch #2
13. Engine Main Harness Connector

Precautions

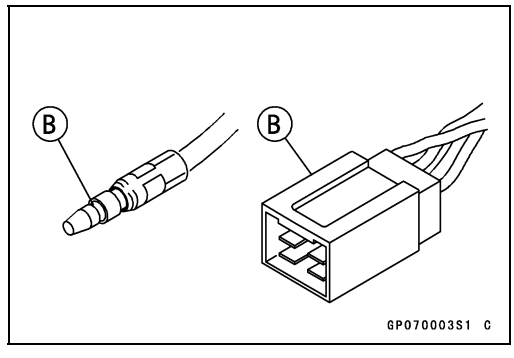
There are a number of important precautions that you must follow when servicing electrical systems. Learn and observe all the rules below.

- ○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]



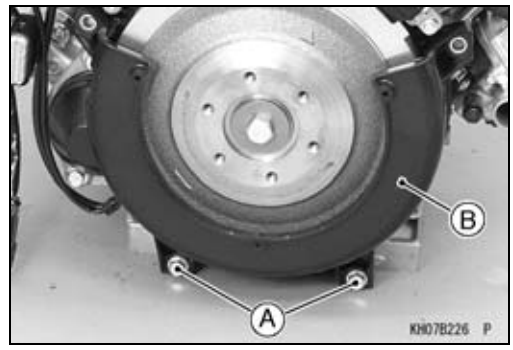
Connectors [B]



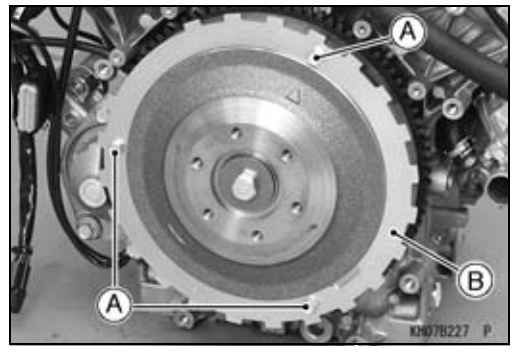
Charging System

Flywheel and Stator Coil Removal

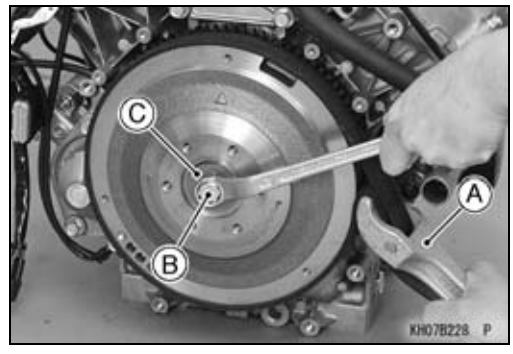
- Remove:
  Radiator (see Radiator Removal in the Cooling System chapter)
  Belt Pully (see Cooling Fan and Fan Belt Removal in the Cooling System chapter)
  Radiator Bracket (see Cylinder Head Removal in the Engine Top End chapter)
  Bolts [A] and Cover [B]



- Remove:
  Crankshaft Sensor (see Crankshaft Sensor Removal)
  Bolts [A]
  Plate [B]

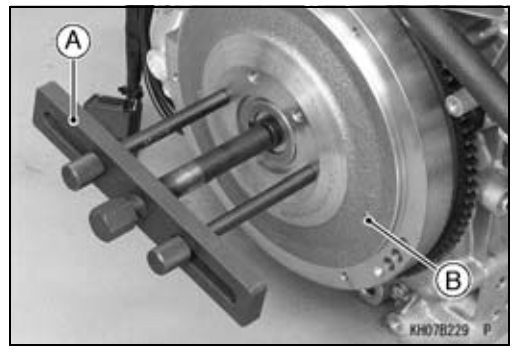


- Hold the flywheel with a suitable tool [A], remove the flywheel bolt [B] and the washer [C].

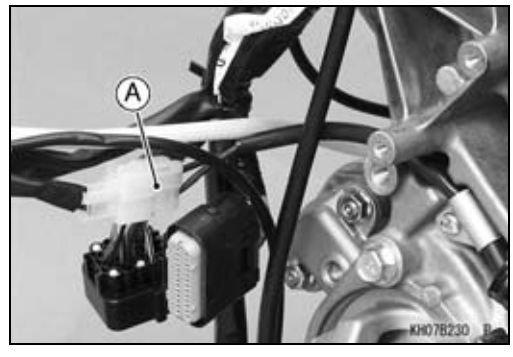


- Using a suitable flywheel puller [A], remove the flywheel [B].

NOTICE
Always use flywheel puller.

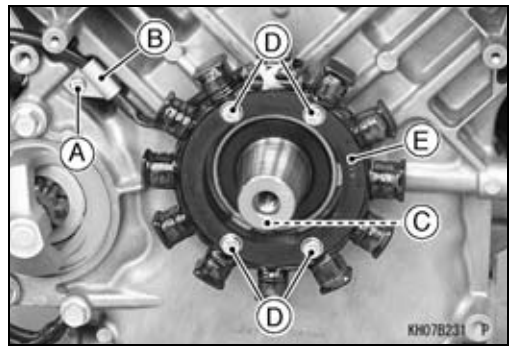


- Disconnect the stator coil lead connector [A].



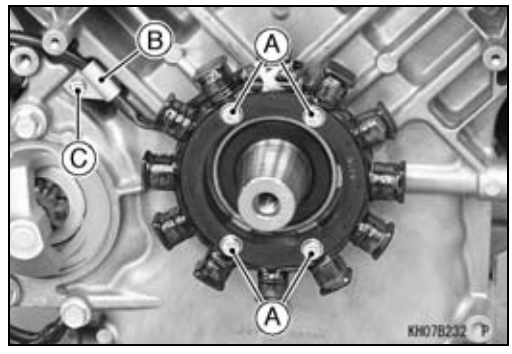
Charging System

- Remove:
  Stator Coil Lead Clamp Screw [A]
  Stator Coil Lead Clamp [B]
  Woodruff Key [C]
  Stator Coil Screws [D]
  Stator Coil [E]

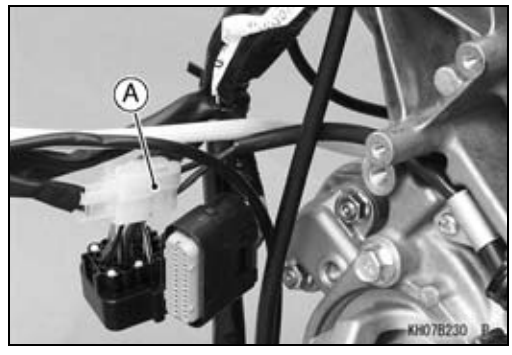


Flywheel and Stator Coil Installation

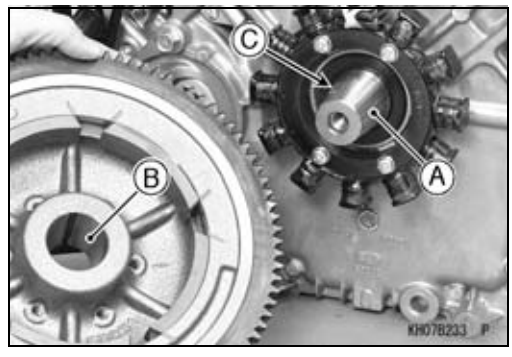
- Install the stator coil and tighten the screws [A].
- Install the stator coil lead clamp [B] and tighten the stator coil lead screw [C].



- Apply grease to the stator coil lead connector terminals.
- Connect the stator coil output connector [A].

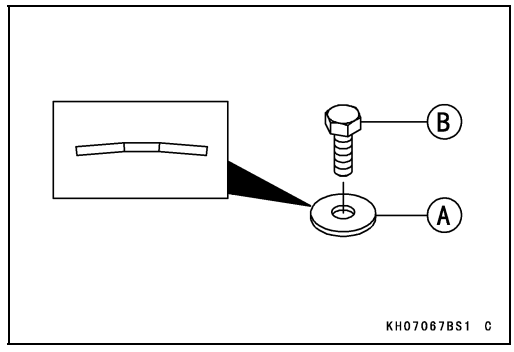


- Using a cleaning fluid, clean off any oil or dirt on the following portions and dry them with a clean cloth.
  Crankshaft Tapered Portion [A]
  Flywheel Tapered Portion [B]
- Fit the woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.
- Install the flywheel onto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



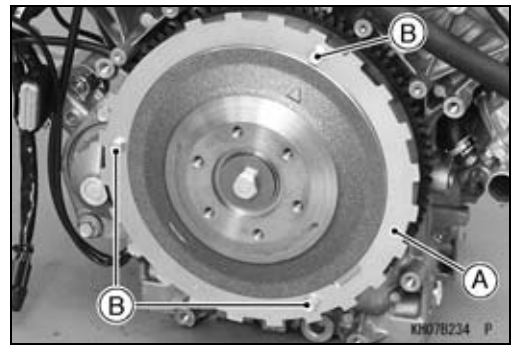
- Install the washer [A].
- Tighten:

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

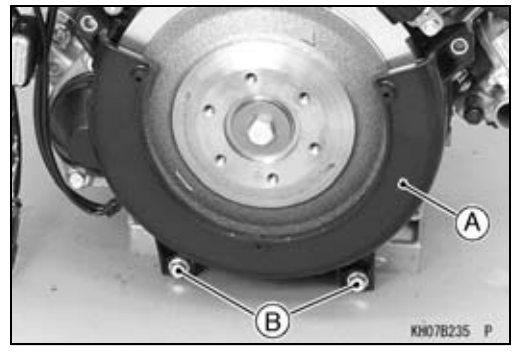


Charging System

● Install the plate [A] and tighten the bolts [B].



● Install the crankshaft sensor (see Crankshaft Sensor Installation).
● Install the Cover [A] and tighten the bolts [B].



Charging System Operational Inspection

● Check the battery condition.

NOTE

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

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

Regulated Output Voltage
Battery Voltage ~ 15 VDC

Charging System

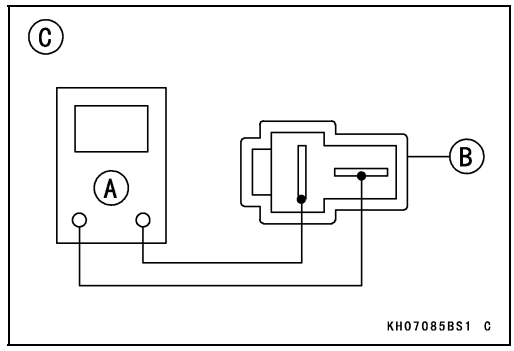
Stator Coil Resistance

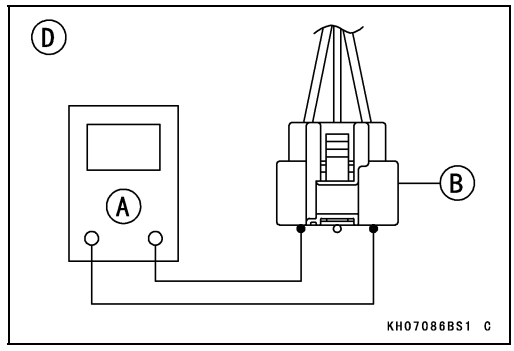
- Disconnect the stator coil connector.
- Measure the stator coil resistance.

○Connect hand tester [A] between stator coil connector pins [B].
12 V - 20 A Model [C]
12 V - 30 A Model [D]

Special Tool - Hand Tester: 57001–1394

Stator Coil Resistance
0.15 ~ 0.22 Ω at 20°C (68°F) (12 V - 20 A model)
0.15 ~ 0.24 Ω at 20°C (68°F) (12 V - 30 A model)





★If the measured value is not within the specification, replace the stator coil with a new one.
★If the coil has normal resistance, but the voltage inspection shows the alternator to be defective; the flywheel magnets have probably weakened, and the flywheel must be replaced.
- Check for continuity between each stator pin and ground. There should be no continuity (infinite ohm).

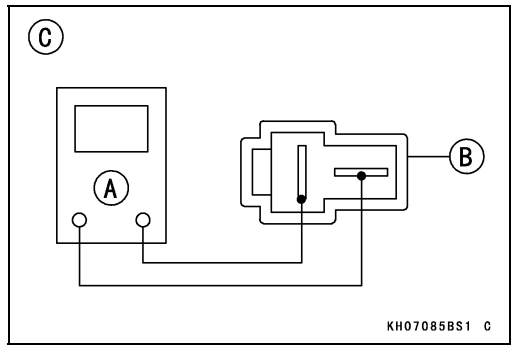
★If the stator coil fails any of these tests, replace the coil with a new one.

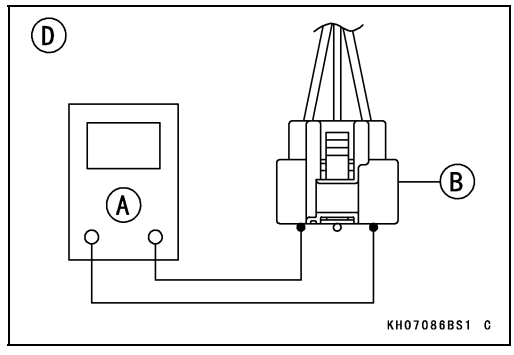
Unregulated Stator Output

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

★If the AC voltage reading is less than the specification replace the stator with a new one.
12 V - 20 A Model [C]
12 V - 30 A Model [D]

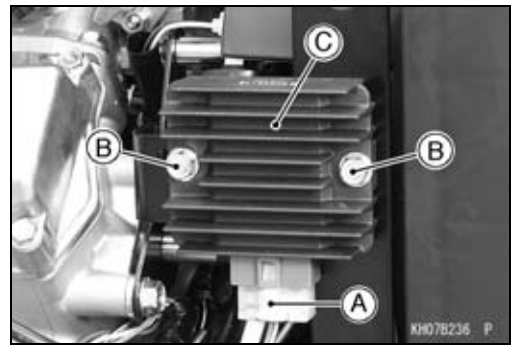
Unregulated Stator Output (MIN)
26 VAC/3 000 rpm





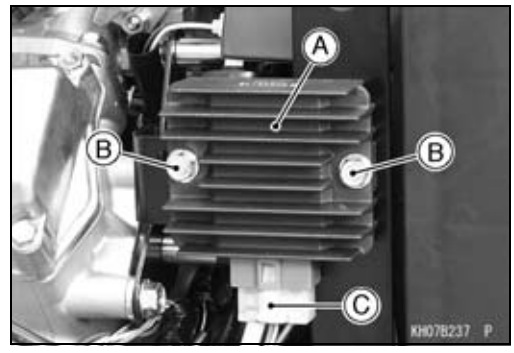
Charging System

Regulator Removal



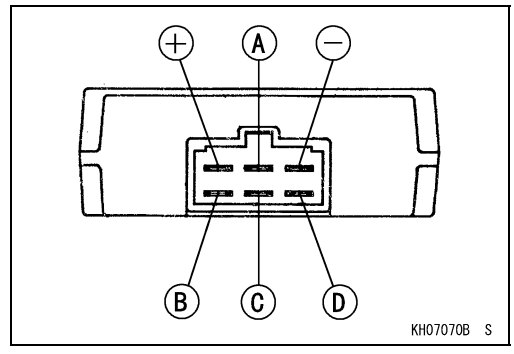
- Remove:
  Regulator Lead Connector [A]
  Regulator Mounting Bolts [B]
  Regulator [C]

Regulator Installation



- Install the regulator [A] and tighten the bolts [B].
- Apply dielectric grease to the regulator terminals.
- Connect the regulator lead connector [C].

Regulator Resistance (12 V - 20 A Model)



- Remove the Regulator (see Regulator Removal).
- Set the KAWASAKI Hand Tester selector switch to the R × 100 Ω position.

  Special Tool - Hand Tester: 57001–1394

- Connect the test leads to the points shown on the chart and read the resistance.

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

NOTE

○*This voltage regulator is an open type one.*

Charging System

By KAWASAKI TESTER **Range: R × 100 Ω**

– / +	A	B	+	–	C	D
A	—	∞	∞	∞	∞	∞
B	1 kΩ ~ 200 kΩ	—	∞	50 Ω ~ 5 kΩ	1 kΩ ~ 200 kΩ	10 kΩ ~ 1M kΩ
+	∞	∞	—	∞	∞	∞
–	500 kΩ ~ 5 kΩ	10 kΩ ~ 1 MΩ	∞	—	500 Ω ~ 50 kΩ	10 kΩ ~ 1M kΩ
C	1 kΩ ~ 200 MΩ	10 kΩ ~ 1 MΩ	∞	50 Ω ~ 5 kΩ	—	10 kΩ ~ 1M kΩ
D	1 kΩ ~ 200 kΩ	10 kΩ ~ 1 MΩ	∞	50 Ω ~ 5 kΩ	1 kΩ ~ 200 kΩ	—

NOTE

○*Resistance value may vary with individual meter.*

Charging System Troubleshooting

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

NOTE

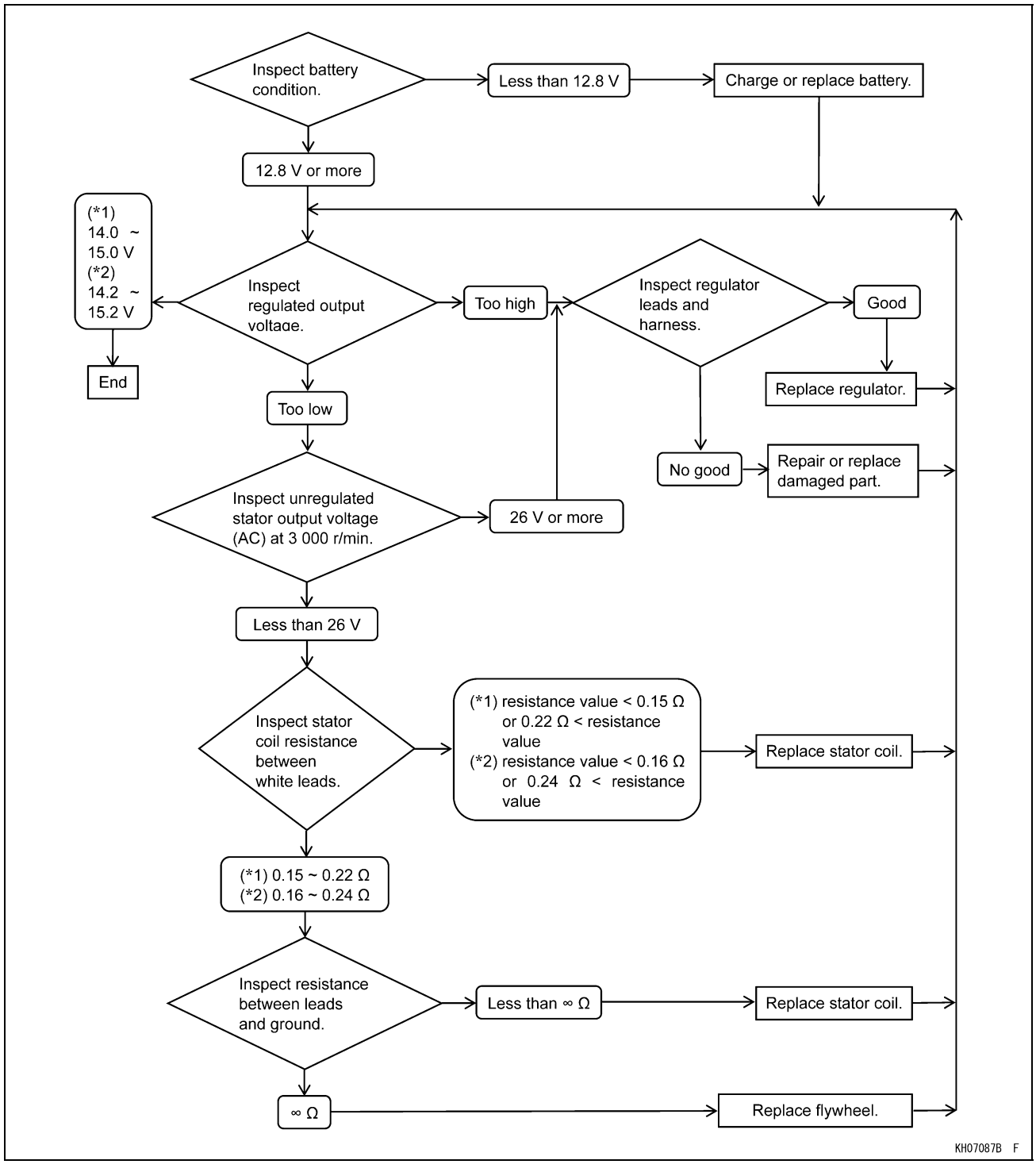
○*Even when the charging system is working properly, the battery may discharge if the vehicle is equipped with too many accessories.*

● Pay attention to riding conditions and the customer's riding habits which could affect the charging system.

○Example (Battery Discharged):
Frequent use at low engine speed

● Recharge the battery if it is discharged.

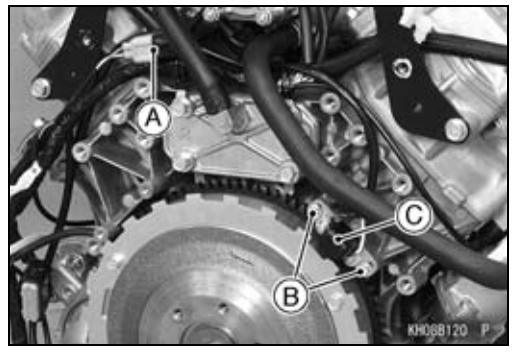
Charging System



*1: 12 V - 20 A Model
*2: 12 V - 30 A Model

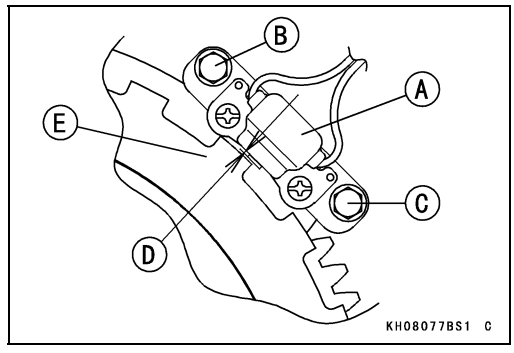
Ignition System

Crankshaft Sensor Removal



- Remove:
  Air Cleaner (see Air Cleaner Body and Bracket Removal in the Fuel System (DFI) chapter)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal in the Cooling System chapter)
  Flywheel Cover (see Flywheel Removal)
- Disconnect the crankshaft sensor lead connector [A].
- Remove:
  Bolts [B]
  Crankshaft Sensor Assembly [C]

Crankshaft Sensor Installation



- Install the crankshaft sensor assembly [A] on the crankcase as shown in the figure, and tighten the bolt [B] first, then tighten the another bolt [C]. While tightening bolts, adjust the air gap [D] between the crankshaft sensor and the projection [E] of the specified gap value as shown.

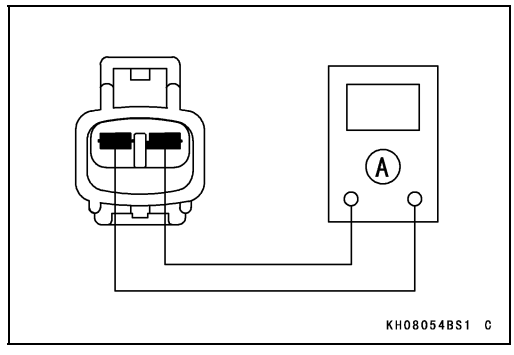
Crankshaft Sensor Air Gap
Standard: 0.5 ~ 0.9 mm (0.020 ~ 0.035 in.)

NOTE

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

- Connect the crankshaft sensor lead connector.
- Install the removed parts (see appropriate chapter).

Crankshaft Sensor Resistance



- Disconnect the crankshaft sensor lead connector (see Crankshaft Sensor Removal).
- Measure the crankshaft sensor resistance with hand tester [A].

Special Tool - Hand Tester: 57001–1394

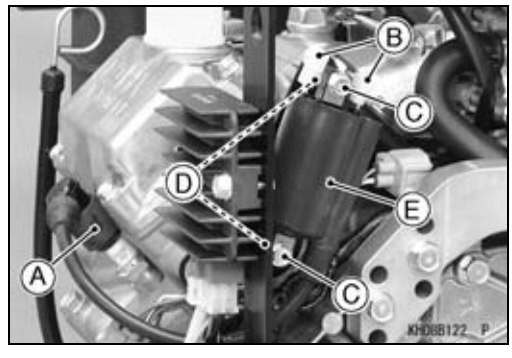
Crankshaft Sensor Resistance
Standard: 88 ~ 132 Ω @20°C (68°F)

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

NOTE

○*Resistance value may very with individual meters.*

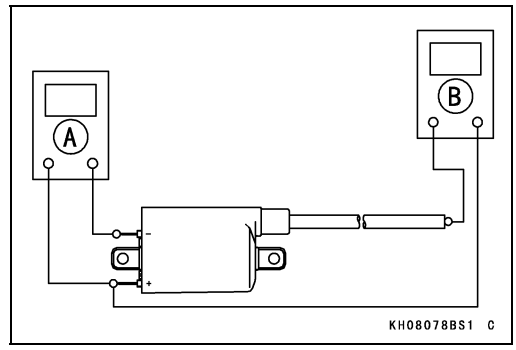
Ignition Coil Removal/Installation



- Remove:
  Radiator (see Radiator Removal in the Cooling System chapter)
  Cooling Fan and Fan Belt (Cooling Fan and Fan Belt Removal in the Cooling System cahpter)
  Spark Plug Cap [A]
  Connectors [B]
  Bolts [C]
  Colors [D]
  Ignition Coil [E]
- Installation is reverse of removal.

Ignition System

Ignition Coil Inspection



- Remove the ignition coils (see Ignition Coil Removal/Installation).
- Unfasten the plug cap from the high tension lead.
- Measure the primary winding resistance [A].

○Connect the hand tester between the coil terminals.
○Set the meter to the R x 1 Ω range, and read tester.

- Measure the secondary winding resistance [B].

○Connect the hand tester between the spark plug lead and the positive (+) terminal.
○Set the meter to the R x 1 KΩ range, and read the tester.

Special Tool - Hand Tester: 57001–1349

Ignition Coil Winding Resistance
Primary windings: 3.4 ~ 4.6 Ω @20°C (68°F)
Secondary windings: 10.4 ~ 15.6 kΩ @20°C (68°F)

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

- Check the spark plug lead for visible damage.

★If the spark plug lead is damaged, replace the coil.

Spark Plug Removal

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

Spark Plug Installation

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

Torque - Spark Plugs: 25 N·m (2.5 kgf·m, 18 ft·lb)

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

Spark Plug Cleaning and Inspection

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

Spark Plug Gap Inspection

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

Troubleshooting

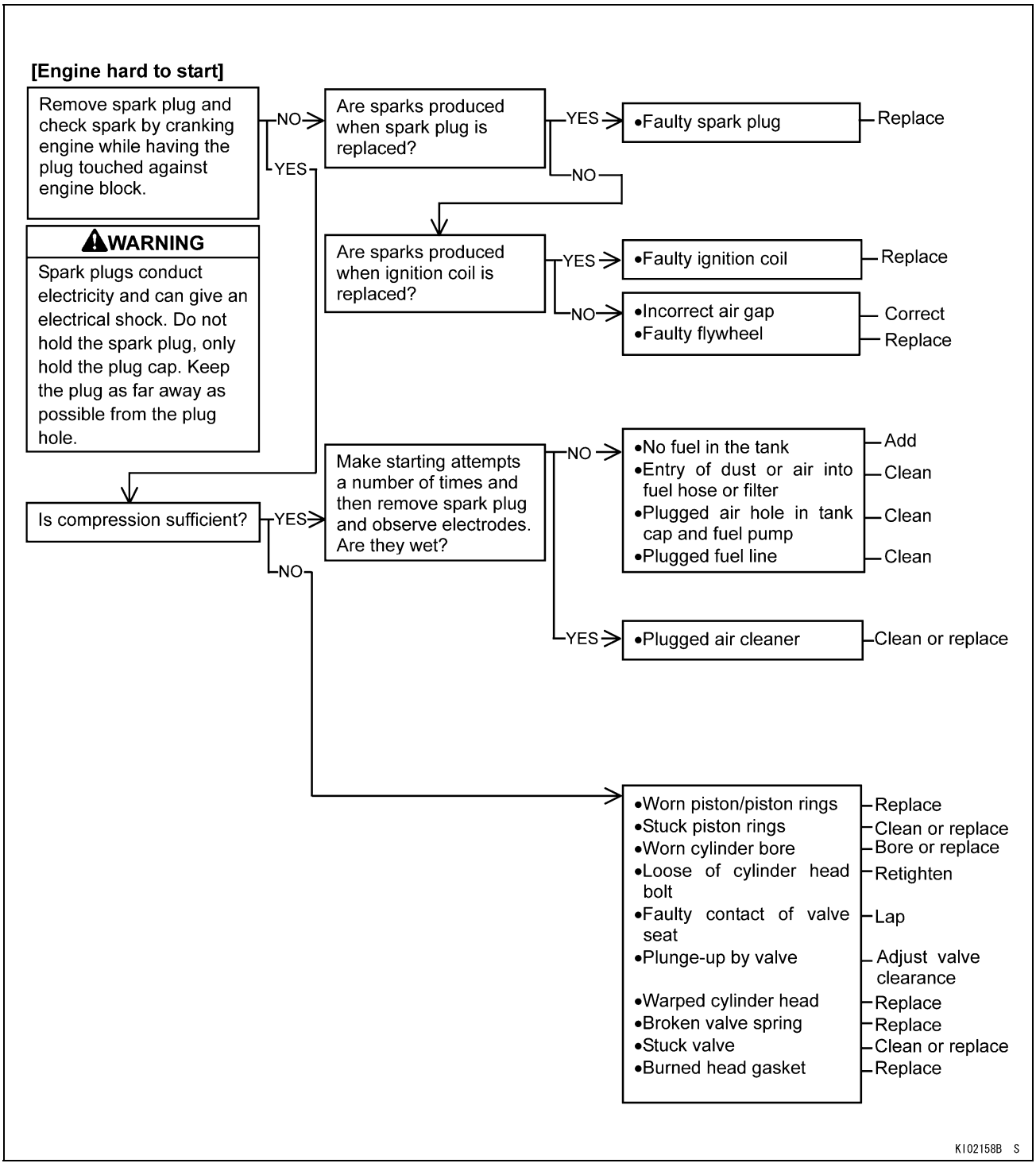
Table of Contents

Engine Troubleshooting Guide

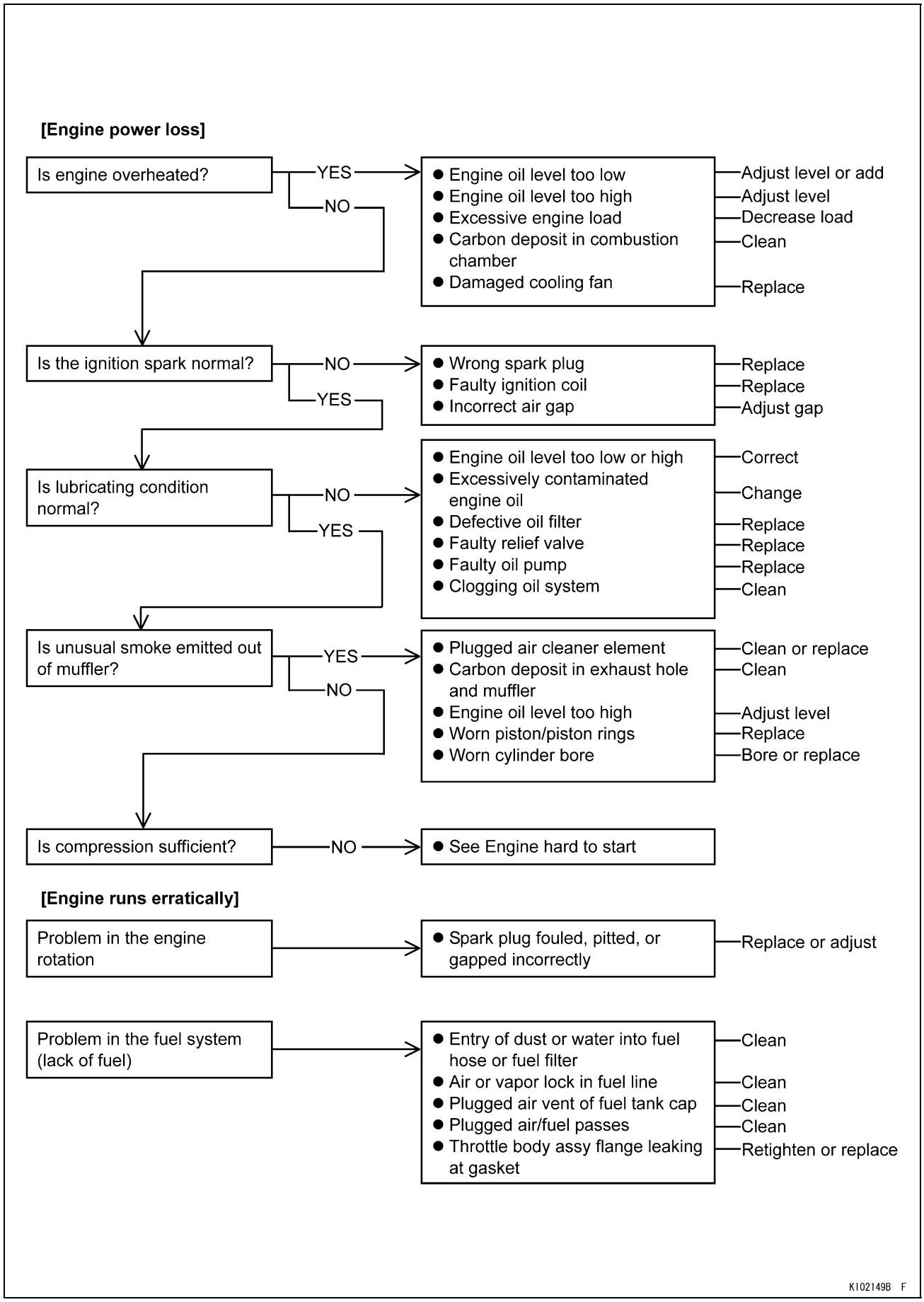
If the engine malfunctions, check if the way the engine is used is correct. If the engine malfunctions even if the engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

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



Engine Troubleshooting Guide



Engine Troubleshooting Guide

[Engine malfunctions at high speed]

Is revolution fluctuation of relatively large period produced when a load is applied?
- YES →
  - ● Plugged air hole in tank cap — Clean
  - ● Entry of dust and air into fuel filter or fuel pipe. — Clean

[Engine malfunctions at low speed]

Remove spark plug and check spark by cranking engine while having the plug touched against engine block.
- WEAK →
  - ● Faulty plug insulation — Replace
  - ● Fouled electrodes — Clean
- STRONG →
  - ● Faulty ignition coil — Replace
  - ● Incorrect air gap — Correct

⚠WARNING

Spark plugs conduct electricity and can give an electrical shock. Do not hold the spark plug, only hold the plug cap. Keep the plug as far away as possible from the plug hole.

↓

Is unusual smoke emitted out of muffler?
- YES →
  - ● Overrich fuel — Check fuel system
- NO →

↓

Directly and gradually open throttle valve by hand. Does the revolution drop or does engine stall at a certain position?
- YES →
  - ● Plugged in fuel system — Disassemble and clean
- NO →

↓

Is air sucked through throttle body assy or intake manifold flange?
- YES →
  - ● Loose flange nuts — Retighten
  - ● Damaged gasket — Replace
- NO →

↓

Are valve clearances of normal values?
- NO →
  - ● Compression leakage — Adjust valve clearance
  - ● Wrong valve timing — Correct alignment of timing gear marks.
- YES →

↓

Is alignment of timing gear marks correct?
- NO →
  - ● Largely deviated valve timing — Correct alignment of timing gear marks.

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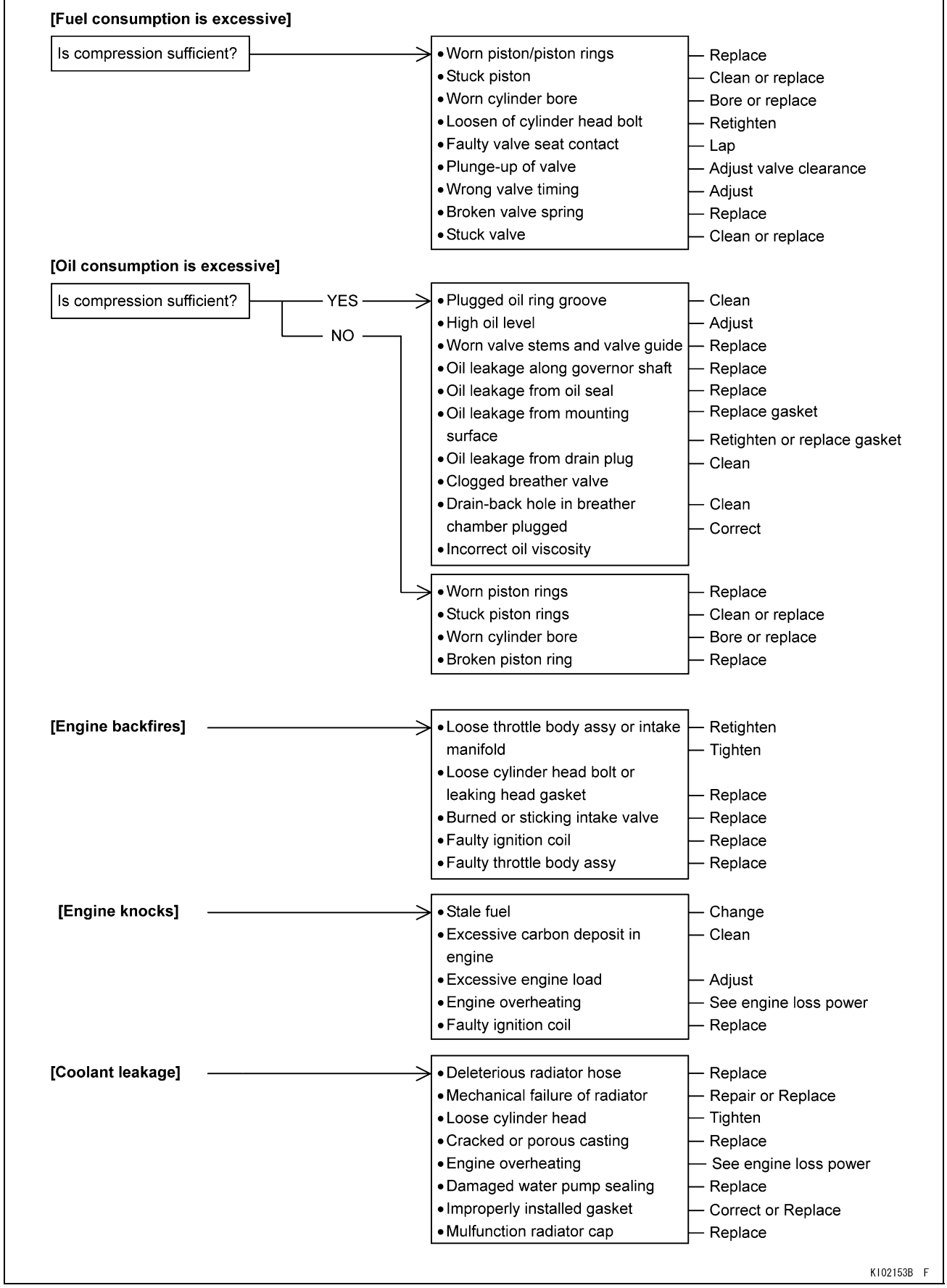
Engine Troubleshooting Guide



Engine Troubleshooting Guide

DFI System Troubleshooting

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

Symptoms → / Operations ↓		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 sensor inspection		●	●												
Fuel pressure inspection		●	●	●	●	○	●	●	●	●	●	○	●	●	
Pressure regulator inspection		○	○	○	○		○	○	○	○	○		○	○	
Fuel leak inspection		○	○		○	○	●		●	●		○		●	
Fuel system cleaning		○	○		○	●	●	○	○		○	○	●	●	
Fuel filter inspection		○	○		○	○	●	○			○	○	○	●	
Intake air temperature sensor inspection		○		○			○	○	○	○	●	●	●	●	
Water temperature sensor inspection		○		●	○	○	○	○	○	○	●	●	●	●	
Intake air pressure sensor inspection		○	○	●	●	○	○	●	○	●	○	○	○	●	
Throttle valve inspection			●		●	●		●							
Idle speed setting inspection					●										
Harness inspection		●	●	○		●	●	○	●	●	●	●	●	○	
Air leak inspection		○	○		●	●	○	●	●	●	○	○		○	
Replace control unit		●	○	○	○	○	●	○	○	○	●	○	●	●	

Engine Troubleshooting Guide

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.

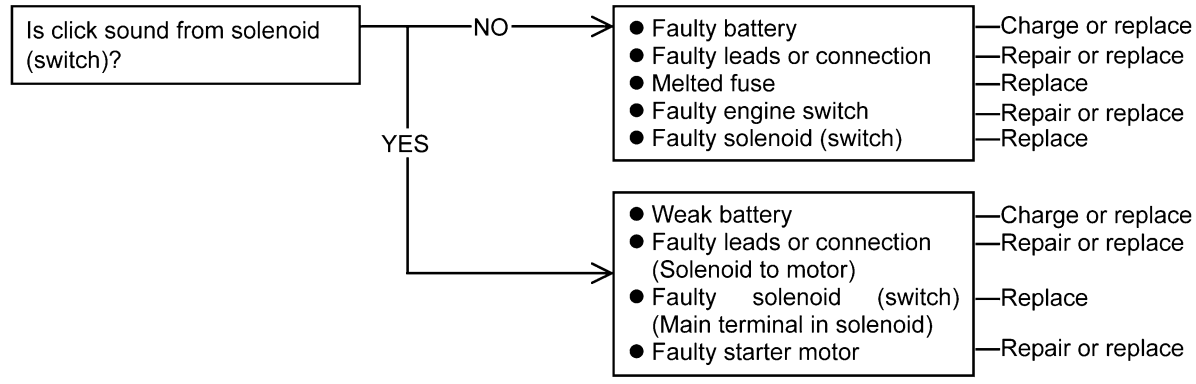
⚠ WARNING

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.

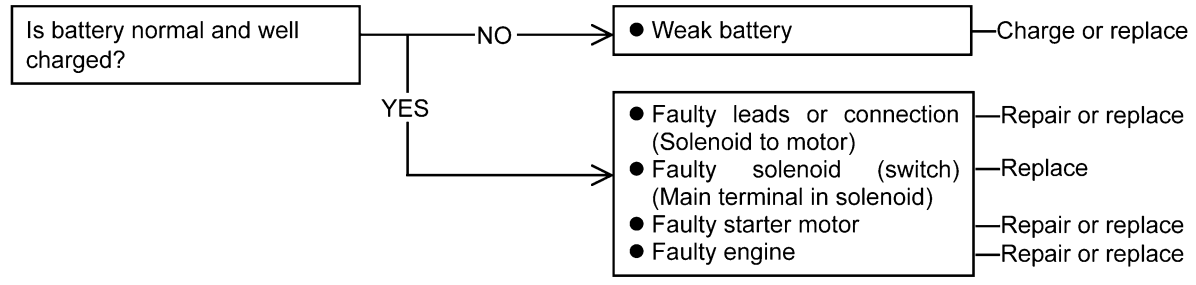
NOTICE

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

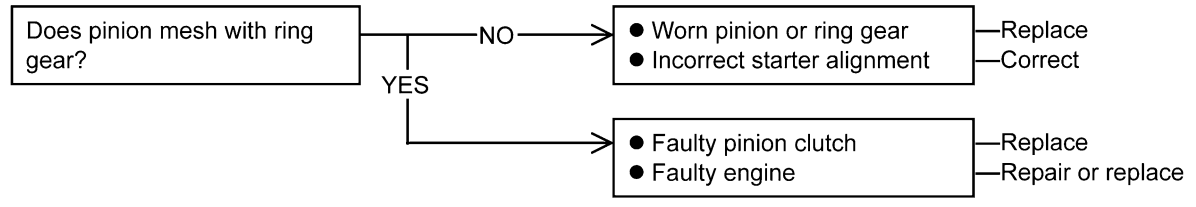
[Starter does not rotate]



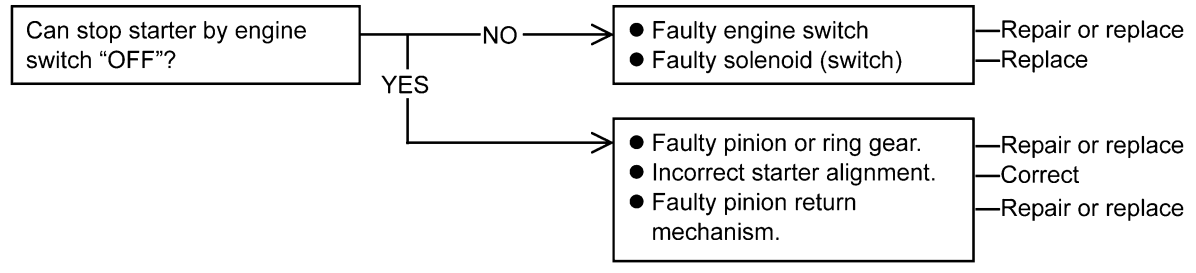
[Starter rotates but slow]



[Starter rotates but engine can not crank]



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



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99924-2097-02

Kawasaki
ENGINES

Kawasaki Motors, Ltd.

Printed in Japan