



SERVICE MANUAL

4-STROKE AIR-COOLED V-TWIN GASOLINE ENGINE

FH601D

FH641D

FH680D

FH721D

Quick Reference Guide

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This quick reference guide will assist you in locating a desired topic or procedure.

- Bend the pages back to match the black tab of the desired chapter number with the black tab on the edge at each table of contents page.
- Refer to the sectional table of contents for the exact pages to locate the specific topic required.

FH601D FH641D FH680D FH721D

4-Stroke Air-Cooled V-Twin Gasoline Engine Service Manual

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All information contained in this publication is based on the latest product information available at the time of publication. Illustrations and photographs in this publication are intended for reference use only and may not depict actual model component parts.

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 gasses. The blow-by gasses are led to a breather chamber through the crankcase and from there to the air cleaner.

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

2. **Exhaust Emission Control System**

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

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

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

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

Among those acts presumed to constitute tampering are the acts listed below:

Do not tamper with the original emission related part:

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

Foreword

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

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

To get the longest life out of your engine:

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

How to Use This Manual

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

The Quick Reference Guide shows you all of the product's system and assists in locating their chapters. Each chapter in turn has its own comprehensive Table of Contents.

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

operations.

If you want spark plug information, for example, go to the Periodic Maintenance Chart first. The chart tells you how frequently to clean and gap the plug. Next, use the Quick Reference Guide to locate the Electrical System chapter. Then, use the Table of Contents on the first page of the chapter to find the Spark Plug section.

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



WARNING

This warning symbol identifies special instructions or procedures which, if not correctly followed, could result in personal injury, or loss of life.

NOTICE

This caution symbol identifies special instructions or procedures which, if not strictly observed, could result in damage to or destruction of equipment.

This manual contains four more symbols (in addition to WARNING and CAUTION) which will help you distinguish different types of information.

NOTE

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

- Indicates a procedural step or work to be done.
- Indicates a procedural sub-step or how to do the work of the procedural step it follows. It also precedes the text of a WARNING, CAUTION, or NOTE.
- ★ Indicates a conditional step or what action to take based on the results of the test or inspection in the procedural step or sub-step it follows.

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

General Information

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1-2 GENERAL INFORMATION

Before Servicing

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

Especially note the following:

(1) Dirt

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

(2) Battery Ground

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

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

(3) Tightening Sequence

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

(4) Torque

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

(5) Force

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

(6) Edges

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

(7) High-Flash Point Solvent

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

(8) Gasket, O-Ring

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

(9) Liquid Gasket, Non-Permanent Locking Agent

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

(10) Press

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

(11) Ball Bearing

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

(12) Oil Seal and Grease Seal

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

Before Servicing

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

(13) Seal Guide

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

(14) Circlip, Retaining Ring

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

(15) Cotter Pin

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

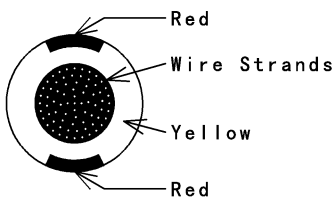

(16) Lubrication

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

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

(17) Electrical Wires

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

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

GB020601W1 C

(18) Replacement Parts

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

(19) Inspection

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

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

1-4 GENERAL INFORMATION

Before Servicing

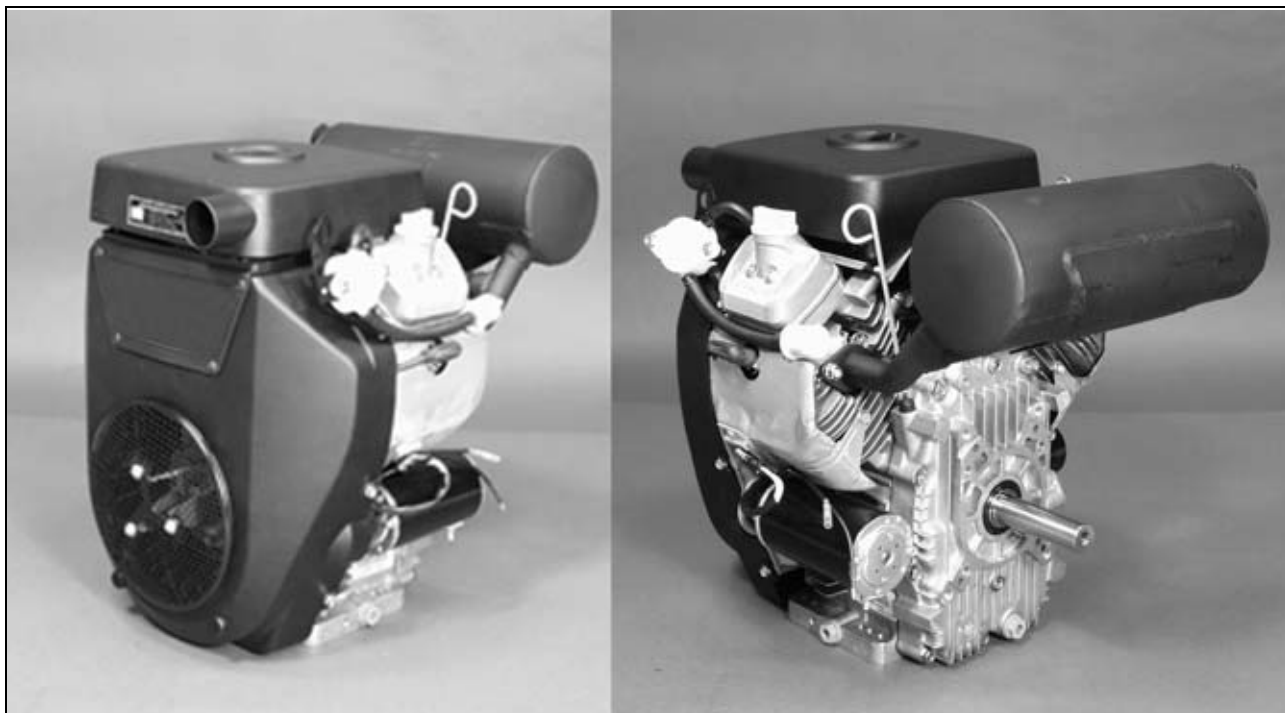
(20) Specifications

Specification terms are defined as follows:

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

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

Model Identification



Cylinder Number Designation:

No.1 Cylinder is on the electric starter side.

No.2 Cylinder is on the oil filter side.

1-6 GENERAL INFORMATION

General Specifications

Items	FH601D, FH641D, FH680D, FH721D
Type	Forced air-cooled, horizontal shaft, OHV, 4-stroke gasoline engine.
Cylinder Layout	90° V-Twin
Bore × Stroke	75.2 mm × 76 mm (2.96 in. × 2.99 in.)
Displacement	675 mL (41.19 cu. in.)
Direction of Rotation	Counterclockwise facing the PTO shaft
Compression Release	Automatic compression release
Low Idle Speed	1 550 rpm
High Idle Speed	3 600 rpm
Ignition System	Transistorized-fly wheel magneto
RFI	Per Canada and U.S.A. requirements
Starting System	Electric starter
Charging System	12 V-13 amps with regulator
Spark Plug	NGK BPR4ES
Carburetor	Float type, fixed main jet, two barrel
Fuel Pump	Diaphragm type pulse pump
Air Cleaner	Dual stage element, dry type/Heavy duty type
Governor	Flyweight all speed governor
Lubrication System:	Pressure feed by positive displacement pump
Oil Filter	Cartridge type full flow filter
Oil Pressuer Switch	ON-OFF switch
Oil Capacity	1.6 L (1.7 US-qt)...(when engine is completely dry)
Cooling System	Forced air cooling by fan
Dimensions (L × W × H):	
Without Muffler	442 mm × 430 mm × 491 mm (17.4 in. × 16.9 in. × 19.3 in.)
Dry Weight:	
Without Muffler	44.5 kg (98.1 lb)

Specifications are subject to change without notice.

Unit Conversion Table

Prefixes for Units:

Prefix	Symbol	Power
mega	M	$\times 1\,000\,000$
kilo	k	$\times 1\,000$
centi	c	$\times 0.01$
milli	m	$\times 0.001$
micro	μ	$\times 0.000001$

Units of Mass:

kg	\times	2.205	=	lb
g	\times	0.03527	=	oz

Units of Volume:

L	\times	0.2642	=	gal (US)
L	\times	0.2200	=	gal (imp)
L	\times	1.057	=	qt (US)
L	\times	0.8799	=	qt (imp)
L	\times	2.113	=	pint (US)
L	\times	1.816	=	pint (imp)
mL	\times	0.03381	=	oz (US)
mL	\times	0.02816	=	oz (imp)
mL	\times	0.06102	=	cu in

Units of Force:

N	\times	0.1020	=	kgf
N	\times	0.2248	=	lb
kgf	\times	9.807	=	N
kgf	\times	2.205	=	lb

Units of Length:

km	\times	0.6214	=	mile
m	\times	3.281	=	ft
mm	\times	0.03937	=	in

Units of Torque:

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

Units of Pressure:

kPa	\times	0.01020	=	kgf/cm ²
kPa	\times	0.1450	=	psi
kPa	\times	0.7501	=	cm Hg
kgf/cm ²	\times	98.07	=	kPa
kgf/cm ²	\times	14.22	=	psi
cm Hg	\times	1.333	=	kPa

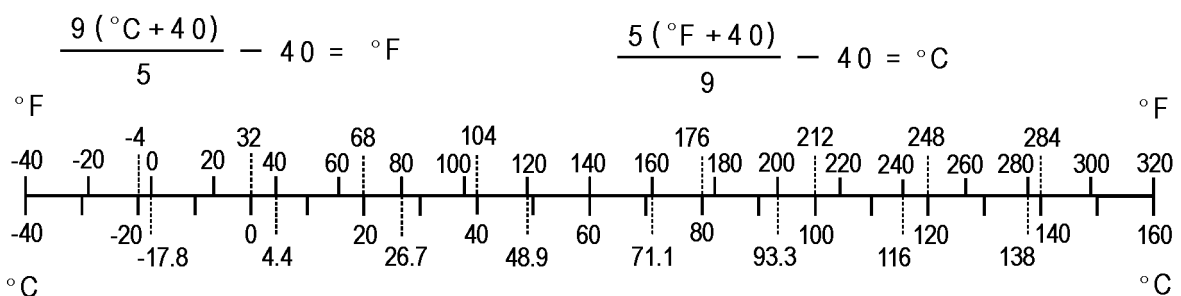
Units of Speed:

km/h	\times	0.6214	=	mph
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Units of Power:

kW	\times	1.360	=	PS
kW	\times	1.341	=	HP
PS	\times	0.7355	=	kW
PS	\times	0.9863	=	HP

Units of Temperature:



Periodic Maintenance

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2-2 PERIODIC MAINTENANCE

Periodic Maintenance Chart

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

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

OPERATION	INTERVAL								
	Daily	First 8 hr.	Every 25 hr.	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 250 hr.	Every 300 hr.	Every 500 hr.
Check and clean air inlet screen	●								
Check and add engine oil	●								
Check for fuel and oil leakage	●								
Check for loose or lost nuts and screws	●								
Check battery electrolyte level	●								
Clean air cleaner foam element (1)			●						
Clean air cleaner paper element (1)				●					
Replace air cleaner paper element (1)						●			
Replace air cleaner primary element (Heavy duty air cleaner model) (1)							●		
Check air cleaner secondary element (Heavy duty air cleaner model) (1)							●		
Replace air cleaner secondary element (Heavy duty air cleaner model) (1)									●
Clean cylinder and cylinder head fins (1)					●				
Tighten nut and screws					●				
Change engine oil		●			●				
Clean and re-gap spark plugs					●				
Change oil filter						●			
◆ Check and adjust valve clearance								●	
◆ Clean and lap valve seating surface								●	
◆ Clean combustion chambers								●	

(1): Service more frequently under dusty conditions.

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

Torque and Locking Agent

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

Letters used in the "Remarks" column mean:

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

M: Apply a molybdenum disulfide lubricant (grease or oil) to the threads, seated surface, or washer.

O: Apply an oil to the threads, seated surface, or washer.

S: Tighten the fasteners following the specified sequence.

SS: Apply silicone sealant.

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Fuel System				
Choke Valve Screw	♦0.95	♦0.097	♦8.4 in·lb	♦ = L
Throttle Valve Screws	♦0.95	♦0.097	♦8.4 in·lb	♦ = L
Plug, Main Jet	18	1.8	13	
Drain Screw (Carburetor)	2.0	0.20	18 in·lb	
Fuel Shut Off Solenoid Valve (Carburetor)	19	1.9	14	
Float Chamber Mounting Screw (Carburetor)	4.0	0.40	35 in·lb	
Governor Arm Clamp Nut	7.8	0.80	69 in·lb	
Governor Shaft Plate Screws	2.0	0.20	17 in·lb	
Carburetor and Inlet Pipe Mounting Bolts and Nuts	5.9	0.60	52 in·lb	
Inlet Manifold Mounting Bolts	5.9	0.60	52 in·lb	
Air Cleaner Body Mounting Bolts	5.9	0.60	52 in·lb	
Air Cleaner Body Bracket Bolts (Heavy Duty Air Cleaner Type)	5.9	0.60	52 in·lb	
Air Cleaner Body Bracket Nuts (Heavy Duty Air Cleaner Type)	9.8	1.0	87 in·lb	
Control Panel Mounting Bolts	5.9	0.60	52 in·lb	
Cooling System				
Screen Bolts	5.9	0.60	52 in·lb	
Engine Shroud Bolt (M8: on Cylinder Head)	6.9	0.70	61 in·lb	
Engine Shroud Bolts (M6)	5.9	0.60	52 in·lb	
Shaft Mounting Bolts	2.0	0.20	18 in·lb	
Engine Top End				
Cylinder Head Bolts	♦28	♦2.8	♦21	♦ = S
Valve Clearance Lock Screws	6.9	0.70	61 in·lb	
Connecting Rod Big End Cap Bolts	♦9.8	♦1.0	♦87 in·lb	♦ = O
Rocker Arm Bolts	28	2.8	21	
Rocker Cover Mounting Bolts	6.9	0.70	61 in·lb	
Muffler Flange Nuts	15	1.5	11	
Spark Plugs	22	2.2	16	
Oil Cooler Mounting Joint	44	4.5	33	
Lubrication System				
Engine Drain Plugs (Plastic)	6.9	0.70	61 in·lb	
Engine Drain Plug (Metal)	20	2.0	14.5	
Engine Drain Plug Joint (Plastic)	17	1.7	12	
Engine Drain Plug Joint (Metal)	39	4.0	29	

2-4 PERIODIC MAINTENANCE

Torque and Locking Agent

Fastener	Torque			Remarks
	N·m	kgf·m	ft·lb	
Oil Pressure Switch	◆9.8	◆1.0	◆87 in·lb	◆ = SS
Oil Pump Cover Plate Mounting Bolts	5.9	0.60	52 in·lb	
Oil Filter	in the text	←	←	
Oil Cooler Mounting Joint	44	4.5	33	
Camshaft/Crankshaft				
Crankcase Cover Bolts (Bolt marked "9" on the top end):				
Beginning Engine No. ~ FH601DA09541	◆25	◆2.6	◆19	◆ = S
Beginning Engine No. ~ FH641DA02234				
Beginning Engine No. ~ FH680DA33212				
Beginning Engine No. ~ FH721DA55225				
Crankcase Cover Bolts (Bolt marked "10" on the top end):				
FH601DA09542 ~	◆32	◆3.3	◆23.6	◆ = S
FH641DA02235 ~				
FH680DA33213 ~				
FH721DA55226 ~				
Breather Chamber Cover Bolts	5.9	0.60	52 in·lb	
Oil Cooler Mounting Joint	44	4.5	33	
Electrical System				
Stator Coil Screws	3.4	0.35	30 in·lb	
Flywheel Bolt	56	5.7	41	
Fan Housing Bolts (M8)	6.9	0.70	61 in·lb	
Fan Housing Bolts (M6)	5.9	0.60	52 in·lb	
Screen Bolts	5.9	0.60	52 in·lb	
Regulator Screws	3.4	0.35	30 in·lb	
Ignition Coil Bolts	5.9	0.60	52 in·lb	
Starter Motor Mounting Bolts	15	1.5	11	
Spark Plugs	22	2.2	16	

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

Basic Torque for General Fasteners

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

Specifications

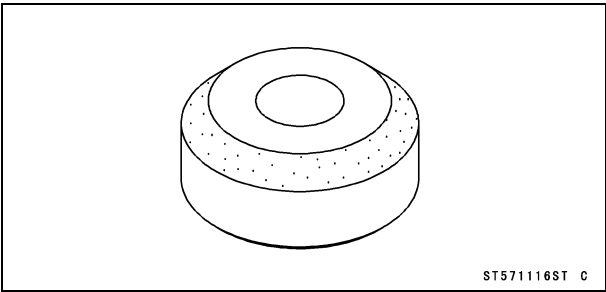
Item	Standard
Fuel System Idle Speed: (1) Low Idle Speed (Carburetor Idle rpm) Low Idle Speed (Governed Idle rpm) High Idle Speed Air Cleaner: Type Pre-cleaner Second-stage Cleaner Air Cleaner: Type Pre-cleaner Second-stage Cleaner	1 450 r/min (rpm) 1 550 r/min (rpm) 3 600 r/min (rpm) Dual stage filtration system Foam element Paper element Heavy duty type Primary element Secondary element
Engine Top End Valve Clearance: Inlet, Exhaust Valve Seating Surface Angle: Inlet, Exhaust Valve Seating Surface Width: Inlet Exhaust	0.10 ~ 0.15 mm (0.004 ~ 0.006 in.) 45° 0.8 ~ 1.4 mm (0.03 ~ 0.06 in.) 1.1 ~ 1.6 mm (0.04 ~ 0.06 in.)
Lubrication System Engine Oil: Type Viscosity Capacity Level	SF, SG, SH, SJ or SL class SAE 40, SAE 30, SAE 10W-30/SAE 10W-40, or SAE 5W-20 1.4 L (1.5 US qt) (When the oil filter is not removed) 1.6 L (1.7 US qt) (When the oil filter is removed) Between "H" and "L" marks on oil gauge
Electrical System Spark Plug Gap	0.75 mm (0.030 in.)
Item	Service Limit
Engine Top End Cylinder Head Warp	0.05 mm (0.002 in.)

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

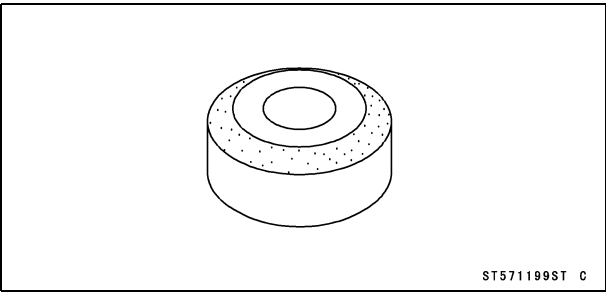
2-6 PERIODIC MAINTENANCE

Special Tools

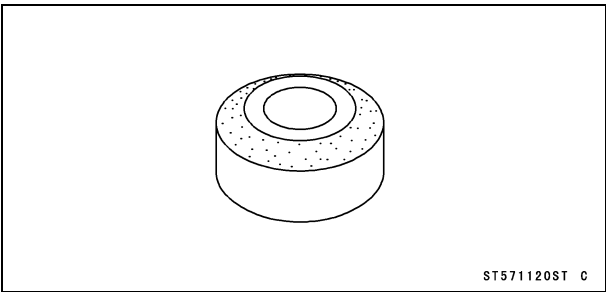
Valve Seat Cutter, 45° - $\phi 35$:
57001-1116



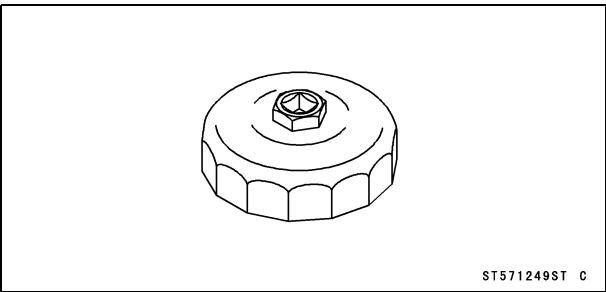
Valve Seat Cutter, 32° - $\phi 33$:
57001-1199



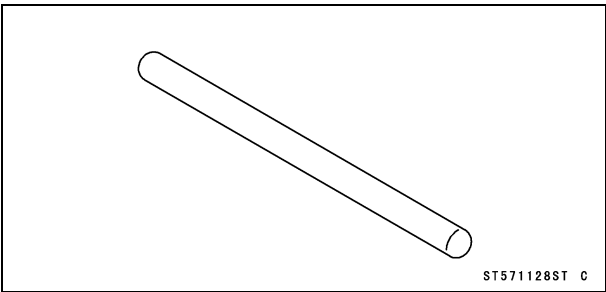
Valve Seat Cutter, 32° - $\phi 30$:
57001-1120



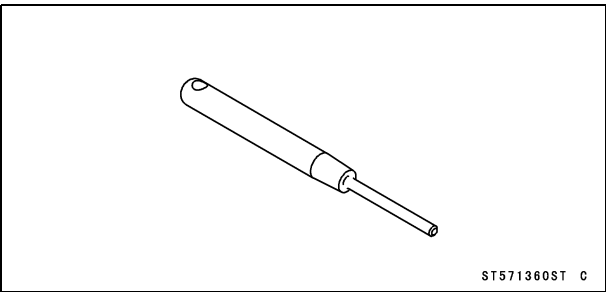
Oil Filter Wrench:
57001-1249



Valve Seat Cutter Holder Bar:
57001-1128



Valve Seat Cutter Holder, $\phi 6$:
57001-1360



Periodic Maintenance Procedures

Fuel System

NOTE

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

Low Idle Speed Adjustment

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



WARNING

Always keep your hands clear of the moving parts.

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

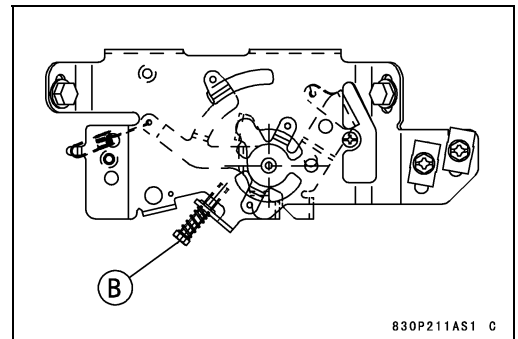
Idle Speed (Carburetor idle rpm)

1 450 rpm

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

Low Idle Speed (Governed idle rpm)

1 550 rpm



830P211AS1 C

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.

2-8 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

WARNING

Always keep your hands clear of the moving parts.

- Move the throttle lever at a dash to the high idle position and match the lever hole position with the panel hole by inserting 6 mm dia. pin or bolt [A].
- Loosen two M6 control panel mounting bolts [B] enough to move the control panel assembly.
- Carefully move the control panel assembly right side [C] up or down to obtain the specified high idle speed.

High Idle Speed

3 600 rpm

- Tighten the M6 mounting bolts.
Torque - Control Panel Mounting Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)
- Remove the 6 mm dia. pin or bolt.
- Check the high idle speed, and readjust the high idle speed if necessary.

NOTICE

Be sure to make the low idle speed and high idle speed respectively correspond to those of the equipment.

Fuel System Cleanliness Inspection

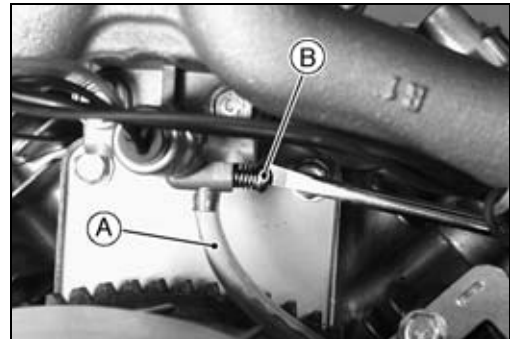
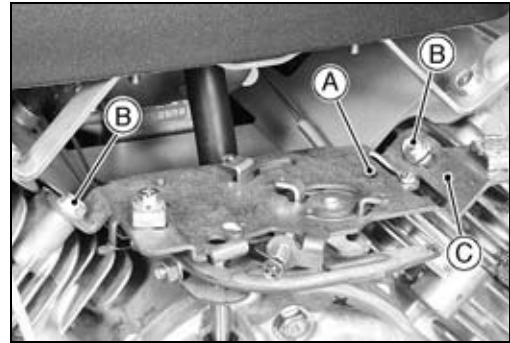
WARNING

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

- Remove the air cleaner (see Air Cleaner Body Removal).
- Connect a plastic tube [A] to the carburetor drain hole and place a suitable container under the plastic tube other end.
- Turn out the drain screw [B] a few turns to drain the carburetor and check if water or dirt has accumulated in the carburetor.
- Tighten the drain screw.

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

- If any water or dirt is found, clean the carburetor (see Carburetor Cleaning) and fuel tank. And check the fuel filter.



Periodic Maintenance Procedures

Element Cleaning and Inspection Standard Type

NOTE

○ In dusty areas, clean the elements more frequently than the recommended intervals.



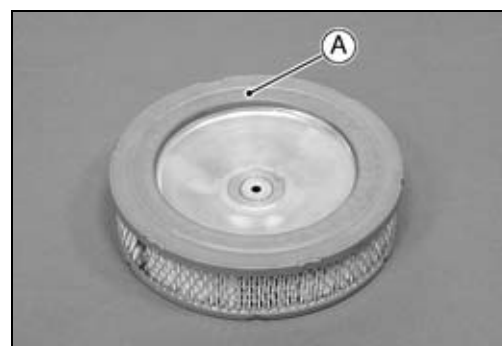
WARNING

Because of the danger of highly flammable liquids, do not use gasoline or a low-flash point solvent to clean the element.

- Remove the foam element and the paper element.
- Clean the foam element [A] in a bath of detergent and water, and air-dry the element thoroughly before installation.
- Clean the paper element [A] by tapping it gently on a flat surface to remove dust. If the element is very dirty, replace it with a new one.

NOTICE

Do not use compressed air to clean the paper element. Do not oil the paper element or the foam element.



Heavy Duty Type

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.

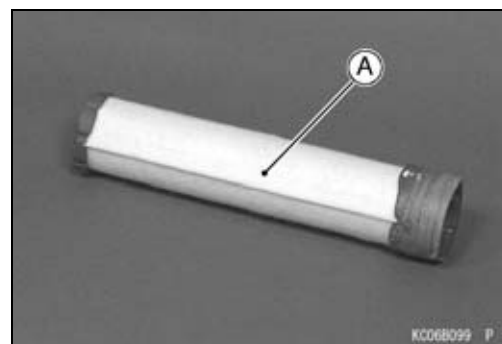
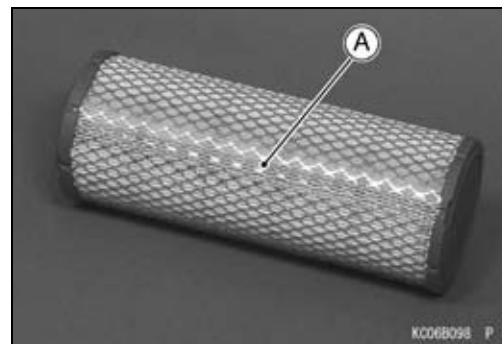
NOTE

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

- Remove the elements (see Elements Removal in the Fuel System 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.



2-10 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Housing (Cap and Body) Inspection

- Clean the housing with detergent and water and dry the housing thoroughly.
- Check the housing for deformation or other damage.
- Seal the housing well and permit only filtered air to reach the carburetor.
- ★ If the housing is damaged, replace the housing with a new one.
- Check that no foreign material obstructs the air passage.

Engine Top End

Cylinder Head Cleaning and Inspection

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



WARNING

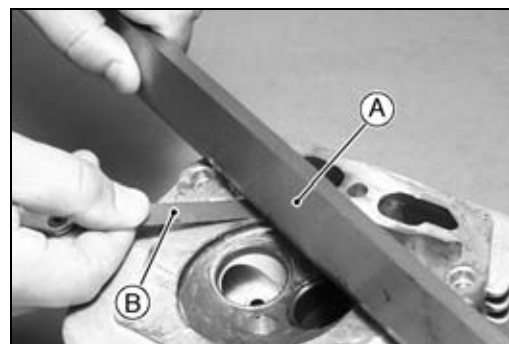
Clean the cylinder head in a well ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean the cylinder head. A fire or explosion could result.

- Lay a straight edge [A] across the mating surface of the cylinder head at several different points, and measure the warp by inserting a thickness gauge [B] between the straight edge and the cylinder head.
- ★ If the warp exceeds the service limit, repair the mating surface. Replace the cylinder head with a new one if the mating surface is badly damaged or warped.

Cylinder Head Warp

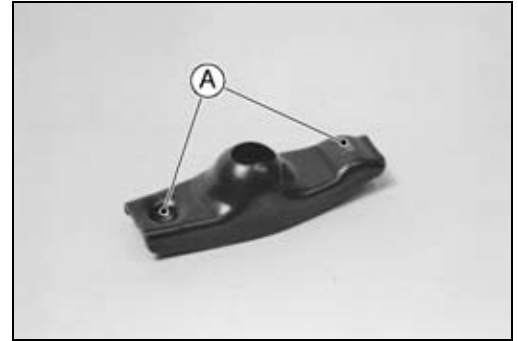
Service Limit: 0.05 mm (0.002 in.)

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



Periodic Maintenance Procedures

- Clean and inspect the rocker arm where it touches the push rod and the valve stem.
- ★ If the contact points [A] are worn or damaged, replace the rocker arm with a new one.



Valve Clearance Inspection

NOTE

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

- Remove the rocker cover (see Cylinder Head Removal).
- Place the piston at the top dead center (TDC) of the compression stroke by turning the crankshaft clockwise facing the flywheel.

No.1 Cylinder:

- The left projection [A] on the flywheel is faced with the right leg [B] on the #1 ignition coil [C] as shown in the figure.
- Check the intake and exhaust valves are closed completely. If they are not closed, turn the flywheel one turn (360°) clockwise and face the left projection with the right leg again.

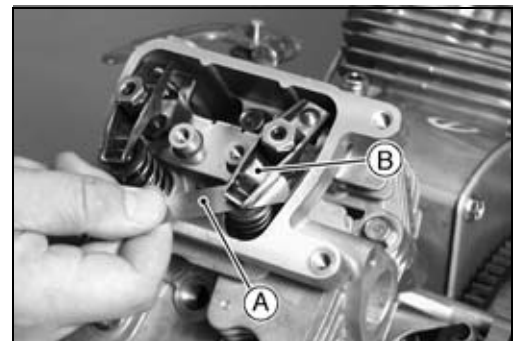
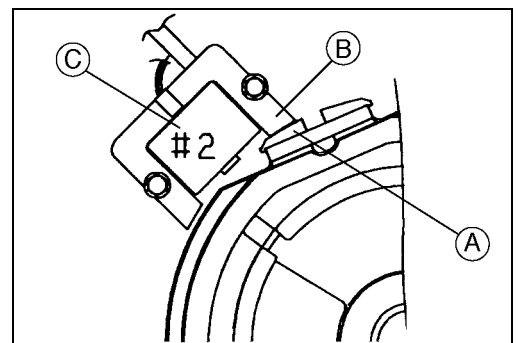
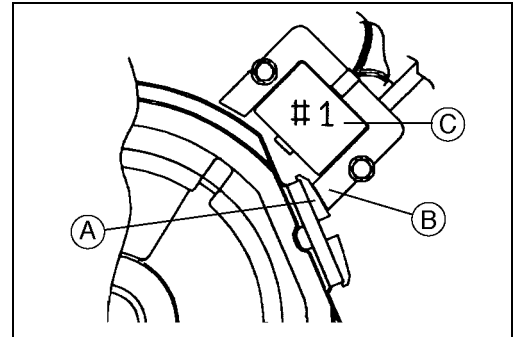
No.2 Cylinder:

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

- Check the valve clearance.
- Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.
- ★ If the valve clearance is not correct, adjust it.

Valve Clearance (when cold)

Inlet, Exhaust 0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)

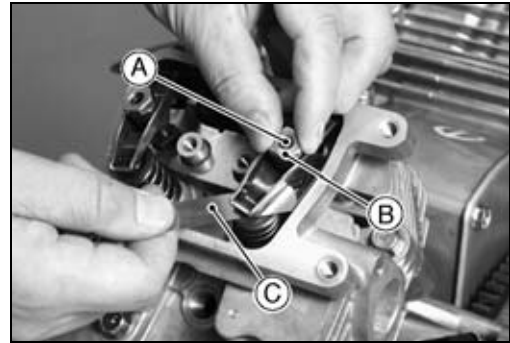


2-12 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Valve Clearance Adjustment

- Since valve repairs change the valve clearance, adjust the valve clearance as specified.
- Assemble the cylinder head and install the cylinder head assembly on the block (see Cylinder Head Installation).
- Turn the crankshaft in proper direction until the piston is at the TDC of the compression stroke (as described above).
- Loosen the lock screws [A] and the valve clearance adjusting nuts [B].
- Insert a 0.10 mm (0.004 in.) thickness gauge [C] between the rocker arm and valve stem. Tighten the adjusting nut until the thickness gauge begins to bind between the rocker arm and valve stem end. Sweep the thickness gauge during this adjustment.



Valve Clearance (when cold)

Inlet, 0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)
Exhaust:

- Holding the adjusting nut with a spanner, tighten the lock screw to the specified torque.

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

- Do not overtighten the valve clearance lock screws.
- 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).
- Inspect the valve seats for damage.
- ★ If the seats are warped or distorted beyond reconditioning, replace the cylinder head with a new one.
- Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.

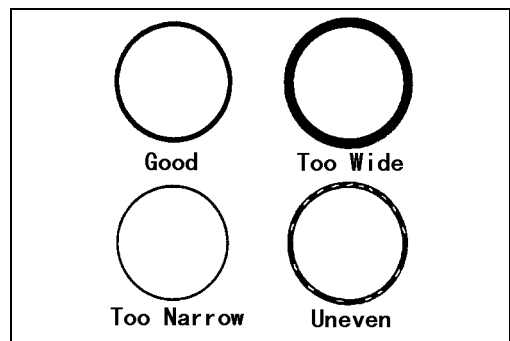
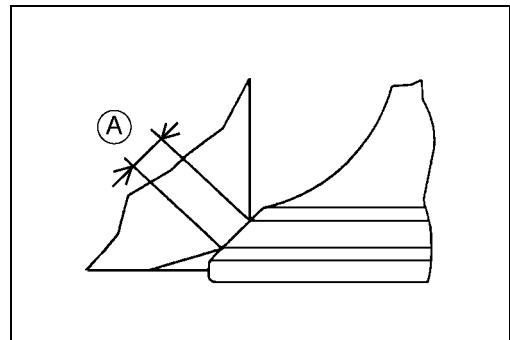
NOTE

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

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

Valve Seating Surface Width (STD)

Inlet 0.8 ~ 1.4 mm (0.03 ~ 0.05 in.)
Exhaust 1.1 ~ 1.6 mm (0.04 ~ 0.06 in.)



Periodic Maintenance Procedures

Valve Seat Repair

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

Special Tools

Inlet Valve:

Seat Cutter 45° - $\phi 35.0$ 57001-1116

Outside Cutter 32° - $\phi 33.0$ 57001-1199

Exhaust Valve:

Seat Cutter 45° - $\phi 30.0$ 57001-1187

Outside Cutter 32° - $\phi 30.0$ 57001-1120

Valve Seat Cutter Holder, $\phi 6$: 57001-1360

Valve Seat Cutter Holder Bar: 57001-1128

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

Seat Cutter Operating Cares:

- This valve seat cutter is designed only for valve seat repair. Do not use the valve seat cutter for other purpose.
- Do not drop or hit the valve seat cutter, or the diamond particles may fall off.
- Be sure to apply engine oil to the valve seat cutter before grinding the seat surface. Also wash off ground particles sticking to the cutter with washing oil.

NOTE

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

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

NOTE

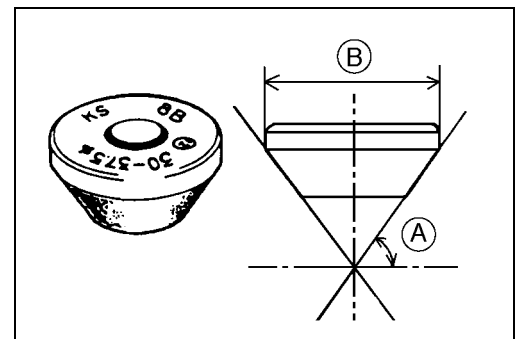
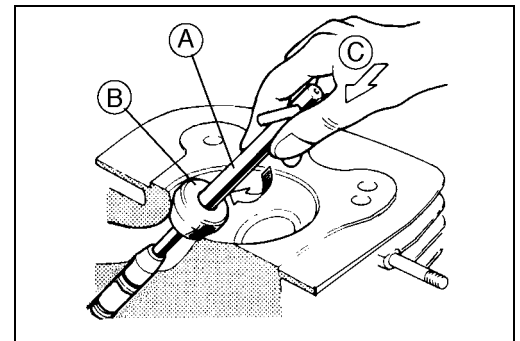
- Prior to grinding, apply oil to the cutter, and during the operation wash off any ground particles sticking to the cutter with washing oil.

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

Marks Stamped on the Cutter:

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

1	Cutter number, selected from 1 to 12
30°	Cutter angle [A]
37.5 ϕ	Outer diameter [B]
KS8B	Manufactured lot number



2-14 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

Operating Procedures:

- Clean the seat area carefully.
- Recondition the valve seats with the valve seat cutters (45°, 30°) and lap the valves.
- Check the seats for good contact all the way around with machinist's dye.
- Measure the seat width [A]. If it is greater than the STD width, reface the seating surface.
- If the valve seating pattern is not correct, repair the seat.

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

NOTICE

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

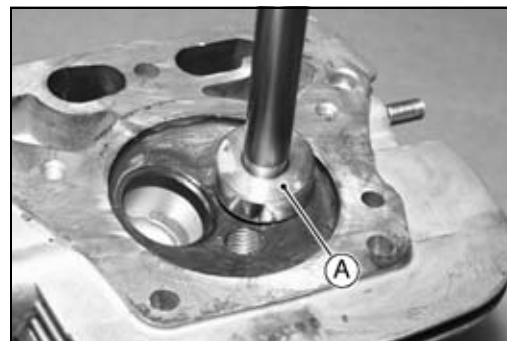
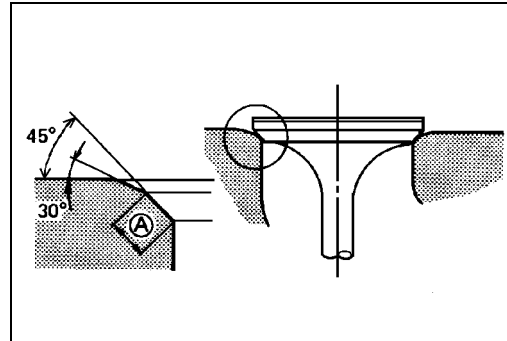
- Use a 30° seat cutter [A] to narrow the seat width to the STD width.
- Turn the seat cutter one turn at a time while pressing down very lightly. Check the seat width after each turn.

NOTICE

The 30° cutter removes material very quickly. Check the seat width frequently to prevent over grinding.

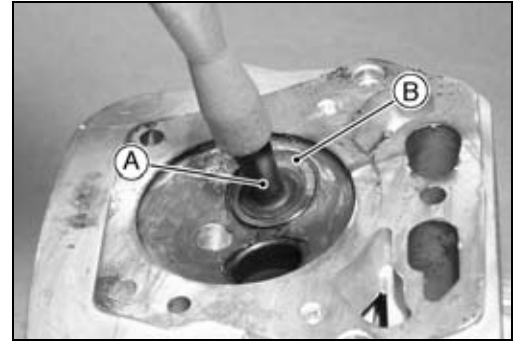
NOTE

- *Keep the seat width as close as possible to the STD width.*
- Make a light contact on the valve seat with the 45° cutter to remove any possible burrs at the edge of the seat.
- After resurfacing the seat, inspect for even valve seating.
- Apply a machinist's dye to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.
- ★ If the seat does not make proper contact, lap the valve into seat with a vacuum cap tool.



Periodic Maintenance Procedures

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

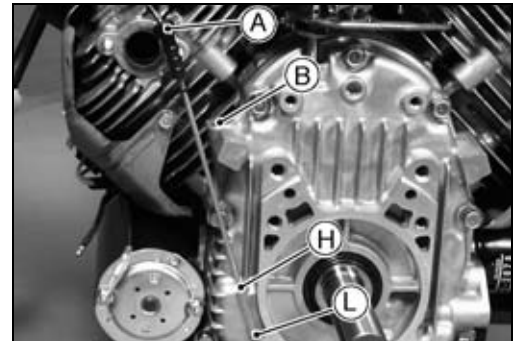


- When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
- Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the valve face.
- When the engine is assembled, be sure to adjust the valve clearances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

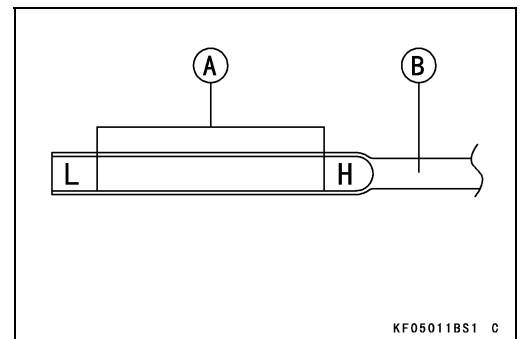
Lubrication System

Oil Level Inspection

- Place the engine on a level surface and check the oil level.
- Clean area around oil gauge [A] before removing it.
- Remove the oil gauge and wipe it with a clean cloth.
- Insert the oil gauge into gauge hole [B] and let its plug firmly fit into the gauge hole, then check the oil level.



- The oil level should be the operating range [A] (between "H" line and "L" line) on the oil gauge [B].



2-16 PERIODIC MAINTENANCE

Periodic Maintenance Procedures

- ★ If the oil level is near or below the “L” line, remove the oil filler cap [C] and add enough engine oil to bring oil level to the “H” line.

NOTICE

Do not fill above the “H” line. Excess oil will cause a smoking condition.

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

NOTE

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

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

Oil Change

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



WARNING

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

- Check the O-ring [B] at the oil drain plug for damage. Replace the O-ring with a new one if it is damaged.
- ★ If the oil drain plug joint is removed, tighten it.

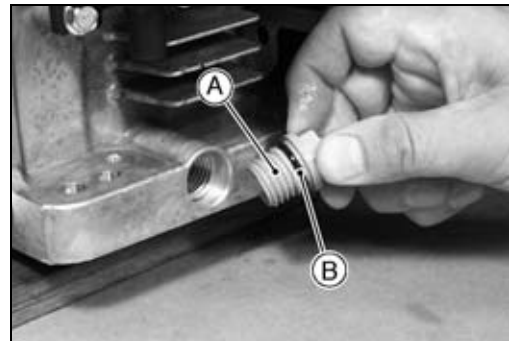
Torque - Oil Drain Plug Joint (Plastic) :17 N·m (1.7 kgf·m, 12.0 ft·lb)

Oil Drain Plug Joint (Metal) :39 N·m (4.0 kgf·m, 29 ft·lb)

- Install the oil drain plug with the O-ring and tighten it.

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

Oil Drain Plug (Metal) :20 N·m (2.0 kgf·m, 14.5 ft·lb)

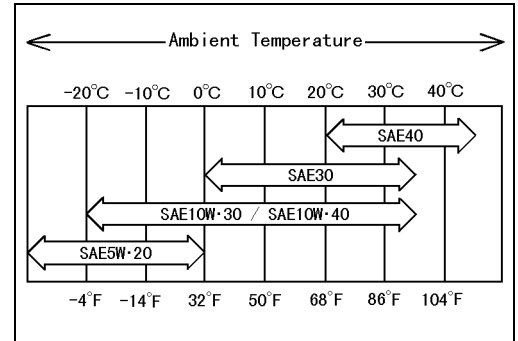


Periodic Maintenance Procedures

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

Engine Oil :

Grade:	API Service Classification: SF, SG, SH, SJ or SL Class
Viscosity:	SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20
Capacity:	1.4 L (1.5 US·qt) [When the oil filter is not removed] 1.6 L (1.7 US·qt) [When the oil filter is removed]
Level:	Between “H” and “L” marks on oil gauge



NOTE

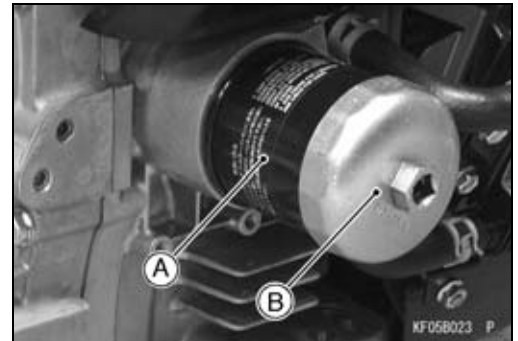
- Some increase in oil consumption may be expected when a multi grade engine oil (10W-30/10W-40, 5W-20) is used. Check the oil level frequently than recommended interval.

Oil Filter Replacement

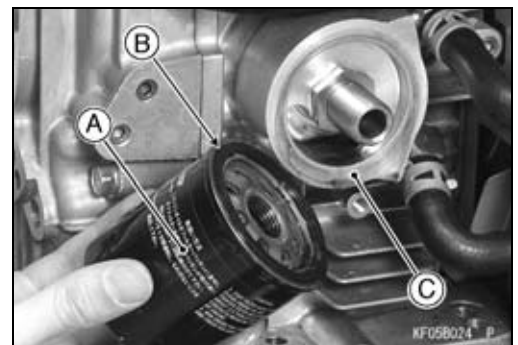
- Drain the engine oil (see Oil Change).
- Remove the oil filter [A] with the oil filter wrench [B] or strap wrench.

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.

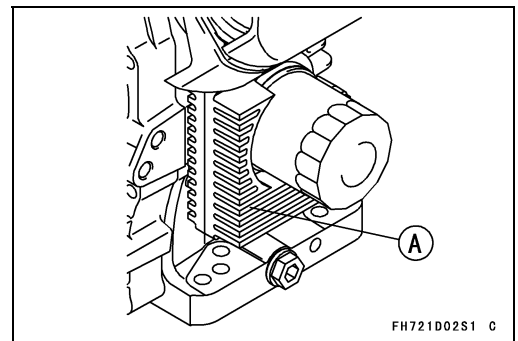


- Replace the oil filter [A] with a new one.
- Apply light film of engine oil to the seal [B].
- Install the oil filter.
- Turn the filter until the seal contacts mounting surface [C] of the engine. Then turn the filter BY HAND (S) 3/4 turn more.
- Run the engine at slow idle speed for 2 minutes.
- While running the engine, check for oil leaks around it.
- Stop the engine and check the oil level (see Oil Level Inspection).



Oil Cooler Cleaning (FH721D)

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



2-18 PERIODIC MAINTENANCE

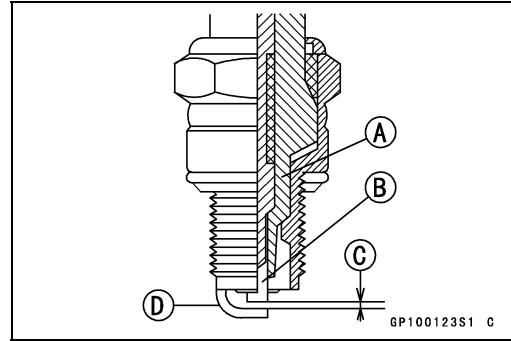
Periodic Maintenance Procedures

Electrical System

Spark Plug Cleaning and Inspection

- Carefully pull the plug cap from the spark plug, and remove the spark plug.
- ★ If the plug is oily or has carbon built up on it, clean the plug using a high-flash point solvent and a 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: 0.75 mm (0.030 in.)

Fuel System

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Exploded View



- T2: 1.2 N·m (0.12 kgf·m, 10.6 in·lb)
T3: 2.0 N·m (0.20 kgf·m, 18 in·lb)
T4: 3.4 N·m (0.35 kgf·m, 30 in·lb)
T5: 5.9 N·m (0.60 kgf·m, 52 in·lb)
T6: 18 N·m (1.8 kgf·m, 13 ft·lb)
T7: 19 N·m (1.9 kgf·m, 14 ft·lb)

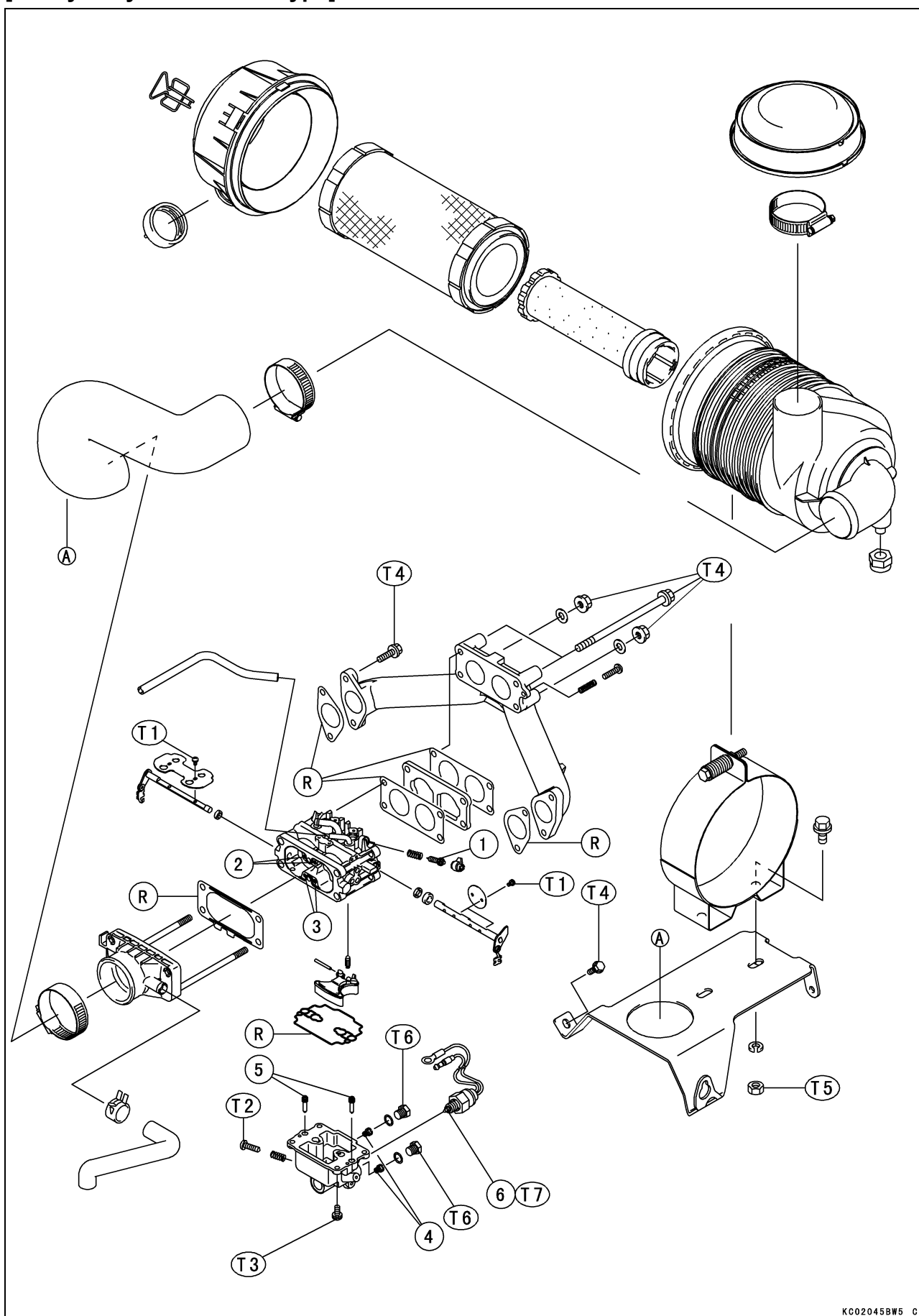
Exploded View

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3-4 FUEL SYSTEM

Exploded View

[Heavy Duty Air Cleaner Type]



Exploded View

[Heavy Duty Air Cleaner Type]

1. Pilot Screw
2. Pilot Air Jet
3. Main Air Jet
4. Main Jet
5. Pilot Jet
6. Solenoid Valve

R: Replacement Parts

T1: 0.93 N·m (0.094 kgf·m, 8.2 in·lb)

T2: 2.0 N·m (0.20 kgf·m, 18 in·lb)

T3: 3.9 N·m (0.40 kgf·m, 35 in·lb)

T4: 5.9 N·m (0.60 kgf·m, 52 in·lb)

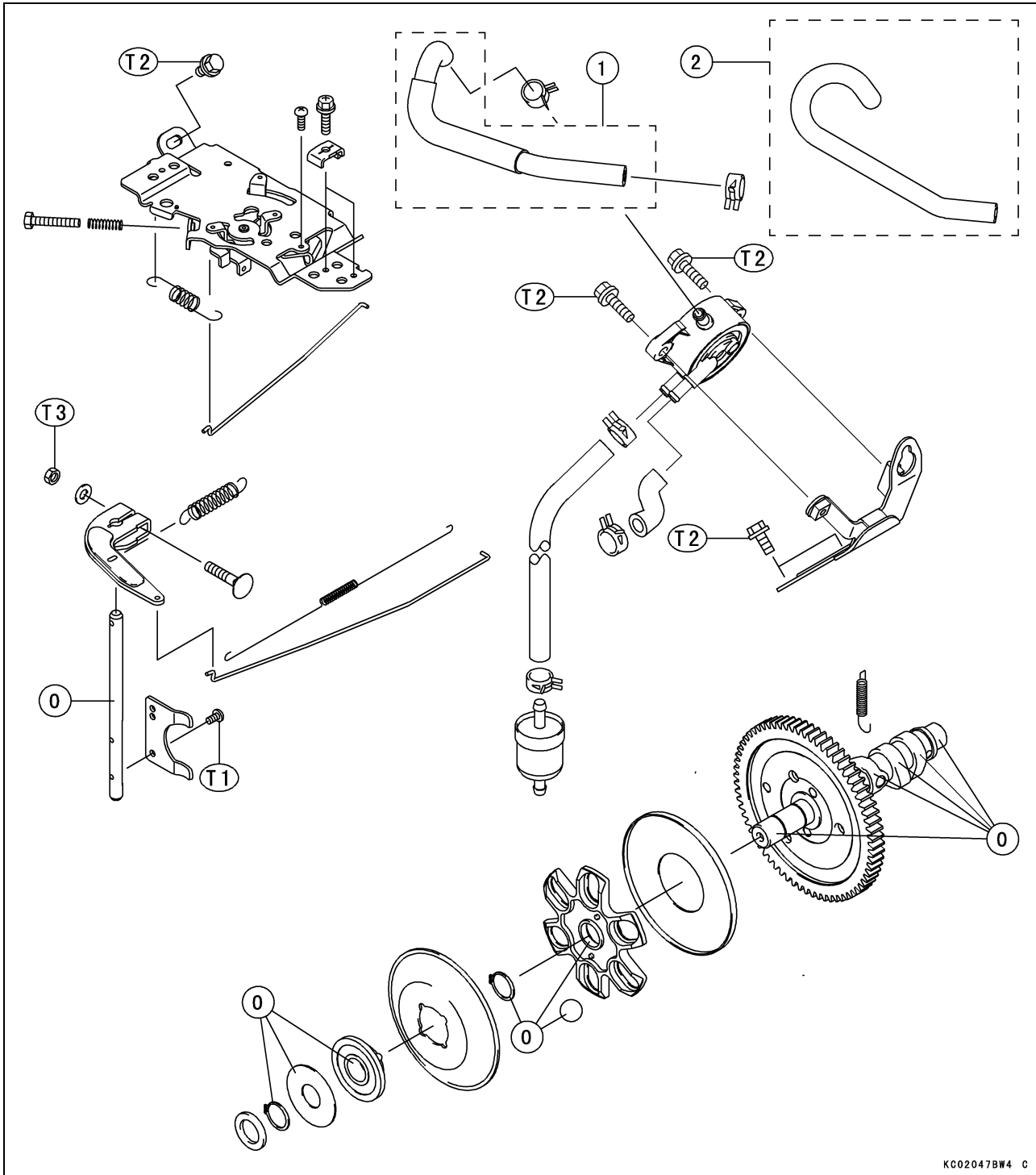
T5: 9.8 N·m (1.0 kgf·m, 87 in·lb)

T6: 18 N·m (1.8 kgf·m, 13 ft·lb)

T7: 19 N·m (1.9 kgf·m, 14 ft·lb)

3-6 FUEL SYSTEM

Exploded View



KC020478W4 C

1. Fuel Tube for FH680D Late Model

2. Fuel Tube for FH680D Early Model

O: Apply engine oil.

T1: 2.0 N·m (0.20 kgf·m, 17 in·lb)

T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)

T3: 7.8 N·m (0.80 kgf·m, 69 in·lb)

Specifications

Item	Standard	
	FH601D, FH641D	FH680D, FH721D
Carburetors Specifications		
Make/ Type	Nikki 13Y244	Nikki 621266
Throttle Bore Diameter	24 mm (0.94 in.)	26 mm (1.02 in.)
Venturi diameter	18 mm (0.71 in.)	21 mm (0.83 in.)
Main Jet (MJ)	in the text	in the text
Pilot Jet (PJ)	#54 (L and R)	#56 (L and R)
Main Air Jet (MAJ)	φ1.4	φ1.4
Pilot Air Jet (PAJ)	φ1.1	φ1.1
Pilot Air Screw Turns Out (PS) (Idle Mixture Screw Turns Out)	1 7/8	1 1/4
Float Level	Float parallel to carburetor body	
Idle Speed: (1)		
Low Idle Speed	1 550 r/min (rpm)	
High Idle Speed	3 600 r/min (rpm)	
Air Cleaner		
Standard Model:		
Type	Dual stage filtration system	
Pre-cleaner	Foam element	
Second-stage Cleaner	Paper element	
Heavy Duty Model:		
Type	Heavy duty type	
Pre-cleaner	Primary element	
Second-stage Cleaner	Secondary element	
Fuel		
Fuel Requirement	Unleaded regular grade gasoline	
Fuel Pump		
Type	Pulse-diaphragm pump	
Governor		
Type	Flyweight all speed governor	

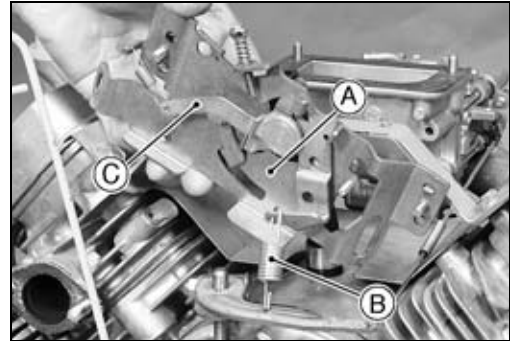
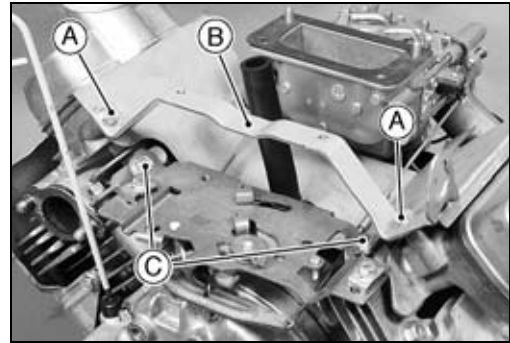
(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.

3-8 FUEL SYSTEM

Governor Link Mechanism

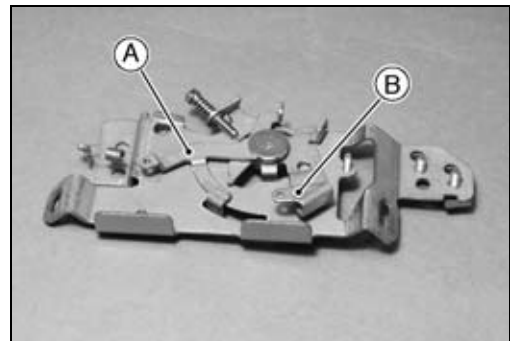
Control Panel Assembly Removal

- Remove:
 - Air Cleaner (see Air Cleaner Body Removal)
 - Air Cleaner Mount Bracket Bolts [A]
 - Air Cleaner Mount Bracket [B]
 - Control Panel Mounting Bolts [C]
- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the panel bracket.
- Clear the choke link rod end from the choke lever [C].



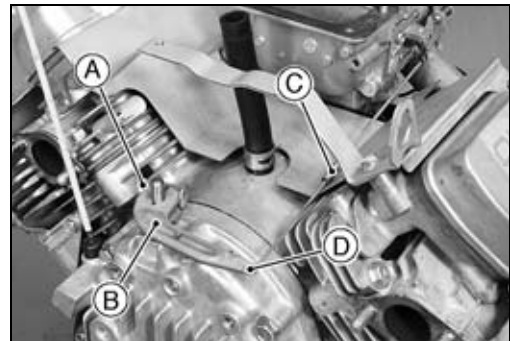
Control Panel Assembly Installation

- Before installing the control panel assembly, check to see that the choke lever [A] and engine speed control lever [B] move smoothly in all directions.
- ★ If any part is worn or damaged, replace the control panel assembly with a new one.
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low Idle Speed and High Idle Speed adjustment in the Periodic Maintenance chapter).



Governor Arm Removal

- Remove:
 - Control Panel Assembly
- Loosen the clamp nut [A] and take off the governor arm [B].
- Unhook the throttle link rod spring [C] end loop and clear the throttle link rod end [D].



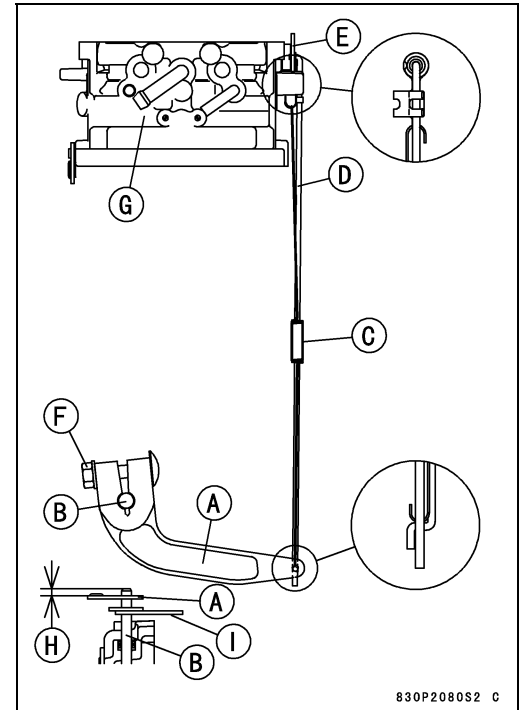
Governor Link Mechanism

Governor Arm Installation

- Insert the jig pin (2 mm dia) [I] through the jig pin hole of governor shaft [B].
- Install the governor arm [A] onto the governor shaft [B] temporarily.
- Be sure the link spring [C] around the throttle link rod [D] is in place and that it pulls the governor arm and throttle lever [E] each other.
- Loosen the clamp nut [F] on the governor arm enough to move the governor shaft.
- Turn the top end of the governor arm counterclockwise to fully open the carburetor [G] throttle valve and hold it there.
- Using the jig pin [I], turn the governor shaft counterclockwise fully to the end of its travel.
- Tighten the clamp nut.

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

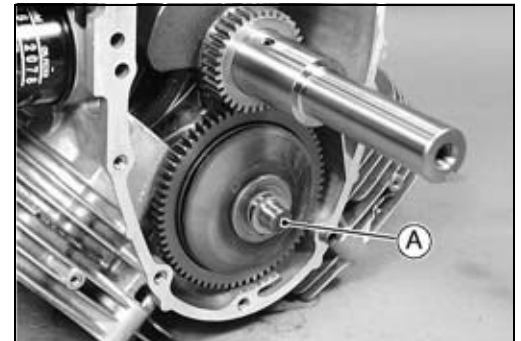
- Be sure the governor shaft extension from the governor arm is approximately 6.6 mm (0.26 in.) [H] as shown in the figure.
- Remove the jig pin [I].
- Install the control panel assembly, and connect the governor arm with the governor spring.



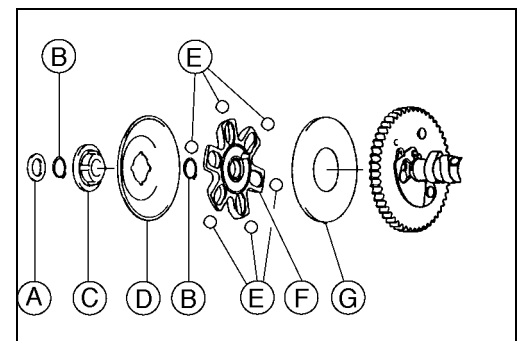
830P2080S2 C

Governor Assembly Removal

- Remove the crankcase cover (see Camshaft/Crankshaft chapter).
- Remove the push rod (see Engine Top End chapter).
- Upside down the engine.
- Remove the camshaft [A].



- Remove:
 - Washer [A]
 - Snap Ring [B]
 - Sleeve [C]
 - Governor Plate [D]
 - Snap Ring [B]
 - Steel balls [E]
 - Ball Guide [F]
 - Ball Plate [G]



3-10 FUEL SYSTEM

Governor Link Mechanism

Governor Assembly Installation

- Fit the snap ring [A] into the groove securely.
- Turn the governor plate by hand and check that the steel balls and governor plate move freely.



Governor Assembly Inspection

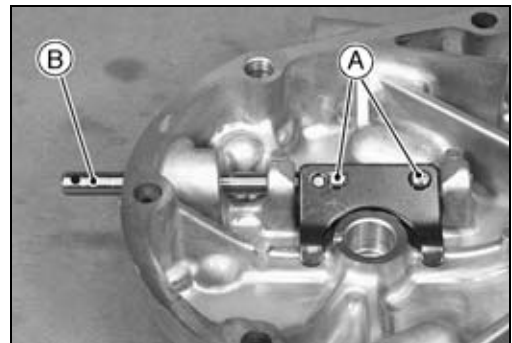
- Visually check all governor parts for wear or damage.
- ★ If any parts are worn or damaged, replace them with new ones.

Governor Shaft Removal

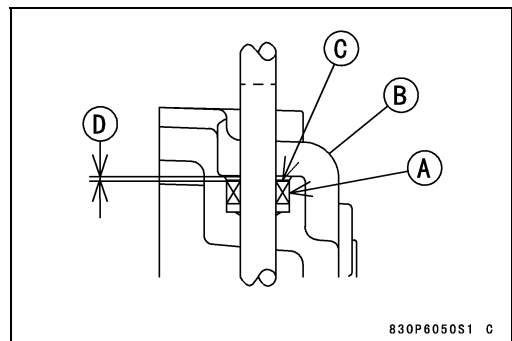
- Split the crankcase (see Camshaft/Crankcase chapter).
- Unscrew the governor shaft plate screws [A], and pull out the governor shaft [B] outside.

NOTE

- Remove the governor shaft only if the replacement of the governor shaft is necessary.



- Replace the oil seal only with a new one if the lip shows signs of leakage or it has been damaged.
- When replacing the oil seal [A] of the governor shaft with a new one, note the following.
- Install the oil seal into the crankcase cover [B] after the governor shaft is inserted in the cover, and so that the marks [C] face out.
- The depth [D] is 0 ~ 2 mm (0 ~ 0.08 in.).

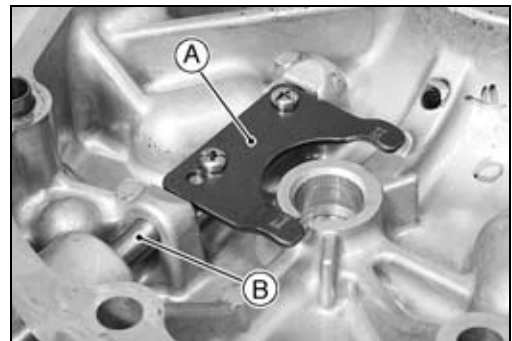


Governor Shaft Installation

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

Torque - Governor Shaft Plate Screws: 2.0 N·m (0.20 kgf·m, 17 in·lb)

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



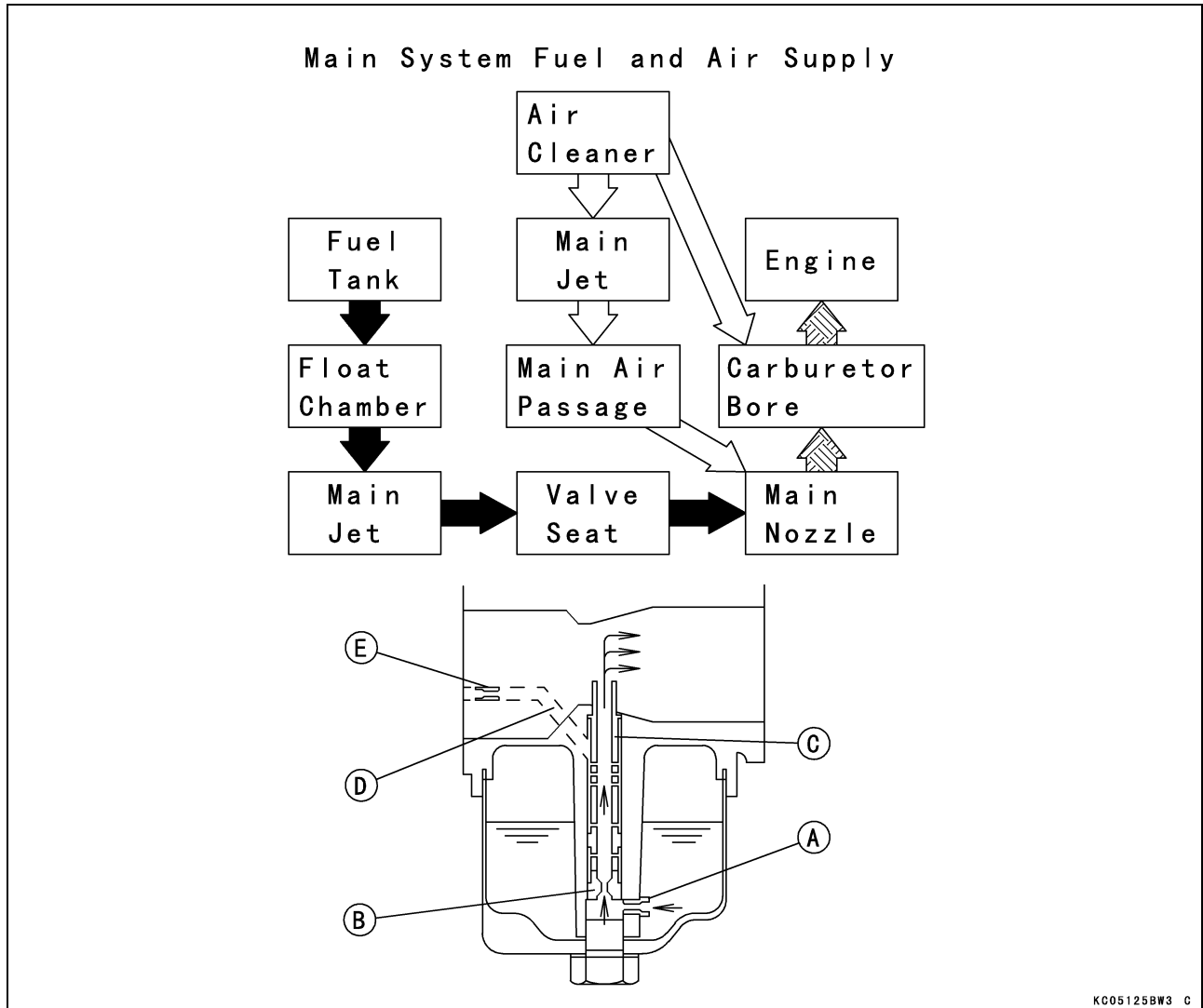
NOTE

- If the oil seal is removed, install the governor shaft first, then install the oil seal.

Carburetor

Fuel and Air Flow

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



3-12 FUEL SYSTEM

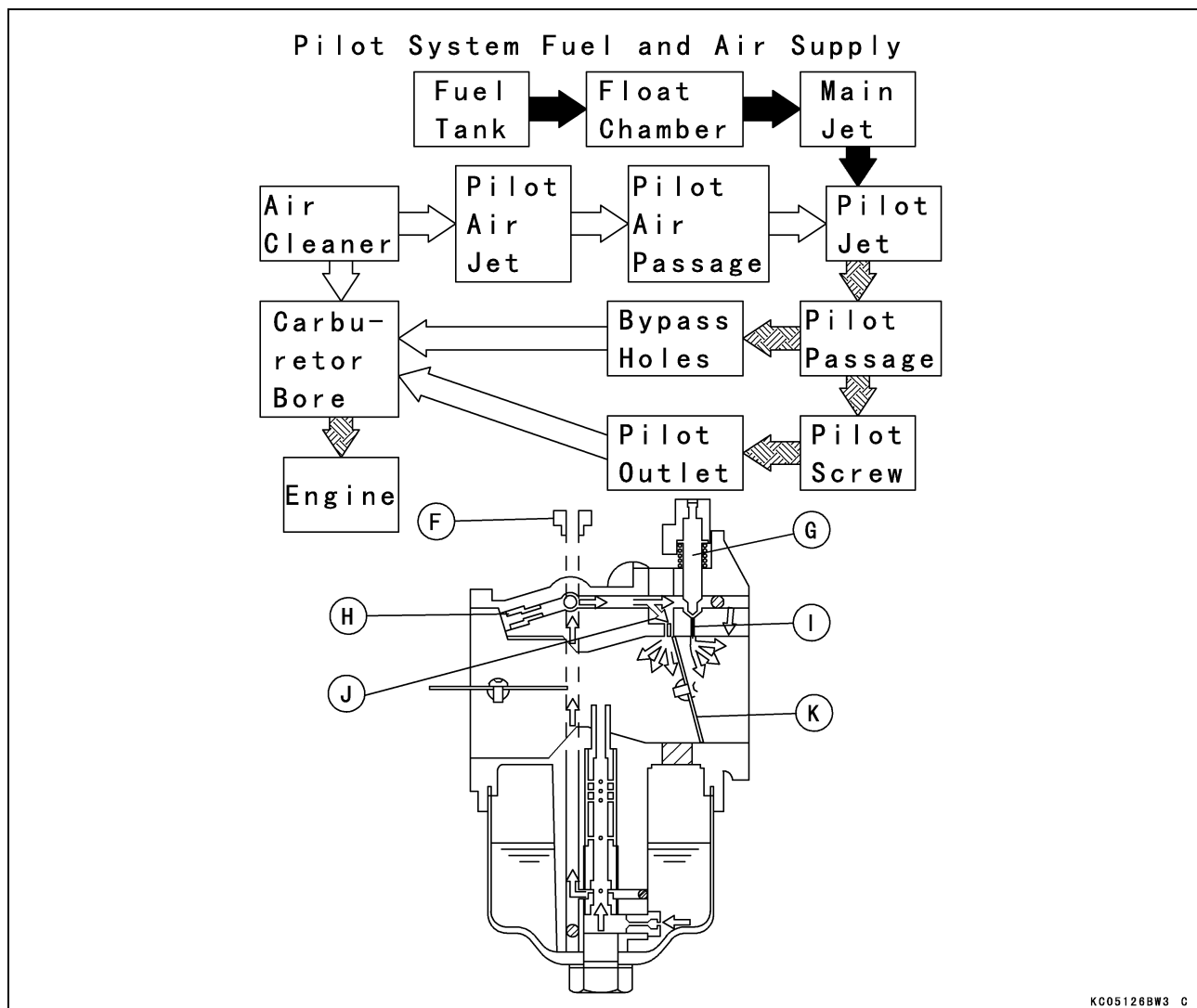
Carburetor

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

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

Main Fuel Flow →

Pilot Fuel Flow ⇒



	Standard Air Cleaner Type				Heavy Duty Air Cleaner Type			
	FH601D, FH641D		FH680D, FH721D		FH680D, FH721D			
	L	R	L	R	Intake-Hose (Starter Side)		Intake-Hose (Oil Filter/Fuel Pump Side)	
					L	R	L	R
0 ~ 1 000 m	#92	#95	#108	←	#112	#108	#114	#110
	*#102	*#106						
1 000 ~ 2 000 m	#89	#92	#105	←	#109	#105	#111	#107
	*#99	*#104						
2 000 m and higher	#86	#89	#102	←	#106	#102	#108	#104
	*#96	*#101						

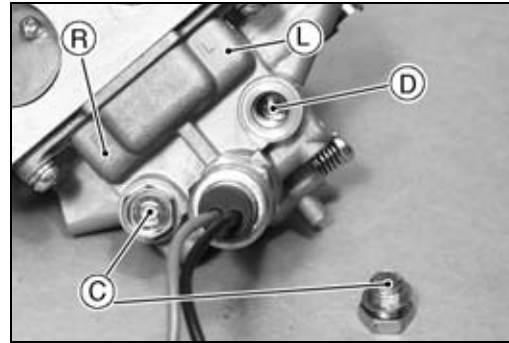
3-14 FUEL SYSTEM

Carburetor

Main Jet Replacement

- Place the engine (equipment) on a level surface.
- Close the fuel shut off valve in the equipment.
- Drain the fuel in the carburetor completely by unscrewing the drain screw at the bottom of the float chamber.
- Remove the carburetor (see Carburetor Removal).
- Unscrew the main jet plugs [C] and take off the main jet plugs and gaskets.
- Make sure that "L" [L] or "R" [R] mark on the float chamber shows the main jet position.
- Using a proper standard tip screw driver, carefully replace the main jet [D] with a new one for altitude expected.
- Tighten the main jet to the specified torque (see Carburetor Disassembly/Assembly).
- Install the gasket and the main jet plug.

Torque - Main Jet Plug: 19 N·m (1.9 kgf·m, 14 ft·lb)



Fuel System Cleanliness Inspection

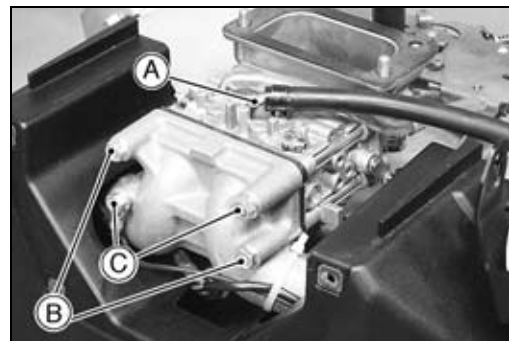
- Refer to the Fuel System Cleanliness Inspection in the Periodic Maintenance chapter.

Carburetor Removal

WARNING

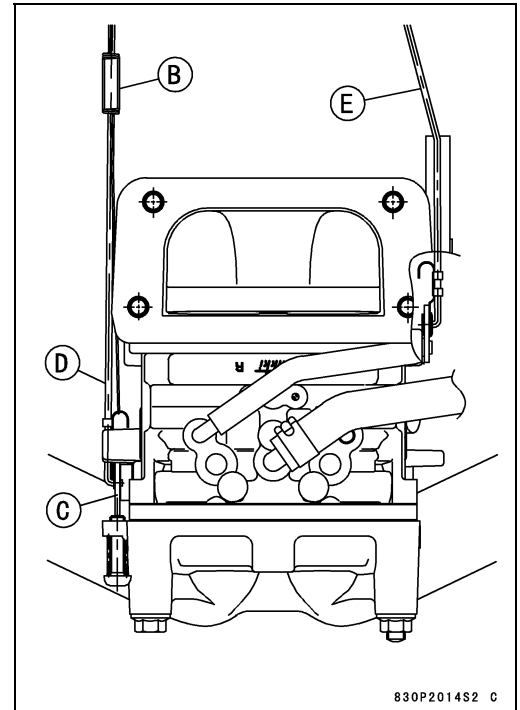
Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Remove:
Air Cleaner and Related Parts (see Air Cleaner Body).
- Turn the fuel shut off valve to the OFF position.
- Drain the carburetor.
- Disconnect the fuel tube at the fuel inlet joint [A] of the carburetor.
- Remove the carburetor mounting bolts [B] and nuts [C].



Carburetor

- Disconnect the solenoid valve lead terminal and remove the earth terminal.
- Unhook the throttle link spring [B] at the throttle shaft lever clip end [C] with a long nose plier.
- Unhook the throttle [D] and choke link rods [E] at the top ends of their arms while pulling off the carburetor.

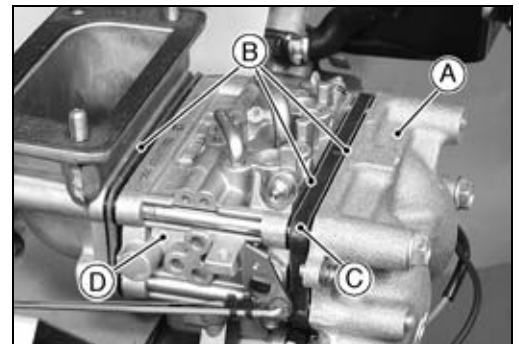


Carburetor Installation

- Clean the mating surfaces of the carburetor and inlet manifold, and fit the new gaskets.
- Take care not to bend the throttle link rod and choke link rods during installation. Make sure that the link spring around the throttle link rod is in place and that it pulls the governor arm and carburetor throttle shaft lever toward each other.
- Install the inlet manifold [A], the new gaskets [B], the insulator [C], the carburetor [D] and the inlet pipe [E] in the sequence as shown.
- Tighten the carburetor mounting bolts and nuts.

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

- Adjust:
 - Carburetor Pilot Screw
 - Idle Speed



3-16 FUEL SYSTEM

Carburetor

Carburetor Disassembly/Assembly

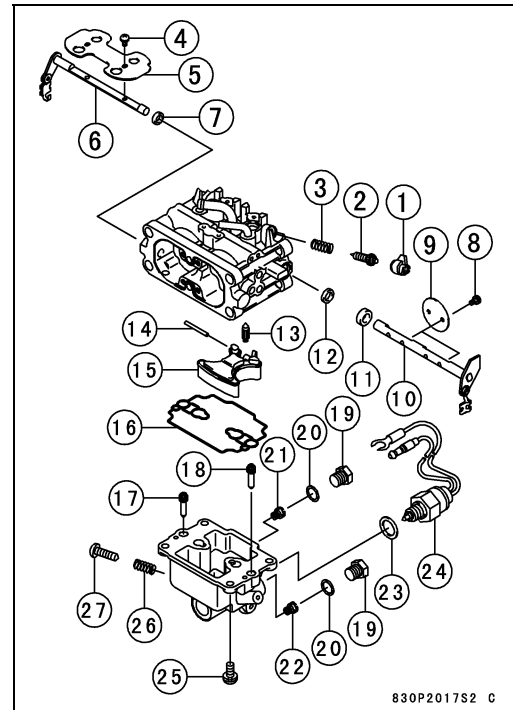
- Refer to the illustration for disassembly and assembly.
- There are several passage plugs (Ball plugs) in the carburetor body. Do not remove them.
- Before disassembly, mark the outside of choke valve and throttle valves for assembling them.
- Replace the pilot screw with a new one if necessary in accordance with the following procedure.
- Carefully mark the position of the pilot screw limiter on the carburetor body so that it can be installed and set to its original position later.
- Remove the limiter. Be careful not to turn the pilot screw at this point.
- Turn the pilot screw clockwise and count the number of turns until screw is gently seated in the pilot passage. Record the number of turns needed to close the screw.
- Turn out the pilot screw to replace it with a new one.
- Install the new pilot screw until the screw is gently seated. Then open the screw the same number of turns as recorded prior to removal.
- Align the limiter with the mark on the carburetor body to install, taking care not to turn the pilot screw.
- Install the choke valve and throttle valve on the shaft as the outside mark of them facing outside, and apply a small amount of a bonding agent to the valve screw threads.

NOTICE

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

- Drive the float pin so that it's big diameter side faces the throttle shaft lever.
- The fuel inlet valve seat is pressed into the carburetor body and is not replaceable.
- Assemble carburetor parts with recommended tightening torque (see Exploded View).

- | | |
|--------------------|--------------------|
| 1. Limiter | 16. Gasket |
| 2. Pilot Screw | 17. Pilot Jet |
| 3. Spring | 18. Pilot Jet |
| 4. Screw | 19. Plug, Main Jet |
| 5. Choke Valve | 20. Gasket |
| 6. Choke Shaft | 21. Main Jet (L) |
| 7. Seal | 22. Main Jet (R) |
| 8. Screw | 23. Gasket |
| 9. Throttle Valve | 24. Solenoid Valve |
| 10. Throttle Shaft | 25. Screws |
| 11. Collar | 26. Spring |
| 12. Seal | 27. Drain Screw |
| 13. Float Valve | |
| 14. Float Pin | |
| 15. Float | |



Carburetor

Carburetor Cleaning



WARNING

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

NOTICE

Do not use compressed air on an assembled carburetor, or the floats may be crushed by the pressure. Remove as many rubber or plastic parts as possible from the carburetor before cleaning the carburetor with a cleaning solution. This will prevent damage to or deterioration of the parts.

The carburetor body has plastic parts that cannot be removed. Do not use a strong carburetor cleaning solution which could attack these parts; instead, use a mild high-flash point cleaning solution safe for plastic parts.

Do not use wire or any other hard instrument to clean carburetor parts, especially jets, as they may be damaged.

- Disassemble the carburetor.
- Immerse all the metal parts in a carburetor cleaning solution.
- Rinse the parts in water and dry them with compressed air.
- Do not use rags or paper to dry parts. Lint may plug the holes or passages.
- Blow air through the holes and fuel passages with the compressed air. All holes must be open.
- Assemble the carburetor.

3-18 FUEL SYSTEM

Carburetor

Carburetor Inspection

WARNING

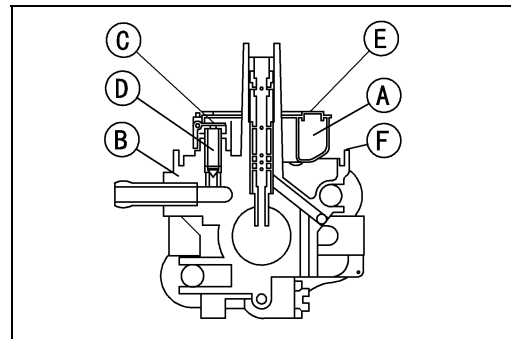
Gasoline is extremely flammable and can be explosive under certain. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burns and nicks. Replace the gasket with a new one if necessary.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.
- ★ If the valves do not move smoothly, replace the carburetor body and/or throttle shaft and choke shaft assembly with new ones.
- Check the gasket on the carburetor body.
- ★ If the gasket is not in good condition, replace it with a new one.
- Check the other parts of the carburetor for any wear or damage. Replace the part with a new one if necessary.
- Clean and check the float level as follows.

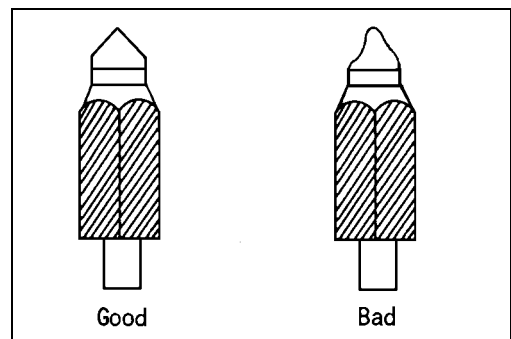
NOTICE

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

- With the float [A] assembly installed onto the carburetor body [B], hold the carburetor upside down at eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab [C] just touches the float valve needle [D]. The float lower surface [E] should be parallel with the carburetor body mating surfaces [F].
- ★ If the float position is not correct, replace it.

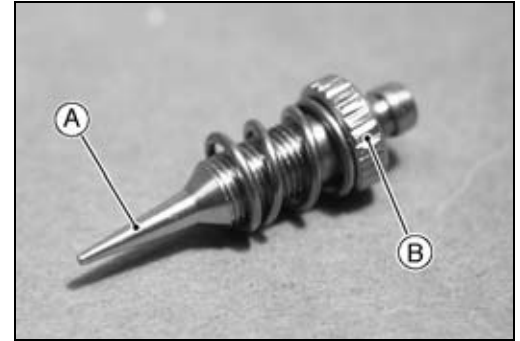


- Inspect the inlet needle valve for excessive wear or damage. The tip should be smooth, without any grooves, scratches, or tears. The rod at the other end of the needle should move smoothly when pushed in and released.
- ★ If either the needle or the seat is worn or damaged, replace the float assembly and carburetor body as a set with a new one.



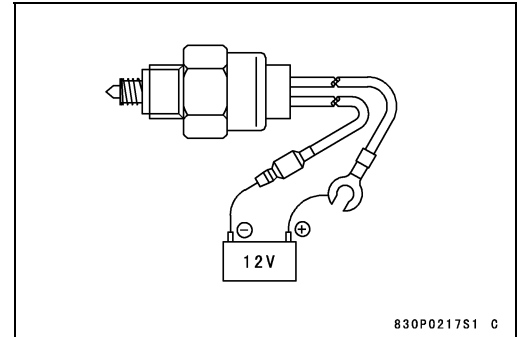
Carburetor

- Inspect the tapered portion [A] of the pilot screw [B] for wear or damage.
- ★ If the pilot screw is worn or damaged on the taper portion, replace it with a new one.
- Check the spring condition, replace it with a new one, if necessary.



Fuel Shut-Off Solenoid Valve Test

- Unscrew the fuel shut off valve and remove the valve.
- Connect a 12 VDC source to the solenoid as shown in the figure.
- ★ If the actuated solenoid plunger (Needle Valve) does not pop out when the Test Voltage is applied, replace it with a new one.



NOTE

○ If necessary, push the plunger slightly to withdraw.

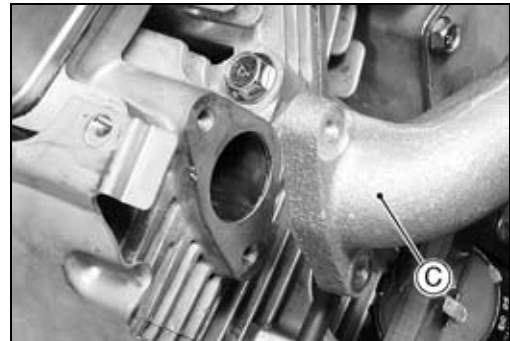
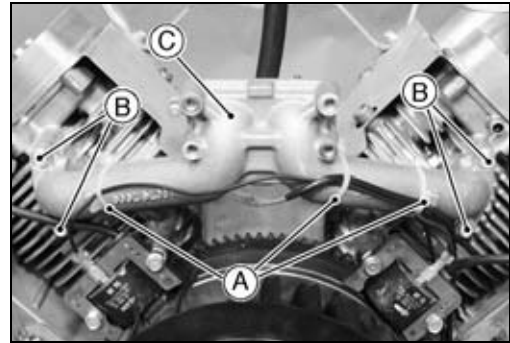
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3-20 FUEL SYSTEM

Inlet Manifold

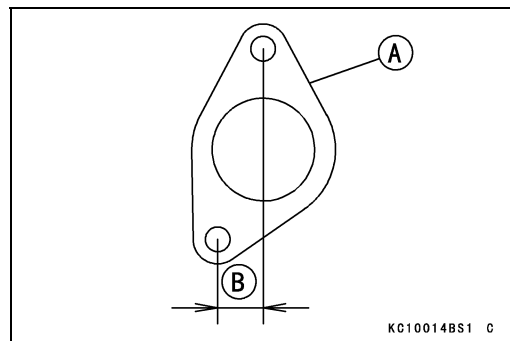
Inlet Manifold Removal

- Remove:
 - Air Cleaner (see Air Cleaner Body Removal)
 - Fan Housing
 - Carburetor (see Carburetor Removal)
- Cut off the band [A] and release the harness and/or lead from the inlet manifold.
- Remove the manifold mounting bolts [B] and the inlet manifold [C].

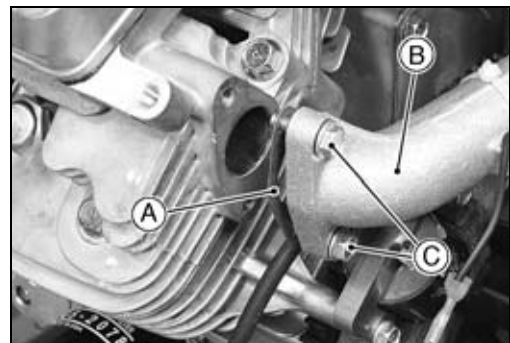


Inlet Manifold Installation

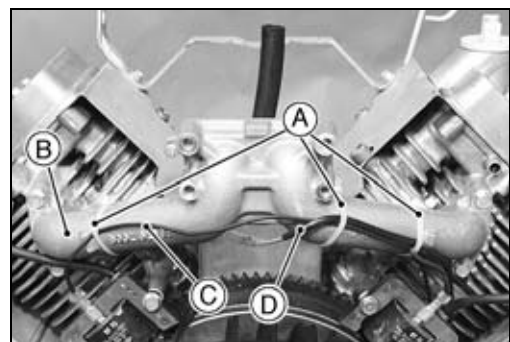
- Replace the inlet manifold gaskets with new ones.
- Clean the mating surfaces of the cylinders and inlet manifolds and fit new gaskets [A].
 - 12 mm (0.47 in.) [B]



- Install the inlet manifold [B].
 - Tighten the mounting bolts [C].
- Torque - Inlet Manifold Mounting Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)**
- Gasket [A]



- Install and tighten the band [A] around the manifold [B] and the lead [C] and/or the harness [D].
- Position the lead and/or the harness on top of the manifold as shown in the figure.
- Cut the excessive band off.
- Install the other removed parts in the reverse order of the disassembly.



Inlet Manifold

Inlet Manifold Inspection

- Inspect the inlet manifold for cracks or porous casting.
- 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 crack is present, the coating will become discolored at the defective area.
- ★ If a crack is present in the inlet manifold, replace it with a new one.
- Inspect the gasket surfaces for burns and nicks.

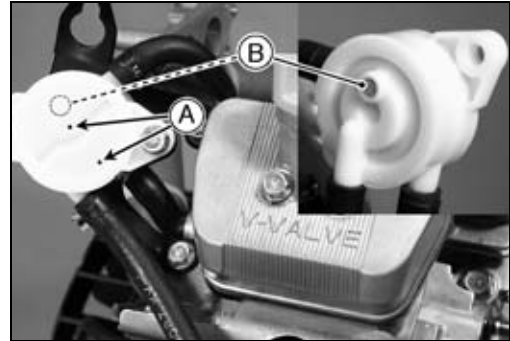
3-22 FUEL SYSTEM

Fuel Pump, Fuel Filter

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

Fuel Pump Inspection

- Check the vent hole [A] and the filter [B] for plugging or clogging.
- ★ If the vent hole and the filter are plugged or clogged, remove the foreign material from them.



Fuel Flow Test

WARNING

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

- Disconnect the fuel pump outlet nozzle from the tube.
- Connect a suitable hose [A] to the outlet nozzle.
- Run the lower end of the hose into a container.
- Start the engine. Check the fuel flow.
- ★ If fuel flow is none or little, replace the fuel pump with a new one.
- ★ Check the tubes and the fuel filter for clogging or damage. Replace the clogged or damaged tubes to fuel filter with new ones.



Fuel Filter Inspection

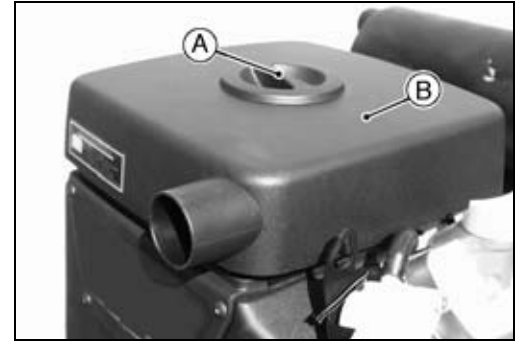
- Visually inspect the fuel filter [A].
- ★ If the filter is clear with no signs of dirt or other contamination, replacement of the fuel filter is not necessary.
- ★ If the filter is dark or looks dirty, replace it with a new one. Also check the rest of the fuel system for contamination.



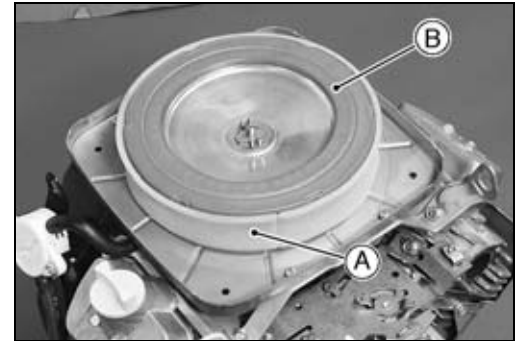
Air Cleaner (Standard Type)

Element Removal

- Remove the air cleaner cover nut [A] and the air cleaner cover [B].



- Remove:
Foam Element [A]
Paper Element [B]



Element Installation

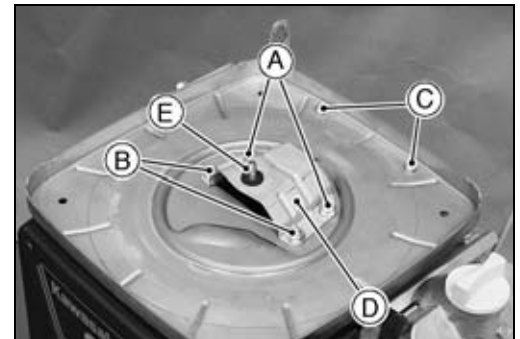
- Install the element correctly on the air cleaner body.
- Be sure to install the paper element into the air cleaner body.
- Be sure to install the foam element on the paper element.

Element Cleaning and Inspection

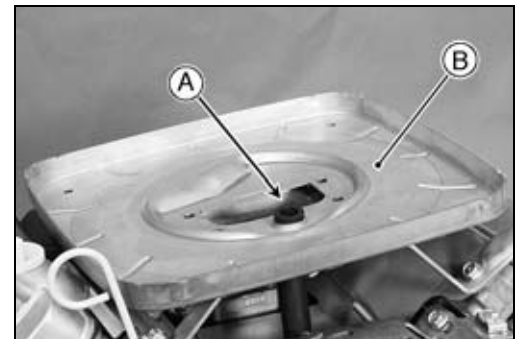
- Refer to the Element Cleaning and Inspection in the Periodic Maintenance chapter.

Air Cleaner Body Removal

- Remove the elements (see Element Removal).
- Remove the air cleaner body mounting bolts [A], the nuts [B], the screws [C], and the holder bracket [D].
- Do not miss rubber seal [E].



- Pull the breather tube [A] off the hole of the air cleaner body [B].



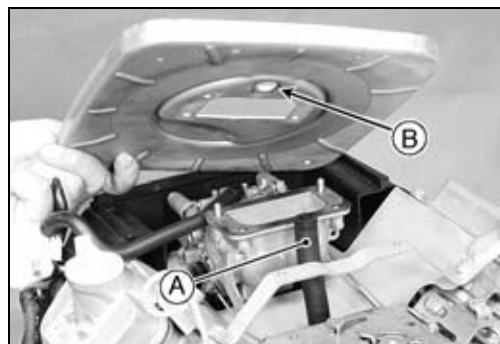
3-24 FUEL SYSTEM

Air Cleaner (Standard Type)

Air Cleaner Body Installation

- Insert the breather tube [A] from the crankcase into the hole [B] of the air cleaner body.
- Install the air cleaner body on the inlet pipe and bracket with mounting bolts, nuts and screws.

Torque - Air Cleaner Body Mounting Bolts and Nuts: 5.9 N·m (0.60 kgf·m, 52 in·lb)



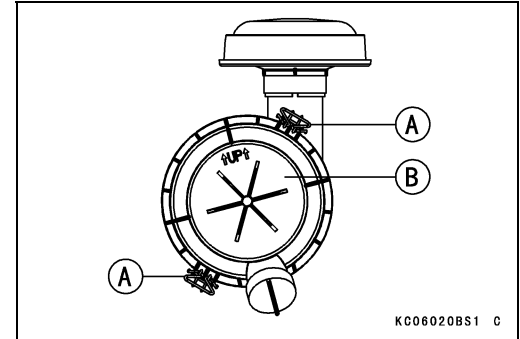
Housing (Cover and Body) Inspection

- Refer to the Housing (Cover and Body) Inspection in the Periodic Maintenance chapter.

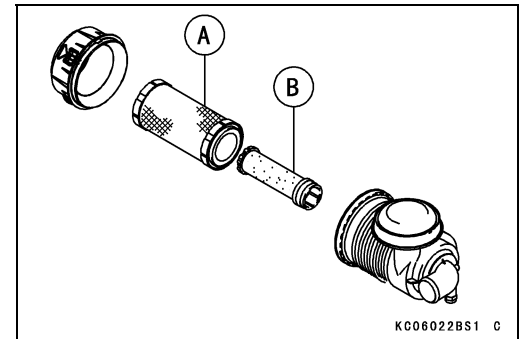
Air Cleaner (Heavy Duty Type)

Element Removal

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

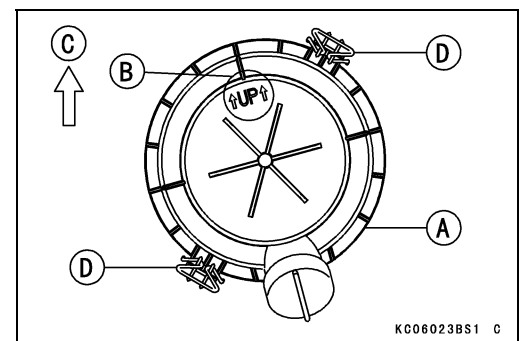


- Remove:
Primary Element [A]
Secondary Element [B]



Element Installation

- Slide the secondary element and primary element into place in the air cleaner body.
- Install the cap [A] direction as shown.
Mark [B]
Upside [C]
- Fasten the two retaining clamps [D].



Element Cleaning and Inspection

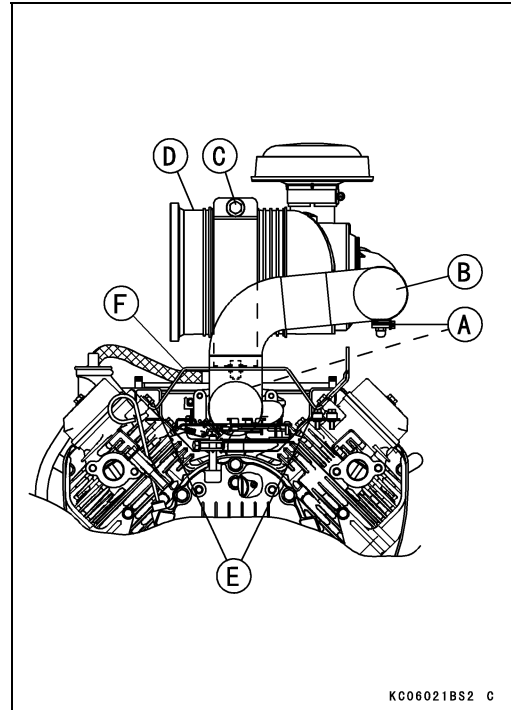
- Refer to the Element Cleaning and Inspection in the Periodic Maintenance chapter.

3-26 FUEL SYSTEM

Air Cleaner (Heavy Duty Type)

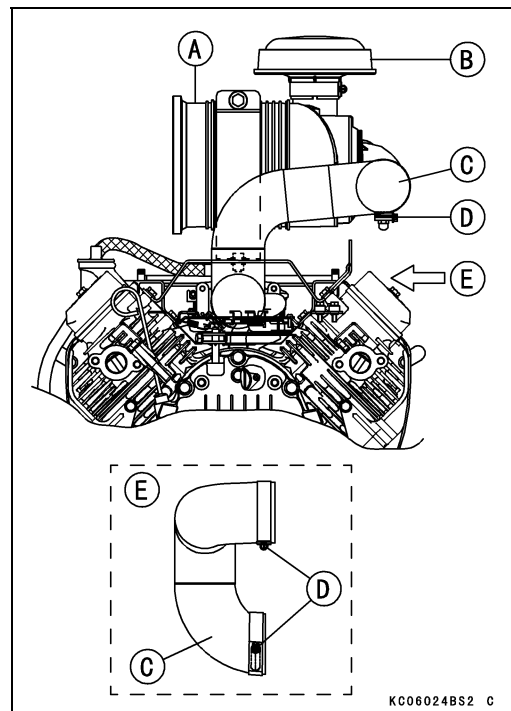
Air Cleaner Body Removal

- Remove the air cleaner elements (see Element Removal).
- Loosen the clamps [A], and remove the inlet hose [B].
- Remove the bolt [C].
- Take out the air cleaner body [D].
- Remove:
 - Air Cleaner Body Bracket Bolts [E]
 - Air Cleaner Body Bracket [F]

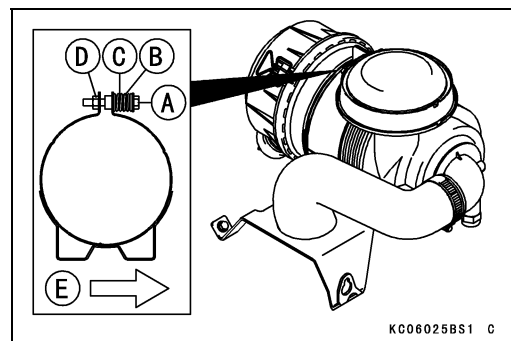


Air Cleaner Body Installation

- Install the air cleaner body bracket with the bolts to the specified torque.
Torque - Air Cleaner Body Bracket Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)
- Set the air cleaner body [A] onto the bracket so that the air inlet duct [B] is facing upward.
- Install the inlet hose [C], and position the clamps [D] pinch heads as shown.
View [E]



- Install the air cleaner body clamp bolt [A] as shown and tighten it.
 - Collar [B]
 - Spring [C]
 - Nut [D]
- Install the air cleaner elements (see Element Installation).
PTO Side [E]



Housing (Cap and Body) Inspection

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

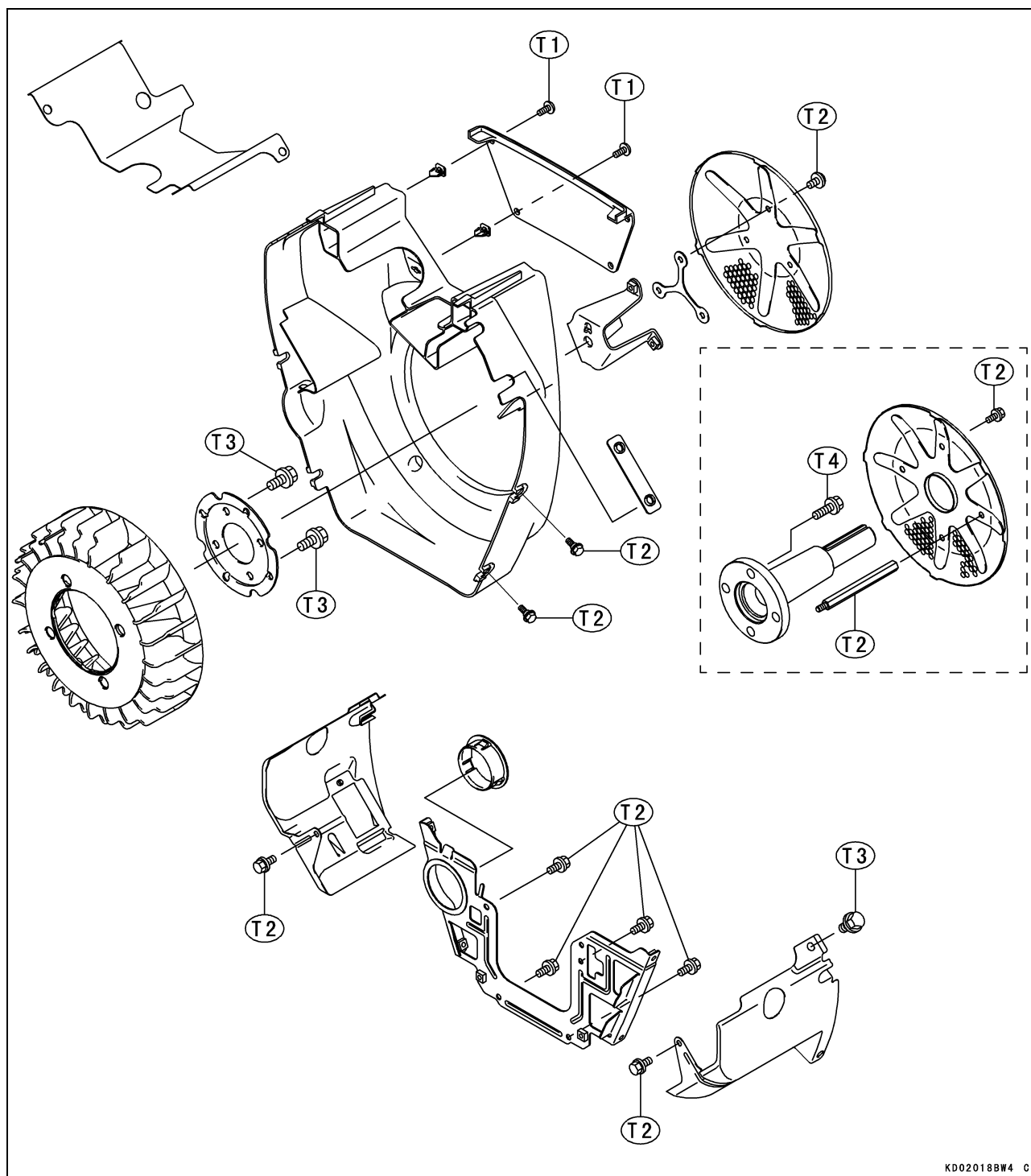
Cooling System

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4-2 COOLING SYSTEM

Exploded View



KD020188W4 C

T1: 2.0 N·m (0.20 kgf·m, 18 in·lb)

T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)

T3: 6.9 N·m (0.70 kgf·m, 61 in·lb)

T4: 2.0 N·m (0.20 kgf·m, 18 in·lb)

Cooling Fan

Cooling Fan Removal

- Refer to the Flywheel Removal in Electrical System chapter.

Cooling Fan Installation

- Refer to the Flywheel Installation in Electrical System chapter.

Cooling Fan Inspection

- Visually inspect the blades [A] in the cooling fan [B].
- ★ If they have any crack, warp or damage, replace the cooling fan with a new one.
- ★ If any mud or dust have stuck to the cooling fan, clean it.
- Wash the cooling fan in detergent and water.



NOTICE

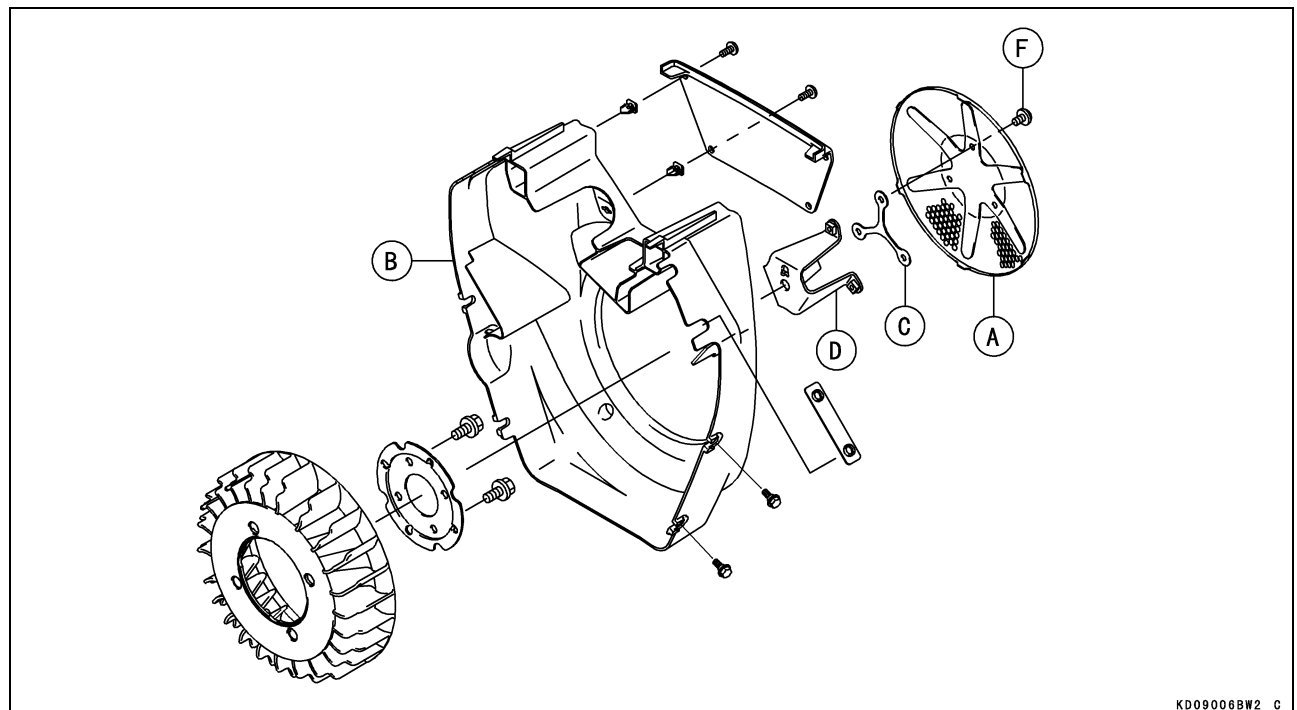
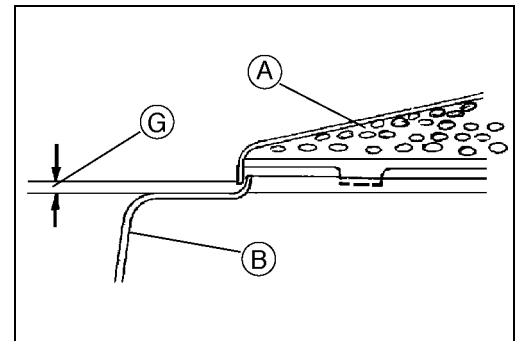
Do not clean the cooling fan in oil solvent. It may be damage by oil solvent.

Screen Clearance Adjustment

- Check the clearance between the screen [A] and the fan housing [B]. If the clearance is less than 1 mm, add proper number of the spacer [C] between the screen and the bracket comp [D] to adjust the clearance [G] 1 ~ 3 mm.

F: Screws

G: Clearance 1 ~ 3 mm



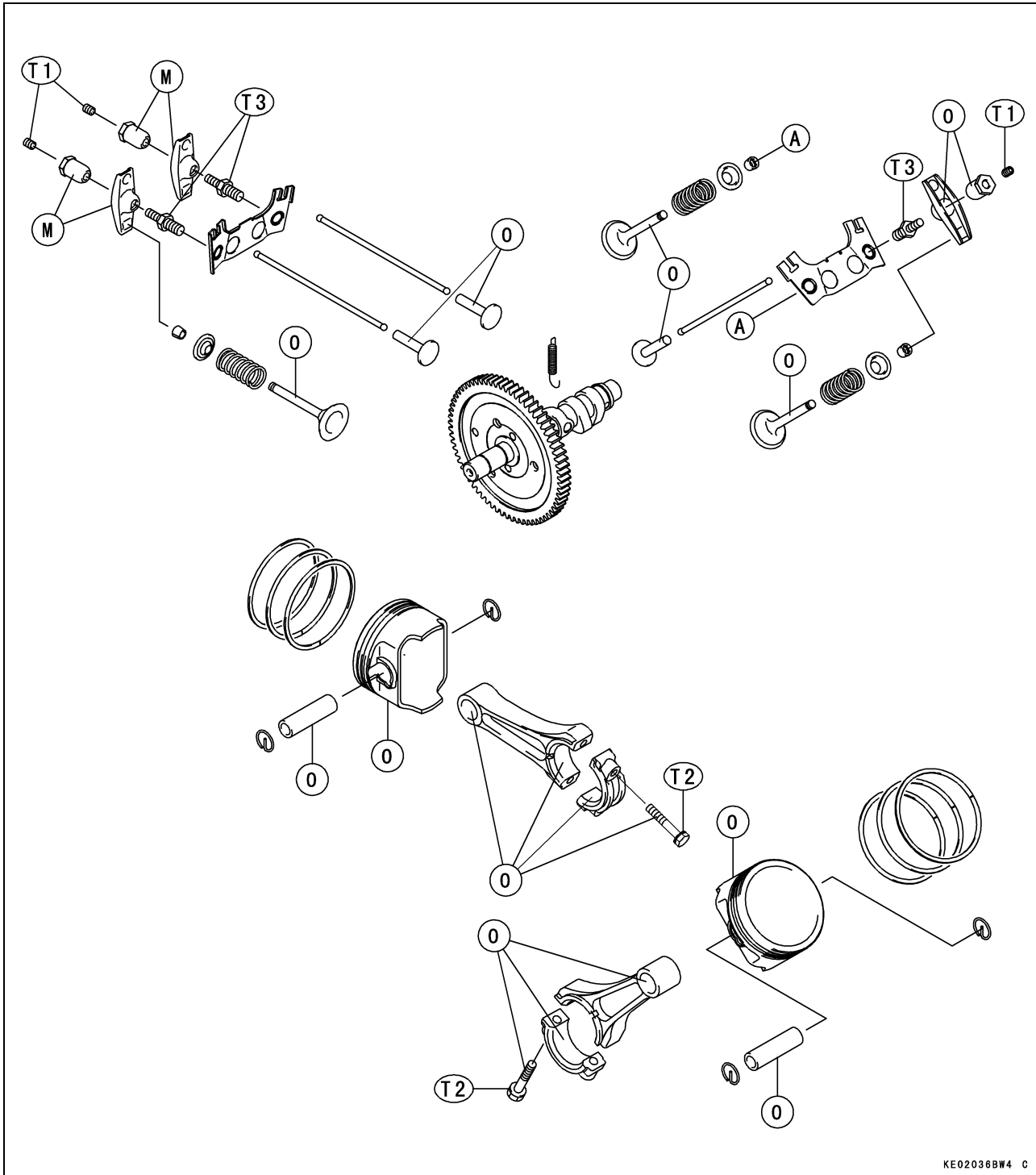
Engine Top End

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5-2 ENGINE TOP END

Exploded View



M: Apply molybdenum disulfide grease.

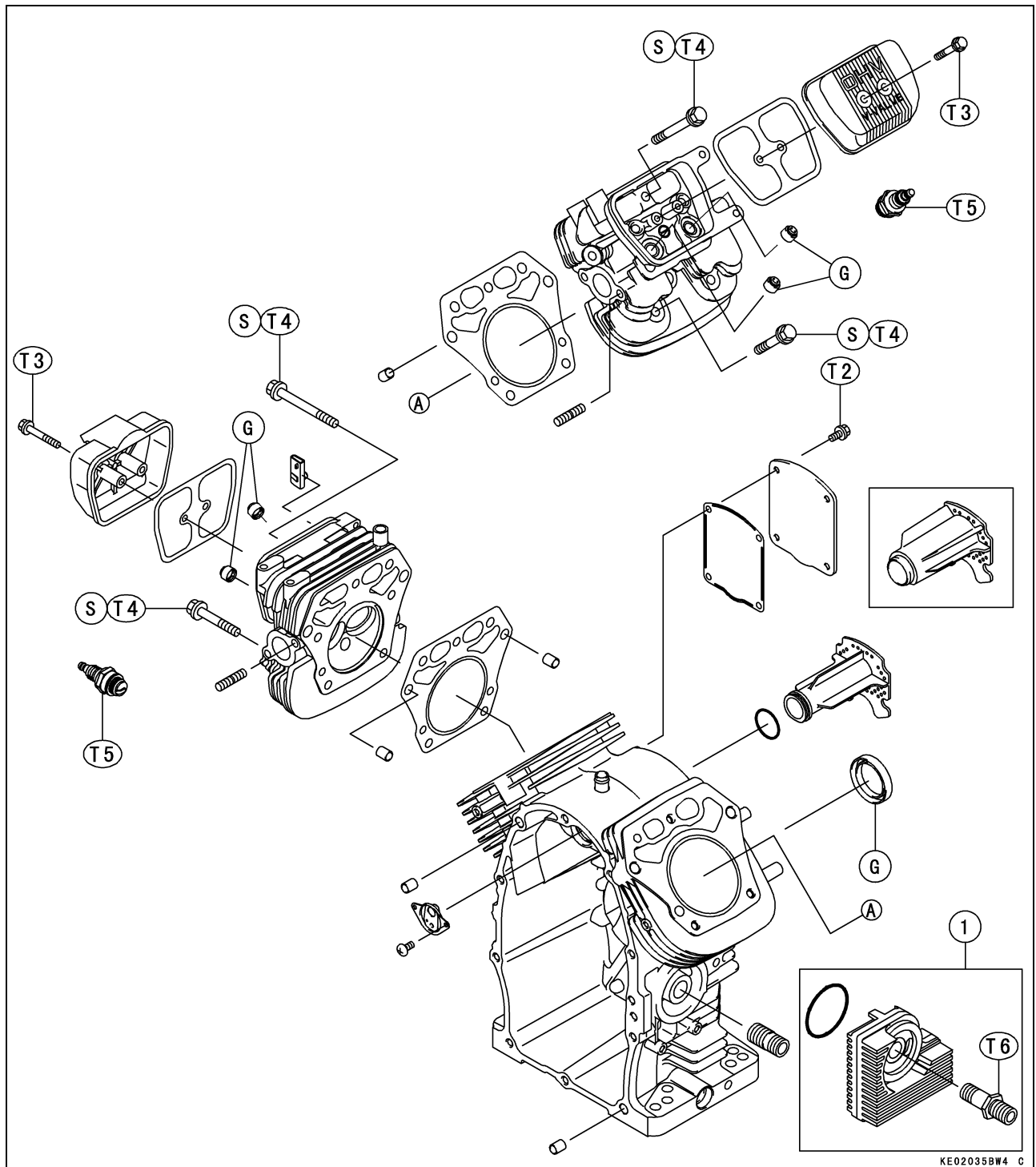
O: Apply engine oil.

T1: 6.9 N·m (0.70 kgf·m, 61 in·lb)

T2: 9.8 N·m (1.0 kgf·m, 87 in·lb)

T3: 28 N·m (2.8 kgf·m, 21 ft·lb)

Exploded View



1. FH721D Engine

G: Apply grease.

S: Follow the specified tightening sequence.

T1: 2.0 N·m (0.20 kgf·m, 18 in·lb)

T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)

T3: 6.9 N·m (0.70 kgf·m, 61 in·lb)

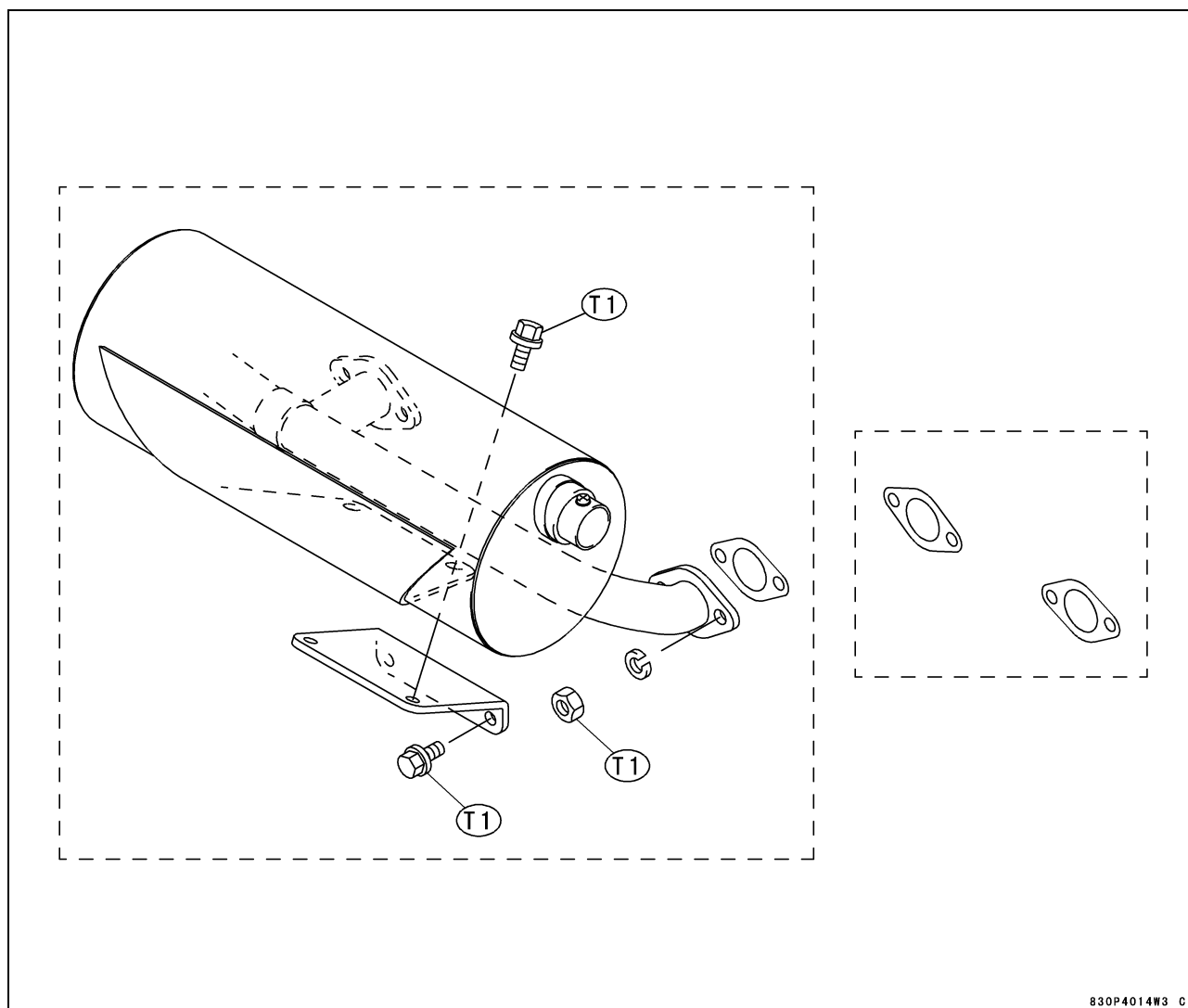
T4: 28 N·m (2.8 kgf·m, 21 ft·lb)

T5: 22 N·m (2.2 kgf·m, 16 ft·lb)

T6: 44 N·m (4.5 kgf·m, 33 ft·lb)

5-4 ENGINE TOP END

Exploded View



830P4014W3 C

T1: 15 N·m (1.5 kgf·m, 11.0 ft·lb)

Specifications

Item	Service Limit
Cylinder Head	
Cylinder Compression (MIN)	[390 kPa (57 psi)] (MIN)
Cylinder Head Warp	0.05 mm (0.002 in.)
Valves	
Valve Head Thickness:	
Inlet, Exhaust	0.35 mm (0.014 in.)
Valve Stem Runout:	
Inlet, Exhaust	0.05 mm (0.002 in.)
Valve Stem Diameter:	
Inlet	5.95 mm (0.0234 in.)
Exhaust	5.93 mm (0.0233 in.)
Valve Guide Inside Diameter:	
Inlet, Exhaust	6.08 mm (0.239 in.)
Valve Spring Free Length:	
Inlet, Exhaust	31.0 in (1.22 in.)
Rocker Arm Push Rod Runout:	
Inlet, Exhaust	0.5 mm (0.02 in.)
Cylinder, Piston	
Piston Diameter	74.99 mm (2.952 in.)
Piston Ring/groove Clearance:	
Top	0.18 mm (0.007 in.)
Second	0.16 mm (0.006 in.)
Piston Ring Thickness:	
Top, Second	1.40 mm (0.055 in.)
Piston Ring End Gap:	
Top	0.65 mm (0.026 in.)
Second	0.78 mm (0.031 in.)
Oil	1.05 mm (0.041 in.)
Piston Pin Outside Diameter	15.96 mm (0.628 in.)
Piston Pin Hole Inside Diameter	16.08 mm (0.633 in.)
Connecting Rod Small end Inside Diameter	16.05 mm (0.632 in.)
Cylinder Inside Diameter:	
Standard Cylinder	75.28 mm (2.964 in.)
0.50 mm Oversize	75.78 mm (2.983 in.)
Cylinder Inside Diameter Out Of Round	0.056 mm (0.0022 in.)

5-6 ENGINE TOP END

Specifications

Item	Standard
Valve Clearance: Inlet, Exhaust	0.10 to 0.15 mm (0.004 to 0.006 in.)
Valve Seating Surface Angle: Inlet, Exhaust	45°
Valve Seating Surface Width: Inlet	0.8 to 1.4 mm (0.03 to 0.06 in.)
Exhaust	1.1 to 1.6 mm (0.04 to 0.06 in.)
Valves Guide Inside Diameter: Inlet, Exhaust	6.00 to 6.012 mm (0.2362 to 0.2367 in.)
Cylinder Bore Diameter Standard Cylinder:	
Standard Cylinder	75.18 to 75.20 mm (2.960 to 2.961 in.)
0.50 mm Over Size	75.68 to 75.70 mm (2.979 to 2.980 in.)

Special Tools - Compression Gauge, 20 kgf/cm²: 57001- 221

Compression Gauge Adapter, M14 ×1.25: 57001-1159

Piston Ring Pliers: 57001-115

Piston Ring Compression Grip: 57001-1095

Piston Ring Compressor Belt, $\phi 67 \sim \phi 79$: 57001-1097

Valve Seat Cutter Holder Bar: 57001-1128

Valve Seat Cutter Holder, $\phi 6$: 57001-1360

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

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

Valve Seat Cutter, 32° - $\phi 30$: 57001-1120

Valve Seat Cutter, 45° - $\phi 30.0$: 57001-1187

Cylinder Head

Compression Measurement

- Before measuring compression, check the following.
- Be sure the battery is fully charged.
- Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help sealing the compression as it does during normal running.
- Stop the engine.
- Disconnect the spark plug caps of each cylinder and remove the spark plugs.
- Attach the compression gauge assembly firmly into one plug hole.

Special Tool - Compression Gauge, 20 kgf/cm²: 57001-221 [A]

Compression Gauge Adapter, M14 × 1.25: 57001-1159 [B]

- Ground the spark plugs to the engine.



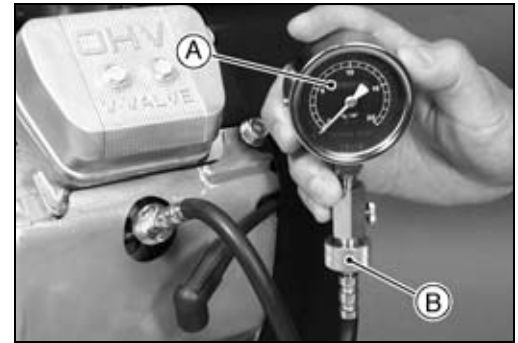
WARNING

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

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

Cylinder Compression (MIN) 390 kPa (57 psi)

- Repeat the measurement on the other cylinder.
- ★ If the compression is higher than the specified value, the piston rings, cylinder and valves are probably in good condition.
- ★ If the compression is too high, check the following.
 1. Carbon build-up on the piston crown and cylinder head - clean off any carbon on the piston crown and cylinder head.
 2. Cylinder head gasket - use only the proper gasket. The use of a gasket of incorrect thickness will change the compression.
 3. Valve guides and piston rings - worn valve guides and/or worn position oil rings may cause rapid carbon accumulation in the combustion chamber. This may be indicated by white exhaust smoke.
- ★ If the cylinder compression is lower than the (MIN), check the following:
 1. Gas leakage around the cylinder head - replace the damaged gasket with a new one and check the cylinder head warp.
 2. Condition of the valve seating.
 3. Valve clearance.
 4. Piston/cylinder wear, piston seizure.
 5. Piston ring, piston ring groove.

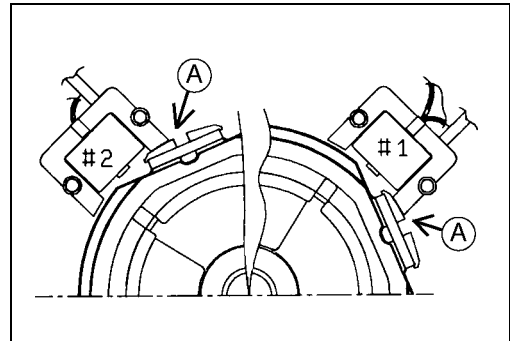
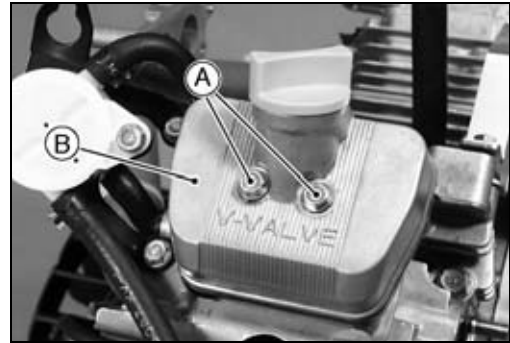


5-8 ENGINE TOP END

Cylinder Head

Cylinder Head Assembly Removal

- Remove:
 - Air Cleaner (see Fuel System chapter)
 - Fan Housing (see Electrical System chapter)
 - Muffler (see Muffler Exhaust Pipe Removal)
 - Carburetor (see Fuel System chapter)
 - Inlet Manifold (see Fuel System chapter)
 - Spark Plug
- Unscrew the rocker cover mounting bolts [A], and then remove the cover [B] and the gasket.
- When removing the #1, #2 cylinder head, set each cylinder at the T.D.C [A] of the power stroke in.



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

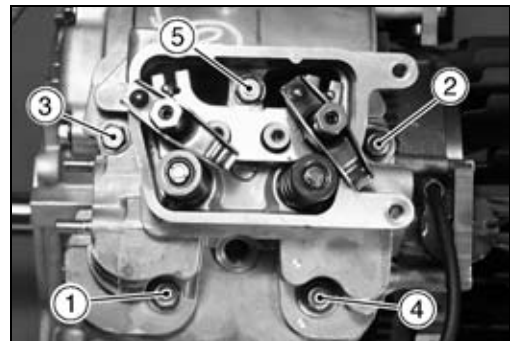
NOTICE

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 to reinstall in their original position during assembly.

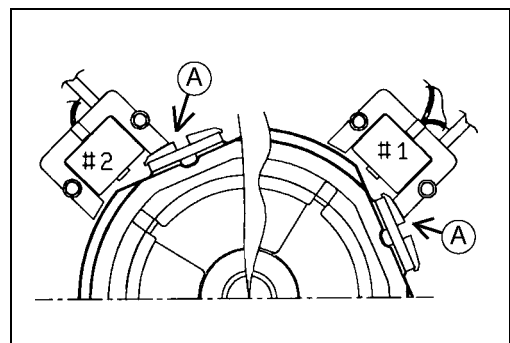


Cylinder Head Assembly Installation

- Clean the mating surfaces of the cylinder heads and cylinders.
- Install the push rods in their original positions on each cylinder (see Push Rod Installation).
- Install the knock pins.
- Set each cylinder at the T.D.C [A] of the power stroke in.
- Put new gaskets and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms.

NOTE

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



Cylinder Head

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

Torque - Cylinder Head Bolts: 25 N·m (2.6 kgf·m, 19.0 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.

- Check and adjust the valve clearance (see Valve Clearance Inspection, Valve Clearance Adjustment).
- Install the gaskets and rocker covers.

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

- Install the other removed parts.

Push Rod Removal

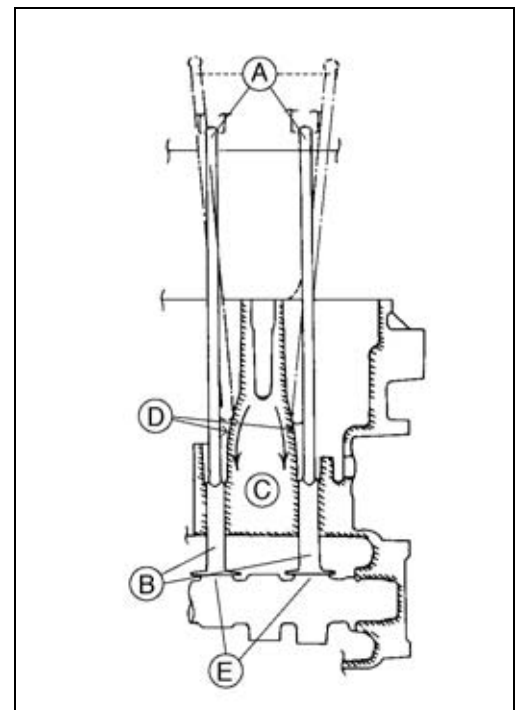
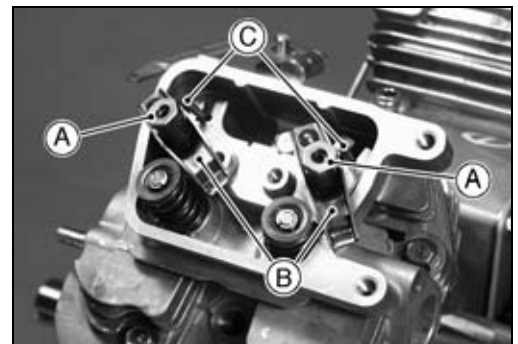
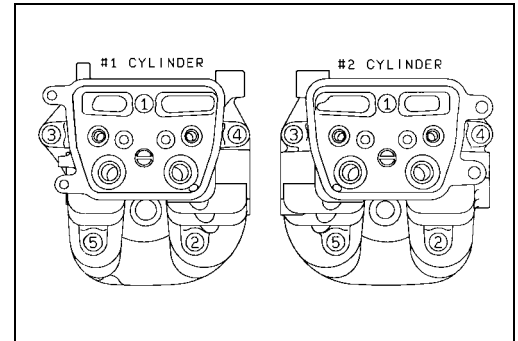
- Set each cylinder at the T.D.C of the power stroke.
- Remove the rocker covers. (see Cylinder Head Assembly Removal)
- Loosen the valve clearance adjusting nuts [A].
- Move the rocker arms [B] to clear the push rod [C] upper ends.
- Pull out the push rods.

NOTE

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

Push Rod Installation

- Set each cylinder at the T.D.C of the power stroke.
- Install the push rods [A] in their original positions on each cylinder.
- 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 inlet and exhaust push rods on each cylinder are at lowest position on the cam lobes [E]. If the piston is not at the T.D.C of the power stroke, turn the fly-wheel clockwise one turn (360°) and reset each cylinder at the T.D.C of the power stroke in.
- Be sure the end of the push rods are correctly seated on the tappets.
- Tighten the valve clearance adjusting nuts.
- Check and adjust the valve clearance.



5-10 ENGINE TOP END

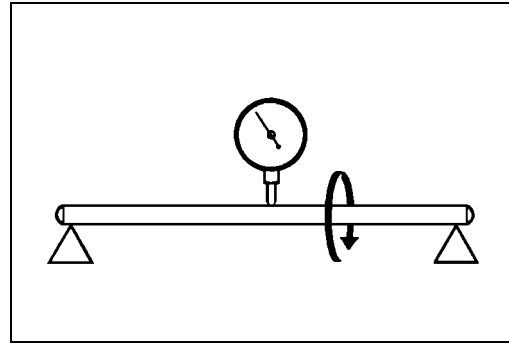
Cylinder Head

Push Rod Inspection

- Place the rocker arm push rod on V blocks as far apart as possible, and set a dial gauge on the rod at a halfway point between the blocks. Turn the rod to measure the runout. The difference between the highest and the lowest dial readings is the amount of runout.
- ★ If the runout exceeds the service limit, replace the rod with a new one.

Rocker Arm Push Rod Runout

Service Limit: 0.5 mm (0.02 in.)



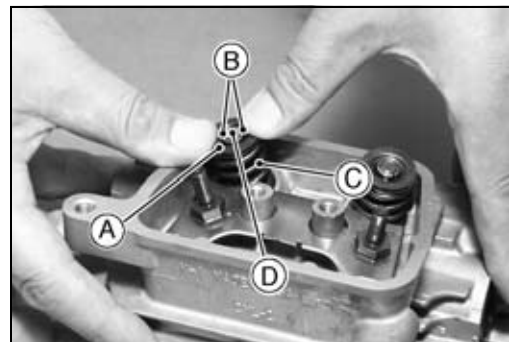
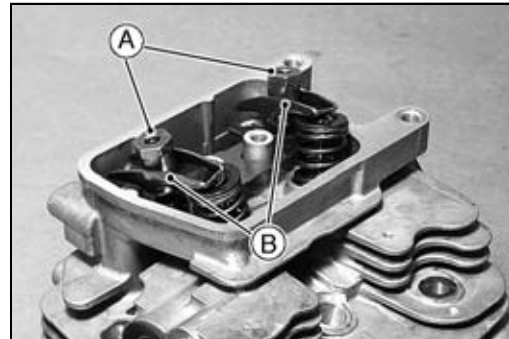
Valve Mechanism Removal/Installation

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

NOTE

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

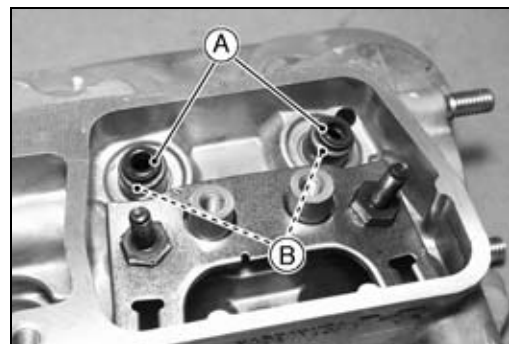
- Remove:
 - Valve Clearance Adjusting Nuts [A]
 - Rocker Arms [B]
- Support the valve head in the combustion chamber with a suitable block.
- To remove the spring retainer [A], push down the spring retainer with thumbs and remove the collets [B].
- Remove the spring [C] and the valve [D].



- Remove the stem seals [A].

NOTE

○ Remove the stem seals only if the replacement of the stems is necessary.
○ Valve guide [B] is not replaceable, do not remove it.



Cylinder Head

- Valve Installation.
 - Apply engine oil to the valve stems to avoid damaging the stem seals.
 - Check to see that the valve moves up and down smoothly in the guide.
 - Check to see that the valve seats properly in the valve seat. If it does not, repair the valve seat.
- Rocker Arm Installation
 - Apply molybdenum disulfide grease to the spherical pivot seat area on the rocker arm.
 - Apply molybdenum disulfide grease to the rocker arm where it touches the push rod and the valve stem end.
 - Install the rocker arm on the stud bolt, and the screw in the pivot and the locknut on the stud bolt temporarily.

NOTE

- *Correct installation must be performed when adjusting the valve clearance (see Valve Clearance Adjustment).*

Cylinder Head Cleaning and Inspection

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

5-12 ENGINE TOP END

Valves

Valve Clearance Inspection

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

Valve Clearance Adjustment

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

Valve Seat Inspection

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

Valve Seat Repair

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

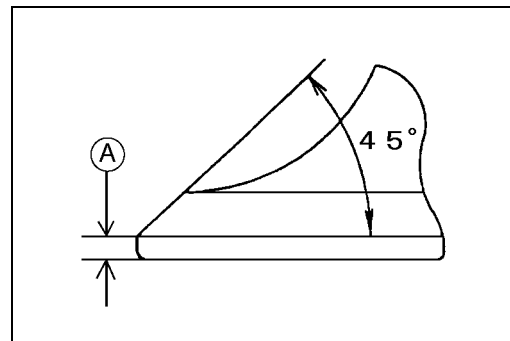
Valve Head Thickness

- Remove the valve (see Valve Mechanism Removal/Installation).
- Measure the valve head thickness.
- ★ If the valve head thickness (valve margin) [A] is less than the service limit, replace the valve with a new one.

Valve Head Thickness

Service Limit :

Inlet, Exhaust 0.35 mm (0.014 in)



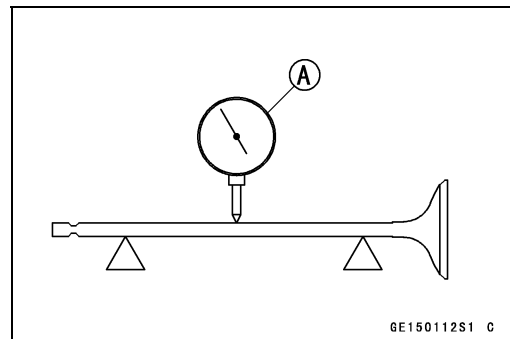
Valve Stem Runout

- Support the valve on V blocks at each end of the stem.
- Position a dial gauge [A] perpendicular to the stem.
- Turn the valve and read the variation on the dial gauge.
- ★ If the stem runout is greater than service limit, replace the valve.

Valve Stem Runout

Service Limit:

Inlet, Exhaust 0.05 mm (0.002 in.)



Valve Stem Diameter

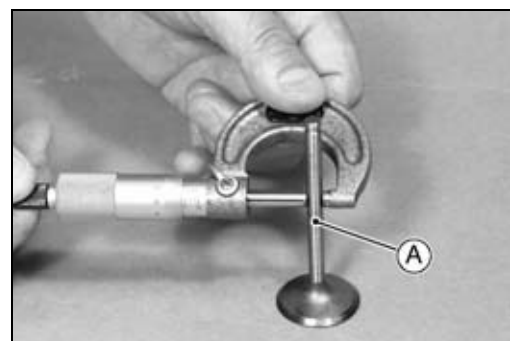
- Measure the diameter of the valve stem [A] in two directions at proper angles, at four different positions on the stem.
- ★ If any single measured valve stem diameter is less than the service limit, replace the valve with a new one.

Valve Stem Diameter

Service Limit:

Inlet 5.95 mm (0.234 in.)

Exhaust 5.93 mm (0.233 in.)



Valves

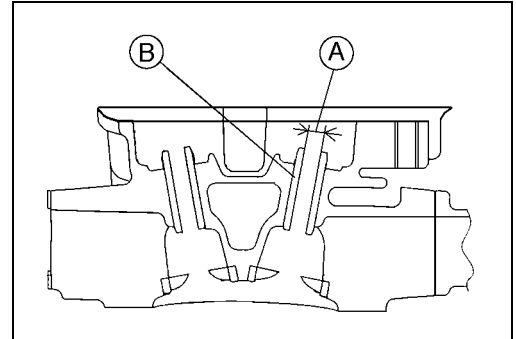
Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter [A] of the valve guide [B] at three positions down the guide length.
- ★ If the measured valve diameter is greater than the service limit, replace the cylinder head with a new one.

Valve Guide Inside Diameter

Service Limit:

Inlet, Exhaust 6.08 mm (0.239 in.)

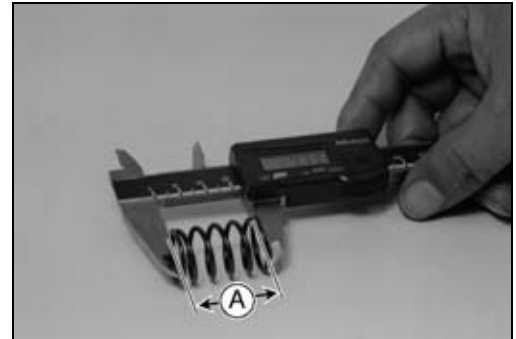


Valve Spring Inspection

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



5-14 ENGINE TOP END

Cylinder, Piston

Piston Removal

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

NOTE

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

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

NOTICE

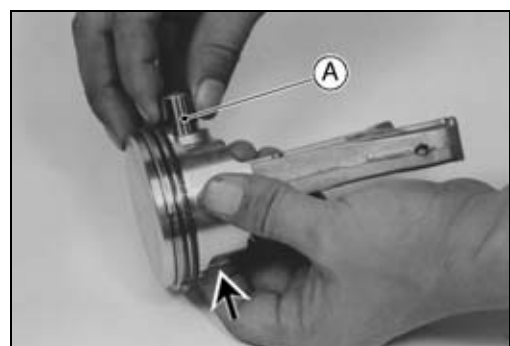
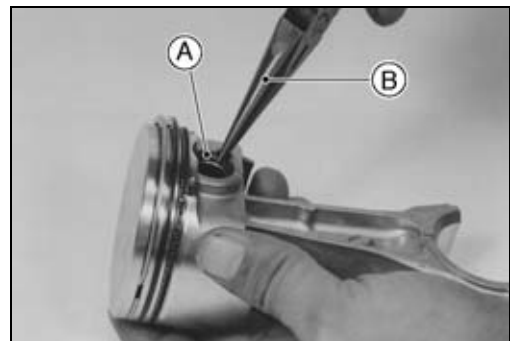
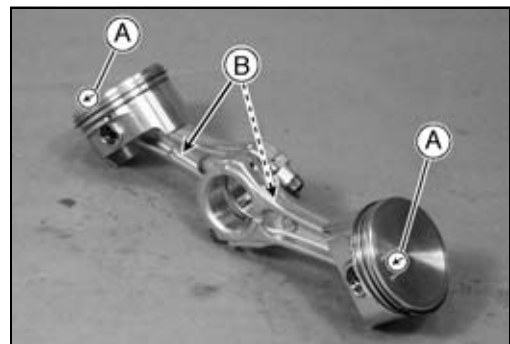
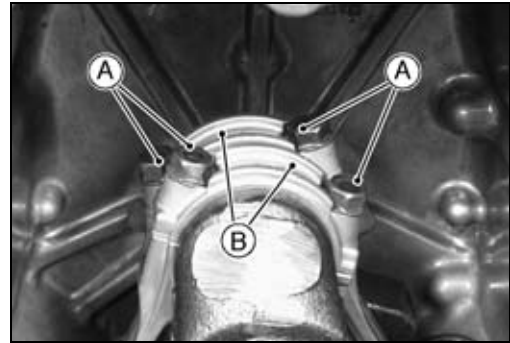
Note a location of the arrow match mark [A] on the piston head in relation to K Mark [B] on the connecting rod.

No.1 cylinder. K mark on the connecting rod is face to face with No.2 cylinder. K Mark on the connecting rod.

Keep parts together as a set.

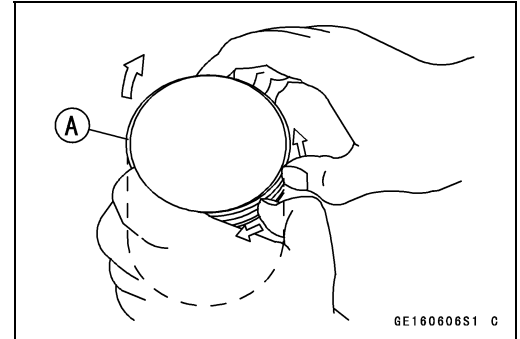
- Remove the piston pin snap ring [A] with needle nose pliers [B].

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



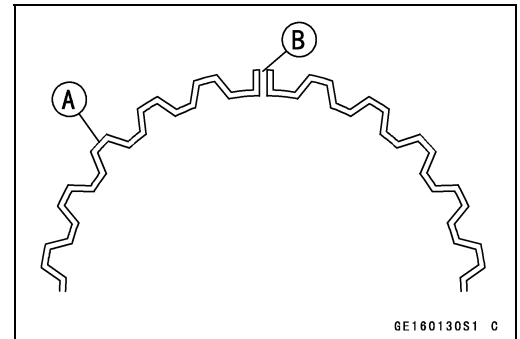
Cylinder, Piston

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

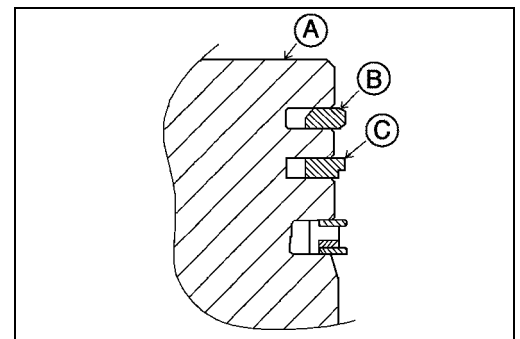


Piston Installation

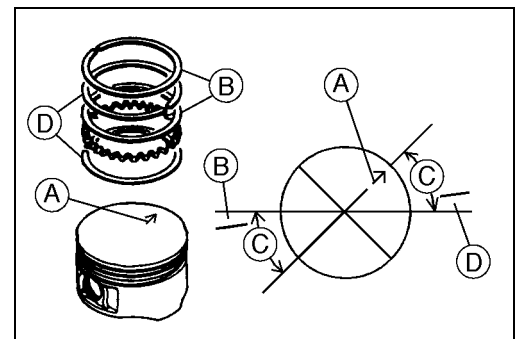
- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap them.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



- Do not mix up the top and second rings.
- Install the top and second rings as shown in the figure.
The rings should turn freely in the grooves.
Piston Head [A]
Top Ring [B]
Second Ring [C]

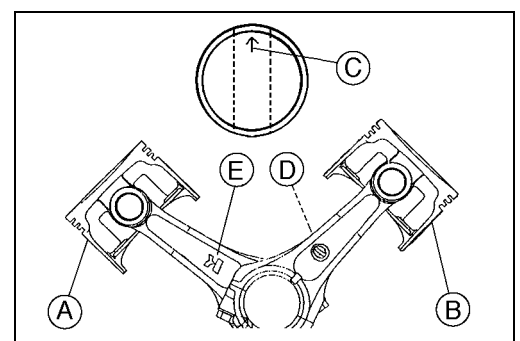


- Align the piston and rings with the piston ring end gap as shown in the figure.
Arrow Match Marks [A]
Top Ring End Gap, Upper Steel Rail End Gap [B]
30° ~ 45° [C]
Second Ring End Gap, Lower Steel Rail End Gap [D]



- Apply engine oil to the piston pins.
- Assemble the pistons onto the connecting rods as follow:
No.1 cylinder piston; align the arrow match mark on the piston crown with the K mark on the connecting rod. Both marks must face the PTO side.
No.2 cylinder piston; align the arrow match mark on the piston head with K Mark on the connecting rod to face the magnet side.

- No.1 Cylinder Piston [A]
- No.2 Cylinder Piston [B]
- Arrow Match Marks [C]
- K Mark [D]
- Opposite K Mark [E]



5-16 ENGINE TOP END

Cylinder, Piston

- When installing a piston pin snap ring, compress it only enough to install it. Do not compress the piston pin snap ring too hard.
- Fit a new piston pin snap ring into the side of the piston so that the ring opening [A] does not coincide with the notch [B] on the edge of the piston pin hole.

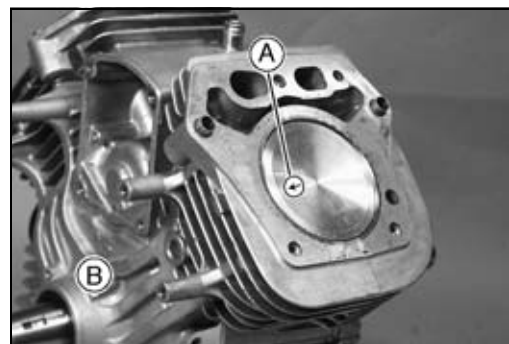
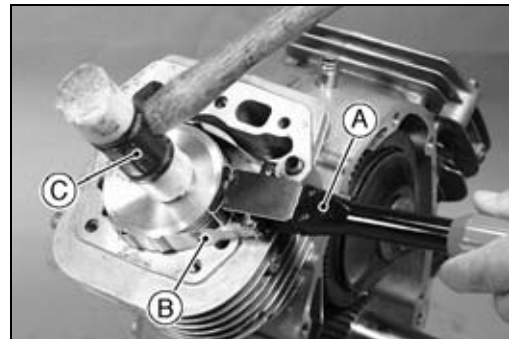
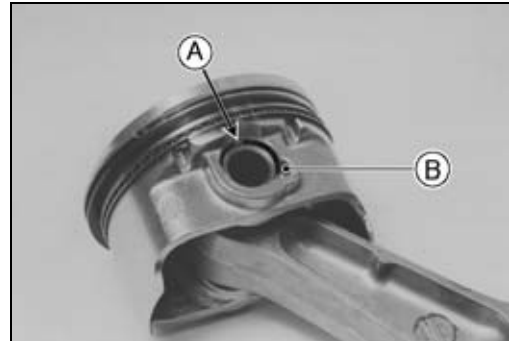
NOTICE

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 Tool - Piston Ring Compressor Grip: 57001-1095
Piston Ring Compressor Belt, $\phi 67 \sim \phi 79$:
57001-1097**

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



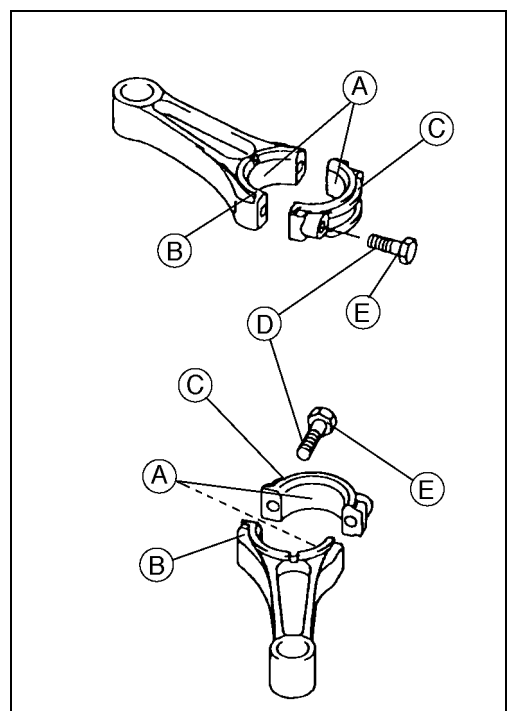
NOTICE

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 engine oil to the inner surface [A] of the connecting rod big end [B] and caps [C].
- 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 the cap bolts.

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

- Install:
Camshaft (see Camshaft/Crankshaft chapter)
Crankcase Cover (see Camshaft/Crankshaft chapter)



Cylinder, Piston

Piston/Cylinder Seizure

- In case of seizure, remove the piston.
- Visually inspect the cylinder and piston 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, the both cylinders must be bored to fit bigger size piston and install oversized pistons installed.

Piston Cleaning

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

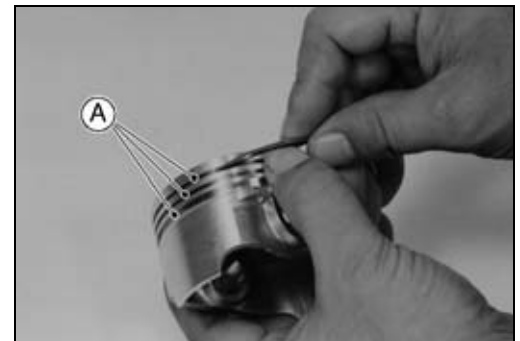
NOTICE

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 [A] the piston head.
- Use the scraping tools carefully. Do not gouge the piston head. To avoid gouging, use scrapers that material will not damage the piston head.
- Clean the piston ring grooves [A] with a broken piston ring or other suitable tools.

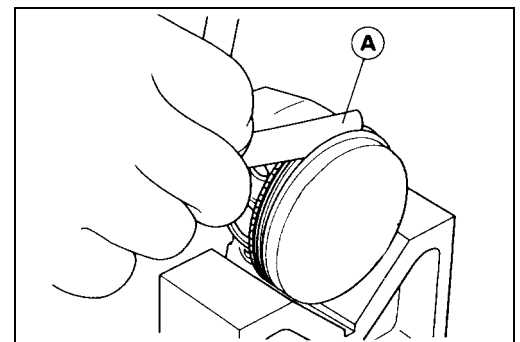
NOTICE

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



Piston Ring and Ring Groove Wear

- Clean the piston (see Piston Cleaning).
- Visually inspect the piston rings and ring grooves.
- ★ If the piston rings are worn unevenly or damaged, replace them with new ones.
- ★ If the ring grooves are worn unevenly or damaged, replace both the piston and the piston rings with new ones.
- 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.
- ★ If the piston ring/groove clearance is greater than the service limit, replace the piston with a new one.



Piston Ring/Groove Clearance

Service Limit:

Top	0.18 mm (0.007 in.)
Second	0.16 mm (0.006 in.)

NOTE

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

5-18 ENGINE TOP END

Cylinder, Piston

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

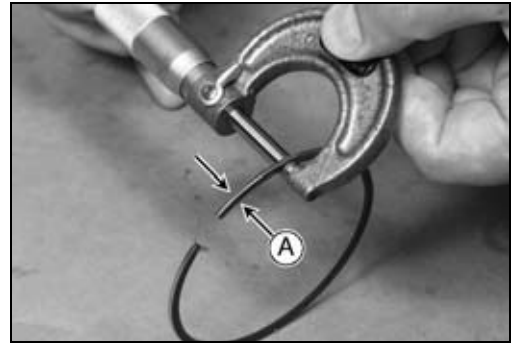
Piston Ring Thickness

Service Limit:

Top, Second	1.40 mm (0.055 in.)
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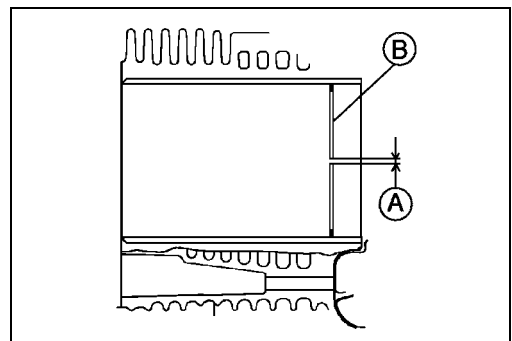
NOTE

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



Piston Ring End Gap

- Remove the piston rings.
- Push each ring (one at a time) in the cylinder bore to a point close to the bottom of the cylinder bore.
- Use the piston to push it in to be sure it is square.
- Measure the gap [A] between the ends of the ring [B] with a thickness gauge.
- ★ If the end gap of any ring is greater than the service limit, replace the entire set of rings with new ones.



Piston Ring End Gap

Service Limit:

Top	0.65 mm (0.026 in.)
Second	0.78 mm (0.031 in.)
Oil	1.05 mm (0.041 in.)

Piston Pin, Piston Pin Hole, and Connecting Rod Wear

- Remove the piston pin.
- Measure the diameter of the piston pin diameter with a micrometer at several points.
- ★ If the outside diameter is less than service limit, replace the piston pin with a new one.

Piston Pin Outside Diameter

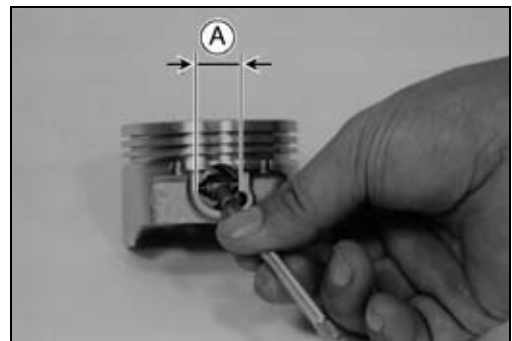
Service Limit:	15.96 mm (0.628 in.)
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- Measure the inside diameter [A] of the piston pin hole at several points on both side. Use a dial bore gauge.
- ★ If the inside diameter is greater than the service limit, replace the piston with a new one.

Piston Pin Hole Inside Diameter

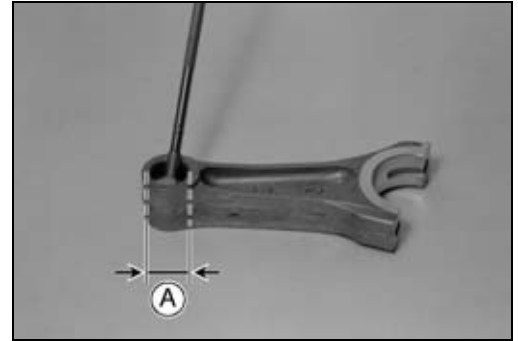
Service Limit:	16.08 mm (0.633 in.)
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Cylinder, Piston

- Measure the inside diameter [A] of the connecting rod small end at several points. Use a dial bore gauge.
- ★ If the inside diameter is more than the service limit, replace the connecting rod with a new one.

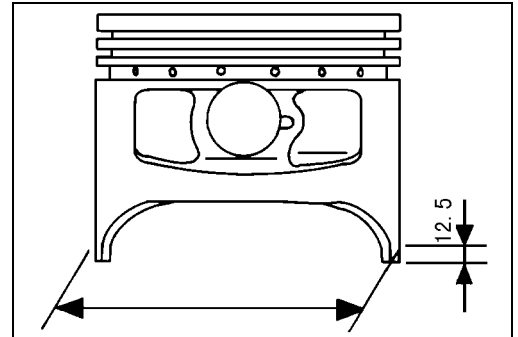
Connecting Rod Small End Inside Diameter
Service Limit: 16.05 mm (0.632 in.)



Piston Diameter

- Measure the outside diameter of the piston 12.5 mm (0.9 in.) up from the bottom of the piston at a right angle to the direction of the piston pin hole.
- ★ If the measured outside diameter is less than the service limit, replace the piston with a new one.

Piston Diameter
Service Limit: 74.99 mm (2.952 in.)



Cylinder Inside Diameter

- Clean and measure the cylinder inside diameter.
- Use a dial bore gauge to measure front-to-back and side-to-side at the points as shown in the figure.
- ★ If any of the cylinder inside diameter measured value is greater than the service limit, the cylinder must be bored to the next oversize and then honed (see Cylinder Boring and Honing).

Cylinder Inside Diameter
Standard:

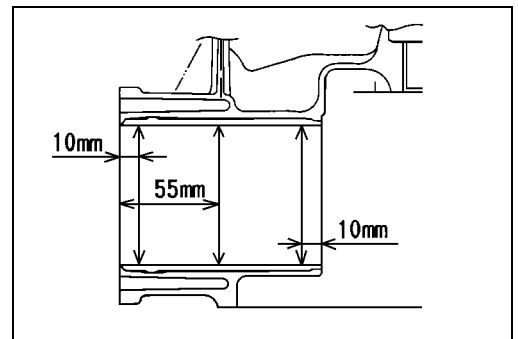
Standard Cylinder	75.18 mm ~ 75.20 mm (2.960 ~ 2.961 in.)
0.5 mm Oversize	75.68 ~ 75.70 mm (2.979 ~ 2.980 in.)

Service Limit:

Standard Cylinder	75.28 mm (2.964 in.)
0.5 mm Oversize	75.78 mm (2.983 in.)

Cylinder Inside diameter Out-of-Round

Standard:	0.01 mm (0.0004 in.)
Service Limit:	0.056 mm (0.0022 in.)



5-20 ENGINE TOP END

Cylinder, Piston

Cylinder Boring and Honing

Always resize to exactly 0.5 mm (0.02 in.) over the standard bore size.

If this is done accurately, the stock oversize rings and piston will fit perfectly and proper clearance will be maintained.

Resize the cylinder bore by a reliable repair shop or by using a drill press and a honing tool.

Use the stone recommended by the hone manufactures to produce correct cylinder wall finish.

Machine-bore first, the inside diameters are shown in the table.

Boring Inside Diameter

Oversize	Inside Diameter
0.50 mm	75.65 to 75.68 mm (2.978 to 2.979 in.)

Honing Inside Diameter

Oversize	Inside Diameter
0.50 mm	75.68 to 75.70 mm (2.979 to 2.980 in.)

- Change to a honing stone for finishing, the final bore diameter should be as shown in the table.
- Be sure to use correct finishing stone and the stone should not be worn.
- Clean the cylinder at the top and bottom of the cylinder to remove burns and pieces of the base and head gasket.
- Anchor the cylinder (block) on the drill press table before honing.
- Align the center of the cylinder bore to the press center. Set the press to operate from 200 to 250 rpm.
- Connect the drive shaft to the hone and set the stop on the drill press so the hone can only extend 20 to 25 mm (3/4 to 1.0 in.) above the top or below the bottom of the cylinder liner.
- Rotate the adjusting nut (knob) on the hone until the stones contact snugly against the narrowest point of the cylinder wall. "Do not Force".
- Turn the honing stone by hand. If you cannot turn it, the stone is too tight. Loosen the hone until you can turn it by hand.
- Be sure that the cylinder and the hone are centered and aligned with the drive shaft and the drill spindle.
- Pour honing oil inside of the cylinder during the honing operation. Start the drill press. Move the hone up and down in the cylinder approximately 20 cycles per minute.
- Check the diameter of the cylinder bore regularly during honing, using an inside micrometer.

Cylinder, Piston**NOTICE**

Stop the drill press before measuring and remove the hone from the cylinder.

NOTE

○The finished cylinder bore surface should not be smooth, but have a 40 to 60 degree crosshatch pattern.

- Hone the cylinder until it is about 0.007 to 0.009 mm (0.0003 to 0.0004 in) large to allow for shrinkage when the cylinder cools.

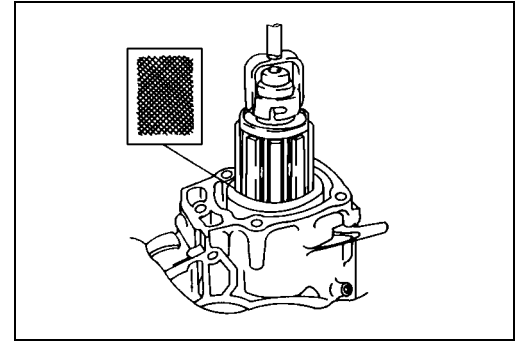
NOTE

○Do not use gasoline, kerosene, or commercial solvent to clean the cylinder bore. These fluids only wash all the oil from the cylinder wall. They do not remove the metal particles produced during honing.

- Using soap, warm water and clean cloth, clean the cylinder wall. A clean white cloth should not show soil from the cylinder wall.
- Dry the cylinder and coat with engine oil.

NOTICE

The cylinder must be thoroughly cleaned after honing to eliminate all grit.

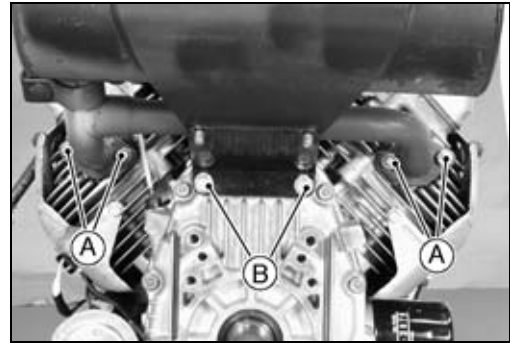


5-22 ENGINE TOP END

Muffler

Muffler Removal

- Remove the bolt [B] on the muffler bracket.
- Unscrew the flange nuts [A], and remove the muffler. Use a penetrating oil if necessary to loosen the nuts easily.
- Do not use unnecessary force when removing the muffler assembly, or they could become damaged or distorted.
- Remove the gaskets.



Muffler Installation

- Clean the muffler flanges to the exhaust port gasket surfaces and install a new gaskets each time the muffler installation.
- Install the gasket.
- Install the muffler.
- To prevent mis-threading, tighten the flange nuts by finger first. Next, tighten the nuts to the specified torque.
- Tighten the nuts.

Torque - Muffler Flange Nuts: 15 N·m (1.5 kgf·m, 11 ft·lb)

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

Inspection

- Inspect the muffler for dents, cracks, rust and holes.
- ★ If the muffler is damaged, replace the muffler with a new one for the best performance and minimum noise.
- Check the muffler for distortion and/or loose internal components. Loose internal components may result in the exhaust flow restriction and the engine output decrease.
- Check for breaks in the seams and check weld at the junction of the exhaust pipes and the muffler.
- Tap the muffler with a plastic hammer to decarbonize.

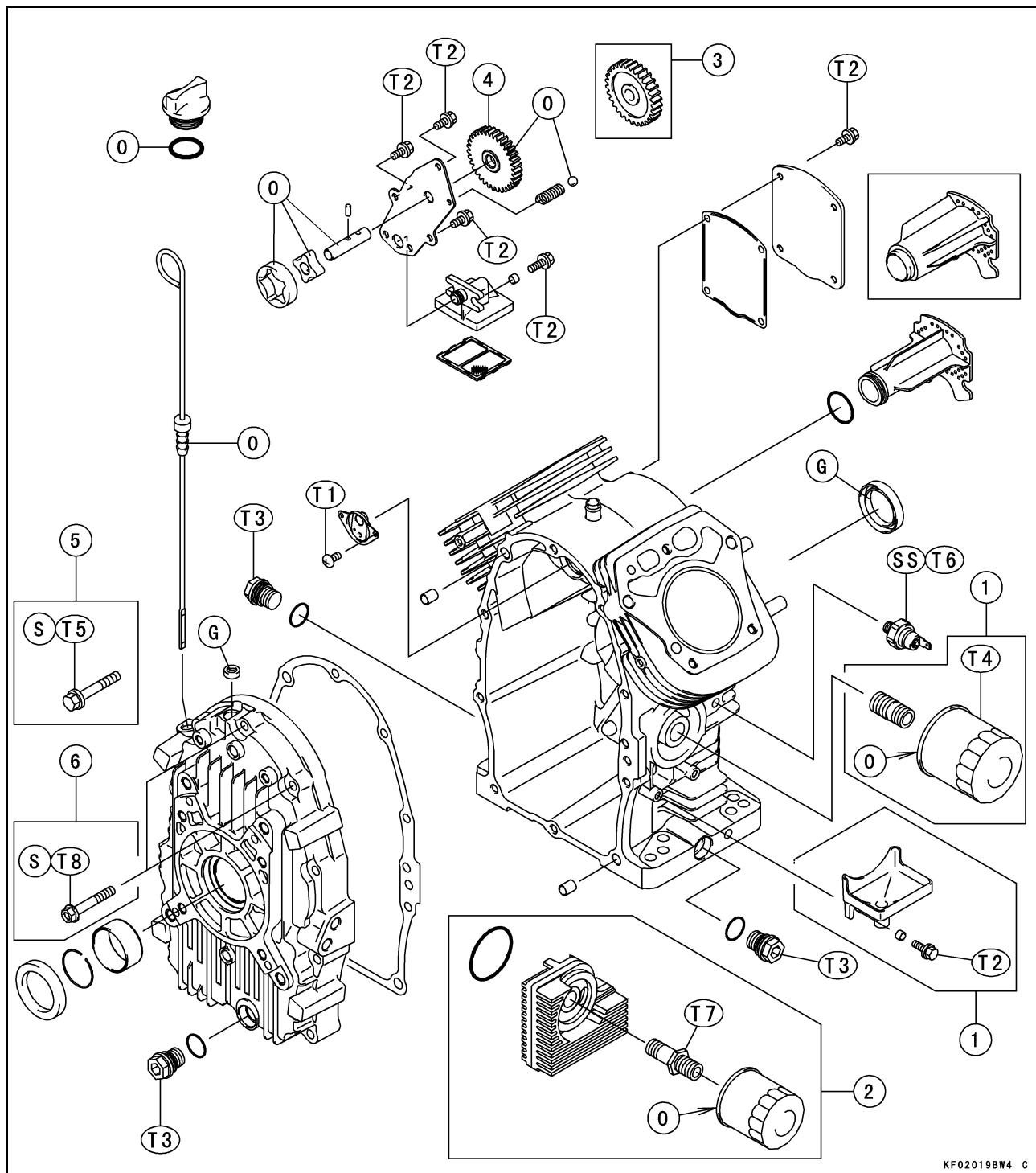
Lubrication System

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6-2 LUBRICATION SYSTEM

Exploded View



KF020198W4 C

1. Other than FH721D Engine
2. FH721D Engine
3. Beginning Engine No. ~ FH680 - A03468
4. FH680D - A03468 ~
5. Bolt marked "9" on the top end
Beginning Engine No.~ FH601DA09541
Beginning Engine No.~ FH641DA02234
Beginning Engine No.~ FH680DA33212
Beginning Engine No.~ FH721DA55225
6. Bolt marked "10" on the top end
FH601DA09542 ~
FH641DA02235 ~
FH680DA33213 ~
FH721DA55226 ~

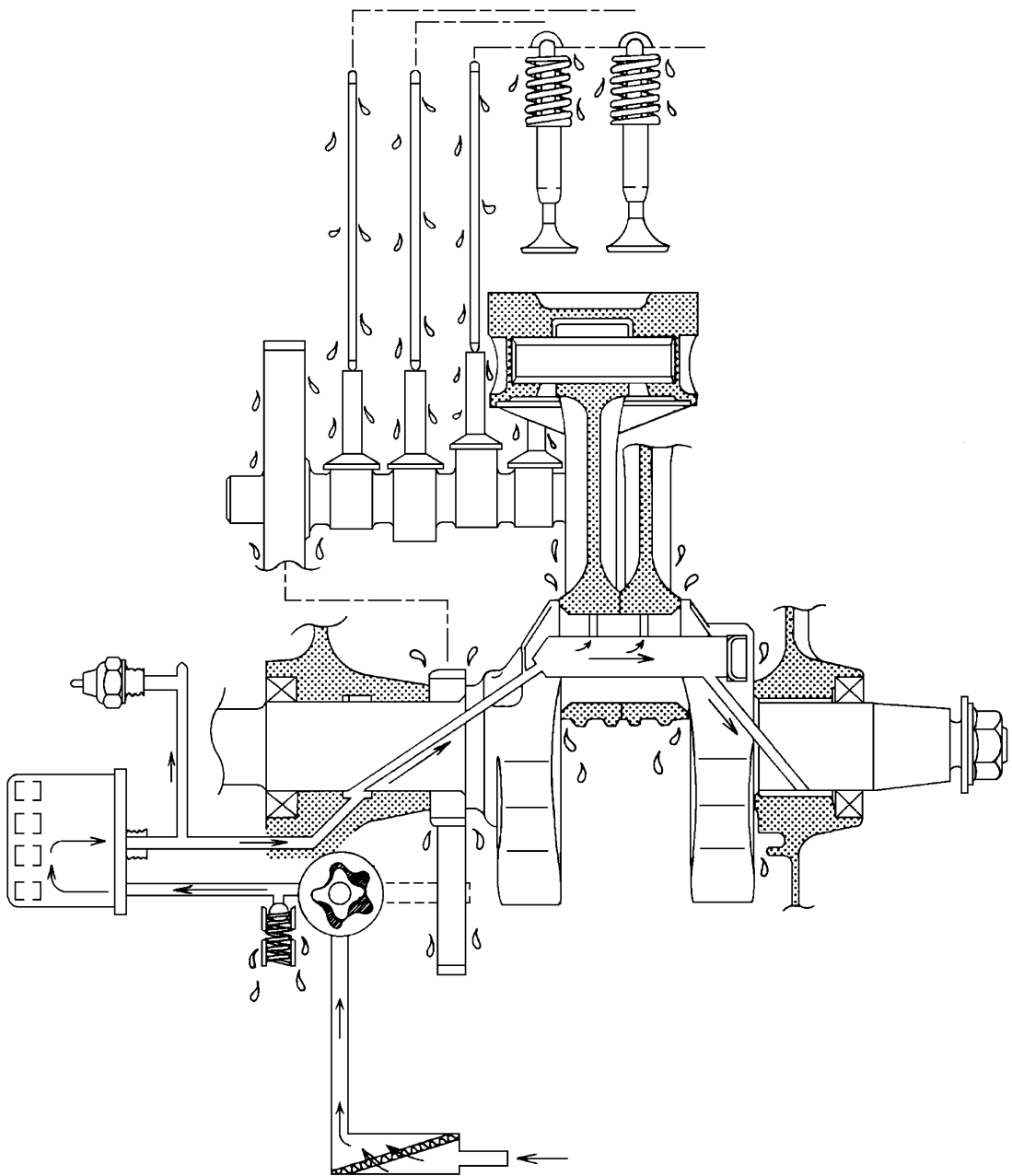
- G: Apply grease.
O: Apply engine oil.
S: Follow the specific tightening sequence.
SS: Apply silicone sealant.
- T1: 2.0 N·m (0.20 kgf·m, 18 in·lb)
T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)
T3: 6.9 N·m (0.70 kgf·m, 61 in·lb)
T4: in the text
T5: 25 N·m (2.6 kgf·m, 19 ft·lb)
T6: 9.8 N·m (1.0 kgf·m, 87 in·lb)
T7: 44 N·m (4.5 kgf·m, 33 ft·lb)
T8: 32 N·m (3.3 kgf·m, 23.6 ft·lb)

Engine Oil Flow Chart

To improve lubrication to crankshaft main bearings, the crankcase and crankshaft are changed from single oil line system to 2 oil lines system.

Single Oil Line System

	Engine Number
FH601D	From the beginning through FH601DA05414
FH641D	From the beginning through FH641DA02233
FH680D	From the beginning through FH680DA24780
FH721D	From the beginning through FH721DA43445

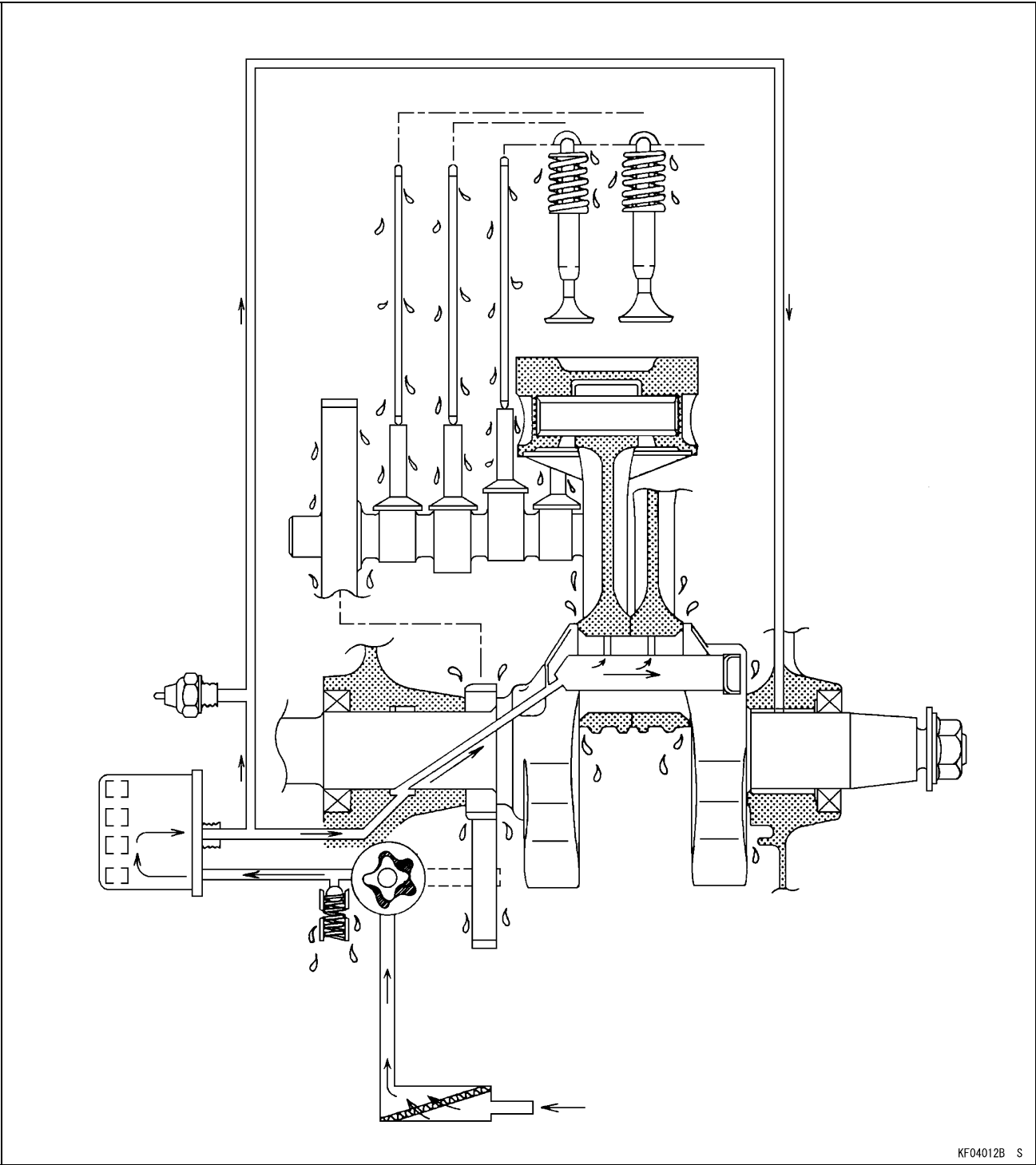


6-4 LUBRICATION SYSTEM

Engine Oil Flow Chart

Two Oil Lines System

	Engine Number
FH601D	FH601DA05415 ~
FH641D	FH641DA02234 ~
FH680D	FH680DA24781 ~
FH721D	FH721DA43446 ~



Specifications

Item	Standard
Engine Oil:	
Grade	API Service Classification: SF, SG, SH, SJ or SL class
Viscosity	SAE40, SAE30, SAE10W-30 / SAE10W-40, or SAE5W-20
Capacity	1.4 L (1.5 US qt) [When the oil filter is not removed] 1.6 L (1.7 US qt) [When the oil filter is removed]
Level	Between "H" and "L" marks on oil gauge
Oil Pressure	241 to 310 kPa (35 to 45 psi): Engine oil temperature 120°C 414 to 690 kPa (60 to 100 psi): Engine oil temperature 50 to 60°C
Oil Pressure Switch:	
Detect Pressure	98 kPa (14.2 psi)
Screw	PT 1/8 pipe thread
Oil Filter By-pass Valve Opening:	
Pressure	78.5 to 117.5 kPa (11.4 to 17.1 psi)

Item	Service Limit
Oil Pump:	
Inner And Outer Rotor Clearance	0.2 mm (0.008 in.)
Outer Rotor Outside Diameter	40.470 mm (1.5933 in.)
Outer Rotor Thickness	9.830 mm (0.3870 in.)
Pump Housing Inside Diameter	40.801 mm (1.6063 in.)
Pump Housing Depth	10.230 mm (0.4028 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	19.50 mm (0.77 in.)

Special Tool - Oil Filter Wrench: 57001-1249

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

6-6 LUBRICATION SYSTEM

Engine Oil, Oil Filter and Oil Cooler

NOTICE

Engine operation with insufficient, deteriorated, or contaminated engine oil will cause accelerated wear and may result in engine seizure and accident. Before starting the engine for the first time, add oil: The engine is shipped dry. Preoil the engine to force all air from the internal oil passages and the oil filter.

- Fill fresh engine oil to the specified level (see Oil Level Inspection).
- Run the engine at slow speed for 2 minutes.
- Stop the engine and check the oil level.

Oil Level Inspection

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

Oil Change

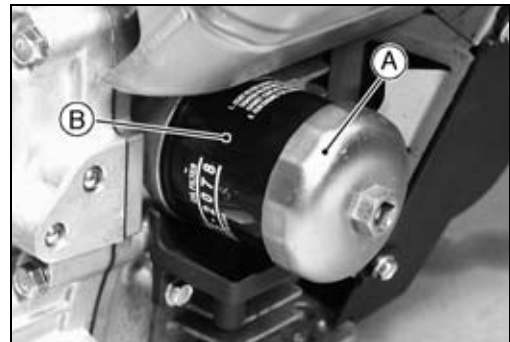
- Refer to the Oil Change in the Periodic Maintenance chapter.

Oil Filter Removal

- Using a strap wrench or oil filter wrench [A], remove the oil filter [B].

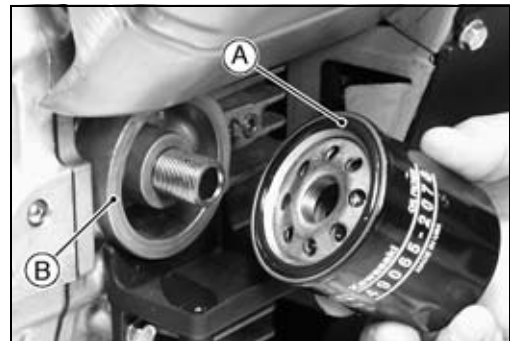
Special Tool - Oil Filter Wrench: 57001-1249

- When unscrewing the oil filter, place a suitable container beneath the oil drip tray to receive oil from the oil filter and oil passages in the engine. Turn the filter counter-clockwise to remove it.



Oil Filter Installation

- Apply a thin layer of the engine oil to the seal [A].
- Install new filter.
- Turn the filter until the seal contacts the mounting surface [B] of the engine. Then turn the filter by hand (S) 3/4 turn more.
- Run the engine at low idle speed 2 minutes. Check for leaks around the engine.
- Stop the engine. Check the oil level (see Oil Level Inspection).



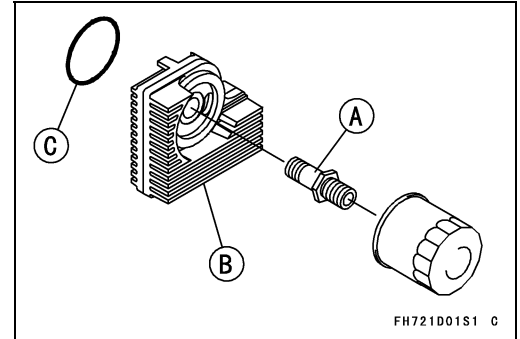
Oil Filter Replacement

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

Engine Oil, Oil Filter and Oil Cooler

Oil Cooler Removal-FH721D

- Remove the oil filter (see Oil Filter Removal).
- Unscrew the mounting joint [A] and remove the oil cooler [B].
- Check the O-ring [C] in the groove of the oil cooler for damage.
- ★ Replace the O-ring with a new one, if necessary.



Oil Cooler Installation-FH721D

- Install the oil cooler with the mounting joint and tighten it.
Torque - Oil Cooler Mounting Joint: 44 N·m (4.5 kgf·m, 33 ft·lb)
- Install the oil filter (see Oil Filter Installation).

Oil Cooler Cleaning-FH721D

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

6-8 LUBRICATION SYSTEM

Pressurized Lubrication System

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

Oil Pressure Measurement

- Remove the oil pressure switch or oil passage plug from the crankcase.
- Install an appropriately sized oil pressure gauge adapter [A] and oil pressure gauge [B].
- Run the engine and warm up thoroughly.
- Run the engine high idle speed and read the oil pressure gauge.
- Stop the engine.
- Remove the oil pressure gauge and the adapter.
- Apply silicone sealant to the threads of the pressure switch and tighten it, or tighten the oil passage plug.

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

Torque - Oil Pressure Switch : 9.8 N·m (1.0 kgf·m, 87 in·lb)

Oil Passage Plug : 3.9 N·m (0.40 kgf·m, 35 in·lb)

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

Oil Pressure

414 to 690 kPa (60 to 100 psi)

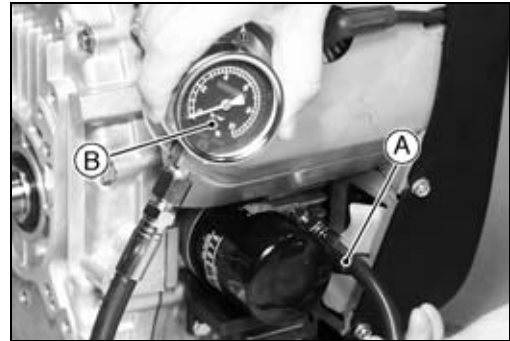
Measurement Condition

Engine Oil: 10W-30

Engine Oil Temperature: 50 ~ 60°C

Oil Pressure Switch

PT 1/8 (Taper Pipe Threads)



Pressurized Lubrication System

Oil Pressure Switch Inspection

When the oil pressure falls below 98 kPa (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 engine switch at the “OFF” position. Then turn the switch key to the “RUN” position. The warning light must be illuminated.
- When the engine is running be sure the warning light is “OFF”.
- ★ 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 when the engine starts 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 with a new one.
- ★ 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.

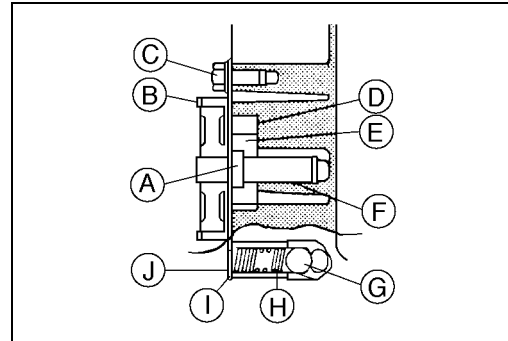
6-10 LUBRICATION SYSTEM

Oil Pump, Relief Valve

Oil Pump, Relief Valve Removal

- Remove the crankcase cover (see Camshaft/Crankshaft chapter).
- Unscrew the mounting bolts and remove the oil pump parts assembly (pump gear, pump cover plate, pump shaft, pins and rotors).
- Take off the relief valve spring and the ball.
- Disassemble the pump parts assembly.

Pin [A]
Pump Gear [B]
Mounting Bolts [C]
Outer Rotor [D]
Inner Rotor [E]
Pump Shaft [F]
Relief Valve Ball [G]
Spring [H]
Pump Cover Plate [I]
6 mm dia. Hole [J]

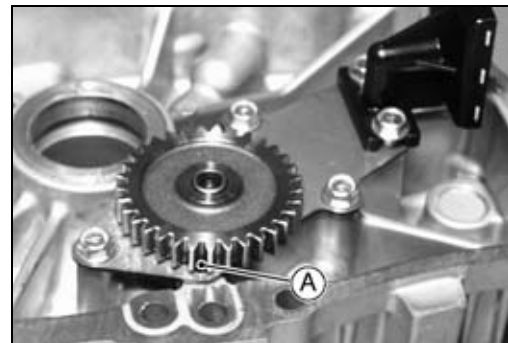


Oil Pump, Relief Valve Installation

- Fill the rotor housing with the engine oil for initial lubrication.
- Install the relief valve ball and spring in position, then install the pump parts assembly in the crankcase cover.

NOTE

○When installing the pump parts assembly, align the 6 mm dia. hole [A] on the cover plate with center of the relief valve.



- Install the mounting bolts and tighten them.

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

Oil Pump, Relief Valve Inspection

- Remove the oil pump (see Oil Pump, Relief Valve Removal).
- Visually inspect the pump gear, the outer and inner rotor, and the cover plate.
- ★ If there is any damage or uneven wear, replace them with new ones.
- Check the clearance [A] between the inner and outer rotor with a feeler gauge. Measure the clearance between the highest point of the inner rotor and the highest point of the outer rotor.
- ★ If the measured value exceeds the service limit, replace the rotors as a set with new ones.



Inner and Outer Rotor Clearance

Service Limit: 0.2 mm(0.008 in.)

Oil Pump, Relief Valve

- Measure the outside diameter [A] of the outer rotor with a micrometer at several points.
- ★ If the rotor diameter is less than the service limit, replace both the inner and outer rotor.

Outer Rotor Outside Diameter

Service Limit: 40.470 mm (1.5933 in.)

- Measure the thickness [B] of the outer rotor with a micrometer at several points.
- ★ If the rotor thickness is less than the service limit, replace both the inner and outer rotor with new ones.

Outer Rotor Thickness

Service Limit: 9.830 mm (0.3870 in.)

- Measure the inside diameter [A] of the pump housing with an inside micrometer at several points.
- ★ If the inside diameter is more than the service limit, replace the crankcase cover 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: 10.230 mm (0.4028 in.)

- Measure the outside [A] diameter of the pump shaft with a micrometer at several points.
- ★ If the diameter is less than the service limit, replace the pump shaft with a new one.

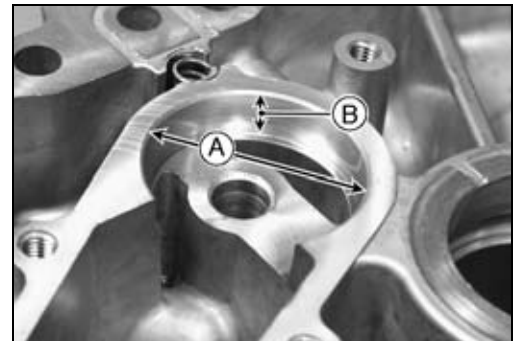
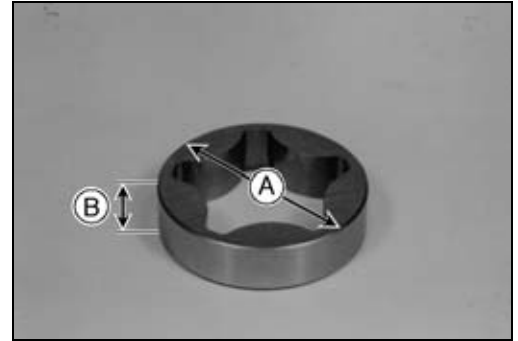
Pump Shaft Outside Diameter

Service Limit: 10.923 mm (0.4300 in.)

- Measure the inside diameter [A] of the pump shaft bearing in the crankcase cover with an inside micrometer at several points.
- ★ If the inside diameter is more than the service limit replace the crankcase cover with a new one.

Pump Shaft Bearing Inside Diameter

Service Limit: 11.072 mm (0.4359 in.)



6-12 LUBRICATION SYSTEM

Oil Pump, Relief Valve

- Visually inspect the relief valve spring, the steel ball and the valve seat in the crankcase cover.
- ★ If any rough spot is found during above inspection, wash the valve clean with a high-flash point solvent and blow out any foreign particles on the valve with compressed air.



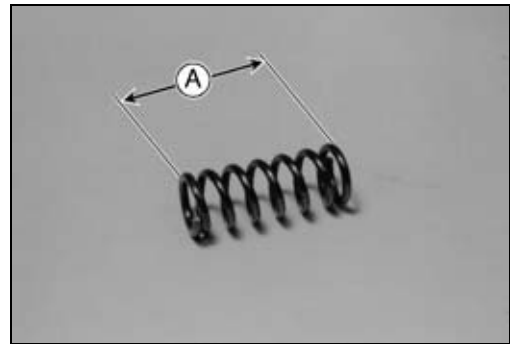
WARNING

Clean the parts in a well ventilated area, and take care that there is no spark or flame anywhere near the working areas. Because of the danger of highly flammable liquids, do not use gasoline or low-flash point solvents.

- ★ If cleaning does not solve the problem, replace the relief valve parts with new ones.
- ★ If necessary, put the ball in position and lightly tap the ball with a suitable tool to form a perfect seat.
- Measure the free length [A] of the spring with a vernier caliper.
- ★ If the free length of the spring is less than the service limit, replace the spring with a new one.

Relief Valve Spring Free Length

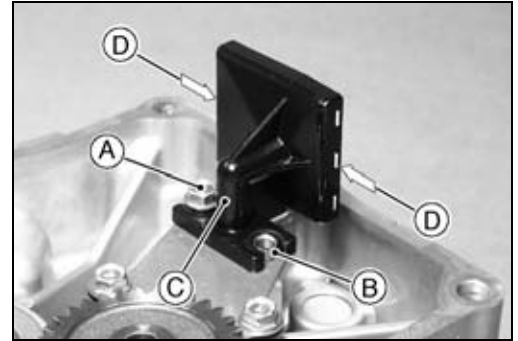
Service Limit: 19.50 mm (0.77 in.)



Oil Screen

Oil Screen Removal

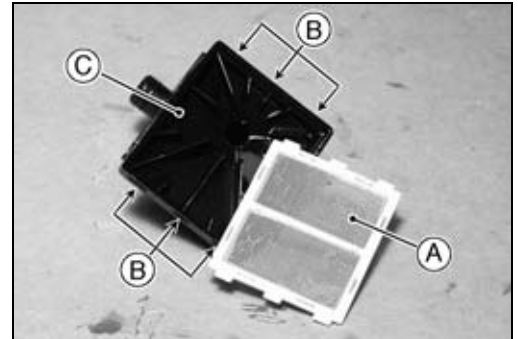
- Remove the crankcase cover (see Camshaft/Crankcase chapter).
- Unscrew the mounting bolts [A] and remove the spacers [B] and pipe [C].
- Push [D] the oil screen with thumbs and remove it.



Oil Screen Installation

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

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



Cleaning and Inspection

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



WARNING

Clean the screen in a well ventilated area, and take care that there is no spark or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or low-flash point solvents.

NOTE

○While cleaning the screen, check for any metal particles that might indicate internal engine damage with a new one.

- Check the screen carefully for any damage: holes and broken wire.
- ★If the screen is damaged, replace it with a new one.

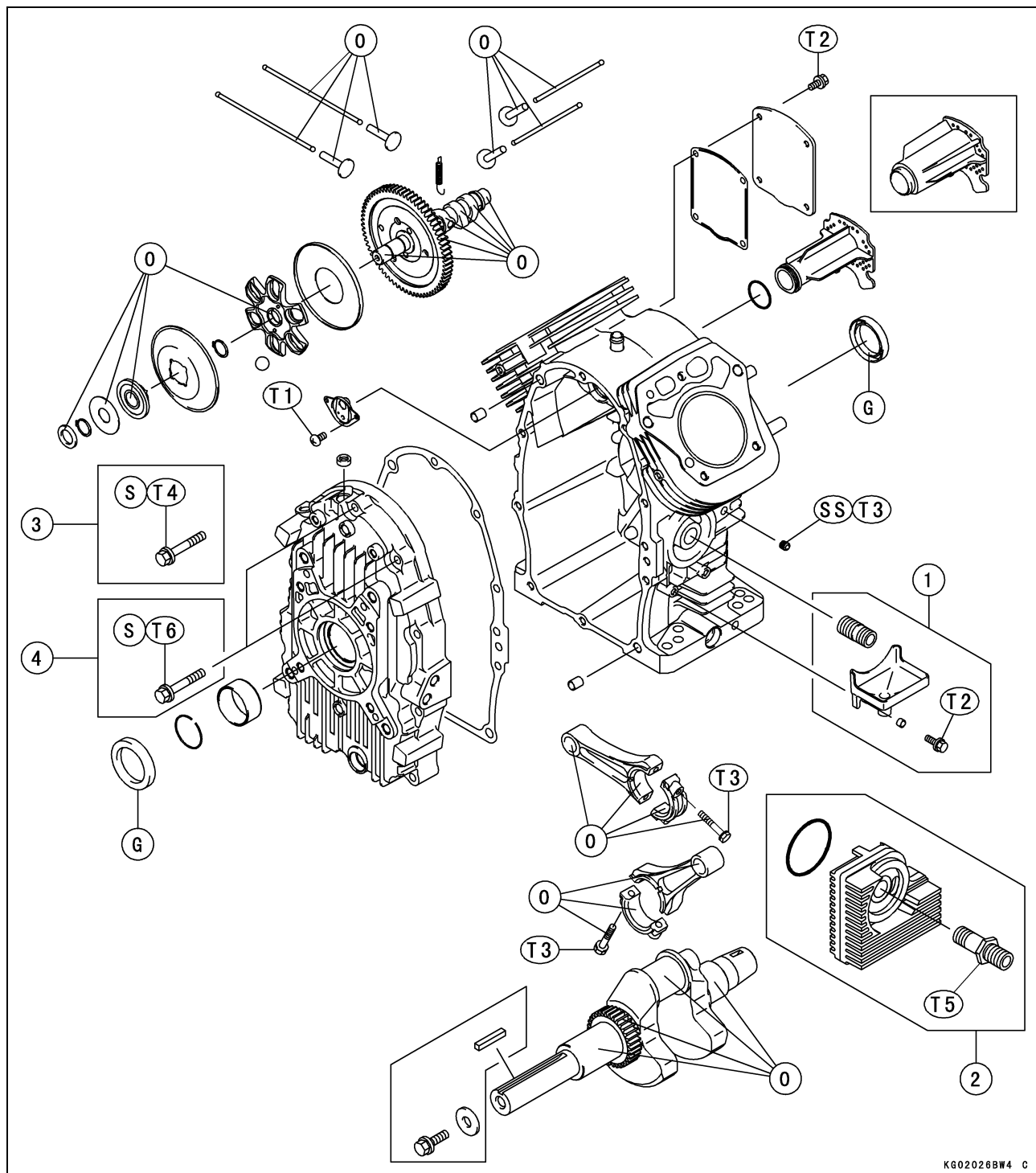
Camshaft/Crankshaft

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7-2 CAMSHAFT/CRANKSHAFT

Exploded View



KG020268W4 C

1. Other than FH721D Engine

2. FH721D Engine

3. Bolt marked "9" on the top end

Beginning Engine No.~ FH601DA09541

Beginning Engine No.~ FH641DA02234

Beginning Engine No.~ FH680DA33212

Beginning Engine No.~ FH721DA55225

4. Bolt marked "10" on the top end

FH601DA09542 ~

FH641DA02235 ~

FH680DA33213 ~

FH721DA55226 ~

G: Apply grease.

O: Apply engine oil.

S: Follow the specific tightening sequence.

SS: Apply silicone sealant.

T1: 2.0 N·m (0.20 kgf·m, 18 in·lb)

T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)

T3: 9.8 N·m (1.0 kgf·m, 87 in·lb)

T4: 25 N·m (2.6 kgf·m, 19 ft·lb)

T5: 44 N·m (4.5 kgf·m, 33 ft·lb)

T6: 32 N·m (3.3 kgf·m, 23.6 ft·lb)

Specifications

Item	Service Limit
Camshaft, Tappet	
Cam Lobe Height:	
Inlet	29.621 mm (1.166 in.)
Exhaust	29.621 mm (1.166 in.)
Camshaft Journal Diameter:	
PTO Side	15.985 mm (0.6293 in.)
Flywheel Side	15.985 mm (0.6293 in.)
Camshaft Bearing Inside Diameter:	
Crankcase	16.136 mm (0.6352 in.)
Crankcase Cover	16.136 mm (0.6352 in.)
Crankshaft, Connecting Rod	
Connecting Rod Bend	0.15/100 mm (0.006/3.94 in.)
Connecting Rod Twist	0.15/100 mm (0.006/3.94 in.)
Connecting Rod Big End Width	20.45 mm (0.805 in.)
Crankpin Width	43.1 mm (1.697 in.)
Connecting Rod Big End Inside Diameter	40.044 mm (1.5765 in.)
Crankpin Outside Diameter	39.940 mm (1.5724 in.)
Crankshaft Runout	0.05 mm (0.002 in.) TIR
Crankshaft Journal Diameter:	
PTO Side	39.896 mm (1.571 in.)
Flywheel Side	39.896 mm (1.571 in.)
Crankcase	
PTO Shaft Bearing Inside Diameter:	
Crankcase Cover	40.15 mm (1.581 in.)
Crankshaft Journal Bearing Inside Diameter:	
Crankcase	40.15 mm (1.581 in.)

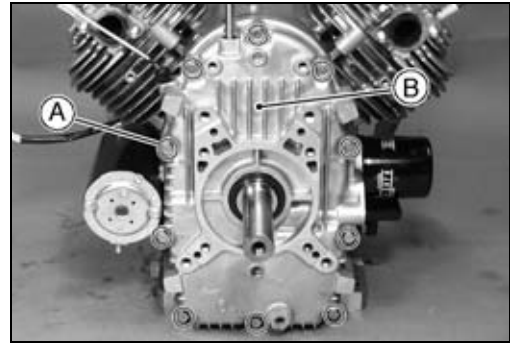
Sealant - Kawasaki Bond (Silicone Sealant): 56019-120

7-4 CAMSHAFT/CRANKSHAFT

Crankcase

Crankcase Cover Removal

- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Lubrication System chapter).
- Remove:
 - Exhaust Pipe and Muffler (see Engine Top End chapter)
 - Control Panel (see Fuel System chapter)
 - Governor Arm (see Fuel System chapter)
- Unscrew the mounting bolts [A] and remove the crankcase cover [B] from the crankcase.
- There are two knock pins on the crankcase mating surface. Using a wooden or plastic mallet, gently tap the crankcase to loosen the crankcase cover.



Crankcase Cover Installation

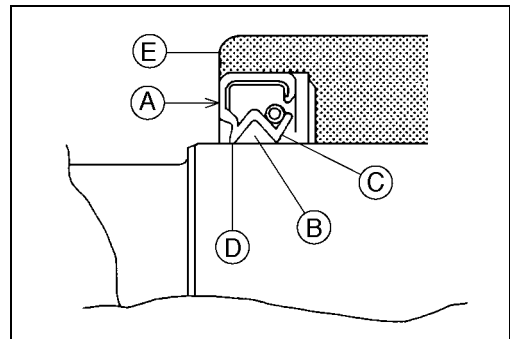
- Remove the old gasket from the mating surfaces of the crankcase and cover.
- Using compressed air, blow out the oil passage in the crankcase cover.
- With a high-flash point solvent, clean off the mating surfaces of the crankcase and the cover, and wipe them dry.



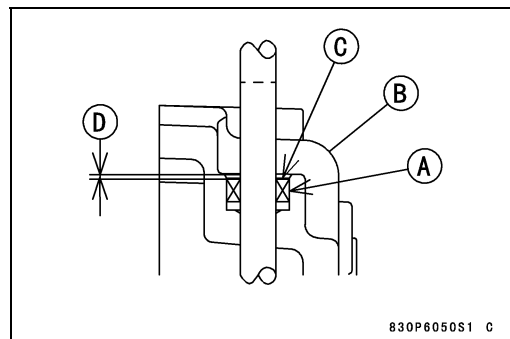
WARNING

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

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



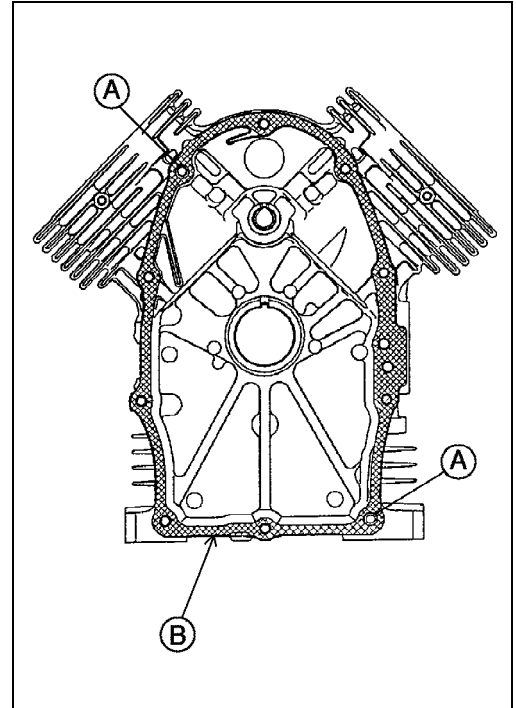
- When replacing the oil seal [A] of the governor shaft, note the following.
- Install the oil seal into the crankcase cover [B] after inserting the governor shaft in the cover, and so that the marks [C] face out.
- The depth [D] is 0~2 mm (0~0.08 in.).
- When installing the governor shaft and plate in the crankcase cover, see Fuel System chapter.



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Crankcase

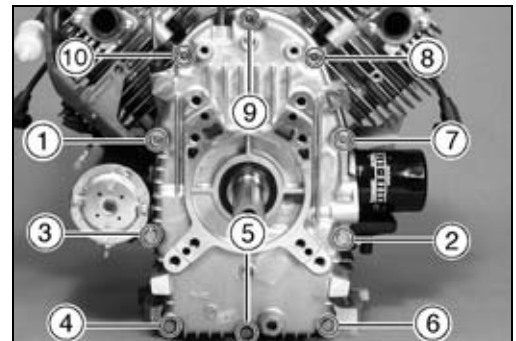
- Check to see that the crankcase dowel pins [A] are in place on the crankcase.
- Install the gasket [B] on the crankcase.



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

Torque - Crankcase Cover Bolts (Bolt marked "9" on the top end): 25 N·m (2.6 kgf·m, 19.0 ft·lb)
 Beginning Engine No.~ FH601DA09541
 Beginning Engine No.~ FH641DA02234
 Beginning Engine No.~ FH680DA33212
 Beginning Engine No.~ FH721DA55225

Crankcase Cover Bolts (Bolt marked "10" on the top end): 32 N·m (3.3 kgf·m, 23.6 ft·lb)
 FH601DA09542 ~
 FH641DA02235 ~
 FH680DA33213 ~
 FH721DA55226 ~



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

Inspection

- Measure the inside diameter [A] of the PTO shaft bearing on the crankcase cover at several points. This bearing is not replaceable. Replace the crankcase cover with a new one if the inside diameter is greater than the service limit.

PTO Shaft Bearing Inside Diameter

Service Limit: 40.15 mm (1.581 in.)



7-6 CAMSHAFT/CRANKSHAFT

Crankcase

- Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase at several points. This bearing is not replaceable. Replace the crankcase with a new one if the inside diameter is greater than the service limit.

Crankshaft Journal Bearing Inside Diameter

Service Limit: 40.15 mm (1.581 in.)



Cleaning

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



WARNING

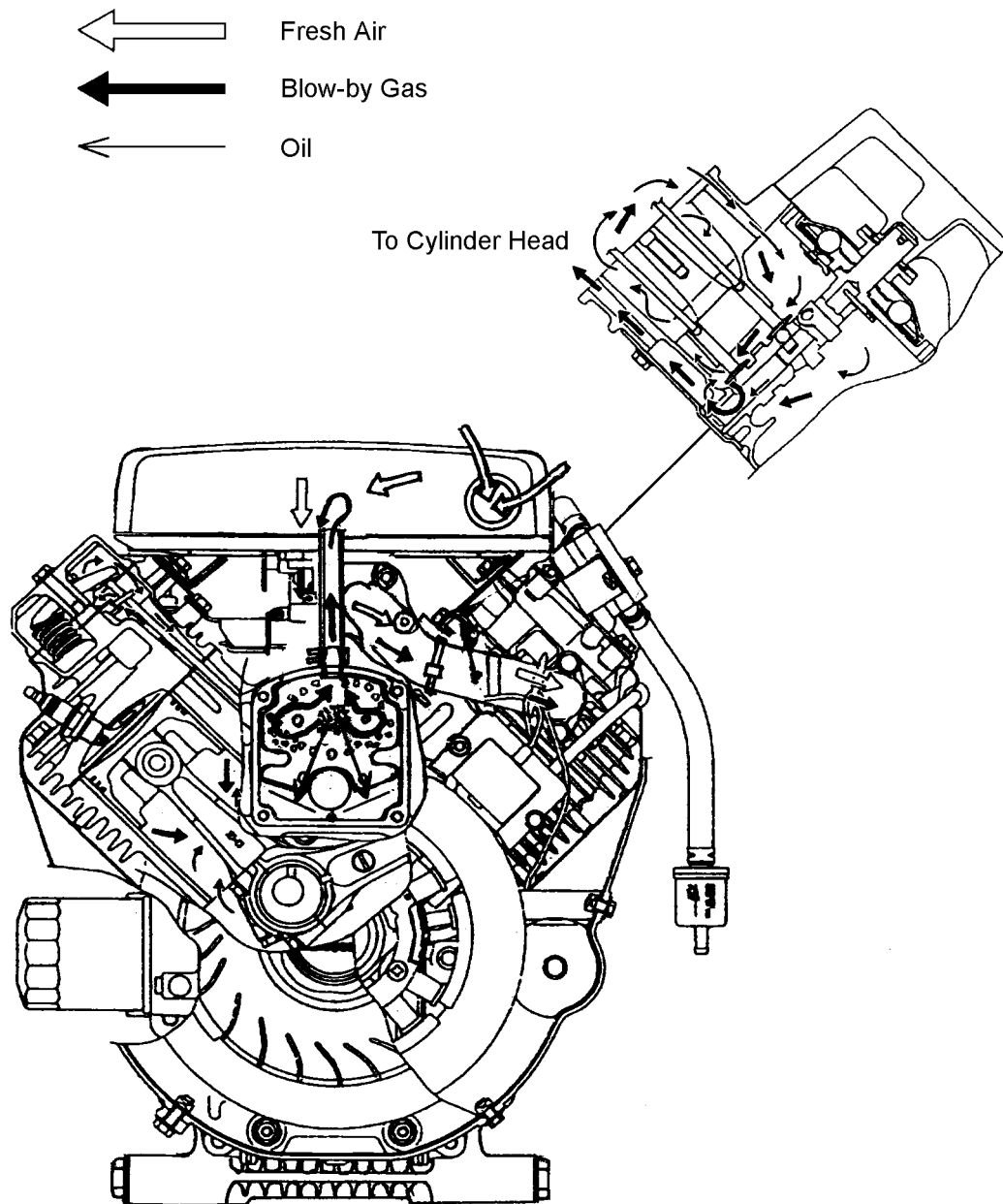
Clean the crankcase and cover in a well ventilated area, and take care that there is no spark or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or low-flash point solvents.

Breather

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

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

[Standard Type]

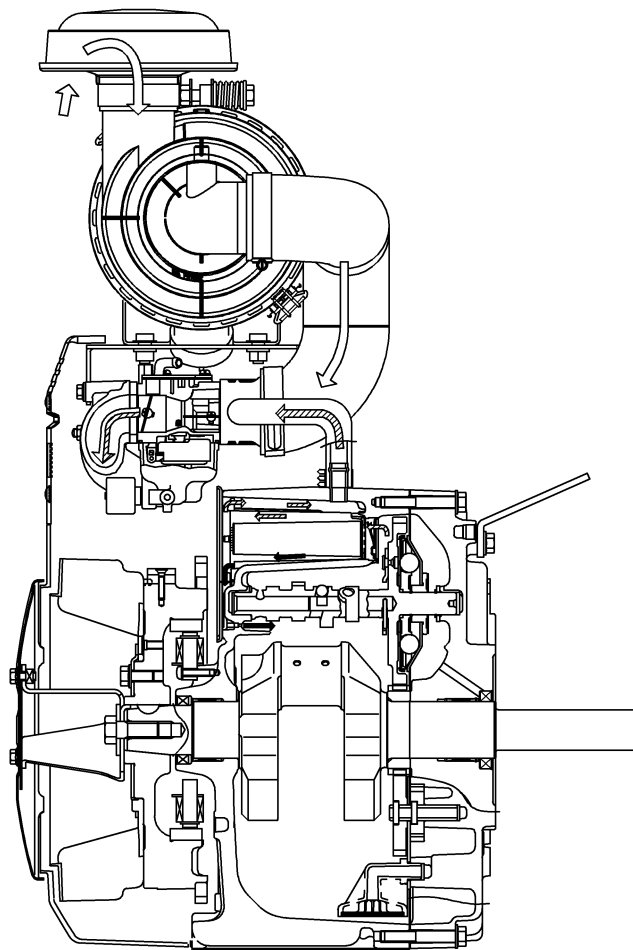
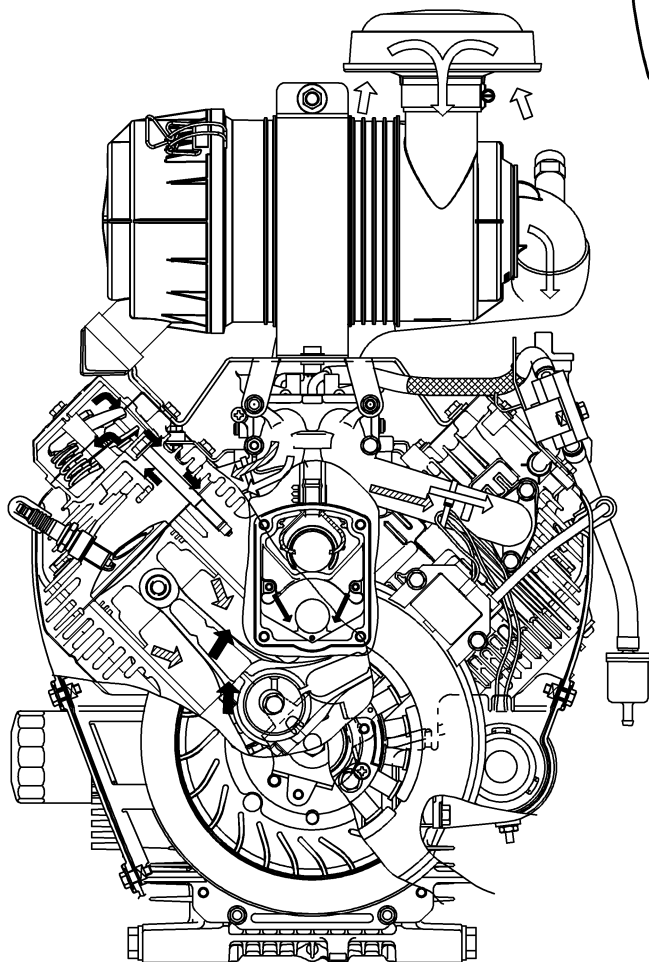


7-8 CAMSHAFT/CRANKSHAFT

Breather

[Heavy Duty Type]

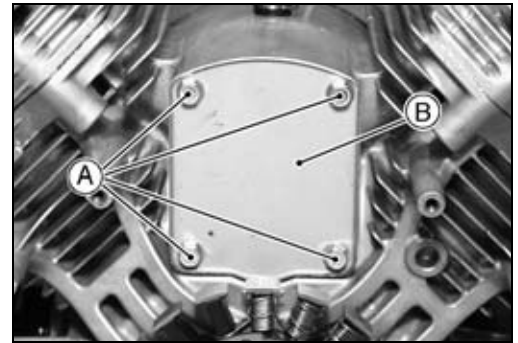
- ← OIL
- ⇐ FRESH AIR
- ⇨ BLOW-BY GAS



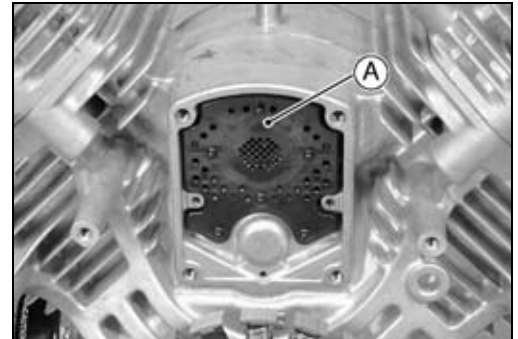
Breather

Breather Valve Removal

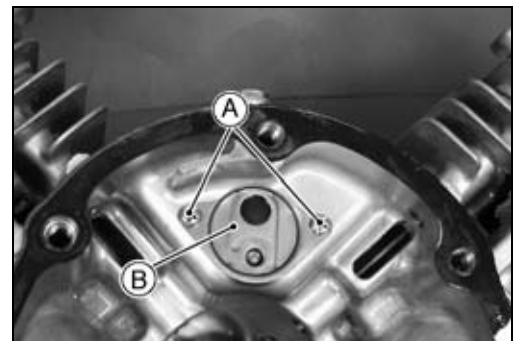
- Remove the bolts [A] and the breather chamber cover [B].



- Remove the pipe [A].

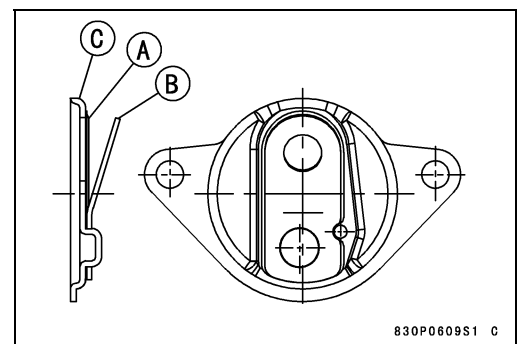


- Remove the breather valve [B] unscrewing the mounting screws [A] at the cam gear side of the crankcase (see Camshaft, Tappet Removal).



Breather Valve Inspection

- Visually inspect the reed valve [A] for breakage, hair cracks or distortion, replace it with a new one if necessary.
- Visually inspect the back plate [B] for damage or rough contact surface, replace it with a new one if necessary.
- Inspect the valve seating surface [C]. The surface should be free of nicks or burrs.



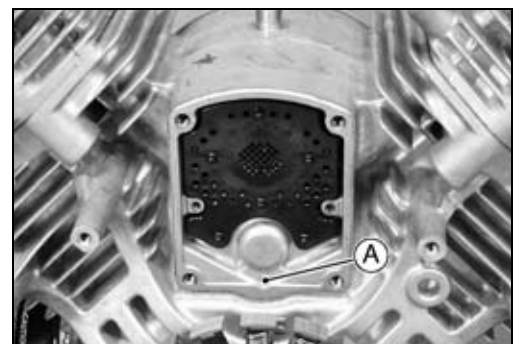
Breather Valve Installation

- Be sure that the drain hole [A] on the breather chamber is not accumulated with slugs.
- Install the breather valve on the cam gear side of the crankcase (see Camshaft, Tappet Removal).

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

- Install a new gasket so that the silicone bead side faces the crankcase and the breather chamber cover, and tighten the bolts.

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

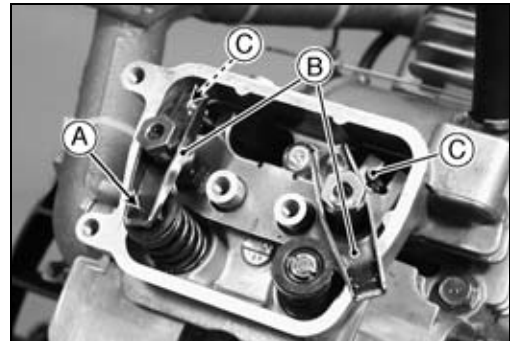
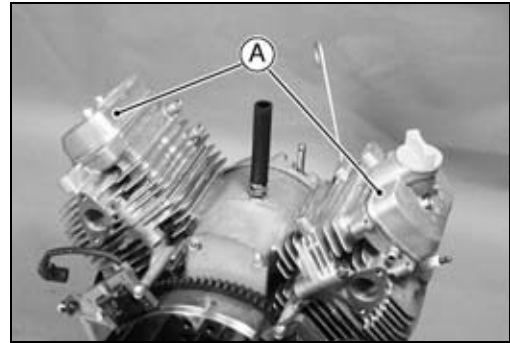


7-10 CAMSHAFT/CRANKSHAFT

Camshaft, Tappet

Camshaft, Tappet Removal

- Set the engine on a clean surface while parts are removed.
- Drain the oil (see Lubrication System chapter).
- Remove:
 - Muffler (see Engine Top End chapter)
 - Throttle Control Panel (see Fuel System chapter)
 - Carburetor (see Fuel System chapter)
 - Inlet Manifold (see Fuel System chapter)
 - Crankcase Cover (see Crankcase Cover Removal)
 - Rocker Covers [A]
- Position the piston at the TDC of the compression stroke.
- Push down [A] the spring side of the rocker arm [B] and move it to clear the push rod [C].
- Remove the push rods and mark them so they can be installed in their original positions during assembly.
- Turn the crankcase upside down so that the tappets will fall away from the cam lobes.
- Pull the camshaft [A] out of the crankcase.

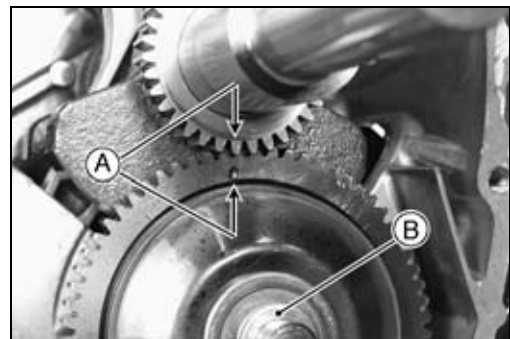


- Remove the tappets [A] and mark them to reinstall in their original positions during assembly.



Camshaft, Tappet Installation

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



Camshaft, Tappet

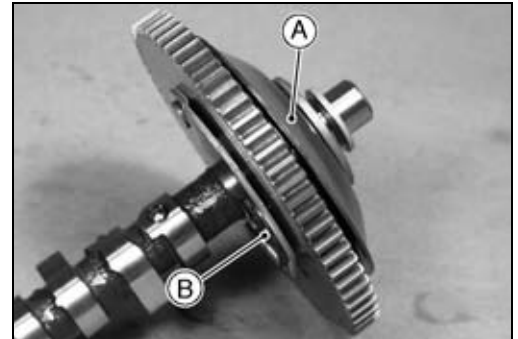
Camshaft Disassembly

- Remove the governor assembly (see Fuel System chapter).
- Remove:
 - Spring [A]
- Do not remove the ACR (automatic compression release) weight [B].



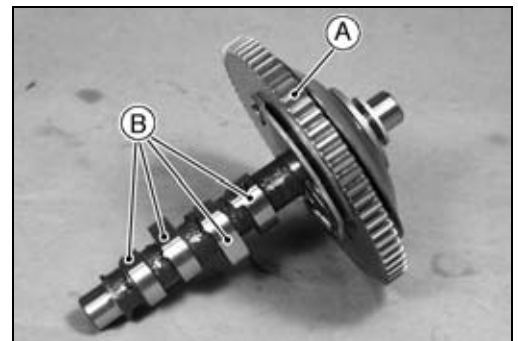
Camshaft Assembly

- Install the governor assembly (see Fuel System chapter).
- After assembling the camshaft, check the following items.
 - The governor plate [A] must move freely.
 - While shaking the camshaft, check if the ACR weight [B] swings smoothly.



Camshaft Inspection

- Check the camshaft gear [A] for pitting, fatigue cracks, burrs or any evidence of improper tooth contact.
- ★ Replace the shaft with a new one if necessary.
- Check the top of the cam lobes [B] for wear, burrs or uneven contact.
- ★ Replace the shaft with a new one if necessary.



Camshaft Bearing/Journal Wear

- Measure the height 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:	IN. 29.621 mm (1.166 in.)
	EX. 29.621 mm (1.166 in.)



- Measure both camshaft journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the camshaft with a new one.

PTO Side Camshaft Journal Diameter

Service Limit:	15.985 mm (0.6293 in.)
----------------	------------------------

Flywheel Side Camshaft Journal Diameter

Service Limit:	15.985 mm (0.6293 in.)
----------------	------------------------



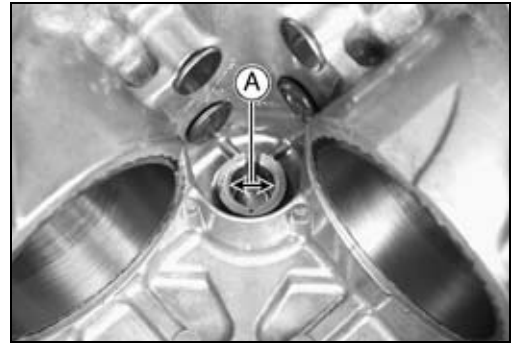
7-12 CAMSHAFT/CRANKSHAFT

Camshaft, Tappet

- Measure the inside diameter [A] of the camshaft bearing on the crankcase at several points. This bearing is not replaceable.
- ★ If the inside diameter is greater than the service limit, replace the crankcase with a new one.

Camshaft Bearing Inside Diameter (Crankcase)

Service Limit: 16.136 mm (0.6352 in.)



- Measure the inside diameter [A] of the camshaft bearing on the crankcase cover at several points. This bearing is not replaceable.
- ★ If the inside diameter is greater than the service limit, replace the crankcase cover with a new one.

Camshaft Bearing Inside Diameter (Crankcase Cover)

Service Limit: 16.136 mm (0.6352 in.)



Crankshaft, Connecting Rod

Connecting Rod Removal

- Remove:
Piston (see Engine Top End Chapter)

Connecting Rod Installation

- Install:
Piston (see Engine Top End chapter)

Crankshaft Removal

- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Lubrication System chapter).
- Remove:
Flywheel (see Electrical System chapter)
Camshaft (see Camshaft, Tappet Removal)
Connecting Rod and Piston Assembly (see Engine Top End chapter)
- Pull the crankshaft [A] out of the crankcase. Using a wooden or plastic mallet, gently tap the crankcase 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 journal and bearing.
- Carefully insert the crankshaft flywheel end into the main bearing and the oil seal in the crankcase.

Cleaning/Inspection

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

7-14 CAMSHAFT/CRANKSHAFT

Crankshaft, Connecting Rod

Connecting Rod Bend/Twist

- Measure the connecting rod bend.
- Select an arbor of the same diameter of the connecting rod big end, and insert the arbor through the connecting rod big end.
- Select an arbor of the same diameter of the piston pin and at least 100 mm 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 100 mm (3.94 in.). Then determine the connecting rod bend from the measured height differences.
- ★ If the connecting rod bend exceeds the service limit, replace the connecting rod with a new one.

Connecting Rod Bend

Service Limit: 0.15/100 mm (0.006/3.94 in.)

- Measure the connection rod twist.
- With the big end arbor still on the V blocks, hold the connection rod horizontally and measure the amount that the small end arbor difference. Using a dial gauge, measure the height at two different positions and the distance of the two positions is 100 mm (3.93 in.). Then determine the connecting rod twist from the measured height differences.
- ★ If connection rod twist exceeds the service limit, replace the connecting rod with a new one.

Connecting Rod Twist

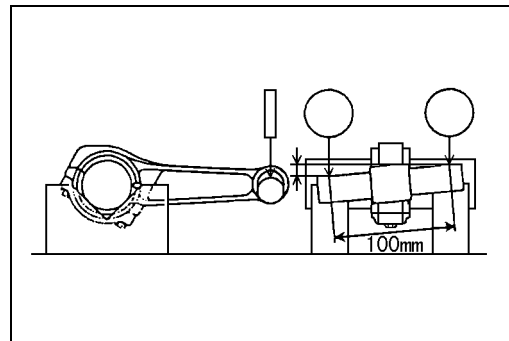
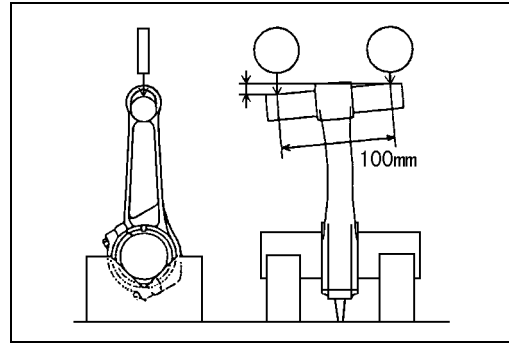
Service Limit: 0.15/100 mm (0.006/3.94 in.)

Connecting Rod Big End/Crankpin Width Wear

- Measure the connecting rod big end width [A] with a micrometer or a dial caliper.
- ★ If the measurement is less than the service limit, replace the connecting rod with a new one.

Connecting Rod Big End Width

Service Limit: 20.45 mm (0.805 in.)

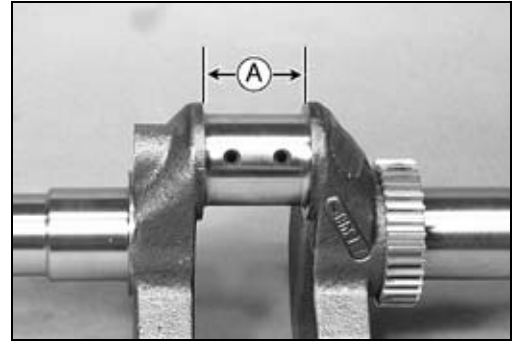


Crankshaft, Connecting Rod

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

Crankpin Width

Service Limit: 43.10 mm (1.697 in.)

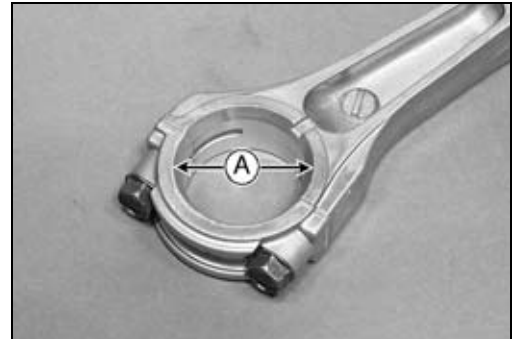


Connecting Rod Big End Bearing/Crankpin Wear

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

Connecting Rod Big End Inside Diameter

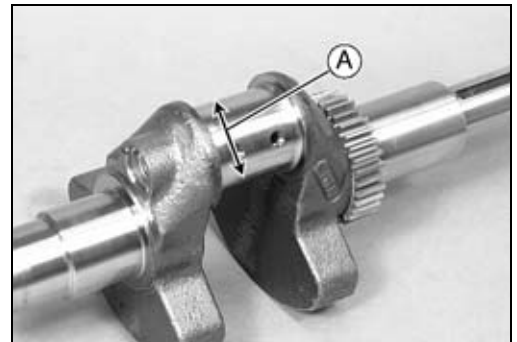
Service Limit: 40.044 mm (1.5765 in.)



- 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: 39.940 mm (1.5724 in.)

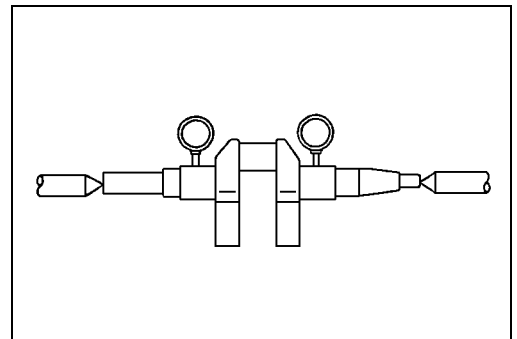


Crankshaft Runout

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

Crankshaft Runout

Service Limit: 0.05 mm (0.002 in.) TIR



7-16 CAMSHAFT/CRANKSHAFT

Crankshaft, Connecting Rod

Crankshaft Main Journal/Wear

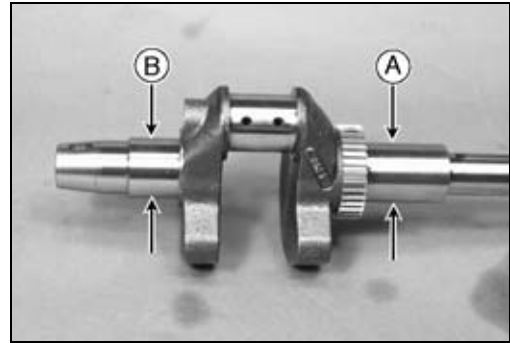
- Measure both main journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the crankshaft with a new one.

PTO Side Crankshaft Journal Diameter [A]

Service Limit: 39.896 mm (1.571 in.)

Flywheel Side Crankshaft Journal Diameter [B]

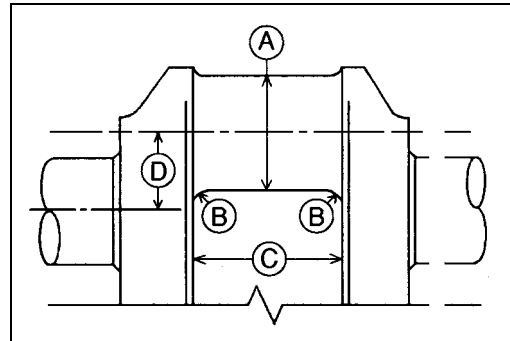
Service Limit: 39.896 mm (1.571 in.)



Crankpin Resizing

Crankpin can be resized to accept 39.5 mm (1.5551 in.) dia under size connecting rod. The crankpin should be reground if the crankpin is so much undersize and so much scored that a lapping operation will prove unsatisfactory. Reground can be done by a reliable repair shop.

- Before sending the crankshaft, inspect the crankpin for cracks.
- ★ If any cracks, no matter how small, are found, the crankshaft must be rejected.
- The final finishing dimensions should be shown in the table.



Finishing Dimensional Specifications

[A]	39.457 ~ 39.470 mm (1.5534 ~ 1.5539 in.)
[B]	R 2.3 ~ 2.7 mm
[C]	43.0 mm MAX (1.693 in. MAX)
[D]	37.95 ~ 38.05 mm (1.4941 ~ 1.4980 in.)

- The crankpin surface should be concentric and parallel to each other within 0.006 mm (0.0002 in.) full indicator reading.
- Finish the crankpin surface with a super finishing stone.

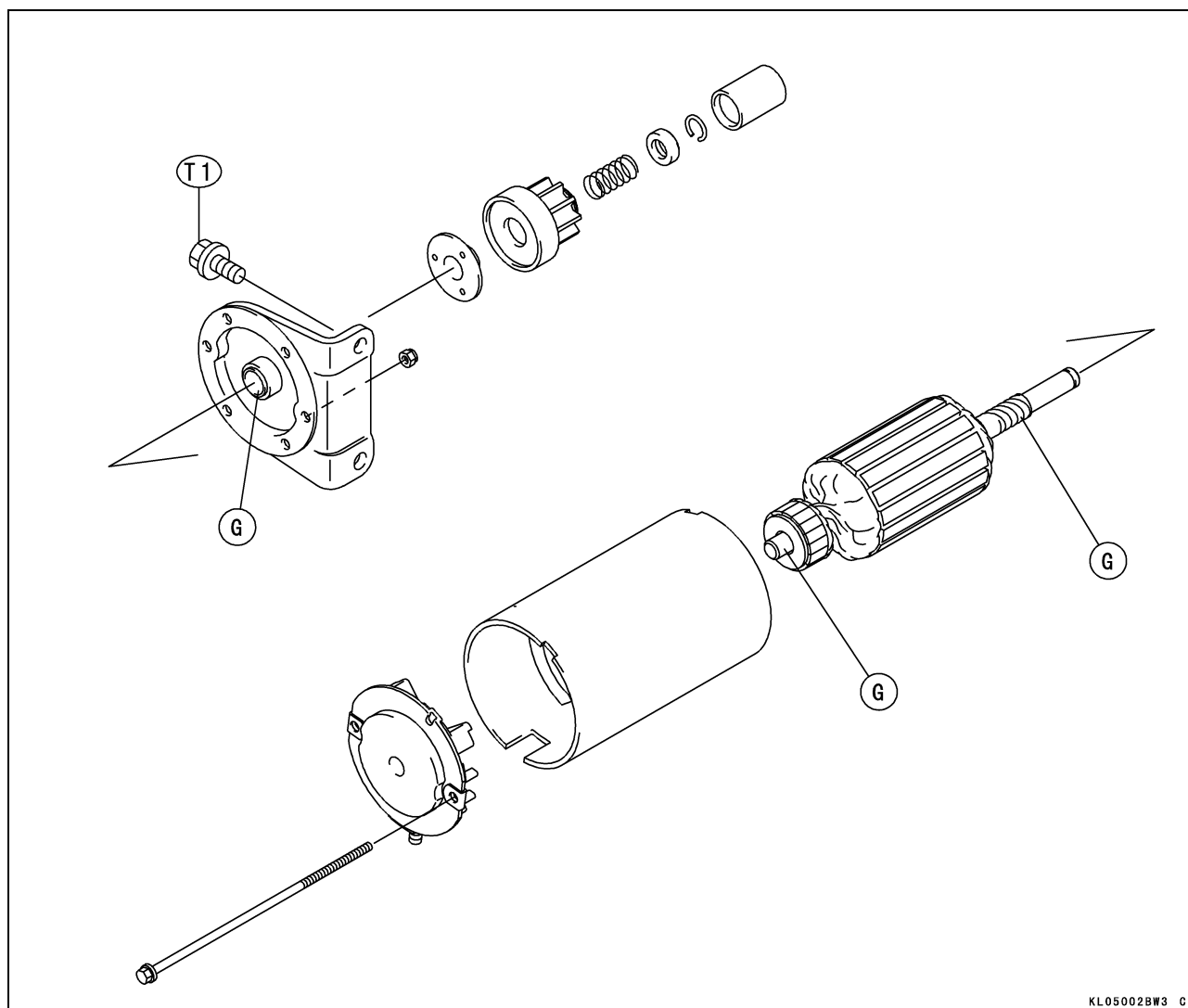
Starter System

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8-2 STARTER SYSTEM

Exploded View



G: Apply grease.
T1: 15 N·m (1.5 kgf·m, 11 ft·lb)

Specifications

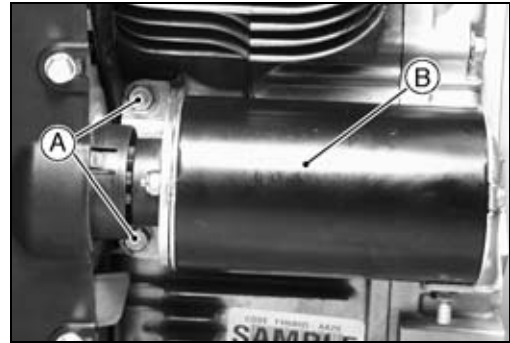
Item	Standard	Service Limit
Electric Starter System		
Starter Motor:		
Carbon Brush Length (with Spring Boss)	12.7 mm (0.500 in.)	6.4 mm (0.250 in.)
Commutator Groove Depth (Approx.)	2.0 mm (0.078 in.)	0.9 mm (0.035 in.)
Commutator Diameter	31.7 mm (1.250 in.)	31.1 mm (1.225 in.)
Commutator Runout	— — —	0.4 mm (0.016 in.)

8-4 STARTER SYSTEM

Starter System

Starter Motor Removal

- Remove the mounting bolts [A] and pull the starter motor [B] from the engine.



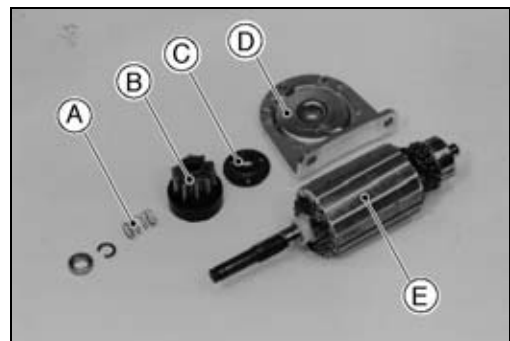
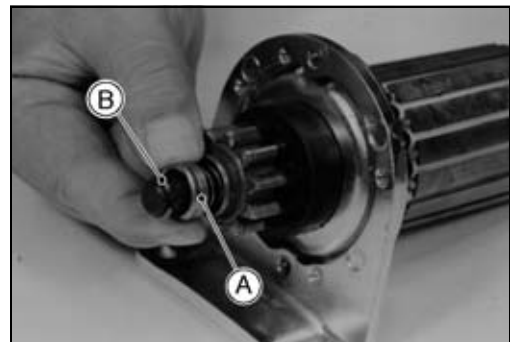
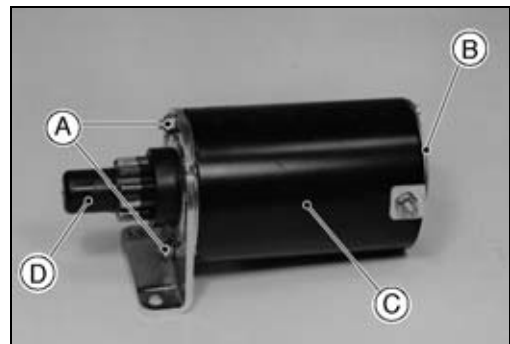
Starter Motor Installation

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

Torque - Starter Motor Mounting Bolts: 15 N·m (1.5 kgf·m, 11.0 ft·lb)

Starter Motor Disassembly

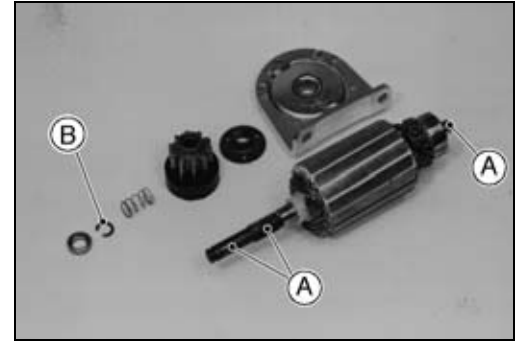
- Remove:
 - Through Bolts and Nuts [A]
 - Brush Plate [B]
 - York [C]
 - Cap [D]
- While pushing the collar [A], remove the snap ring [B].
- Remove:
 - Spring [A]
 - Pinion Assembly [B]
 - Washer [C]
 - Bracket [D]
 - Armature [E]



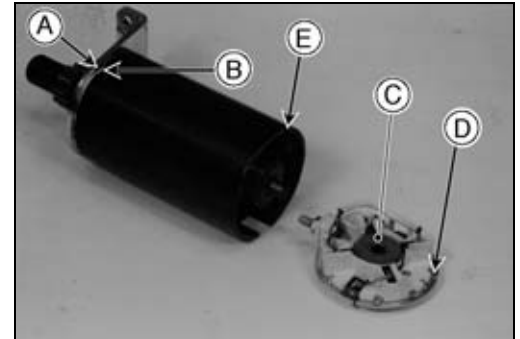
Starter System

Starter Motor Assembly

- Assemble the starter motor in the reverse of disassembly.
- Apply a small amount of grease [A] to the armature shaft.
- Do not reuse the snap ring [B]. Replace it with a new one.
- Check the cap and replace it with a new one if damaged.



- Fit the projection [A] on the bracket into the notch [B] in the yoke.
- Press the springs and holding the brush leads with suitable clips.
- Put the washer [C] among the brushes.
- Fit the projection [D] on the brush plate into the notch [E] in the yoke.

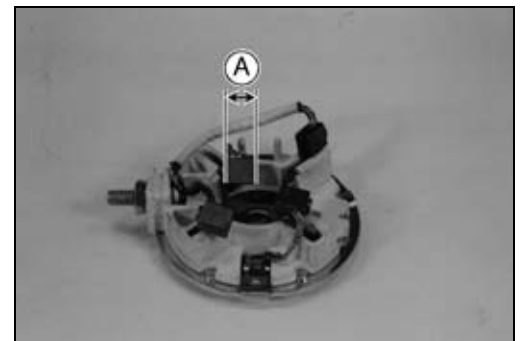


Starter Motor Brush Inspection

- Measure the overall length of each brush [A].
- ★ If the brushes are shorter than the service limit, replace them with new ones.

Brush Length

Service Limit: 6.4 mm (0.25 in.)

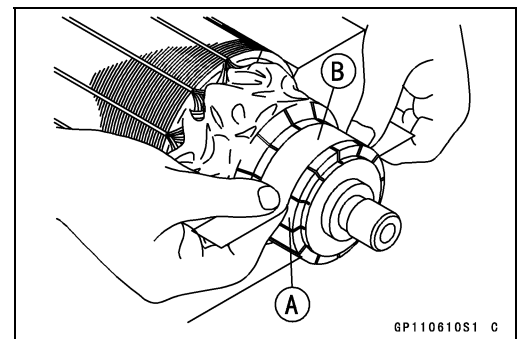


Brush Spring Inspection

- Inspect the brush springs for pitting, cracks, rusting and burrs.
- ★ Replace the spring with a new one if necessary.
- Inspect the springs for weakened conditions and distortion.
- ★ Replace the springs with new ones if necessary.
- ★ If the brush springs can press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them with new ones.

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.



8-6 STARTER SYSTEM

Starter System

- 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 Limit

0.9 mm (0.035 in.)

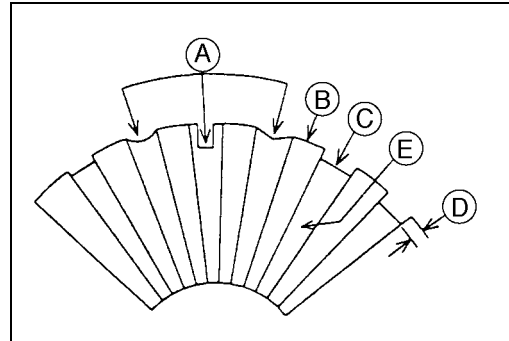
Bad [A]

Segment [B]

Good [C]

0.9 mm (0.035 in.) limit [D]

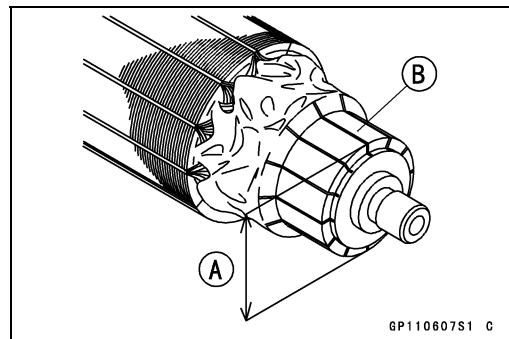
Mica [E]



- Measure the commutator outside diameter [A] at several points.
- ★ If the diameter is less than the service limit, replace the armature with a new one.

Commutator Outside Diameter

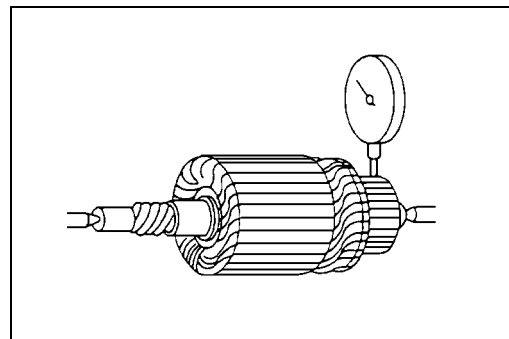
Service Limit: 31.1 mm (1.225 in.)



- Support the armature in an alignment jig at each end of the shaft as shown in the figure. Position a dial indicator perpendicular to the commutator.
- Rotate the armature slowly and read the commutator runout.
- ★ If runout is greater than the service limit, turn down the commutator or replace the armature with a new one.

Commutator Runout

Service Limit: 0.4 mm (0.016 in.)



- Measure the armature winding resistance.
- Set the hand tester to the $R \times 1 \Omega$ range and measure the resistance between each segment [A] and all the others.
- ★ If the resistance is too high or even infinite, the armature winding has an open circuit. Replace the starter motor with a new one.

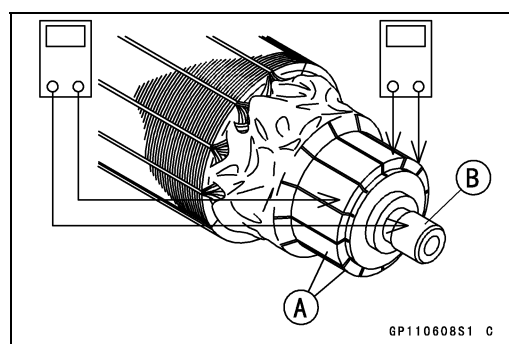
Armature Winding Resistance

Close to 0 Ω

- Set the hand tester to the $R \times 1 \text{ k}\Omega$ range and measure the resistance between the commutator and the armature shaft [B].
- ★ If the resistance is less than infinite, the armature is shorted. Replace the starter motor with a new one.

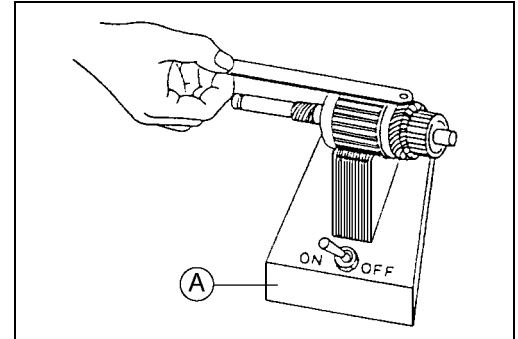
Commutator to Shaft Resistance

(∞)



Starter System

- 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, replace the starter motor with a new one.



Yoke Assembly Inspection

- Set the hand tester to the $R \times 1 \text{ k}\Omega$ range and measure the resistance between the positive brush (es) [A] and brush plate [B].
- ★ If the resistance is less than infinite, the positive brush is shorted to ground. Replace the brush plate assembly with a new one.

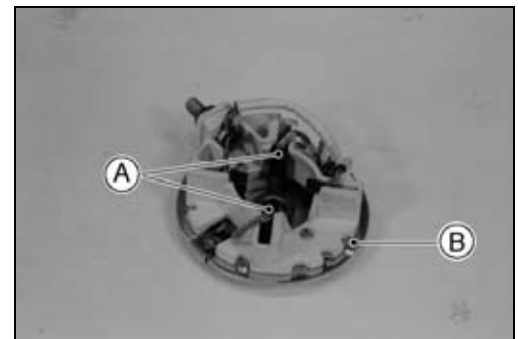
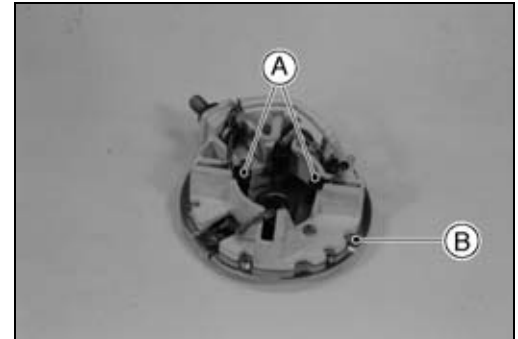
Positive Brush to Ground Resistance

(∞)

- Set the hand tester to the $R \times 1 \Omega$ range and measure the resistance between the negative brush (es) [A] and brush plate [B].
- ★ If the meter does not read close to 0Ω , the brush plate is faulty. Replace the brush plate assembly with a new one.

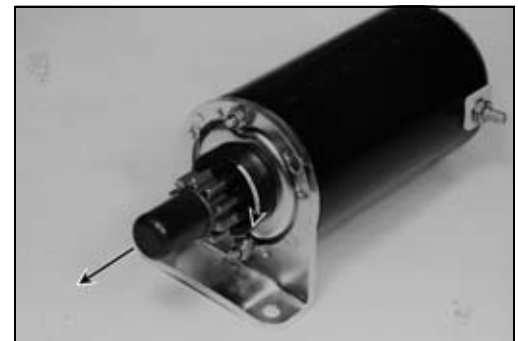
Negative Brush to Ground Resistance

Close to 0Ω



Pinion Clutch Inspection

- Turn the pinion gear by hand. The pinion gear should turn clockwise freely.
- ★ If the pinion clutch does not operate as it should, or if it makes noise, replace the pinion clutch with a new one.



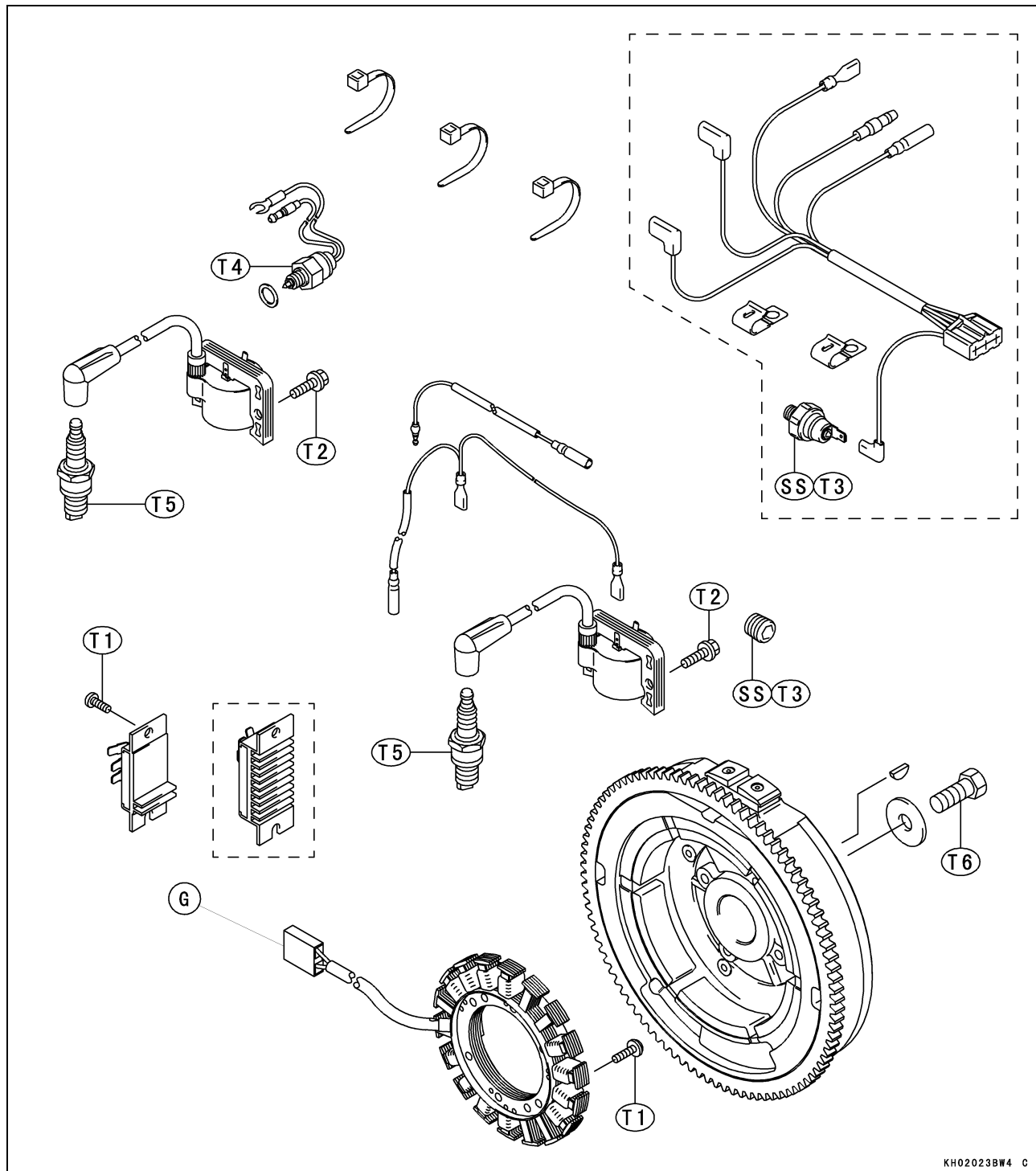
Electrical System

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9-2 ELECTRICAL SYSTEM

Exploded View



KH02023BW4 C

G: Apply grease [Three Bond: TB2585G or Grease No. Rykon premium grease EP#2 general purpose (Green)].

SS: Apply silicone sealant.

T1: 3.4 N·m (0.35 kgf·m, 30 in·lb)

T2: 5.9 N·m (0.60 kgf·m, 52 in·lb)

T3: 9.8 N·m (1.0 kgf·m, 87 in·lb)

T4: 19 N·m (1.9 kgf·m, 14 ft·lb)

T5: 22 N·m (2.2 kgf·m, 16 ft·lb)

T6: 56 N·m (5.7 kgf·m, 41 ft·lb)

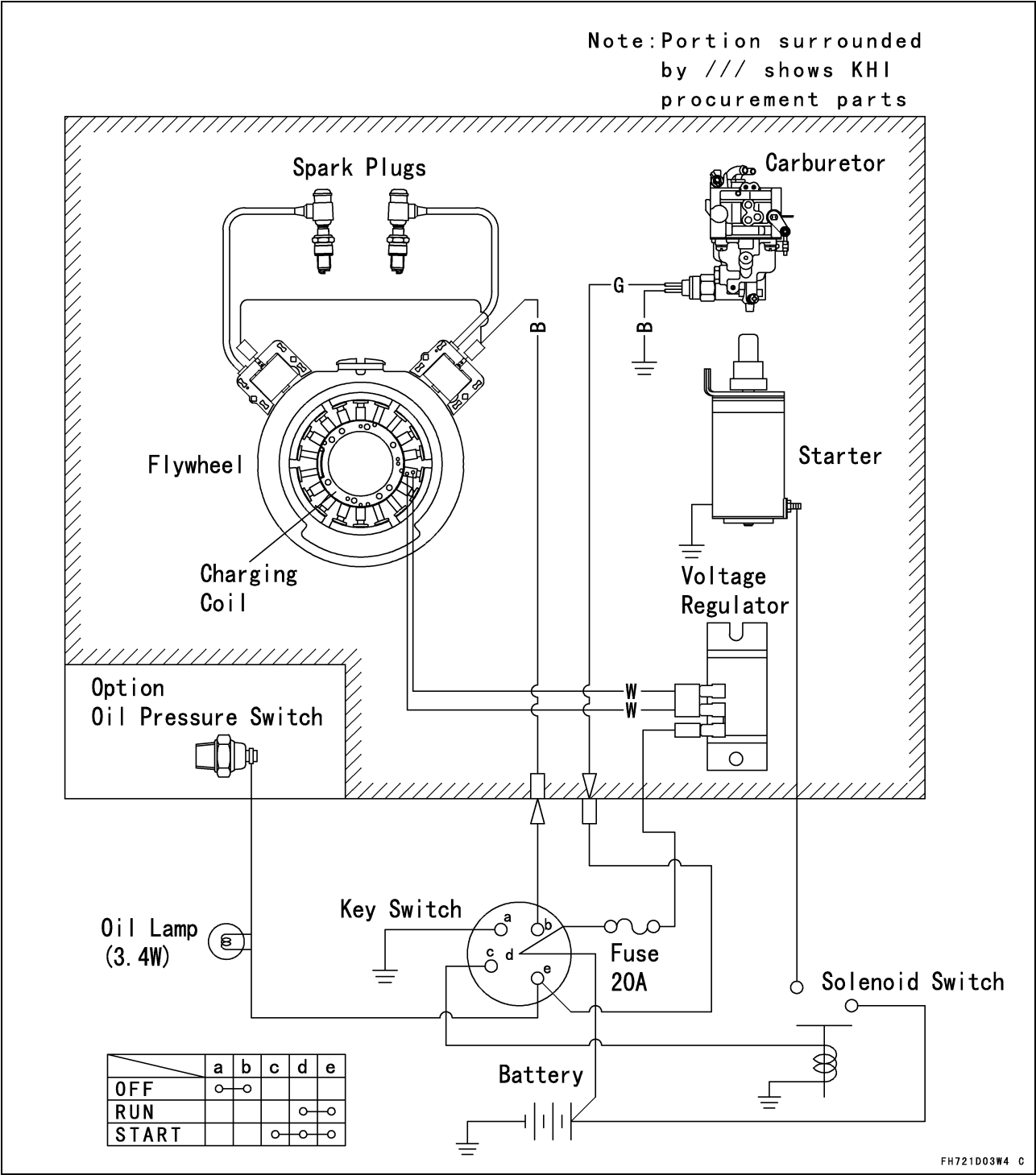
Specifications

Item	Standard	Service Limit
Charging System		
Regulated Output Voltage	14.1 V DC	15 V DC
Alternator Stator Coil Resistance	in the text	— — —
Unregulated Stator Output	28.4 V AC/3 000 rpm	26 V AC/3 000 rpm
Regulator Resistance	in the text	
Ignition System		
Ignition Coil:		
Primary Winding Resistance	in the text	— — —
Secondary Winding Resistance	8 to 11 kΩ	— — —
Spark Plug:	CHAMPION RCJ8Y	— — —
Plug Gap	1.0 mm (0.040 in.)	— — —

Special Tool - Hand Tester: 57001-1394

9-4 ELECTRICAL SYSTEM

Wiring Diagram

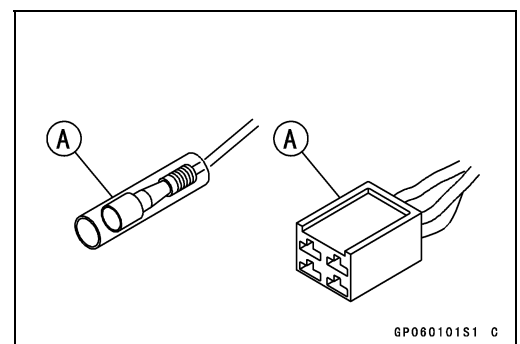


Precautions

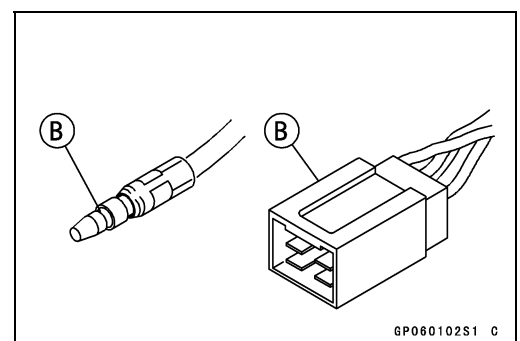
There are a number of important precautions that you must follow when servicing electrical systems. Learn and observe all the rules below.

- Do not reverse the battery cable connections. This will burn out the diodes in the electrical parts.
- Always check the battery condition before judging other parts of the electrical system. A fully charged battery is necessary for conducting accurate electrical system tests.
- Do not hit the electric parts with a hammer or do not drop the electric parts. These may result in the electric parts damaged 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 happened 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]

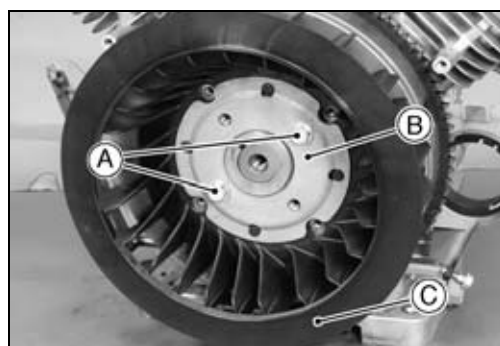
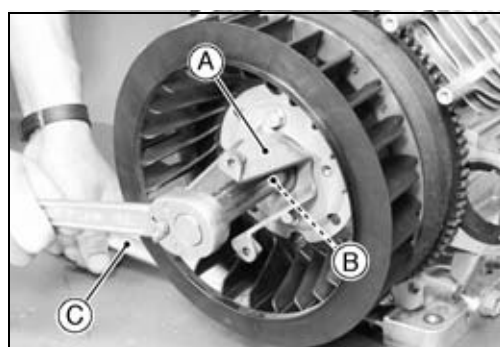
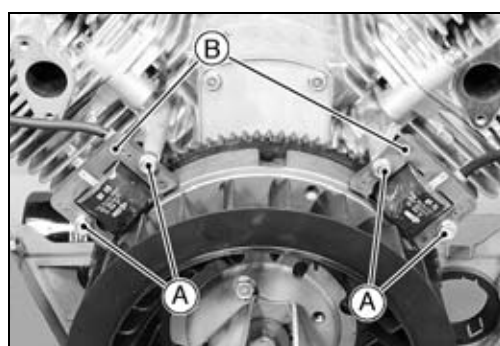
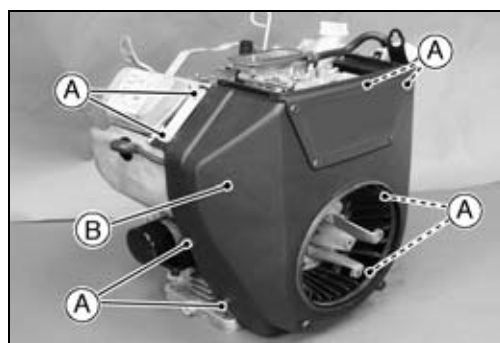
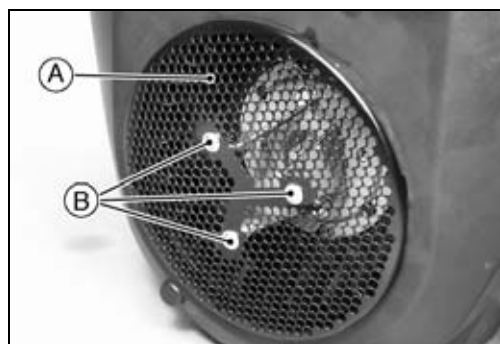


9-6 ELECTRICAL SYSTEM

Charging, Ignition System

Flywheel, Stator Coil Removal

- Remove:
Screws [B] and Screen [A]
- Loosen the fan housing bolts [A] and remove the fan housing [B].
- Remove:
Bolts [A]
Ignition Coils [B] (see Ignition Coil Removal)
- Hold the flywheel with a suitable tool [C], remove the flywheel bolt [B], the washer, and the bracket [A].
- Remove the bolts [A], the plate [B] and the fan [C].

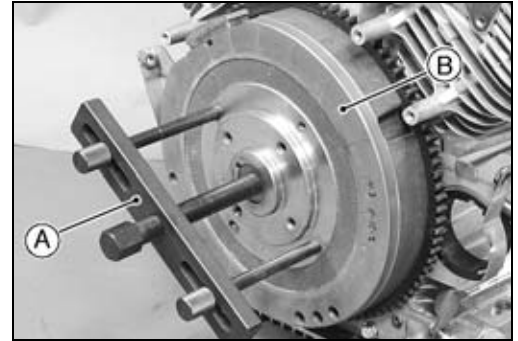


Charging, Ignition System

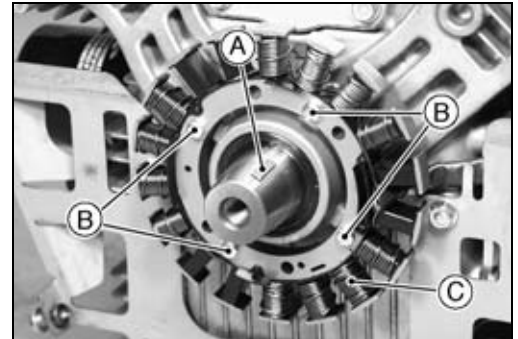
- Using a suitable flywheel puller [A], remove the flywheel [B].

NOTICE

Always use flywheel puller.

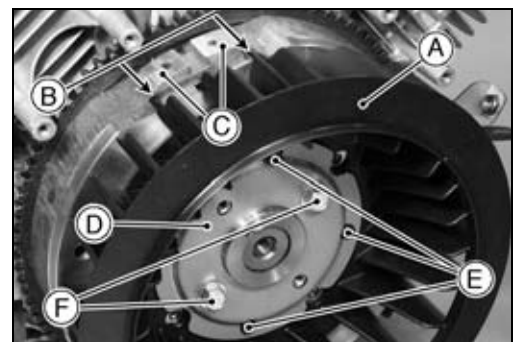
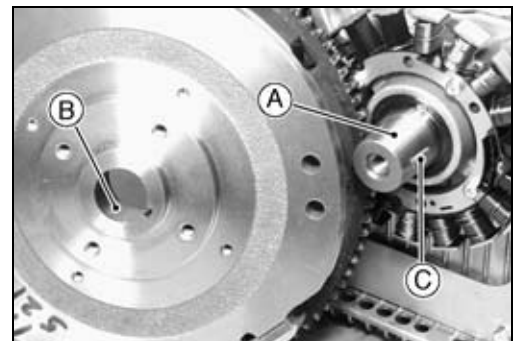


- Remove:
Woodruff Key [A]
Screws [B]
Stator Coil [C]



Flywheel, Stator Coil Installation

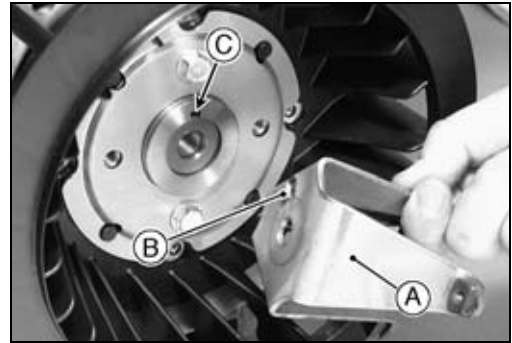
- Apply grease to the stator coil connector, and connect it.
Grease - Three Bond: TB2585G or Grease No. Rykon premium grease EP#2 general purpose (Green)
- Install the stator coil and tighten the screws.
Torque - Stator Coil Screws: 3.4 N·m (0.35 kgf·m, 30 in·lb)
- Using a cleaning fluid, clean off any oil or dirt on the following portions and dry them with a clean cloth.
Crankshaft Tapered Portion [A]
Flywheel Tapered Portion [B]
- Fit the woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.
- Install the flywheel onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.
- Install the fan [A] so that two positioning bosses [B] fit around flywheel ignition magnet [C].
- Install the plate [D] so that the bosses [E] of the fan fit in the holes of the plate with bolts [F].



9-8 ELECTRICAL SYSTEM

Charging, Ignition System

- Install the bracket [A] so that the notch [B] inserts into the slot [C] in the flywheel.



- Fit the conical washer [A] onto the flywheel bolt [B], and tighten the flywheel bolt.

NOTICE

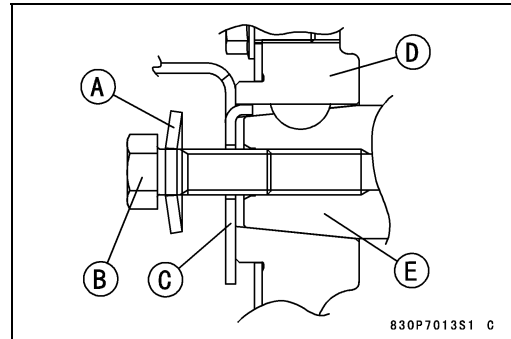
Make sure the direction of conical washer [A] for flywheel bolt [B]. Direction is as illustration.

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

Bracket [C]

Flywheel [D]

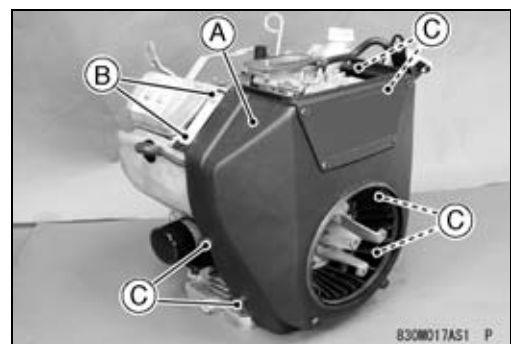
Crankshaft [E]



- Install the fan housing [A] and tighten the bolts [B] [C].

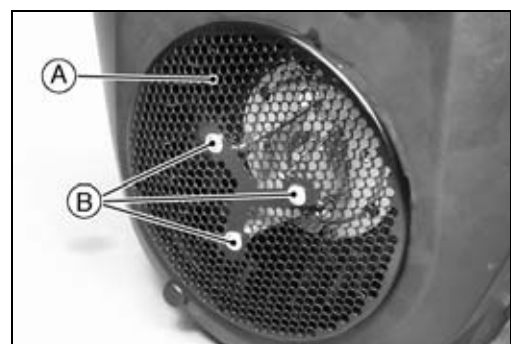
Torque - Fan Housing Bolts [B] (M8): 6.9 N·m (0.70 kgf·m, 61 in·lb)

Fan Housing Bolts [C] (M6): 5.9 N·m (0.60 kgf·m, 52 in·lb)



- Install the screen [A] and tighten the screen bolts [B].

Torque - Screen Bolt: 5.9 N·m (0.60 kgf·m, 52 in·lb)



Charging, Ignition System

Charging System Operational Inspection

- Check the battery condition.

NOTE

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

- Warm up the engine to bring the components up to their normal operating temperatures.
- Measure regulated output voltage at various engine speeds.
- Connect a voltmeter across the battery terminals.
- ★ The readings should show nearly battery voltage when the engine speed is low, and as the engine speed rises, the readings should also rise. But they must stay within the specified range.
- ★ If the output voltage is much higher than the specification, the regulator is defective, or the regulator leads are loose or open.
- ★ If the output voltage does not rise as the engine speed increases, the regulator is defective or the alternator output is insufficient for the loads.

Regulated Output Voltage
Battery Voltage to 15 V DC

Stator Coil Resistance

- Disconnect the connector [A].
 - Measure the stator coil resistance.
- (Electric Starter Model)
- Connect an ohmmeter between the stator pins [B].

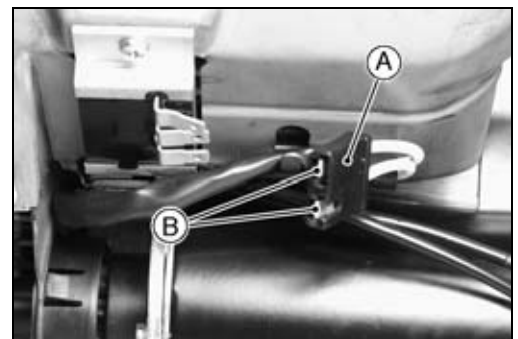
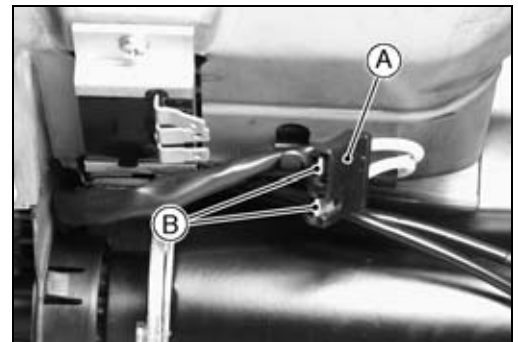
Stator Coil Resistance (Electric Starter Model)
0.01 to 0.1 Ω

- ★ If the measured value is not within the specification, replace the stator coil with a new one.
- ★ If the coil has normal resistance, but the voltage inspection shows the alternator to be defective; the flywheel magnets have probably weakened, and the flywheel must be replaced.
- Check for continuity between each stator pin and ground. There should be no continuity (infinite ohm).
- ★ If the stator coil fails any of these tests, replace the coil with a new one.

Unregulated Stator Output

- Disconnect the connector [A].
- Connect AC voltmeter to the stator pins [B].
- Start the engine. Run the engine at the 3 000 rpm speed.
- Voltage reading should be minimum 26 V AC/3 000 rpm.
- ★ If the AC voltage reading is less than the specification, replace the stator.

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

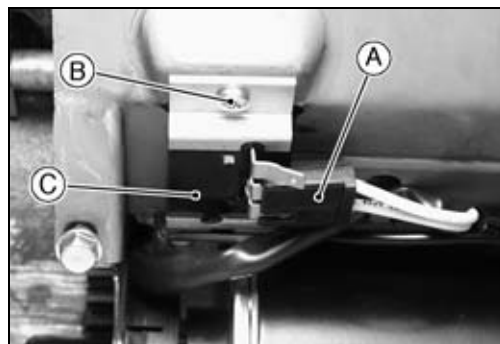


9-10 ELECTRICAL SYSTEM

Charging, Ignition System

Regulator Removal

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



Regulator Installation

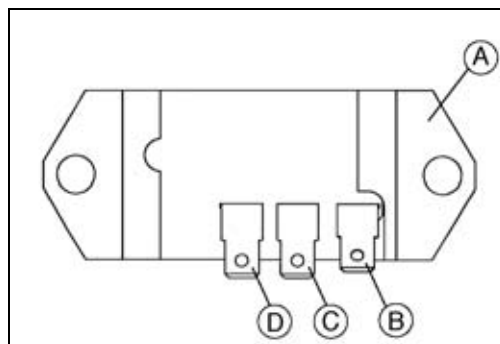
- Install the regulator and tighten the screws.
Torque - Regulator Screw: 3.4 N·m (0.35 kgf·m, 30 in·lb)

Regulator Resistance

- Set the KAWASAKI Hand Tester selector switch to the R $\times 100 \Omega$ position.
- Connect the test leads to the points shown on the chart and read the resistance.
- There are two (2) types of Regulator on FH engines as follows:

(Without Charging Monitor Type ...3 Blades)

	+	A	B	C	D
—					
A			∞	∞	∞
B		∞		0	500 $\Omega \sim \infty$
C		∞	0		500 $\Omega \sim \infty$
D		7.8 k $\Omega \sim \infty$	800 $\Omega \sim \infty$	800 $\Omega \sim \infty$	



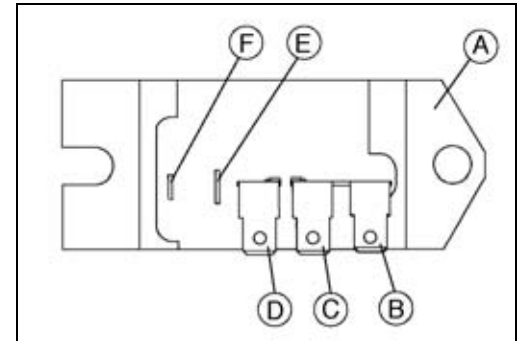
NOTE

Resistance value may vary with individual meters.

Charging, Ignition System

(With Charging Monitor type ... 5 Blades)

+	A	B	C	D	E	F
—	A	B	C	D	E	F
A		∞	∞	∞	19 Ω ~ 3 K Ω	3 K Ω ~ ∞
B	∞		0	500 Ω ~ ∞	∞	∞
C	∞	0		500 Ω ~ ∞	∞	∞
D	7.5 K Ω ~ ∞	925 Ω ~ ∞	925 Ω ~ ∞		10 K Ω ~ ∞	10 K Ω ~ ∞
E	330 Ω ~ 14 K Ω	∞	∞	∞		1.2 K Ω ~ ∞
F	14 k Ω ~ ∞	∞	∞	∞	110 Ω ~ ∞	



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

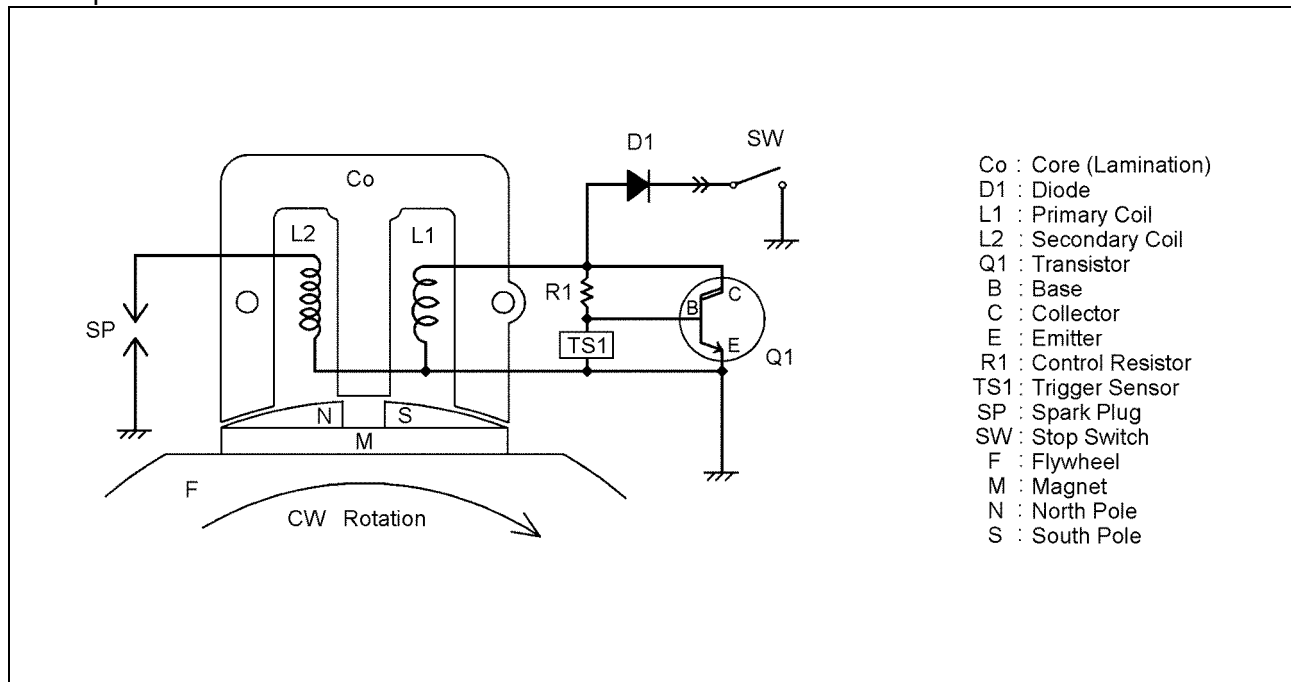
9-12 ELECTRICAL SYSTEM

Charging, Ignition System

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

The system consists of the following:

- Inductive Ignition Assemblies
- Permanent Magnet Flywheel
- Spark Plugs
- Stop Switch



Ignition Theory of Operation

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

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

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

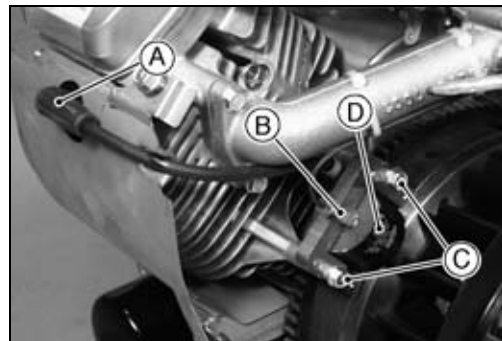
The trigger sensor (TS1) senses the optimum time (peak current) to remove the base drive from the transistor (Q1). This abrupt "turning off" of the transistor causes an interruption in current flow which allows its associated flux collapse, and several hundred volts is induced through the primary winding (L1) inducing a very large voltage in the secondary winding (L2). When the secondary voltage reaches several thousand volts, the spark plug (SP) gap is ionized and ignition occurs. The placement of the trigger sensor internal to the ignition insures the constant timing over speed and temperature and prevents counterclockwise operation.

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

Charging, Ignition System

Ignition Coil Removal

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



Ignition Coil Installation

- Install the ignition coil on the crankcase so that the stop switch lead connector [B] face the screen, and tighten the bolt (1) first, then tighten the bolt (2). While tightening bolts, adjust the ignition coil air gap [A] between the three legs of ignition coil and the two pole-plates to the specified value.

Ignition Coil Air Gap

Standard: 0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)

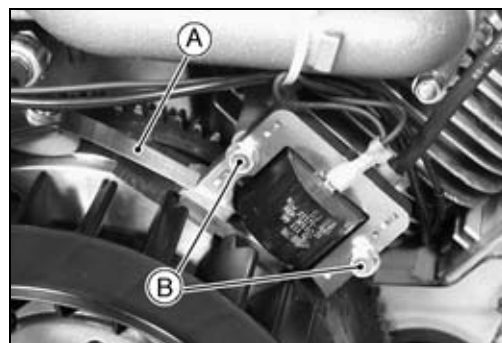
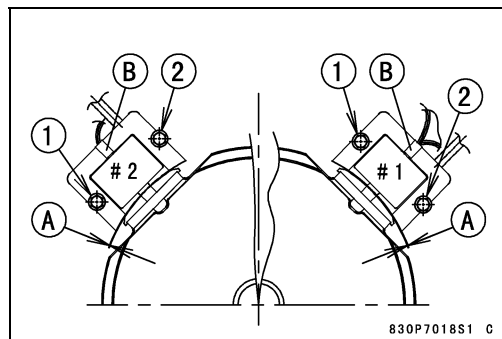
Torque - Ignition Coil Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)

NOTE

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

Thickness Gauge [A]

Bolts [B]



9-14 ELECTRICAL SYSTEM

Charging, Ignition System

Ignition Coil Inspection

- Remove the ignition coils (see Ignition Coil Removal).
 - Measure the primary winding resistance as follows:
- Set the hand tester to the $R \times 1 \text{ k}\Omega$ range.

Special Tool - Hand Tester: 57001-1394

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

Ignition Coil Primary Winding Resistance

<div>+ —</div>	A	B	C
A		2 ~ 18 k Ω	2 ~ 18 k Ω
B	∞		∞
C	2 ~ 18 k Ω	10 ~ 30 k Ω	

NOTICE

Use only Tester 57001-1394 for this test. A tester other than the Kawasaki Hand Tester may show different readings.

If a megger or a meter with a large capacity battery is used, the ignition coil will be damaged.

- Measure the secondary winding resistance as follows:
- Set the hand tester to the $\times 1 \text{ k}\Omega$ range.
- Connect the tester between the iron core [A] and plug cap terminal [C].

Ignition Coil Secondary Winding Resistance:

8 ~ 11 k Ω

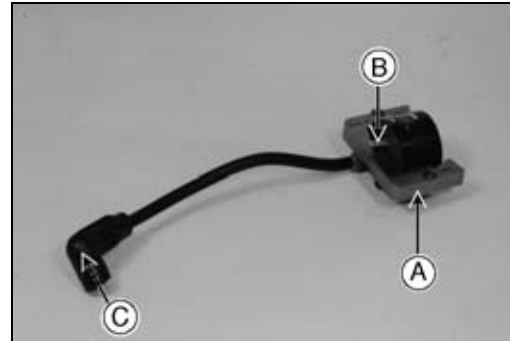
- ★ If the tester does not read as specified, replace the coil with a new one.

Spark Plug Cleaning and Inspection

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

Spark Plug Gap Inspection

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



Troubleshooting

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Engine Troubleshooting Guide	10-2
Starter Motor Troubleshooting Guide	10-6

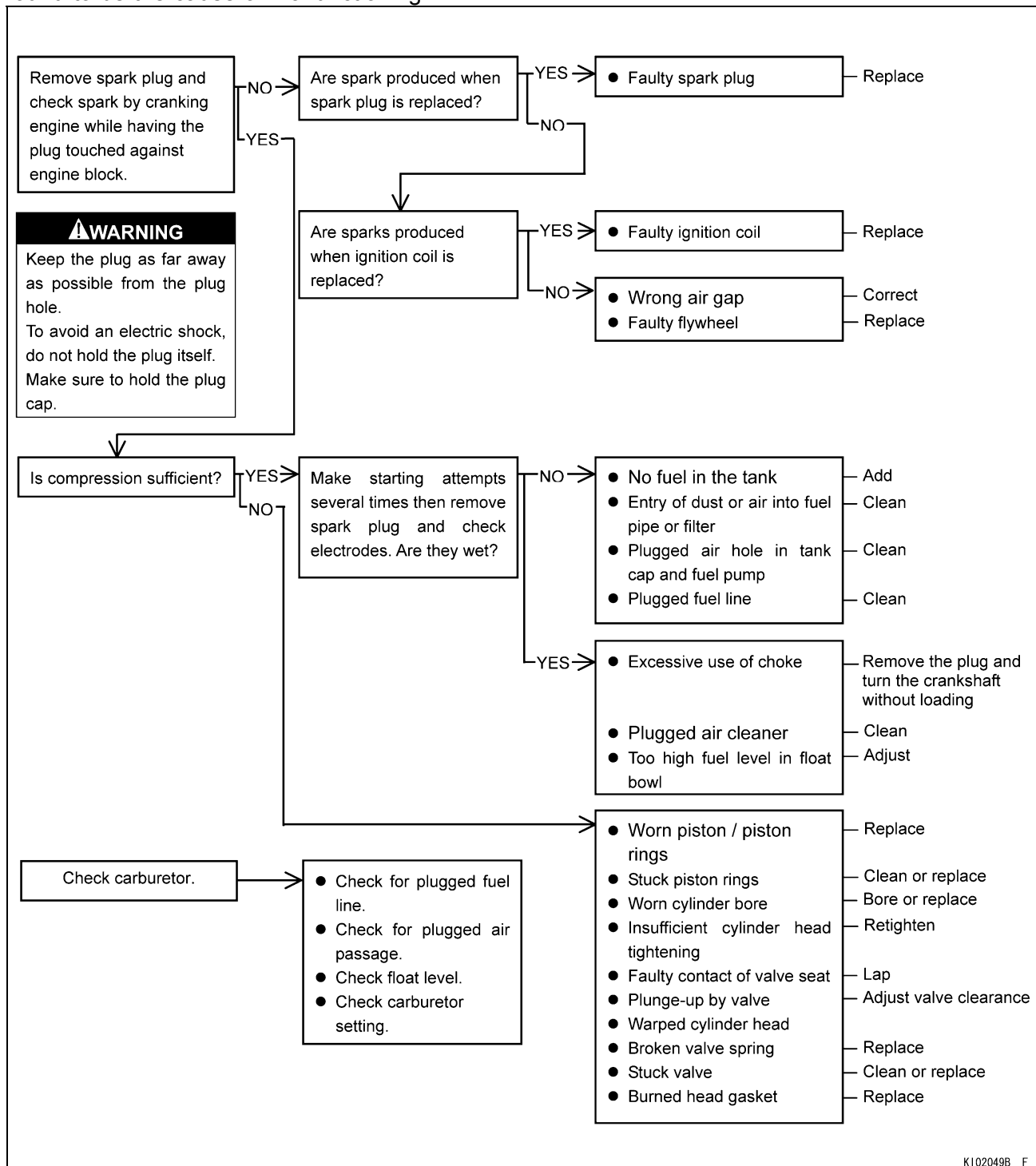
10-2 TROUBLESHOOTING

Engine Troubleshooting Guide

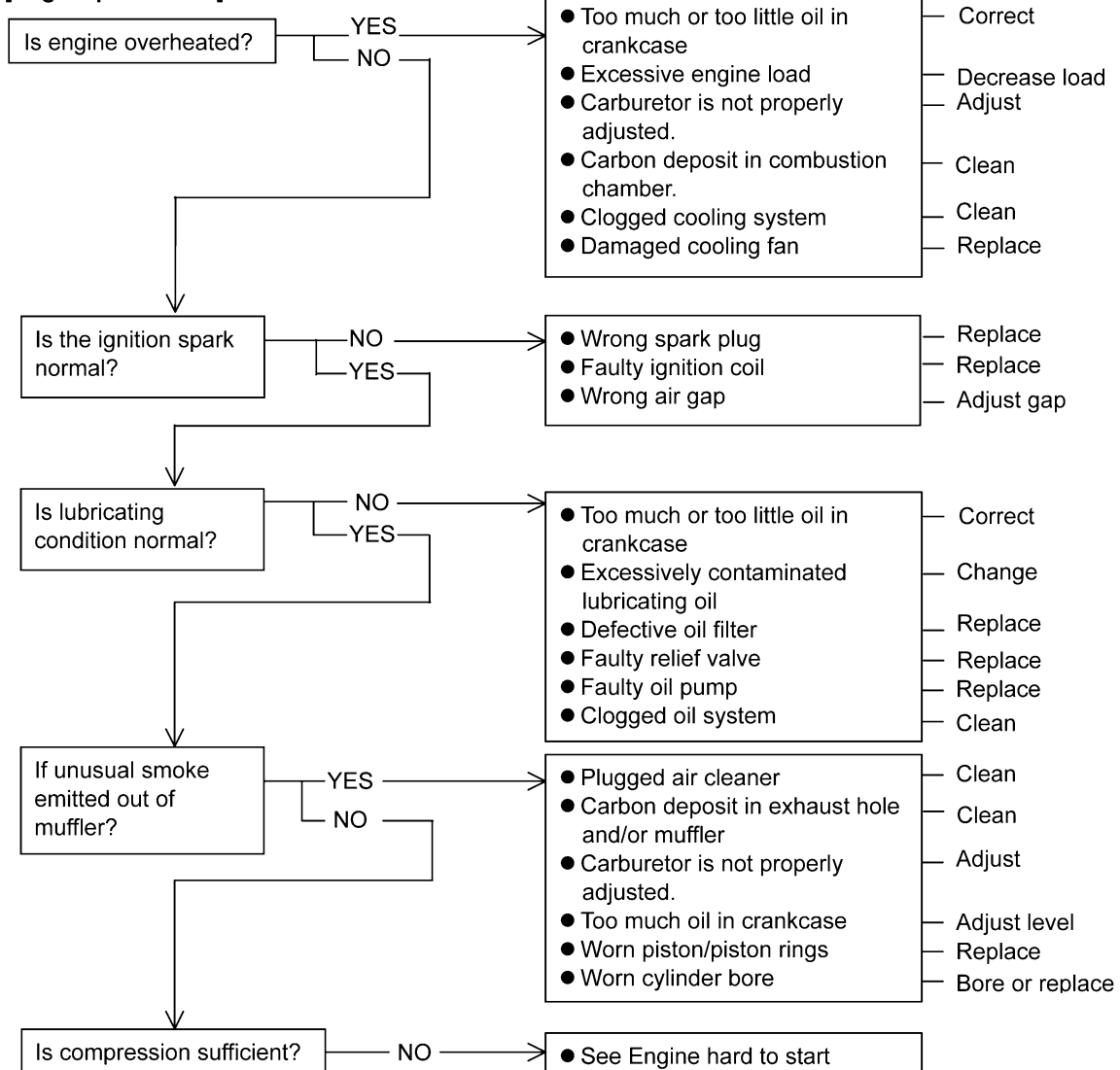
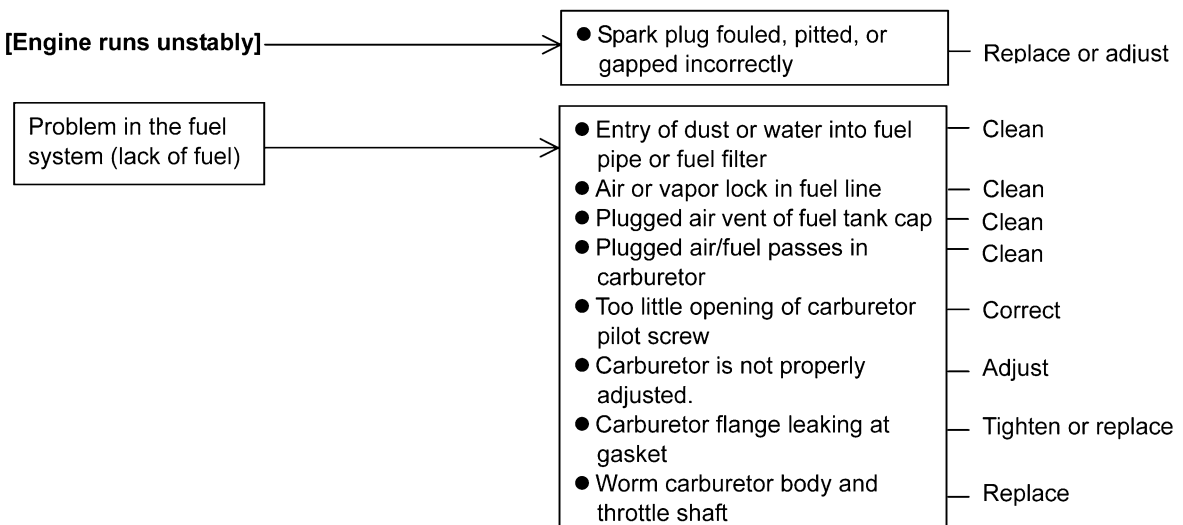
If the engine malfunctions, check if the way the engine is used is correct. If the engine malfunctions even if the engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

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

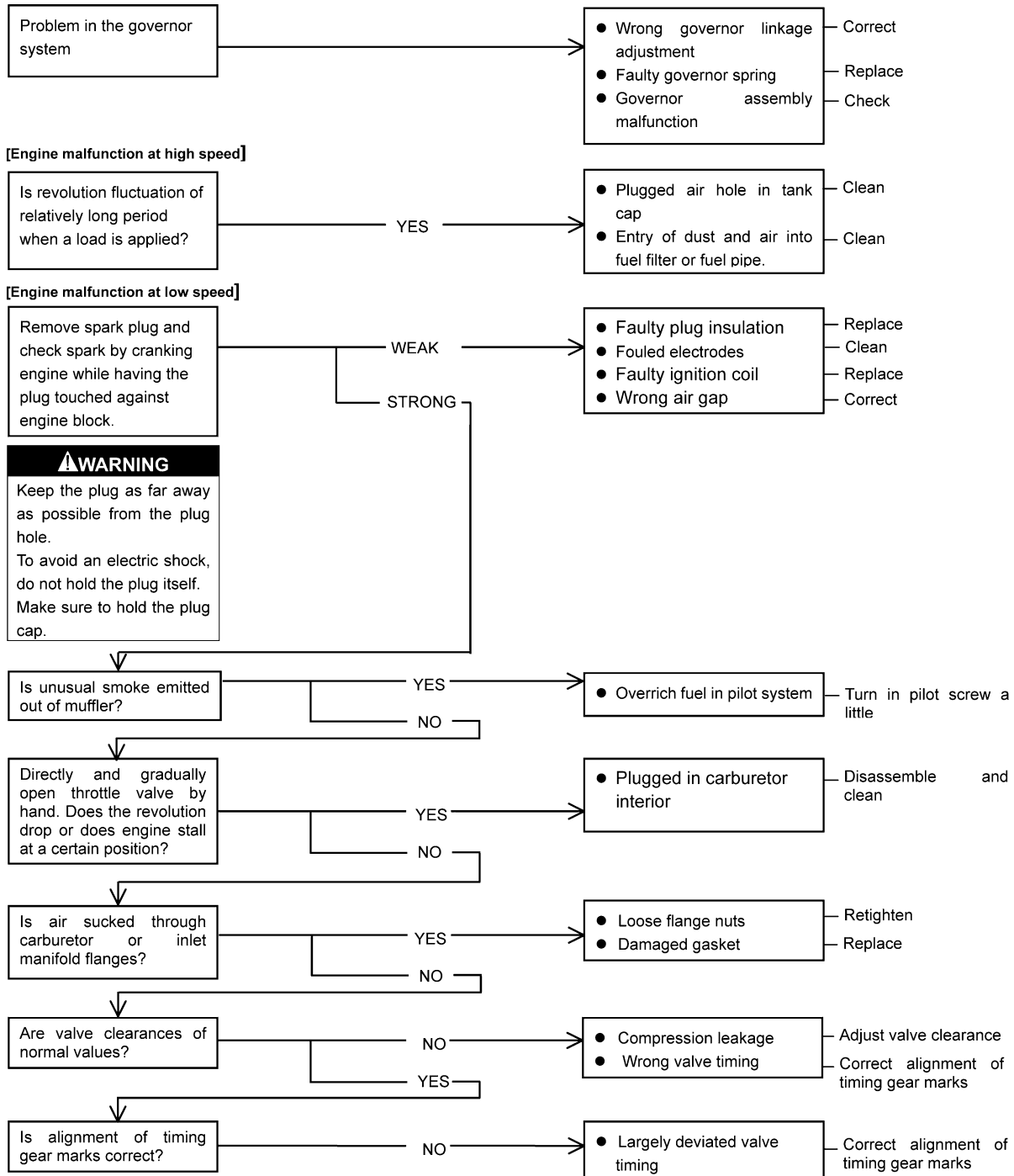


Engine Troubleshooting Guide

[Engine power loss]**[Engine runs unstably]**

10-4 TROUBLESHOOTING

Engine Troubleshooting Guide



Engine Troubleshooting Guide

[Excessive fuel consumption]

Is compression sufficient?

YES

NO

- High fuel level in carburetor float chamber (including overflow)
- High idling R.P.M
- Choke partially closed
- Excessively backed off carburetor pilot screw

Adjust
Adjust
Open choke
Adjust

- Worn piston/piston rings
- Stuck piston
- Worn cylinder bore
- Insufficient cylinder head tightness
- Faulty valve seat contact
- Plunge-up of valve
- Wrong valve timing
- Broken valve spring
- Stuck valve

Replace
Clean or replace
Bore or replace
Retighten
Lap
Adjust valve clearance
Adjust
Replace
Clean or replace

[Excessive oil consumption]

Is compression sufficient?

YES

NO

- Plugged oil ring groove
- High oil level
- Worn valve stems and valve guide
- Oil leakage along governor shaft
- Oil leakage from oil seal
- Oil leakage from mounting surface
- Oil leakage from drain plug
- Clogged breather valve
- Plugged drain-back hole in breather chamber
- Wrong oil viscosity

Clean
Adjust or drain
Replace
Replace
Replace
Replace gasket
Retighten or replace gasket
Clean
Clean
Correct

- Worn piston rings
- Stuck piston rings
- Worn cylinder bore
- Broken piston ring

Replace
Clean or replace
Bore or replace
Replace

[Engine backfire]

- Loose carburetor or inlet manifold
- Loose cylinder head or leaking head gasket
- Burned or sticking inlet valve
- Faulty ignition coil
- Carburetor not properly adjusted

Tighten
Tighten
Replace
Replace
Adjust

[Engine knock]

- Stale fuel
- Excessive carbon deposit in engine
- Excessive engine load
- Engine overheating
- Faulty ignition coil

Change
Clean
Adjust
See Engine power loss
Replace

10-6 TROUBLESHOOTING

Starter Motor Troubleshooting Guide

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

WARNING

Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

NOTICE

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

[STARTER DOES NOT ROTATE.]

Is there click sound from solenoid (switch)?

NO

- Faulty battery
- Faulty leads or connection
- Melted fuse
- Faulty engine switch
- Faulty solenoid (switch)

Charge or replace
Repair or replace
Replace
Repair or replace
Replace

YES

- Weak battery
- Faulty leads or connection (Solenoid to motor)
- Faulty solenoid (switch)
- (Main terminal in solenoid)
- Faulty starter motor

Charge or replace
Repair or replace
Replace
Repair or replace
Repair or replace

[STARTER ROTATES BUT SLOW.]

Is battery normal and well charged?

NO

- Weak battery

Charge or replace

YES

- Faulty leads or connection (Solenoid to motor)
- Faulty solenoid (switch)
- (Main terminal in solenoid)
- Faulty starter motor
- Faulty engine

Repair or replace
Replace
Repair or replace
Repair or replace
Repair or replace

[STARTER ROTATES BUT CAN NOT CRANK ENGINE.]

Does pinion mesh with ring gear?

NO

- Worn pinion or ring gear
- Wrong starter alignment

Replace
Correct

YES

- Faulty pinion clutch
- Faulty engine

Replace
Repair or replace

[STARTER DOES NOT STOP IN ENGINE SWITCH "OFF".]

Can stop starter by engine switch "OFF"?

NO

- Faulty engine switch
- Faulty solenoid (switch)

Repair or replace
Replace

YES

- Faulty pinion or ring gear.
- Wrong starter alignment.
- Faulty pinion return mechanism.

Repair or replace
Correct
Repair or replace



* 9 9 9 2 4 - 2 0 6 0 - 0 7 *

Kawasaki
— ENGINES —