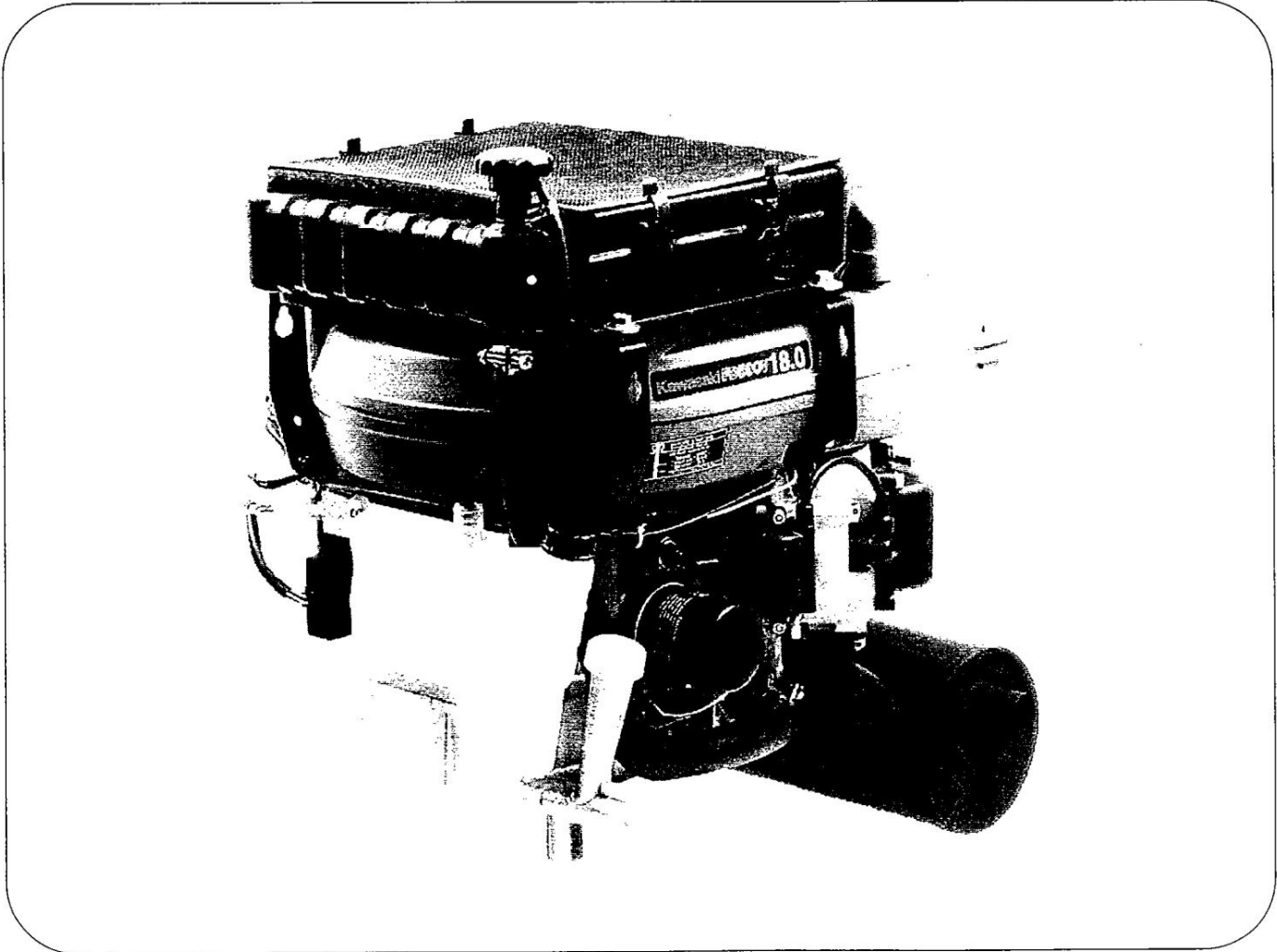




**FD440V**  
**FD501V**  
**FD590V**  
**FD611V**



**4-stroke liquid-cooled v-twin gasoline engine**

# **Service Manual**





# Quick Reference Guide

<b>General Information</b>	<b>1</b>
<b>Fuel System</b>	<b>2</b>
<b>Cooling System</b>	<b>3</b>
<b>Engine Top End</b>	<b>4</b>
<b>Lubrication System</b>	<b>5</b>
<b>Camshaft / Crankshaft</b>	<b>6</b>
<b>Electric System</b>	<b>7</b>
<b>Trouble Shooting</b>	<b>8</b>
<b>Supplement</b>	<b>9</b>

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.





**FD440V**  
**FD501V**  
**FD590V**  
**FD611V**

**4-stroke liquid cooled v-twin gasoline engine**

# **Service Manual**

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The right is reserved to make changes at any time without prior notice and without incurring an obligation to make such changes to products manufactured previously.

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.

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**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)		

**Read OWNER'S MANUAL before operating.**

# 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 has 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.

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## How to Use this Manual

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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 electric System chapter. Then, use the Table of Contents on the first page of the chapter to find the Spark Plug section.

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

### **▲WARNING**

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

### **CAUTION**

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

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

#### NOTE

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

● Indicates a procedural step or work to be done.

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

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

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

# General Information

## Table of Contents

Before Servicing .....	1-2
Model Identification .....	1-5
General Specifications .....	1-6
Periodic Maintenance Chart .....	1-7
Torque and Locking Agent .....	1-8



## 1-2 GENERAL INFORMATION

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### Before Servicing

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

#### Especially note the following:

- (1) **Dirt**

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

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

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

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

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

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

Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.
- (7) **High-Flash Point Solvent**

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

Do not reuse a gasket or O-ring once it has been in service. The mating surfaces around the gasket should be free of foreign matter and perfectly smooth to avoid oil or compression leaks.
- (9) **Liquid Gasket, Non-Permanent Locking Agent**

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

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

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, Grease Seal**

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

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

**(13) Seal Guide**

A seal guide is required for certain oil or grease seals during installation to avoid damage to the seal lips.

Before a shaft passes through a seal, apply a little oil, preferably high temperature grease on the lips to reduce rubber to metal friction.

**(14) Circlip, Retaining Ring**

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.

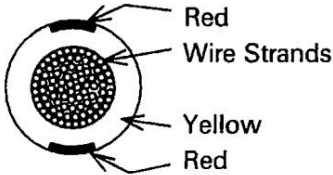
**(16) Lubrication**

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 ( $\text{MoS}_2$ ) 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)	Name of Wire Color
	Yellow/Red

**(18) Replacement Parts**

When there is a replacement instruction, replace these parts with new ones every time they are removed.

These replacement parts will be damaged or lose their original function once removed.

**(19) Inspection**

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

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

**(20) Specifications**

Specification teams are defined as follows:

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

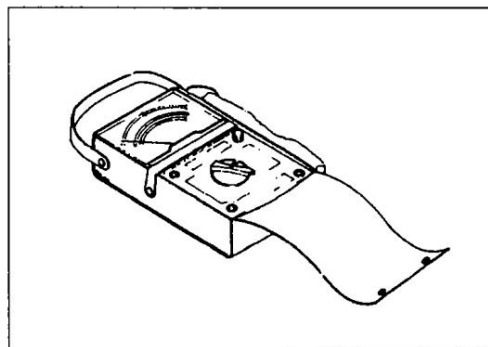
"Service Limits" Indicate the usable limits. If the measurement shows excessive wear or deteriorated performance, replace the damaged parts.

## 1-4 GENERAL INFORMATION

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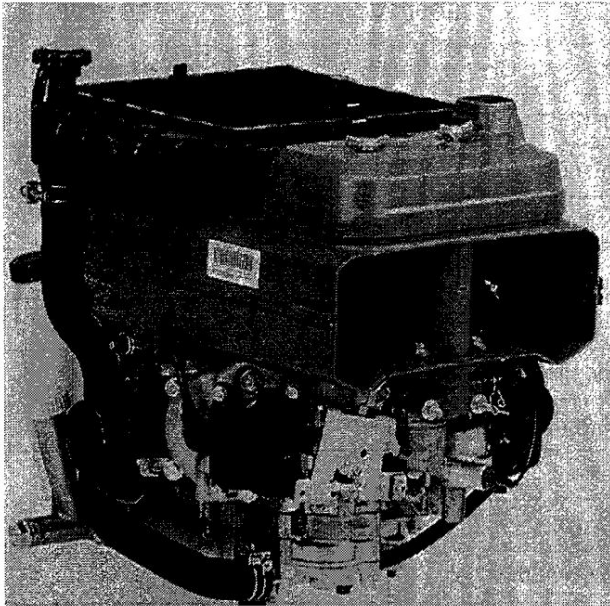
### Hand Tester:

Kawasaki hand tester (P/N 57001-1394) is recommended for the electrical system check because a meter of other type may indicate different value.

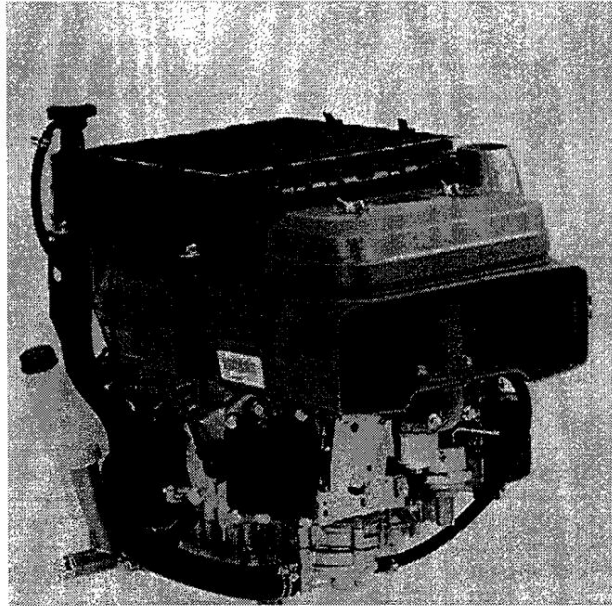


**Model Identification**

**FD501V Shown**



**FD590V Shown**



**Cylinder Number Designation:**

**Let No.1 Cyl. be right-hand viewed from the flywheel.**

**Let No.2 Cyl. be left-hand viewed from the flywheel.**



**1-6 GENERAL INFORMATION****General Specifications**

Items	FD440V	FD501V	FD590V
Type of engine	Liquid-cooled, Vertical shaft, OHV, 4-stroke, 90°V-twin, Gasoline engine.		
Bore × Stroke	67 × 62 mm (2.64 in × 2.44 in.)		74 × 68 mm (2.90 × 2.66 in.)
Piston displacement	437 mL (26.7 cu-in.)		585 mL (35.7 cu-in.)
Direction of rotation	Counterclockwise facing PTO shaft end		
Low idle speed	1 550 rpm		
Fast idle speed	3 400 rpm	3 550 rpm	3 400 rpm
Ignition system	Battery, Full transistor, Fixed timing		
RFI	Per Canada and U.S.A. requirements		
Starting system	Shift type electric starter		
Charging system	12 V - 20 amps with regulator		
Carburetor	Horizontal draft type, Fixed main jet		
Fuel pump	Mechanical Type		
Air cleaner	Dual stage element		
Governor	All speed mechanical fly weights		
Lubrication system	Pressure feed by positive displacement pump		
*Oil filter	Cartridge type full flow filter		
*Oil pressure switch	ON - OFF switch		
Cooling system	Pressurized forced circulation type		
*Radiator	3 - rows with louverless corrugated fin		
Dimensions (L × W × H)	573 × 358 × 543 mm (22.6 × 14.1 × 21.4 in.)		595 × 388 × 702 mm (23.5 × 15.3 × 27.7 in.)
Dry weight	35.2 kg (77.6 lb)		43.1 kg (95.0 lb)

\*Specifications are subject to change without notice.

### 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	Every 20 hr.	Every 25 hr.	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 300 hr.	Every 400 hr.
Check and add fuel	●							
Check and add engine oil	●							
Check and add coolant	●							
Check for fuel, oil and coolant leakage	●							
Check radiator for dust and insect	●							
Check for loose or lost nut and screw	●							
Check battery electrolyte level	●							
Tighten nut and screws					●			
Clean air cleaner foam element (1)			●					
Clean air cleaner paper element (1)					●			
Change engine oil		● (first)			●			
Clean and re-gap spark plugs					●			
Oil filter change		● (first)				●		
Change air cleaner paper element (1)							●	
Change spark plugs							●	
Inspect radiator and hoses*						●		
Check carburetor adjustment				●				
Check engine speeds*				●				
Check and adjust valve clearance*							●	
Check fuel lines*							●	
Valve maintenance*							●	
Clean combustion chamber*							●	
Coolant Change*								●

(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.

## 1-8 GENERAL INFORMATION

### Torque and Locking Agent

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

Letters used in the "Remarks" column mean\*

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.

Fastener	Torque			Remarks
	N-m	kg-m	ft-lb / in-lb	
<b>Fuel System:</b>				
Carburetor Mounting Nuts	17	1.7	12	
Governor Arm Nut	7.8	0.8	69 in-lb	
Fuel Shut-Off Solenoid Valve	9.8	1.0	7.0	
<b>Cooling System:</b>				
Cooling Fan Extension Bolts	6.0	0.6	52 in-lb	
Water Pump Cover Bolts	7.8	0.8	69 in-lb	
Thermo Switch	27	2.8	20	L
<b>Engine Top End:</b>				
Cylinder Head Bolts and Nuts	21	2.1	15	S
Valve Clearance Adjust Nuts	8.8	0.9	78 in-lb	
Spark Plugs	17	1.7	12	
<b>Lubrication System:</b>				
Oil Drain Plug	25	2.5	18	
Oil Pressure Switch				L
<b>Camshaft/Crankshaft:</b>				
Case Cover to Block Bolts	21	2.1	15	S
Con-Rod Cap Bolts	12	1.2	106 in-lb	O
<b>Electrical System:</b>				
Flywheel Nut – FD440V/FD501V	88	9.0	65	
Flywheel Nut – FD590V	120	12.0	87	

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	kg-m	ft-lb
4	1.2 ~ 2.2	0.12 ~ 0.22	10 ~ 19 in-lb
5	3.4 ~ 4.9	0.35 ~ 0.50	30 ~ 43 in-lb
6	5.9 ~ 7.8	0.60 ~ 0.80	52 ~ 69 in-lb
8	14 ~ 19	1.4 ~ 1.9	10 ~ 14 in-lb

# Fuel System

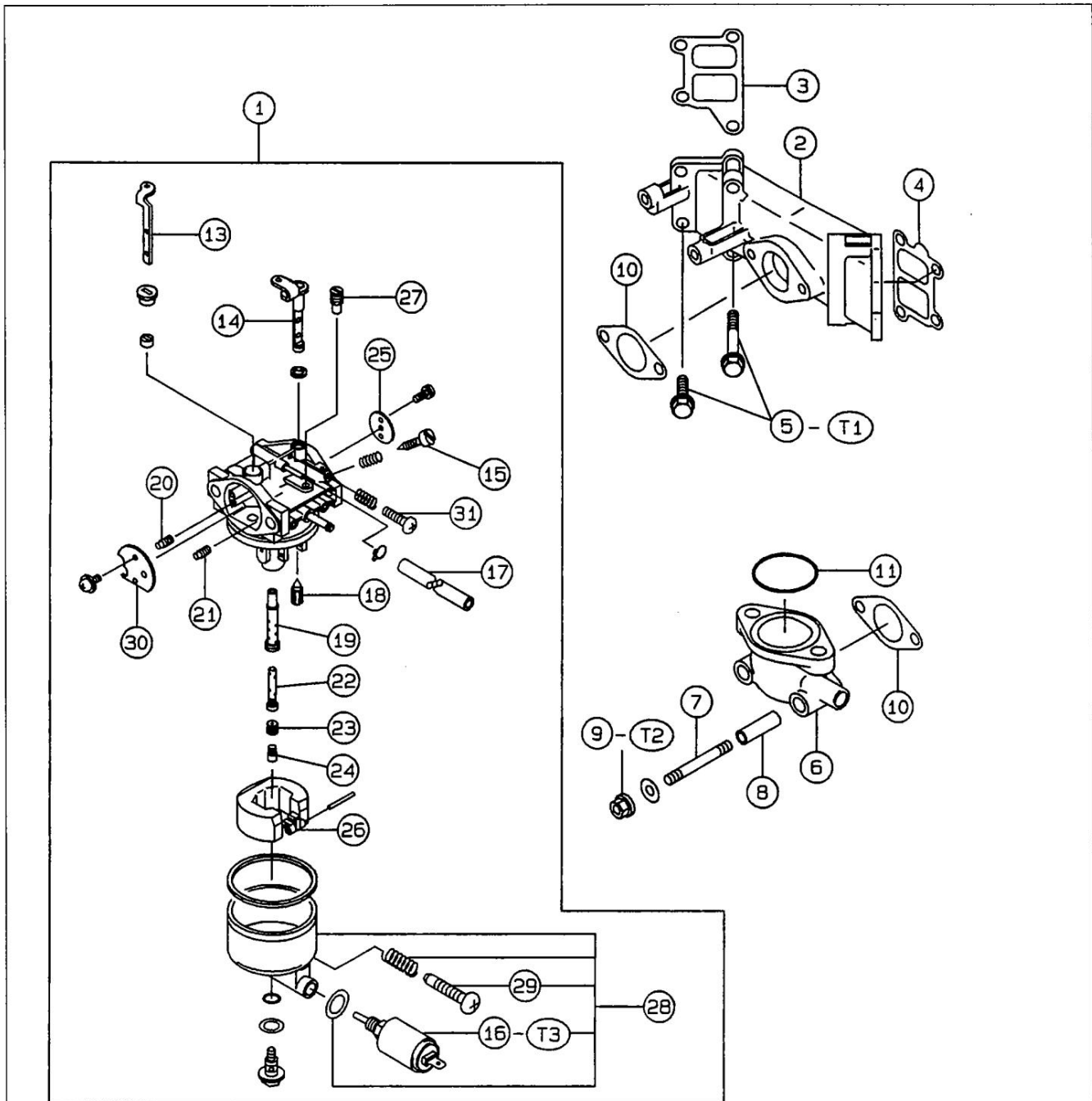
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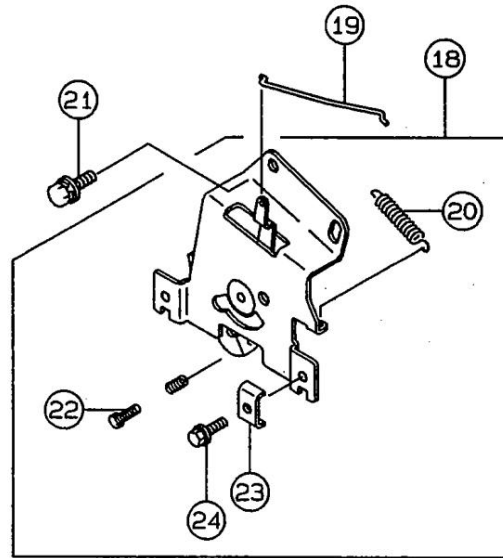
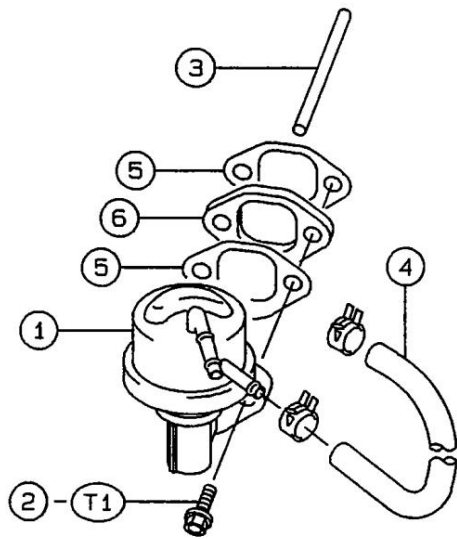
## 2-2 FUEL SYSTEM

### Exploded View

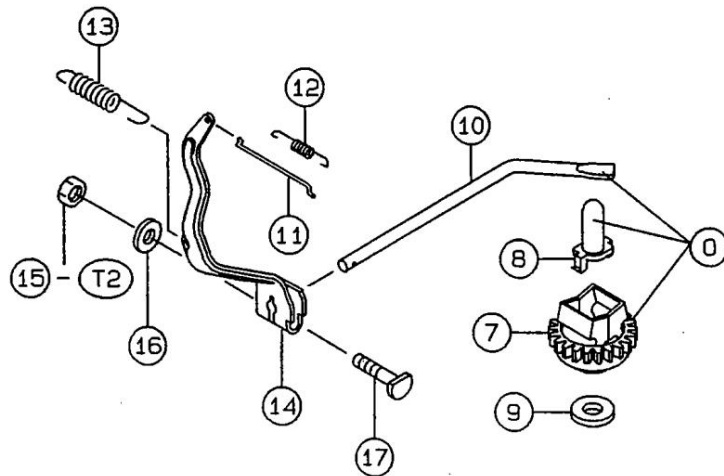


- |                             |                                 |                                   |
|-----------------------------|---------------------------------|-----------------------------------|
| 1. Carburetor               | 13. Choke Shaft                 | 23. Main Jet Holder               |
| 2. Intake Manifold          | 14. Throttle Shaft              | 24. Main Jet                      |
| 3. Gasket                   | 15. Pilot Air Screw             | 25. Throttle Valve                |
| 4. Gasket                   | (Idle Mixture Screw)            | 26. Float                         |
| 5. Manifold Bolts           | 16. Fuel Shut-Off Solenoid      | 27. Pilot Jet                     |
| 6. Intake Elbow             | (FD501V/FD590V)                 | 28. Float Chamber                 |
| 7. Studs                    | 17. Vent Hose                   | 29. Float Chamber Drain Screw     |
| 8. Collars                  | 18. Float Needle Valve          | 30. Choke Valve                   |
| 9. Carburetor Mounting Nuts | 19. Main Nozzle (Emulsion Tube) | 31. Throttle Stop Screw           |
| 10. Gasket                  | 20. Main Air Jet                | T1: 7.8 N-m (0.8 kg-m, 69 in-lb)  |
| 11. Gasket (O-Ring)         | 21. Pilot Air Jet               | T2: 17 N-m (1.7 kg-m, 12 ft-lb)   |
| 12. Gasket                  | 22. Main Nozzle                 | T3: 9.8 N-m (1.0 kg-m, 7.0 in-lb) |





1. Fuel Pump (Mechanical)
2. Fuel Pump Bolts
3. Push Rod
4. Pump-to-Carburetor Hose
5. Gaskets
6. Insulator
7. Governor Flyweight Assembly
8. Sleeve
9. Thrust Washer
10. Governor Shaft
11. Throttle Link
12. Throttle Link Spring
13. Governor Spring
14. Governor Arm
15. Governor Arm Clamp Nut
16. Plain Washer
17. Governor Arm Clamp Bolt
18. Control Panel
19. Choke Link
20. Choke Control Lever Return Spring
21. Control Panel Fixing Bolts
22. Choke Adjustment Screw
23. Throttle Cable Clamp
24. Throttle Cable Clamp Bolt



T<sub>1</sub> : 17N-m (1.7kg-m, 12.0ft-lb)

T<sub>2</sub> : 7.8N-m (0.8kg-m, 69in-lb)

O : Apply engine oil

**2-4 FUEL SYSTEM****Specifications**

Item	Standard		
	FD440V	FD501V	FD590V
<b>Carburetor Specifications:</b>			
Make/type	MIKUNI/BV20-15	MIKUNI/BV24-18	MIKUNI/BV24-18
Main bore diameter	20 mm (0.78 in)	24 mm (0.94 in)	24 mm (0.94 in)
Venturi diameter	15 mm (0.59 in)	18 mm (0.70 in)	18 mm (0.70 in)
Main jet (MJ)	#87.5	#110	#112.5
Pilot jet (PJ)	#37.5	#43.8	#38.8
Main air jet (MAJ)	φ1.5	φ1.7	φ1.2
Pilot air jet (PAJ)	φ0.9	φ1.0	φ1.0
Pilot Screw turns out (PS) (Idle mixture screw turns out)	1-11/16	1-3/8	1-3/8
Float level	Float parallel to carburetor body		
<b>Idle Speed:</b>			
Low idle speed	1 550 rpm	1 550 rpm	1 550 rpm
Fast idle speed	3 400 rpm	3 550 rpm	3 400 rpm
<b>Air Cleaner:</b>			
Type	Dual stage filtration system		
Pre-cleaner	Foam element		
Second-stage cleaner	Paper element		
<b>Fuel:</b>			
Fuel requirement	Leaded or unleaded automotive grade gasoline		
<b>Fuel Pump:</b>			
Type	Mechanical Diaphragm Type		
Delivery (MIN)	800 mL (0.8 qt)/at 1 550 rpm		
Shut-off delivery pressure	2.45 kPa (0.36 psi)		
<b>Governor:</b>			
Type	Flyweight all speed governor		

## Governor Link Mechanism

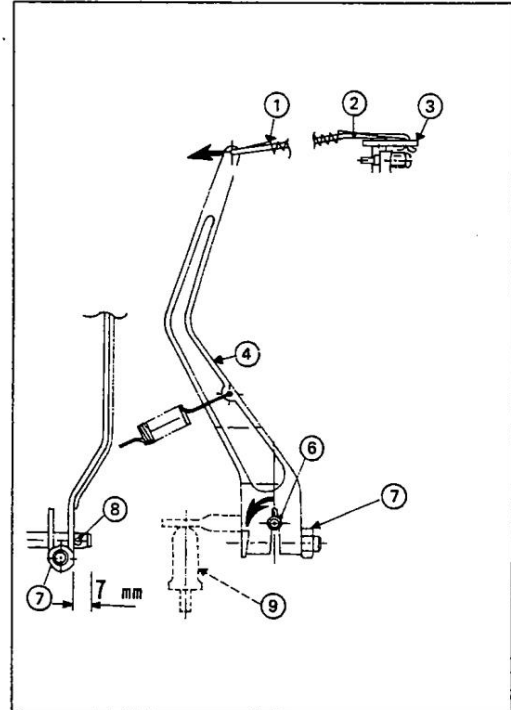
### Governor Arm Installation

#### (Governor Arm-to-Shaft Adjustment)

- Install the governor arm onto the governor shaft temporarily.
- Install the control panel assembly, and connect the governor arm with the governor spring.
- Be sure the link spring around the throttle link rod is in place and that it pulls the governor arm and throttle lever each other.
- Loosen the clamp nut on the governor arm enough to move the governor shaft.
- Turn Top end of the governor arm counterclockwise to fully open the carburetor throttle valve and hold it there.
- Turn the governor shaft counterclockwise by inserting a needle into shaft end hole. Fully turn the shaft to end of its travel and tighten the clamp nut to the specification (see Exploded View).
- Be sure the governor shaft extend from the governor arm is approximately 7mm (0.3in).

- |                      |                    |
|----------------------|--------------------|
| 1. Link Spring       | 6. Governor Shaft  |
| 2. Throttle Link Rod | 7. Clamp Nut       |
| 3. Throttle Lever    | 8. Small Hole      |
| 4. Governor Arm      | 9. Governor Sleeve |
| 5. Carburetor        |                    |

(Control panel is removed for clarity)



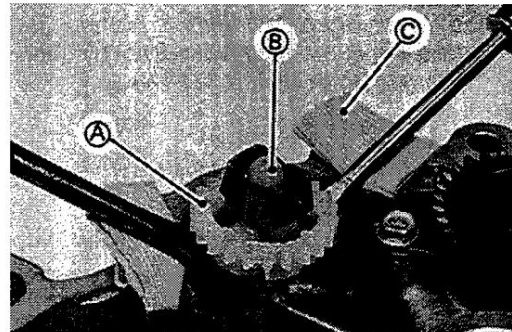
### Governor Assembly Removal

- Split the crankcase (see Crankcase Splitting in the Camshaft/Crankshaft chapter).
- Remove the governor assembly (A) with the sleeve (B) by prying the gear with two proper size screw drivers.
- To avoid damaging the parting surface of the casecover, use a suitable soft mats (C) as shown.

#### CAUTION

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

- Remove the thrust washer.



### Governor Assembly Installation Notes

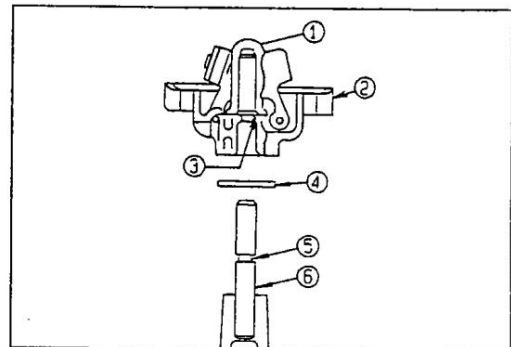
- Fit the sleeve into the governor assembly, and install them as a set.

#### NOTE

- The sleeve and the governor assembly cannot be installed separately. Push the set onto the shaft until inner flange snaps into the groove securely.

- |                      |
|----------------------|
| 1. Sleeve            |
| 2. Governor Assembly |
| 3. Inner Flange      |
| 4. Thrust Washer     |
| 5. Groove            |
| 6. Shaft             |

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



### Governor Assembly Inspection

- Visually check the assembly for wear and damage.
- ★ If any part is worn or damaged, replace the assembly.



## 2-6 FUEL SYSTEM

### Governor Shaft Removal

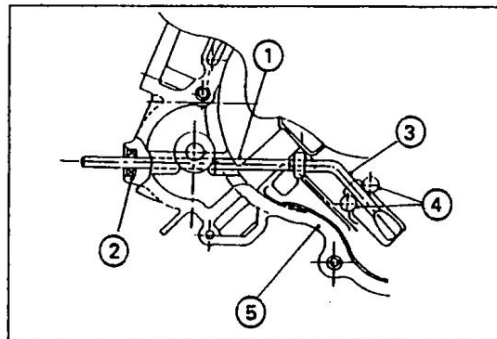
- Remove:
  - Camshaft (see Camshaft Tappet Removal in the camshaft/Crankshaft chapter).
- Unscrew the governor arm clamp nut, and remove the governor arm.
- Turn the governor shaft clockwise 1/4 turn to remove governor shaft.

#### NOTE

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

- Replace the oil seal only if the lip shows signs of leakage or it has been damaged.
- The oil seal must be assembled with seal lip towards inside of the engine.
- Press in the oil seal 1.0mm (0.04 in) below the crankcase surface.

- |                   |                |
|-------------------|----------------|
| 1. Governor Shaft | 4. Projections |
| 2. Oil Seal       | 5. Crankcase   |
| 3. Shaft Arm      |                |



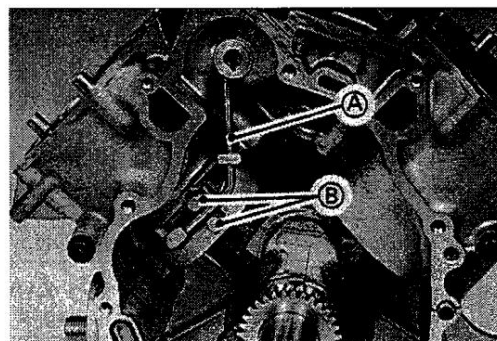
### Governor Shaft Installation Notes

- Install the governor shaft (A) by properly positioning shaft arm between projections (B) as shown.

#### NOTE

○ Install the governor shaft before installing the camshaft to the crankcase.

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



## Carburetor Theory

### Fuel and Air Flow

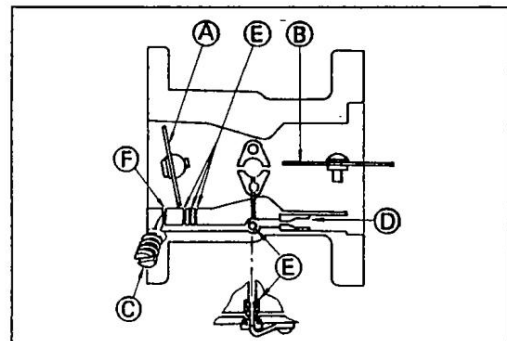
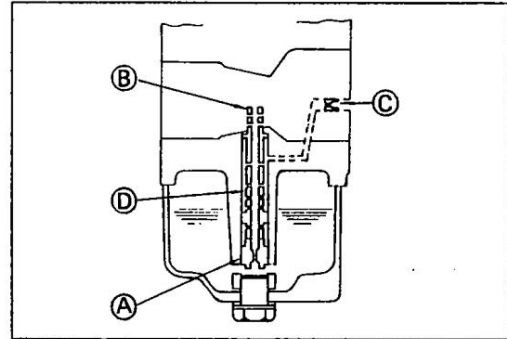
The main system of the carburetor consists of the main jet, main nozzle, and the main air passage (main air jet). The main system meters fuel to the engine during heavy load conditions. Fuel flows through the main jet and into the main nozzle, where it is joined by air from the main air passage (main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

- |                |                 |
|----------------|-----------------|
| A. Main Jet    | C. Main Air Jet |
| B. Main Nozzle | D. Bleed Pipe   |

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

Fuel flow in the pilot system is metered by the pilot jet. Air for better atomization is admitted via the pilot air jet in the mouth of the carburetor. The fuel/air mixture passes into the bore of the carburetor downstream 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) enriches the mixture; turning it in (clockwise) leans the mixture.

- |                    |                 |
|--------------------|-----------------|
| A. Throttle Valve  | E. Pilot Jet    |
| B. Choke Valve     | F. Pilot Outlet |
| C. Pilot Air Screw | G. Bypass Holes |
| D. Pilot Air Jet   |                 |

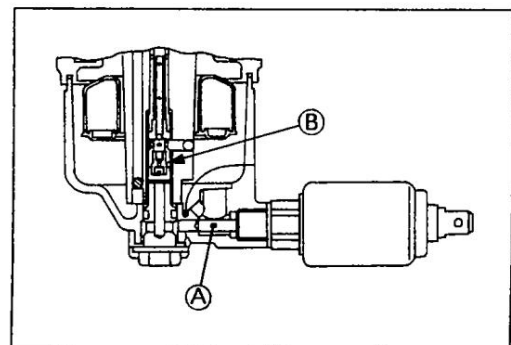


### Fuel Shut Off Solenoid Valve (FD501V/FD590V)

To avoid after firing when stopping the engine, a solenoid actuated fuel shut off valve is installed in the carburetor bowl. The valve shuts off the fuel supply to the main jet simultaneously when the switch key is turned to the "OFF" position.

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

- |                   |
|-------------------|
| A. Solenoid Valve |
| B. Main Jet       |

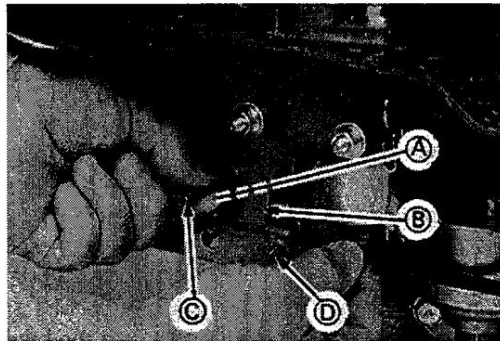




## 2-8 FUEL SYSTEM

### Throttle Cable Adjustment

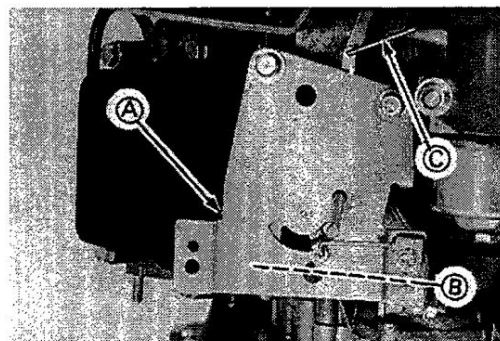
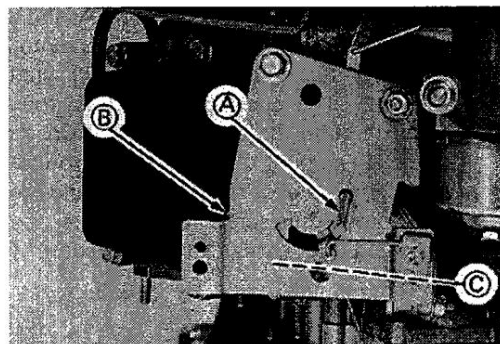
- Move the throttle to the fast idle position.
- Align the hole in the throttle control lever (A) with the hole in the throttle control plate (B).
- Put a 6 mm (15/64-in) drill bit (C) through both holes to keep the throttle control lever from moving. Be sure the drill bit is perpendicular to the throttle control plate. Loosen a retaining bolt [D] and pull the throttle cable tight. Tighten the retaining bolt (D).
- Remove the drill bit.
- Move the throttle lever to the slow idle position. Be sure the throttle valve tab on the carburetor contacts the slow idle stop screw before the throttle lever bottoms out.
- Move the throttle lever through full range to be sure linkage is not binding.



FD590V Shown

### Choke Adjustment

- Adjust the throttle cable before adjusting the choke (see Throttle Cable Adjustment).
- Move the throttle lever to the fast idle position.
- Align the hole in the throttle control lever with the hole in the throttle control plate.
- Put a 6 mm (15/64-in.) drill bit (A) through both holes to keep the throttle control lever from moving. Be sure the drill bit is perpendicular to the throttle control plate.
- Turn the choke adjusting screw (B) counterclockwise until the screw (B) does not contact the choke control lever (C).
- Move the throttle lever to the full choke position.
- Try to move the choke rod (C) to the left (facing the throttle control plate). If the choke rod (C) moves to the left, the choke is not fully closed. Adjust the choke adjusting screw (A) and the choke control lever (B) again. Move the throttle lever to be sure the choke linkage is not binding.



### Slow Idle Speed Adjustment

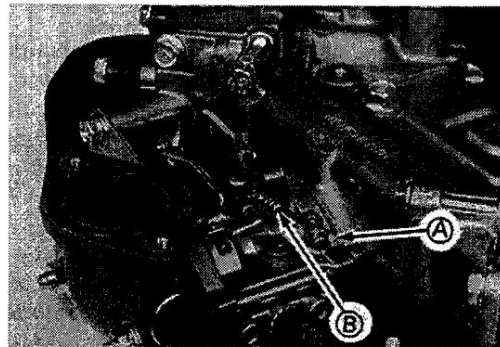
#### CAUTION

Do not attempt to adjust the pilot air screw with the air cleaner removed.

#### CAUTION

Do not turn the pilot air screw in too far or the carburetor body will be damaged and require replacement.

- Turn the pilot air screw (A) clockwise until lightly seated, then turn counterclockwise 1-1/8 turns for FD440V or 1-3/8 turns for FD501V.
- Start and let the engine running at medium idle speed.
- Move the throttle lever to the slow idle position.
- Check engine speed using a tachometer.
- Turn the throttle stop screw (B) on the carburetor until slow idle speed is  $1\ 400 \pm 50$  rpm.
- Turn the pilot air screw (A) clockwise until the engine speed drops, then counterclockwise the engine speed increases and begins to drop again.
- Adjust the pilot air screw (A) for the highest engine speed between drops, then turn the screw counterclockwise an additional 1/4 turn.
- Turn the throttle stop screw (B) on the carburetor to get the specified slow idle speed.

**Pilot Air Screw Turns Out**

<b>Standard:</b>	1-1/8 .....	FD440V
	1-3/8 .....	FD501V

**Slow Idle Speed**

<b>Standard:</b>	1 550 rpm .....	FD440V/FD501V/FD590V
------------------	-----------------	----------------------

**FD590V Shown****Fast Idle Speed Adjustment**

- Start and let the engine turning at medium idle.

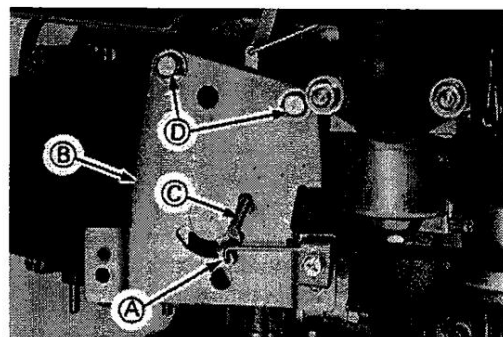
**⚠ WARNING**

Always keep your hands clear of the moving parts.

**⚠ WARNING**

Engine will be hot. Be careful not to burn hands.

- Move the throttle lever to the fast idle position.
- Align the hole in the throttle control plate (A) with the hole in the throttle control plate (B). Put a 6 mm (15/64-in.) drill bit (C) through both holes to keep the throttle control lever from moving. Be sure the drill bit is perpendicular to the throttle control plate.
- Check engine speed using a tachometer.
- If the fast idle speed does not meet the specifications, loosen the fixing screws (D).
- Move the throttle control plate (B) left to increase speed until fast idle speed for FD440V/FD590V is 3 400 rpm or for FD501V is 3 550 rpm.
- Hold the throttle control plate and tighten the fixing bolts.

**Fast Idle Speed**

<b>Standard:</b>	3 400 rpm .....	FD440V/FD590V
	3 550 rpm .....	FD501V

**FD590V Shown**



## 2-10 FUEL SYSTEM

### *High Altitude Operation*

At high altitude, the standard carburetor air-fuel mixture will be excessively rich. Performance will decrease, and fuel consumption will increase. High altitude performance can be improved by installing a smaller diameter main-jet in the carburetor and readjusting the pilot screw (idle mixture screw) to meet good idling and idle speed is the specified rpm.

### NOTE

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

### High Altitude Main Jet

	FD440V	FD501V	FD590V
0 ~ 1000 m (0~3000 ft) (STD)	#87.5	#110	#112.5
1000 ~ 2000 m (3000~6000 ft)	#85	#107.5	#110
2000 m (6000 ft) and higher	#82.5	#105	#107.5

### *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 to disassemble the carburetor (see Carburetor Disassembly-Assembly Notes).
- Using a proper blade screw driver, carefully replace the main jet with a new one for altitude expected.
- Tighten the main jet to the specification (see Carburetor Disassembly Assembly Notes).

### *Fuel System Cleanliness Inspection*

#### ▲ WARNING

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

- Place a suitable container under the carburetor.
- Turn out the drain screw a few turns to drain the carburetor and check to see if water or dirt has accumulated in the carburetor.
- Tighten the drain screw.
- ★ If any water or dirt come out, clean the carburetor (see carburetor Cleaning), and fuel tank, and check the fuel filter.

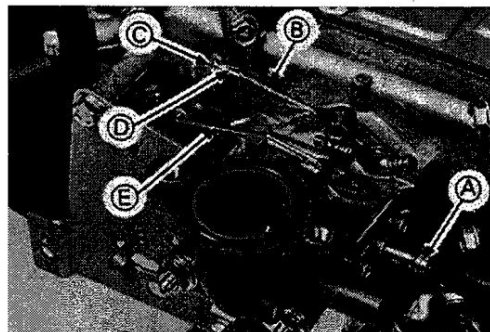


### Carburetor Removal

**⚠ 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).
- Turn the fuel shut off valve in the equipment to the OFF position.
- Drain the carburetor.
- Disconnect the fuel tube at the fuel inlet joint (A) of the carburetor.
- Disconnect the solenoid valve lead terminal.
- Unscrew the carburetor mounting nuts.
- Unhook the throttle link spring (B) at the governor arm (C) top end with a long nose plier.
- Unhook the throttle and choke link rods (D,E) at the top ends of their arms while lifting off the carburetor.



### Installation Notes

- Clean the mating surfaces of the carburetor and intake manifold and fit a new gasket.
- Take care not to bend the throttle and choke link rods during installation. Make sure the link spring around the throttle link rod is in place and that it pulls the governor arm and carburetor throttle lever toward each other.
- Adjust slow idle speed (see Slow Idle Speed Adjustment).

### Disassembly Assembly Notes

- Refer to the exploded view shown for disassembly and assembly.
- There are a number of the plate or ball plugs in the carburetor. None of these should be removed.
- Turn in the idle mixture screw and count the number of turns until it seats fully but not tightly, and then remove the screw. This is to set the screw to its original position when assembling.
- Turn the idle mixture screw all the way in until it seats lightly, and then back it out the same number of turns counted during disassembly.
- Install the throttle valve on the shaft as the numerical mark on the valve facing out side.
- Note the metering hole in the choke valve, install the choke valve on the shaft so that the metering hole is towards fuel inlet joint of the carburetor.
- Drive in the float pin so that the pin extends the same distance on both sides of the float hinge bracket.
- The fuel inlet valve seat is pressed into the carburetor body and is not replaceable.
- When assembling for the carburetor parts which are attached to the carburetor with the recommended tightening torque of bolts and screws. (see Exploded View)

## 2-12 FUEL SYSTEM

---

### *Cleaning*

#### **▲WARNING**

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

#### **CAUTION**

Do not use compressed air on an assembled carburetor, the float may be crushed by the pressure. Remove as many rubber or plastic parts from the carburetor as possible before cleaning the carburetor with a cleaning solution. This will prevent damage 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 carburetor metal parts in a carburetor cleaning solution and clean them.
- Rinse the carburetor parts in water and dry them with compressed air.
- Do not use a 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.

### *Inspection/Float Level Adjustment*

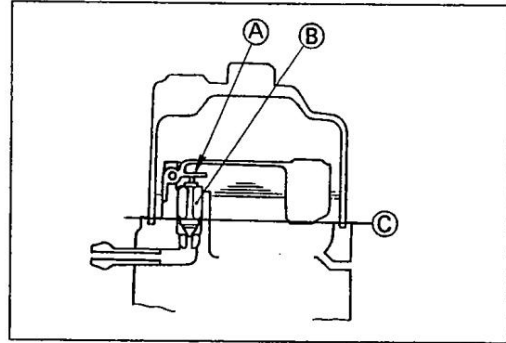
- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burrs and nicks. Replace the gasket if necessary.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.
- ★ If the valves do not move smoothly, replace the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

#### **CAUTION**

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

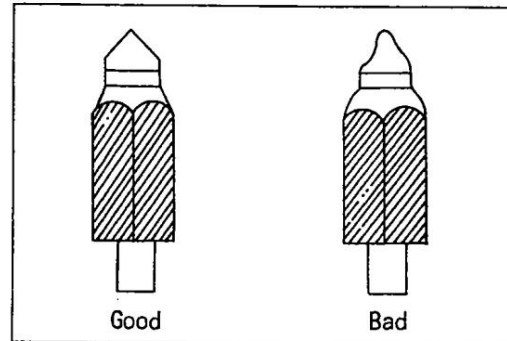
● Hold the carburetor upside down at an eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab (A) just touches the float valve needle (B). The float lower surface should be parallel with the carburetor body surface (C).

★ If the float position is not correct, bend the tab [A] as required for correct adjustment.



● 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 push in and released.

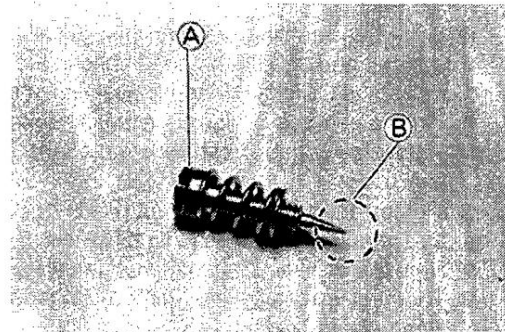
★ If either the needle or the seat is worn or damaged, replace the float assembly and carburetor body as a set.



● Inspect the tapered portion (B) of the screw for wear or damage.

★ If the pilot screw (A) is worn or damaged, on the taper portion, replace it.

● Check the spring for weakened condition, replace it, if necessary.



#### Fuel Shut-Off Solenoid Valve Test (FD501V/FD590V)

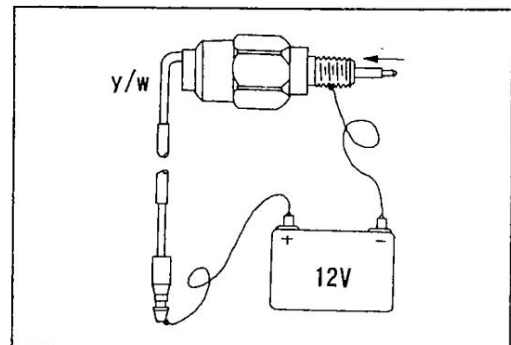
##### CAUTION

Do not apply a DC current for more than 30 seconds, or the solenoid will be damaged.

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

##### NOTE

- It may be necessary to push the plunger slightly for the plunger to withdraw.



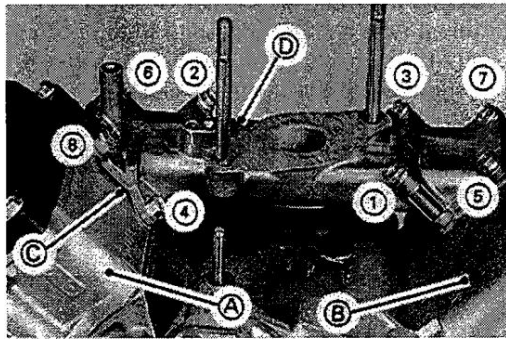


## 2-14 FUEL SYSTEM

### Intake Manifold

#### Removal:

- Remove:
  - Air Cleaner
  - Carburetor
  - Control Panel Assembly
- Drain the coolant in the engine (see coolant Draining)
- Unscrew the manifold mounting bolts in numerical sequence, 1/4 turn at a time, until all bolts are loose.
- ★ If the mounting bolts removal sequence is not followed, manifold mating surfaces may be warped.
- Remove the manifold and gaskets.
  - A. No.1 Cyl. Head
  - B. No. 2 Cyl. Head
  - C. Gaskets
  - D. Intake Manifold



#### Installation Notes

- Before assembling the manifold, install the cylinder heads on each cylinder and tighten the head bolts in the specified sequence temporarily (see Cylinder Head Installation Notes).
- Place a new gaskets on each mating surface, and install the manifold.
- Follow the sequence shown, tighten the mounting bolts to 4 N-m (35 in-lb).
- Tighten the bolts in sequence 3 N-m (26 in-lb) at a time until the torque on each bolt is 7.8 N-m (69 in-lb).
- Note the position of the different length of bolts.
- Then tighten the cylinder head bolts to the specified torque. Cylinder Head Assembly Installation Note.

#### Inspection

- Visually inspect the coolant passage in the manifold for deposits or corrosion in layers inside the passage, clean the passage if necessary.
- An improperly installed gaskets can cause coolant leakage and air drawn into the induction passage. Check the gaskets for correct installation.

#### NOTE

○ *Small coolant leaks appear only as a rust, corrosion or stain.*

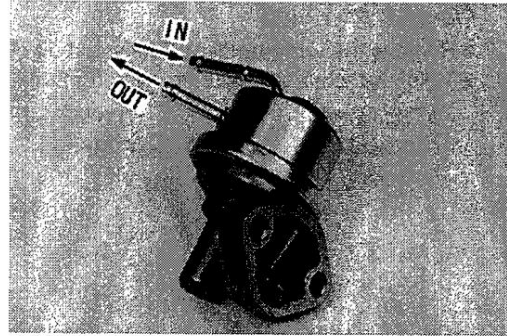
- Inspect the intake manifold for cracks or porous casting.
- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25 % kerosene and 75 % light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a cracks is present, the coating will become discolored at the defective area.
- ★ If a cracks is present in the intake manifold, replace it.
- Inspect the gasket surfaces for burrs and nicks.

## Fuel Pump

The fuel pump is a mechanical drive type unit. A cam on the camshaft of the engine moves actuating the plunger.

This plunger moves the pivot arm which is connected to the diaphragm. A spring is also connected to the diaphragm.

- |                 |                   |
|-----------------|-------------------|
| A. Plunger      | F. Inlet Chamber  |
| B. Spring       | G. Outlet Chamber |
| C. Diaphragm    | H. From Tank      |
| D. Outlet Valve | I. To Carburetor  |
| E. Inlet Valve  |                   |



### Fuel Pump Test

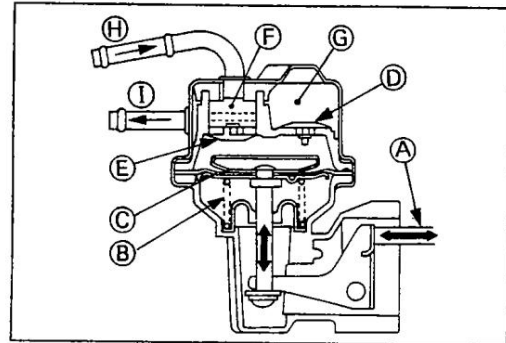
#### ⚠ WARNING

**Gasoline is explosive. Do not expose to spark or flame. Personal injury could result.**

- Disconnect the fuel outlet tube.
- Connect a proper pressure gauge to the fuel outlet tube.
- Start the engine and allow it to idle to make the pump operate. Record the pressure reading. Stop the engine.
- Remove the pressure gauge and connect the fuel outlet tube.
- Disconnect the fuel outlet tube from the carburetor inlet.
- Put the tube end in a graduated container.
- Keep the engine idling for 60 seconds. Stop the engine. Record the container measurement.
- Compare the reading and the record to the specifications.

#### Minimum Specifications

<b>Shut-off Delivery Pressure</b>	<b>2.45 kPa (0.36 psi)</b>
<b>Fuel Flow</b>	<b>800 mL/60 seconds at 1 550 rpm</b>



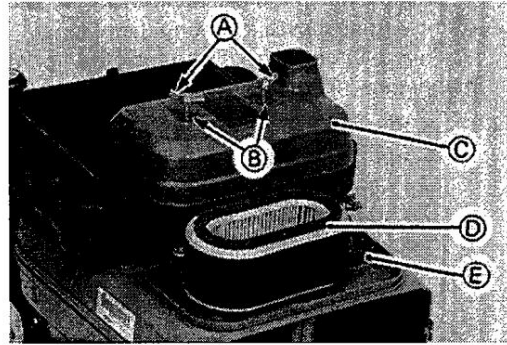
## 2-16 FUEL SYSTEM

### Air Cleaner

#### Element Removal

- Remove the wing bolts, washers and air cleaner case.
- Take off the air cleaner elements from the body.

- |               |             |
|---------------|-------------|
| A. Wing Bolts | D. Elements |
| B. Washers    | E. Body     |
| C. Case       |             |



#### Element Installation Notes

- Install the elements correctly on the air cleaner body.
- The elements can be installed either way on the air cleaner body. Be sure the elements is in place on the air cleaner body.

#### Element Cleaning and Inspection

##### NOTE

- In dusty areas, the elements should be cleaned or replaced more frequently than the recommended intervals.

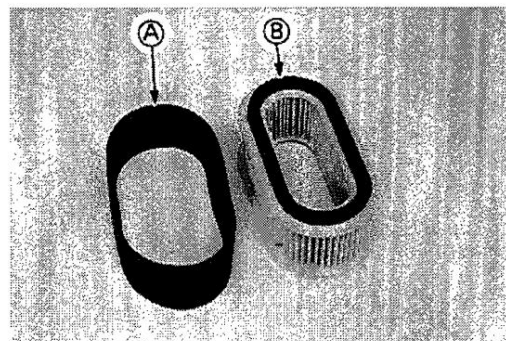
##### ▲WARNING

Clean the element in a well-ventilated area, and take ample care that there are no sparks or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or a low flash-point solvent to clean the element.

- Remove the air cleaner element, and separate the foam element (A) from the paper element (B).
- Clean the foam element in a bath of detergent and water, and then dry it with compressed air or by shaking it.
- After cleaning, saturate the foam element with clean engine oil, squeeze out the excess, then wrap it in a clean rag and squeeze it as dry as possible. Be careful not to tear the foam element.

##### CAUTION

Do not clean the paper element. Replace if dirty or damaged in any way, or direct light can be seen through paper.





# Cooling System

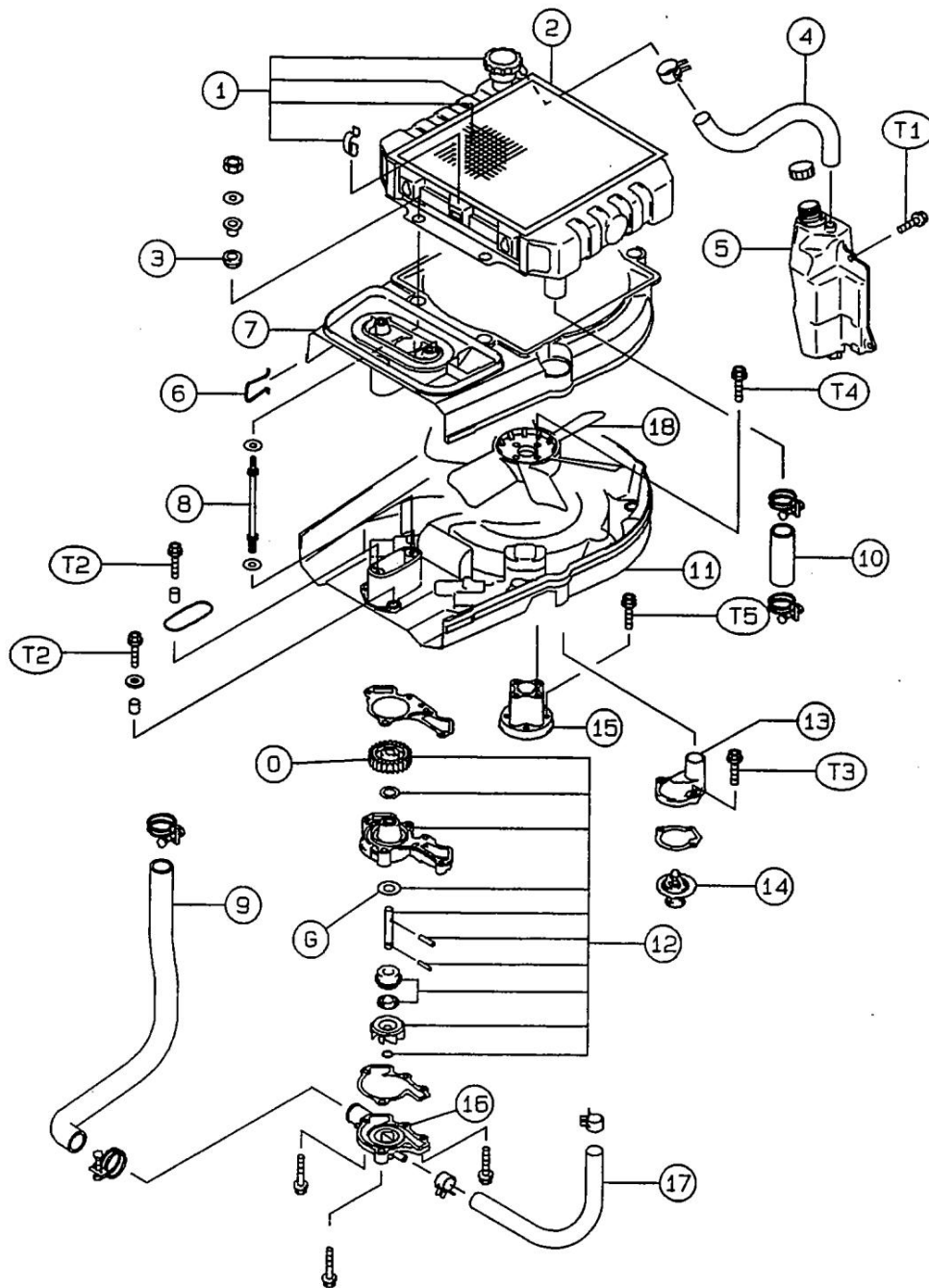
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### 3-2 COOLING SYSTEM

#### Exploded View - FD440V/FD501V



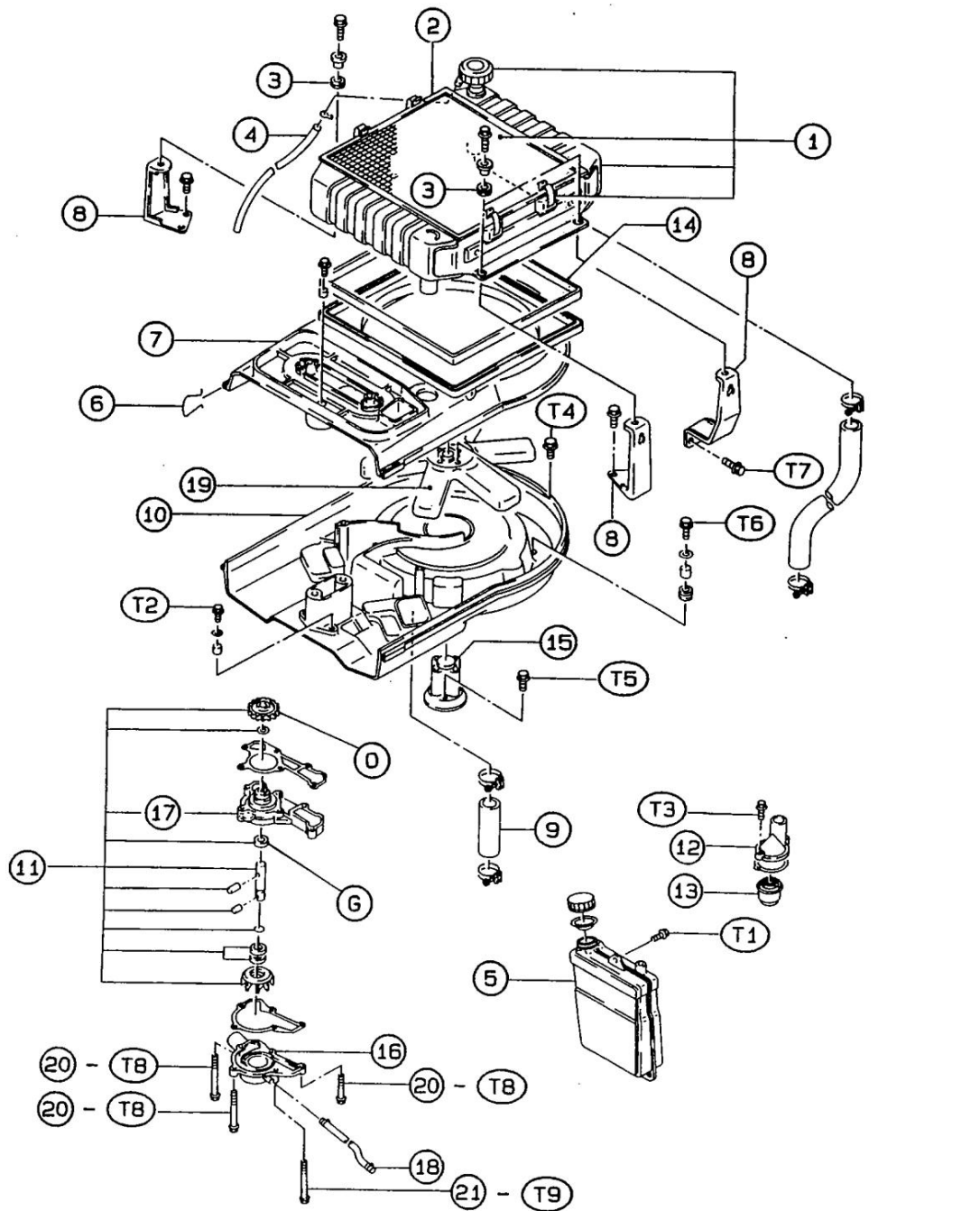
- 1. Radiator
- 2. Screen
- 3. Dumper Bushings
- 4. Over Flow Tube
- 5. Reservoir
- 6. Retaining Clips
- 7. Top Half Air Duct
- 8. Studs
- 9. Outlet Hose

- 10. Return Hose
- 11. Bottom Half Air Duct
- 12. Water Pump
- 13. Thermostat Housing
- 14. Thermostat
- 15. Fan Extension
- 16. Water Pump Cover
- 17. Bypass Hose
- 18. Cooling Fan

- T<sub>1</sub> : 4N-m (0.4kg-m, 35in-lb)
- T<sub>2</sub> : 6N-m (0.6kg-m, 52in-lb)
- T<sub>3</sub> : 6N-m (0.6kg-m, 52in-lb)
- T<sub>4</sub> : 6N-m (0.6kg-m, 52in-lb)
- T<sub>5</sub> : 6N-m (0.6kg-m, 52in-lb)
- O : Apply engine oil
- G : Apply grease



## Exploded View - FD590V



- |                          |                         |                                  |
|--------------------------|-------------------------|----------------------------------|
| 1. Radiator              | 12. Thermostat Housing  | T1: 4 N-m (0.4 kg-m, 35 in-lb)   |
| 2. Screen                | 13. Thermostat          | T2: 6 N-m (0.6 kg-m, 52 in-lb)   |
| 3. Dumper Bushings       | 14. Seal                | T3: 6 N-m (0.6 kg-m, 52 in-lb)   |
| 4. Cover Flow Tube       | 15. Fan Extension       | T4: 6 N-m (0.6 kg-m, 52 in-lb)   |
| 5. Reservoir             | 16. Water Pump Cover    | T5: 6 N-m (0.6 kg-m, 52 in-lb)   |
| 6. Retaining Clips       | 17. Water Pump Case     | T6: 6 N-m (0.6 kg-m, 52 in-lb)   |
| 7. Top Half Air Duct     | 18. Bypass Hose         | T7: 15 N-m (1.5 kg-m, 11 ft-lb)  |
| 8. Radiator Brackets     | 19. Cooling Fan         | T8: 8.8 N-m (0.9 kg-m, 78 in-lb) |
| 9. Return Hose           | 20. Water Pump M6 Bolts | T9: 22 N-m (2.2 kg-m, 15 in-lb)  |
| 10. Bottom Half Air Duct | 21. Water Pump M8 Bolt  | O: Apply engine oil              |
| 11. Water Pump           |                         | G: Apply grease                  |

**3-4 COOLING SYSTEM****Specifications**

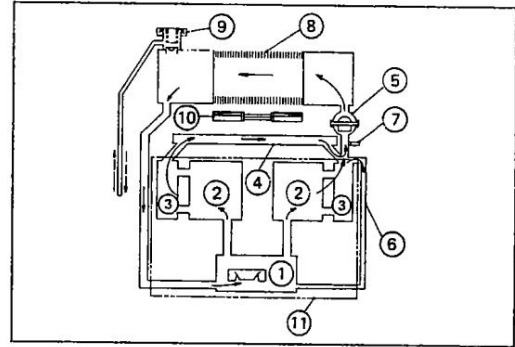
Item	FD440V/FD501V	FD590V
<b>*Coolant:</b>		
Type	Permanent type of antifreeze for aluminum engine and radiator	
Color	Green	
Mixed ratio	50% solution of ethylene glycol	
Freezing point	- 35°C (-31°F)	
Total amount	2.10 L (2.2 qt)	3.04 L (3.2 qt)
<b>Radiator Cap Relief Pressure:</b>		
Pressure valve (positive)	78.2 to 97.8 kPa (11.3 to 14.2 psi)	
Vacuum Valve (negative)	4.90 kPa (0.71 psi)	
<b>Thermostat:</b>		
Begin opening temperature	82°C (180°F)	
Fully open temperature	95°C (203°F)	
<b>Thermo Switch:</b>		
Detect Temperature	108 to 114°C (226 to 237°F)	

\*Coolant is not installed in the cooling system when shipped.

**Cooling System**

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

1. Coolant Pump
2. Cylinder Jackets
3. Cylinder Heads
4. Intake Manifold
5. Thermostat
6. Bypass Tube
7. Thermo Switch
8. Radiator
9. Radiator Cap
10. Cooling Fan
11. Cylinder Block



## 3-6 COOLING SYSTEM

### Coolant

#### *Coolant Deterioration*

- Visually inspect the coolant in the radiator.
- If whitish cotton-like wafts are observed, aluminum parts in the cooling system are corroded. If the coolant is brown, iron or steel parts are rusting. In either case, flush the cooling system.
- If the coolant gives off an abnormal smell when changing, check for a cooling system leak. It may be caused by exhaust gas leaking in to the cooling system.

#### *Coolant Level Inspection*

- Put the engine on a level surface.
- Remove the radiator cap turning it counterclockwise and check the coolant level in the radiator.

#### ⚠ WARNING

**Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.**

- Coolant level must be maintained a level of the filler neck bottom (A).
- ★ If the amount of the coolant is insufficient, fill the radiator up to the bottom of the radiator filler neck (A) with the coolant, and install the cap turning it clockwise.



#### CAUTION

**For refilling, add the specified mixture of coolant and soft water. Adding water alone dilutes the coolant and degrades its anticorrosion properties. The diluted coolant can attack the aluminum engine parts. In an emergency, soft water can be added. But the diluted coolant must be returned to the correct mixture ratio within a few days.**

**If coolant must be added often, there is probably leakage in the cooling system. Check the system for leaks (see Visual Leak Inspection, and pressure Testing).**

#### *Coolant Draining*

The coolant should be changed periodically to ensure long engine life.

#### CAUTION

**Use coolant containing corrosion inhibitors made specifically for aluminum engines and radiators in accordance with the instructions of the manufactures (see Coolant Filling Section).**

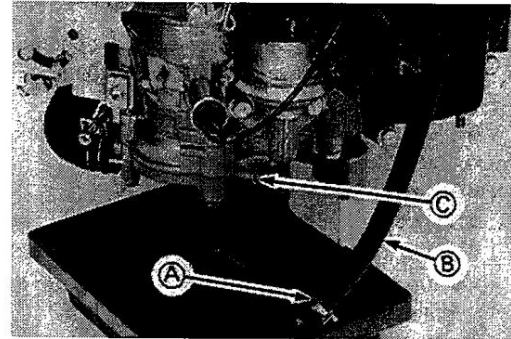
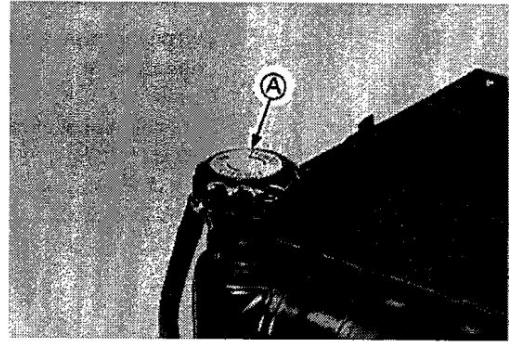


**▲WARNING**

**To avoid burns do not remove the radiator cap or try to change the coolant when the engine is still hot. Wait until it cools down. Since coolant is harmful to the human body, do not use for drinking.**

- Remove the radiator cap (A).
- First turn the cap counterclockwise to the first stop and wait there for a few seconds.
- Push down the cap, then turn the cap counterclockwise to the next stop.
- Lift off the cap.
- Slip the retaining clip (A) down and pull the coolant bypass hose (B) out of the coolant pump inlet (C).
- Put a suitable container under the coolant pump.
- Quick lead the coolant bypass hose end into the container.

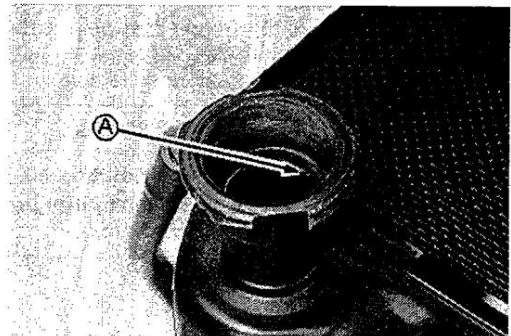
**FD501V Shown**

**Coolant Filling**

- Install the drain plugs. Always replace the gaskets with a new ones, if they are damaged.
- Tighten the drain screws to the specification (see Exploded Views).
- Fill the radiator up to the radiator filler neck bottom (A) with coolant, and install the cap turning it clockwise.

**NOTE**

- Pour in the coolant slowly so that it can expel the air from the engine and radiator.
- To install the radiator cap, push down it and then turn the cap clockwise to the rest of the way.

**CAUTION**

**Soft or distilled water must be used with the antifreeze in the cooling system.**

**If hard water is used in the system, it causes scales accumulation in the water passages, and considerably reduces the efficiency of the cooling system.**

**NOTE**

- Choose a suitable mixture ratio by referring to the coolant manufacturer's instructions.

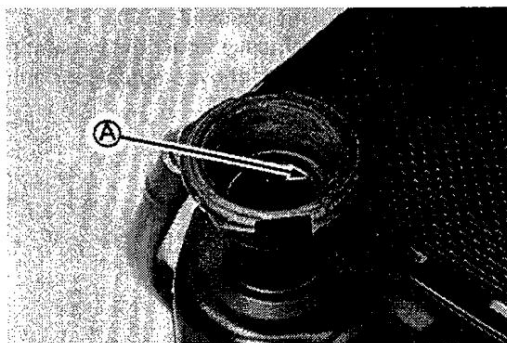
## 3-8 COOLING SYSTEM

<b>Original Coolant Type:</b>	<b>Permanent type antifreeze for aluminum engine and radiator</b>
<b>Color:</b>	<b>Green</b>
<b>Mixed ratio:</b>	<b>50% solution of ethylene glycol</b>
<b>Freezing Point:</b>	<b>-35°C (-31°F)</b>
<b>Total amount:</b>	<b>2.1 L (2.2 qt).....FD440V/FD501V</b>
	<b>3.04 L (3.2 qt).....FD590V</b>

### Air Bleeding

Before putting the engine into operation, any air trapped in the cooling system must be removed as follows.

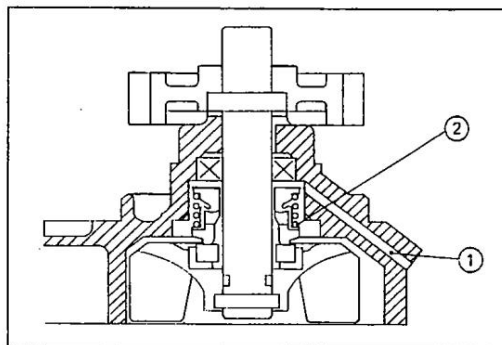
- Remove the radiator cap.
- Fill the radiator up to the radiator filler neck with coolant.
- Check the cooling system for leaks.
- Install the radiator cap.
- Start the engine, warm it up thoroughly, and then stop it.
- Check the coolant level in the radiator after the engine cools down.
- ★ If the coolant level is low, add coolant up to the filler neck bottom (A). Install the cap.



### Visual Leak Inspection

Any time the system slowly loses water, inspect for leaks. Small leaks may appear only a rust, corrosion or stain due to evaporation. Watch for these trouble spots.

- Check the water pump housing drainage outlet passage (1) for coolant leaks.
- ★ If the mechanical seal is damaged, the coolant leaks through the seal and drain through the passage. Replace the mechanical seal (2).
- ★ If there are no apparent leaks, pressure test the system.



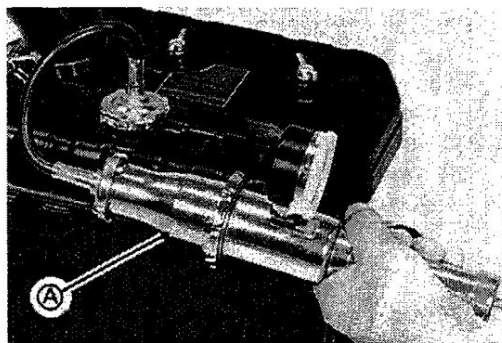
### Cooling System Pressure Testing

Air pressure leakage tester can help locate external leaks but they cannot be depended upon to locate small combustion leaks.

#### CAUTION

During pressure testing, do not exceed the pressure for which the system is designed. The maximum pressure is 97.8 kPa (14.2 psi).

- Remove the radiator cap, and install a cooling system pressure tester (A) on the radiator filler neck.
- Wet the cap sealing surfaces with water or coolant to prevent pressure leaks.
- Build up pressure in the system carefully until the pressure reaches 90 kPa (13 psi).
- Watch the pressure gauge for at least 15 seconds. If the pressure holds steady, the system is all right.
- Remove the pressure tester, replenish the coolant, and install the cap.
- ★ If the pressure drops and no external source is found, check for internal leaks. Droplets in the engine oil indicate internal leakage. Check the cylinder head gaskets.





### *Flushing*

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

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

CAUTION
<b>Avoid the use of a flushing compound which is harmful to the aluminum engine and radiator. Carefully follow the instructions supplied by the manufacturer of the cleaning product.</b>

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

---

### **Disassembly and Assembly Precautions**

---

- Prior to disassembly of cooling system parts (radiator, pump, sensor, etc), wait until the coolant cools down, and then drain the system with coolant.
- After assembling and filling the system with a coolant, purge any air from the system.

## 3-10 COOLING SYSTEM

### Coolant Pump

#### Coolant Pump Removal

- Drain the coolant (see Coolant Draining).
- Loosen the tube clamp (D), and pull off the coolant by-pass tube (E).
- Unscrew the coolant pump mounting bolts, and remove the coolant pump assembly.

#### NOTE

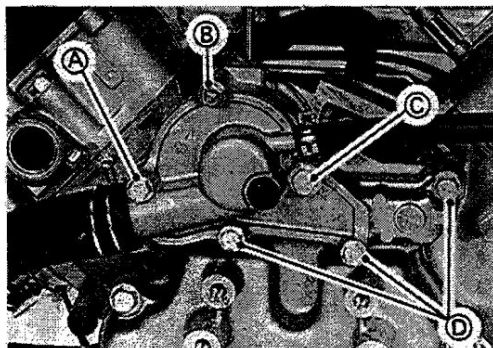
- Note the position of different length of bolts so they can be installed in their original positions.

#### Installation Notes

- Chip the old gasket off the mating surfaces of the casecover and pump housing.
- Put a new gasket on the pump housing.
- Be sure to suitable set the pump gear to be meshed with the cam gear when installing the pump assembly. Do not force the pump into position.
- Install the mounting bolts and tighten them to the specification (see Torque Table or Exploded View).
- Note the position of different length of bolts.

#### Bolt Dimensions

- A. Bolt M6 l = 75 mm (2.95 in)
- B. Bolt M6 l = 65 mm (2.56 in)
- C. Bolt M8 l = 70 mm (2.76 in)
- D. Bolt M6 l = 45 mm (1.77 in)



#### Disassembly

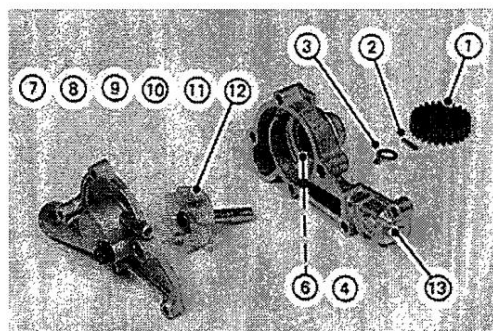
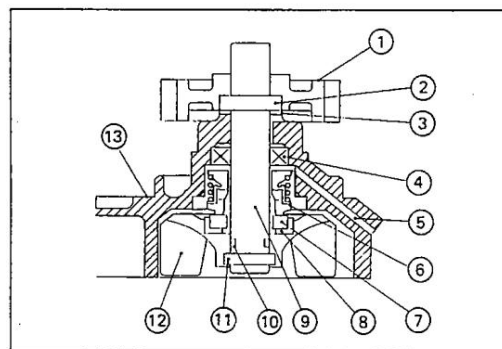
For disassembly, follow the steps (A ~ J) shown below (see illustration).

#### NOTE

- Do not attempt to remove the mechanical seal, oil seal and O-ring unless they are to be replaced.

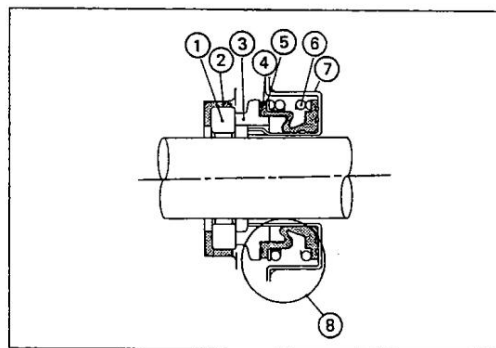
- A. Plastic pump gear (1)
- B. Dowel pin (2)
- C. Claw washer (3)
- D. Extract the impeller subassembly (12)(11)(10)(9)(8)(7) from the pump housing (13).
- E. Mechanical seal cartridge (6)
- F. Oil seal (4)
- G. Dowel pin (11)
- H. Impeller (12)
- I. Mating ring (7) and cup-gasket (8)
- J. O-ring (10)

- |                            |                   |
|----------------------------|-------------------|
| 1. Pump Gear               | 8. Cup Gasket     |
| 2. Dowel Pin (1)           | 9. Pump Shaft     |
| 3. Claw Washer             | 10. O-Ring        |
| 4. Oil Seal                | 11. Dowel Pin (2) |
| 5. Drainage outlet passage | 12. Impeller      |
| 6. Cartridge               | 13. Pump Housing  |
| 7. Mating Ring             |                   |



**Internal Parts – Mechanical Seal**

1. Mating Ring (Floating Seat)
2. Cup Gasket (Cushion Ring)
3. Seal Ring
4. Bellows
5. Spring Retainer
6. Coil Spring
7. Casing
8. Cartridge

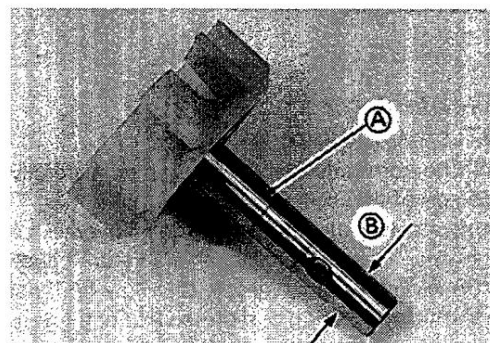
**Pump Parts Inspection**

- Clean All parts except plastic and rubber parts in a bath of high flash-point solvent and dry them compressed air. Clean non-metal parts with detergent and water, and dry them.
- Inspect the pump housing for damage. Mating surfaces should be smooth and free of burrs and nicks. Replace the gasket if necessary.
- Check the other parts for wear or damage, replace the parts if necessary.
- ★ If the mechanical seal is damaged, the coolant leaks through the seal, and drains through the drainage outlet passage.
- ★ If the oil seal is damaged, the engine oil drains through the drainage passage.
- ★ If the mechanical seal parts are damaged, replace the seal as a set.
- Visually check the impeller.
- ★ If the surface is corroded, or if the blades are damaged, replace all internal pump parts.

- Measure the outside diameter (B) of the impeller shaft (A) end with a micrometer at several points.
- ★ If the shaft end diameter is less than service limit, replace the shaft.

**Outside Diameter of Impeller Shaft End**

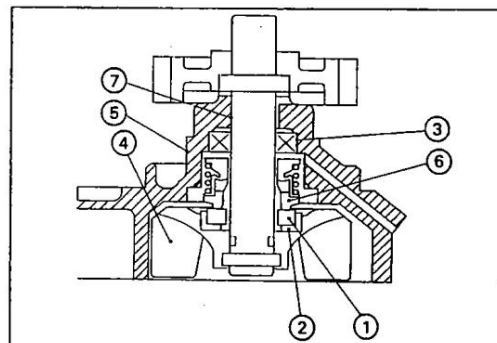
**Service Limit: 9.935 mm (0.3911 in)**

**Assembly Notes**

- When installing the mating ring (1) into the cup gasket (2), moisten outside surface of the mating ring with fresh water and then push the ring into the stop end. Do not damage mating surfaces.
- Pack some amount of high temperature grease into the oil seal (3). Press in the oil seal using a suitable tools so that the oil seal is flush with the shoulder surface.

**NOTE**

- The oil seal must be assembled with spring loaded lip toward inside of the engine.





## 3-12 COOLING SYSTEM

- When installing the impeller (4) sub assembly to the housing (5), coat mating surfaces between the mating ring and seal ring (6) with a clean water.
- To avoid oil seal damage, coat thin film of engine oil on the pump shaft (7), and then carefully insert pump shaft into the housing.

### Radiator

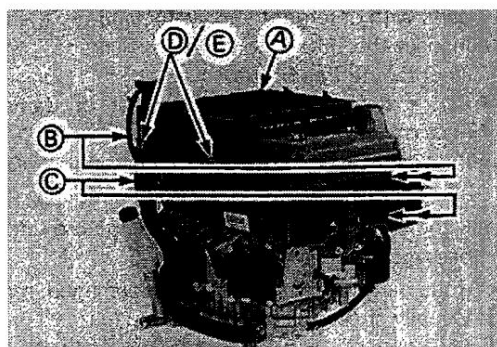
#### Removal

#### ⚠ WARNING

**Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.**

- Remove the radiator cap and drain the coolant in the radiator (A) (see Coolant Draining).
- Loosen the hose clamps (B), and disconnect the radiator hoses (C) at the coolant inlet and outlet of the radiator.
- Unscrew the radiator mounting bolts (D), and remove the distance collars (E).
- Carefully remove the radiator.

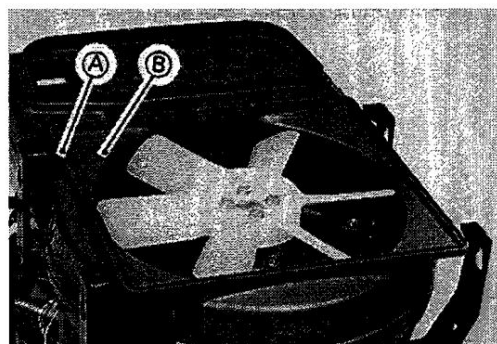
FD590V shown



#### Radiator Installation Notes – FD440V/FD501V

The radiator seal must sit in the groove (A) of the top half air duct (B). Replace if damaged.

FD501V shown

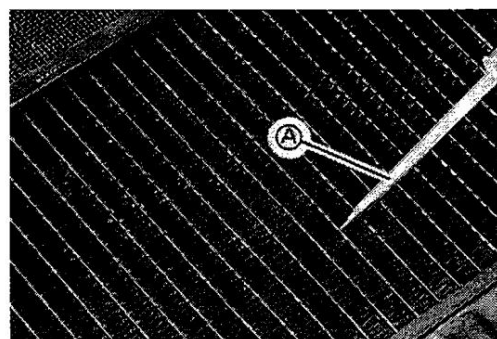


#### Radiator Inspection

- Check the radiator core.
- ★ If the corrugated fins are deformed, carefully straighten them with the blade of thin screw driver (A).
- Inspect the inlet and outlet tubes for cracks, kinks, dents, and fractured seams. Repair or replace the radiator, if necessary.
- Check for dirt and insects that may be lodged in the radiator. Clean them out by using compressed air or a low-pressure washer.

#### CAUTION

**Using high-pressure water, as from a car wash facility, could damage the radiator fins and impair the radiator's effectiveness.**

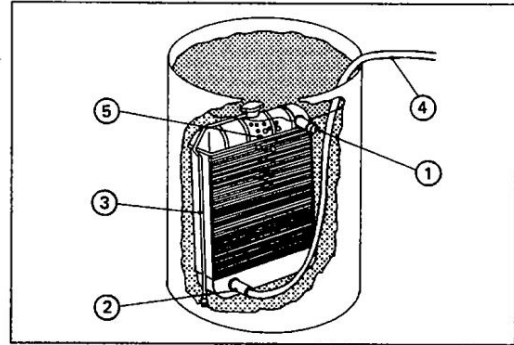




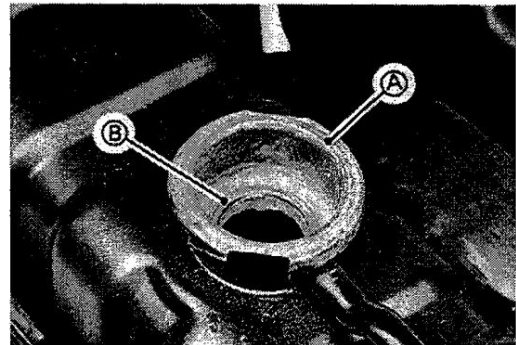
● If the air passages of the radiator core are blocked more than 30% by unremoval obstructions or irreparably deformed fins, replace the radiator with a new one.

★ If a radiator leak is detected, but cannot be spotted visually, test it as follows:

1. Install the radiator cap, and plug the overflow tube (3) and inlet pipe (1). Attach an air hose (4) to the outlet connection (2).
2. Pressurize the inside of the radiator with compressed air to about 50 to 70 kPa (7 to 10 psi).
3. Submerge the radiator in water and look for bubbles (5) which indicate the location of the leak.
4. Repair any leaks or replace it with a new one.



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



### Radiator Cap Inspection

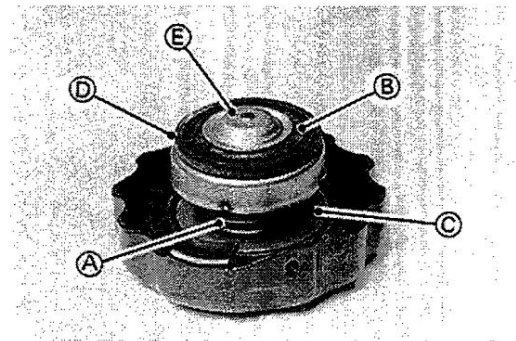
The radiator cap has two functions:

1. Allow atmospheric pressure to enter the cooling system.
  2. Prevents coolant escape at normal operating pressure.
- A pressure valve (D) in the cap permits the escape of coolant or steam when the pressure in the system rises above the relief pressure.

A vacuum valve (E) in the cap opens when needed to prevent a vacuum in the cooling system.

- Check the condition of the valve spring (A), and the top (B) and bottom (C) valve seats of the radiator cap.

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



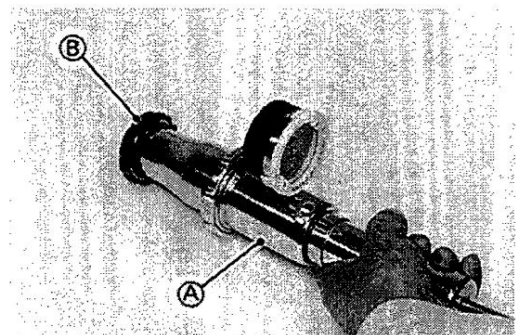
- Wet the radiator cap (B) sealing surfaces with water or coolant to prevent pressure leaks.
- Install the cap on a cooling system pressure tester (A).
- Watching the pressure gauge, pump the pressure tester to build up the pressure. The cap must retain the pressure at least 6 seconds. Also the cap must open at the pressure shown in the table.

### Radiator cap Relief Pressure

Pressure Valve: 78.2 to 97.8 kPa (11.3 to 14.2 psi)

Vacuum Valve: 4.90 kPa (0.71 psi) (vacuum)

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



## 3-14 COOLING SYSTEM

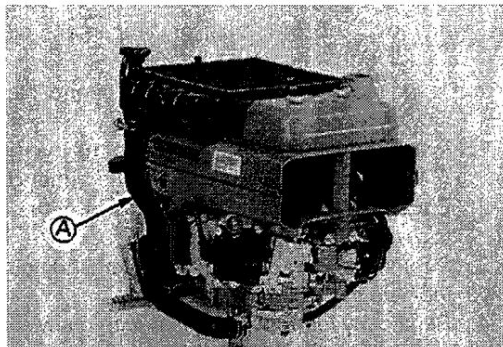
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### *Radiator Hose Inspection*

- In accordance with the Periodic Maintenance Chart, visually inspect the hoses (A) for signs of deterioration. Squeeze the hose. A hose should not be hard and brittle, nor should it be soft or swollen.
- Replace any damaged hose.

#### **NOTE**

- Hoses can deteriorate on the inside and still appear to be in good condition on the outside.

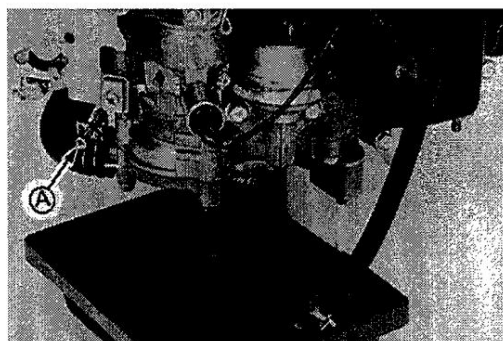


### *Radiator Hose Installation Notes*

- Install the radiator hoses being careful to follow bending direction (see Exploded View). Avoid sharp bending, kinking, flattening, or twisting.

#### **NOTE**

- Locate the hose clamps (A) properly over the connections. A pressurized cooling system will blow a hose that is not installed properly. Tighten the hose clamps securely.



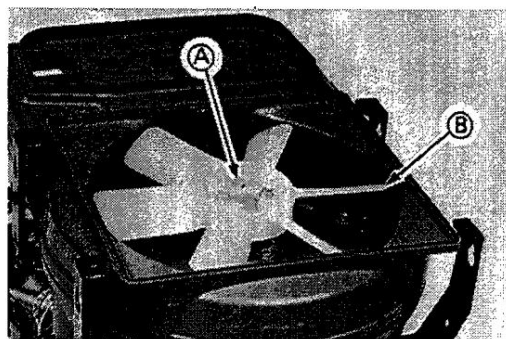
## Cooling Fan and Cooling Air Duct

The only service on the cooling fan is to be sure the fan blades are not deformed, and the blade tips are far enough from the air duct not to strike the duct.

### Cooling Fan Removal

Remove the radiator (see Radiator Removal).

- Unscrew the mounting bolts (A), and take off the cooling fan (B).



### Installation Notes

- Install the cooling fan as "AISHIN" raised lettering (A) on the fan boss facing toward the radiator.
- Clean the drive belt by wiping with a clean cloth. Immediately wipe off any spilled oil or grease. Do not use solvent.
- Install the belt on the sheave to rotate same direction as original installation.
- When tightening the sheave/hub mounting nuts, rotate the fan in either direction to avoid pinching the belt.
- Check the belt tension.

### Inspection

- Be sure the fan blades are straight. Deformed blades reduce the cooling system efficiency and throw the fan out of balance.
- Check for excessive side wall wear of the sheaves and belt, replace if necessary. The belt and sides of the sheaves should wear evenly.
- Check to be sure dirt has not lodged and packed in the sheave V-grooves.
- Check the belt for swells or lumps, replace if necessary.



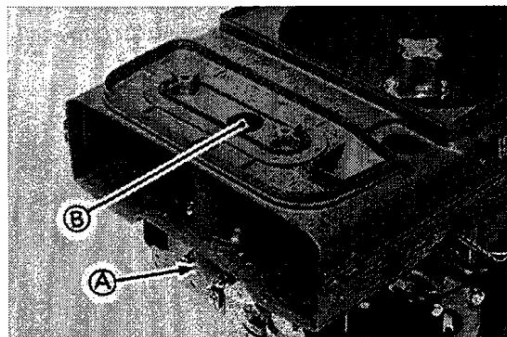
## 3-16 COOLING SYSTEM

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### *Cooling Air Duct Removal and Installation*

**CAUTION**

Do not let small fasteners and collars fall into the intake elbow (A) through the hole (B) during removal and installation, or the engine may jam.





## Thermostat

### Thermostat Removal

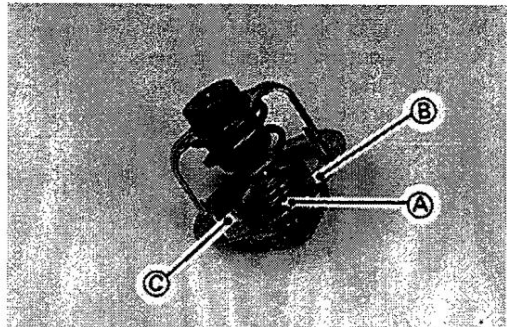
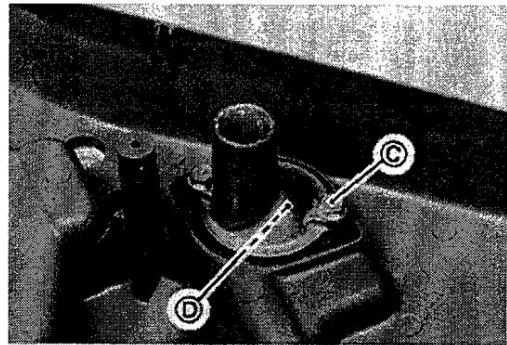
- Remove the radiator (see Radiator Removal).
- Remove the top half cooling air duct (see Cooling Air Duct Removal).
- Remove the cooling fan (see Cooling Fan Removal).
- Remove the bottom half cooling air duct (see Cooling Air Duct Removal).
- Unscrew the thermostat cover bolts (C), and remove the cover.
- Take off the thermostat (D).

### NOTE

- With the thermostat installed, the jiggle valve may be positioned up-side of the thermostat when installing.

### Thermostat Inspection

- Remove the thermostat, and check the jiggle valve (A) for sticking or binding on the flange (B) due to accumulation of a rust, scale or lime. Clean up the valve to ensure free movement of the valve (C), if necessary.



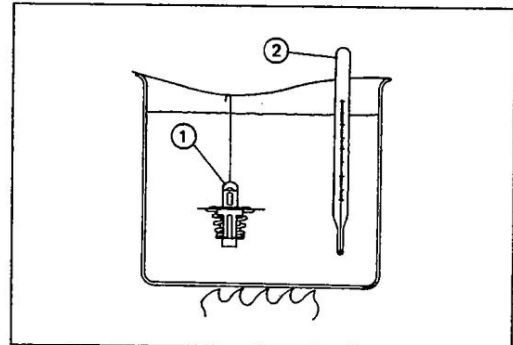
- Inspect the thermostat valve (1) at room temperature.
- ★ If the valve is open, replace the valve with a new one.
- To check valve opening temperature, suspend the thermostat and an accurate thermometer (2) in a container filled with a water.
- Place the container over a source of heat and gradually raise the temperature of the water while stirring the water gently.
- Watch the valve. The valve should begin to open at the temperature specified.
- It should be fully opened to 7mm (0.28 in) or more at the temperature specified.

### Thermostat Valve Specification

Begin Opening	80 to 84°C (176 to 183°F)
Full Open	95°C (203°F)

The thermostat and thermometer must not touch the container sides.

- ★ If the thermostat fails any of these check, replace it.



## 3-18 COOLING SYSTEM

### Thermo Switch

When coolant temperature rises above 111°C (232°F), the thermo switch detects this and turns on a warning light on dash. Whenever you start the engine, make sure the warning light is not on in started engine.

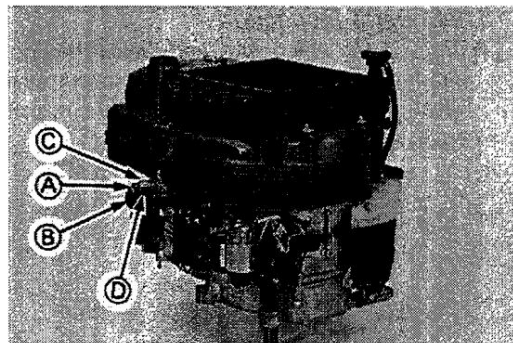
If the warning light comes on, stop the engine immediately, and check the cooling system for over heating. Over heating can caused by:

- Lack of coolant
- Loose or slipping fan belt
- Clogging of cooling system
- Malfunction water pump or thermostat

Check the coolant level and temperature frequently.

#### Thermo Switch Removal and Installation

- Drain the coolant (see Coolant Draining).
- Disconnect switch lead terminal (A).
- Loosen the bypass tube clamp (C) and disconnect the tube (B).
- Unscrew the thermo switch and remove it.
- When installing the thermo switch (D), apply a non-permanent locking agent to the threads and tighten the switch to the specified torque (see Exploded View).



#### thermo Switch Inspection

- Using a ohmmeter, check to see that only the connections in the table have continuity.
- ★ If the switch has an open or short, repair it or replaced it with a new one.

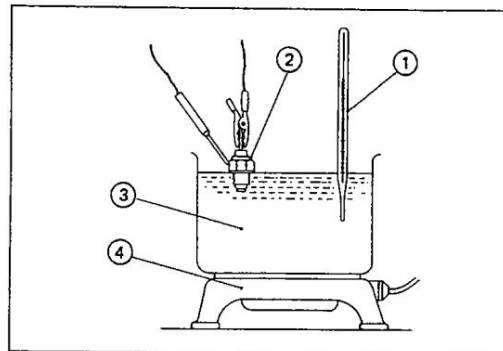
#### Termo Switch Connections

- Rising temperature:  
From Off to On at 108 - 114°C (226 - 237°F)
- Falling temperature:  
From On to OFF at 101 - 107°C (214 - 225°F)
- ON: Continuity
- OFF: Infnit

- Suspend the switch (2) in a container of coolant (3) so that the temperature sensing projection and threaded portion are submerged.
- Suspend an accurate thermometer (1) in the coolant.

#### NOTE

- The switch and thermometer must not touch the container sides or bottom.
- Place the container over a source of heat (4) and gradually raise the temperature of the coolant while stirring the coolant gently.



# Engine Top End

4

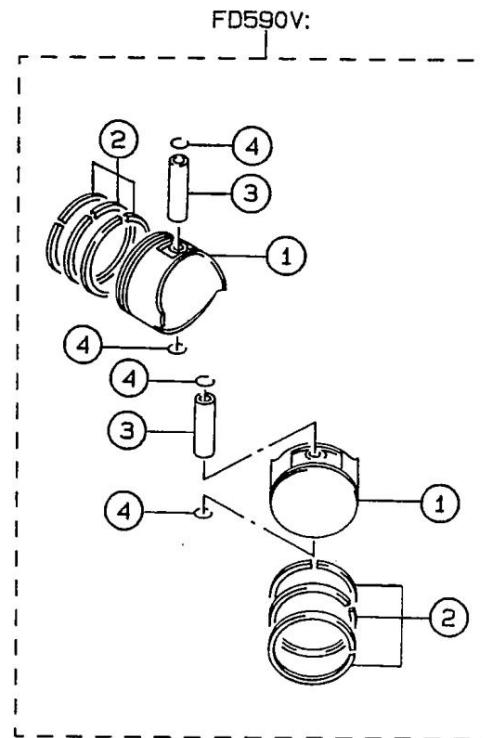
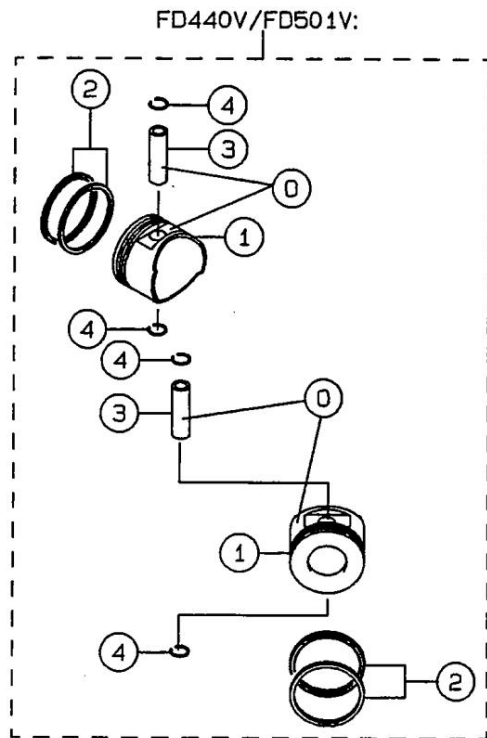
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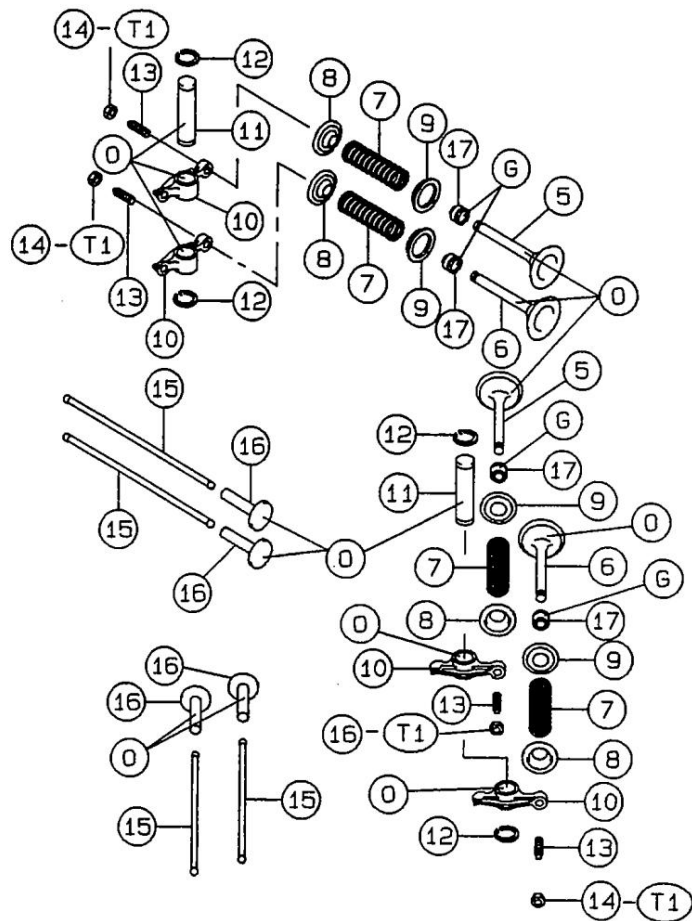


## 4-2 ENGINE TOP END

### Exploded View

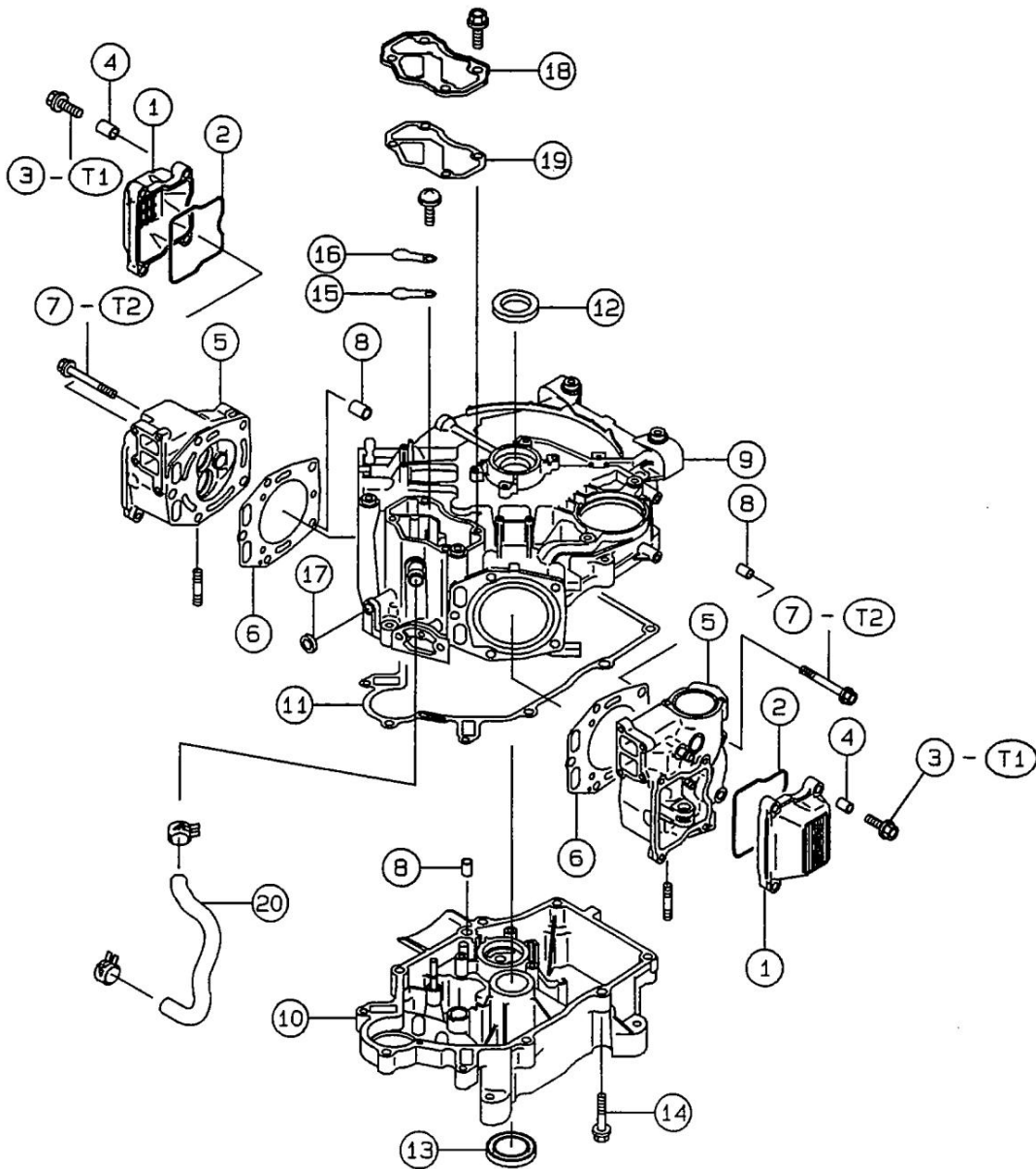


1. Piston
  2. Piston Ring Set
  3. Piston Pins
  4. Snap Rings
  5. Intake Valves
  6. Exhaust Valves
  7. Valve Springs
  8. Valve-Springs Retainers
  9. Valve-Spring Seats
  10. Rocker Arms
  11. Rocker Shafts
  12. Circlips
  13. Valve Clearance Adjuster Screws
  14. Lock Nuts
  15. Push Rods
  16. Tappets
  17. Oil Seals
- T<sub>1</sub> : 9N-m (0.9kg-m, 79in-lb)  
 O : Apply engine oil  
 G : Apply grease



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- |                           |                                    |  |
|---------------------------|------------------------------------|--|
| 1. Rocker Chambers        | 11. Crankcase Cover Gasket         | T <sub>1</sub> : 5.9N-m (0.6kg-m, 52in-lb) |
| 2. Rocker-Chamber Gaskets | 12. Oil Seal (Flywheel Side)       | T <sub>2</sub> : 21N-m (2.1kg-m, 186in-lb) |
| 3. Rocker-Chamber Bolts   | 13. Oil Seal (P.T.O. Side)         |  |
| 4. Collars                | 14. Crankcase Cover Bolts          |  |
| 5. Cylinder Heads         | 15. Breather Reed Valve            |  |
| 6. Cylinder-Head Gaskets  | 16. Breather Reed Valve Back Plate |  |
| 7. Cylinder-Head Bolts    | 17. Governor Shaft Oil Seal        |  |
| 8. Dowel Pins             | 18. Breather Chamber Cover         |  |
| 9. Crankcase              | 19. Breather Chamber Cover Gasket  |  |
| 10. Crankcase Cover       | 20. Breather Tube                  |  |

**4-4 ENGINE TOP END****Specifications – FD440V/FD501V**

Item	Service Limit
<b>CYLINDER HEAD AND VALVES</b> Valve Clearance Rocker Arm Minimum Shaft O.D. Maximum Bearing I.D. Adjusting Nut Torque Push Rod Maximum Bend Valves and Springs Minimum Valve Spring Free Length Minimum Valve Stem O.D. Intake Exhaust Maximum Valve Guide I.D. Maximum Valve Stem Bend Standard Valve Seating Surface Valve Seating Width Tolerance Valve Seat and Face Angle Minimum Valve Margin Valve Narrowing Angle	0.15 mm (0.006 in.)  11.95 mm (0.470 in.) 12.07 mm (0.475 in.) 9 N-m (79 in-lb) 0.80 mm (0.031 in.)  27.30 mm (1.074 in.)  4.93 mm (0.194 in.) 4.92 mm (0.193 in.) 5.06 mm (0.199 in.) 0.03 mm (0.001 in.) 0.80 mm (0.031 in.) 0.50 ~ 1.10 mm (0.020 ~ 0.034 in.) 45° 0.50 mm (0.020 in.) 30°
<b>Cylinder Head</b> Maximum Cylinder Head Flatness Cap Screw Torque In Sequence (Lubricated) Initial Torque Final Torque Spark Plug Torque	0.06 mm (0.002 in.)  13 N-m (115 in-lb) 21 N-m (186 in-lb) 17 N-m (150 in-lb)
<b>Piston</b> Maximum Ring Groove Clearance Top Ring Oil Ring Maximum Ring End Gap Top Ring Oil Ring Minimum Pin O.D. Maximum Pin Bore I.D. Height of piston O.D. measurement Piston O.D. Piston-to-Cylinder Bore Clearance	0.10 mm (0.004 in.) Not Measured  1.0 mm (0.040 in.) Not Measured 15.98 mm (0.629 in.) 16.04 mm (0.631 in.) 13.5 mm (0.531 in.) 66.950 ~ 66.965 mm (2.6358 ~ 2.6364 in.) 0.015 ~ 0.150 mm (0.00059 ~ 0.0059 in.)
<b>Connecting Rod</b> Maximum Crankshaft Bearing I.D. Maximum Piston Pin Bearing I.D. End-Cap Screw Torque	31.06 mm (1.223 in.) 16.05 mm (0.632 in.) 12 N-m (106 in-lb)
<b>Crankshaft</b> Minimum Side Journal O.D. Minimum Connecting Rod Journal Maximum T.I.R. (Total Indicated Runout)	29.92 mm (1.178 in.) 30.93 mm (1.218 in.) 0.05 mm (0.002 in.)
<b>Plain Bearings</b> Maximum Crankcase and Cover I.D.	30.09 mm (1.185 in.)
<b>CYLINDER BLOCK</b> <b>Cylinder Bore</b> Standard I.D. Maximum I.D. <b>Rebore Cylinder</b> Oversize Diameter 0.50 mm	66.98 ~ 67.00 mm (2.637 ~ 2.638 in.) 67.06 mm (2.640 in.)  67.46 ~ 67.48 mm (2.656 ~ 2.657 in.)

## Specifications - FD590V /611

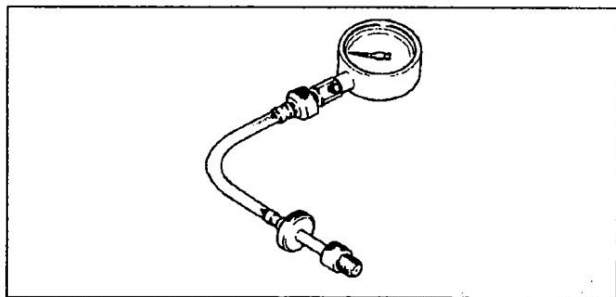
Item	Service Limit
<b>CYLINDER HEAD AND VALVES</b>	
Valve Clearance	0.25 mm (0.010 in.)
Rocker Arm	
Minimum Shaft O.D.	11.95 mm (0.470 in.)
Maximum Bearing I.D.	12.07 mm (0.475 in.)
Adjusting Nut Torque	9 N-m(79 in-lb)
Push Rod	
Maximum Bend	0.80 mm (0.031 in.)
Valves and Springs	
Minimum Spring Free Length	29.70 mm (1.170 in.)
Minimum Valve Stem O.D.	
Intake	5.94 mm (0.234 in.)
Exhaust	5.92 mm (0.233 in.)
Maximum Valve Guide I.D.	6.05 mm (0.238 in.)
Maximum Valve Stem Bend	0.03 mm (0.001 in.)
Standard Valve Seating Surface	0.80 mm (0.031 in.)
Valve Seating Width Tolerance	0.50 ~1.10 mm (0.020 ~0.043 in.)
Valve Seat and Face Angle	45°
Minimum Valve Margin	0.60 mm (0.024 in.)
Valve Narrowing Angle	30°
<b>Cylinder Head</b>	
Maximum Cylinder Head Flatness	0.06 mm (0.002 in.)
Cap Screw Torque In Sequence (Lubricated)	
Initial Torque	13 N-m(115 in-lb)
Final Torque	21 N-m (186 in-lb)
Spark Plug Torque	17 N-m (150 in-lb)
<b>Piston</b>	
Maximum Ring Groove Clearance	
Top and Second Ring	0.10 mm (0.004 in.)
Oil Ring	Not Measured
Maximum Ring End Gap	1.00 mm (0.040 in.)
Minimum Pin O.D.	16.98 mm (0.668 in.)
Maximum Pin Bore I.D.	17.04 mm (0.671 in.)
Height of piston O.D. measurement	11 mm (0.433 in.)
Piston O.D.	73.935 ~ 73.950 mm (2.9108 ~ 2.9114 in.)
Piston-to-Cylinder Bore Clearance	0.030 ~ 0.170 mm (0.00118 ~ 0.00670 in.)
<b>Connecting Rod</b>	
Maximum Crankshaft Bearing I.D.	34.06 mm (1.341 in.)
Maximum Piston Pin Bearing I.D.	17.05 mm (0.671 in.)
End-Cap Screw Torque	21 N-m (186 in-lb)
<b>Crankshaft</b>	
Minimum Side Journal O.D.	33.91 mm (1.335 in.)
Minimum Connecting Rod Journal	33.93 mm (1.336 in.)
Maximum T.I.R.	0.05 mm (0.002 in.)
<b>Plain Bearings</b>	
Maximum Crankcase and Cover I.D.	34.07 mm (1.341 in.)
<b>CYLINDER BLOCK</b>	
<b>Cylinder Bore</b>	
Standard I.D.	73.98 ~ 74.00 mm (2.915 ~ 2.916 in.)
Maximum I.D.	74.07 mm (2.918 in.)
<b>Rebore Cylinder</b>	
Oversize Diameter	
0.50 mm	74.46 ~ 74.48 mm (2.934 ~ 2.935 in.)



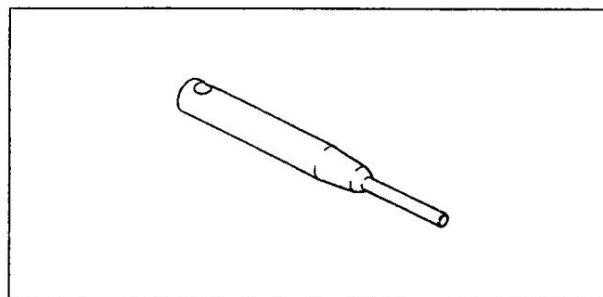
## 4-6 ENGINE TOP END

### Special Tools

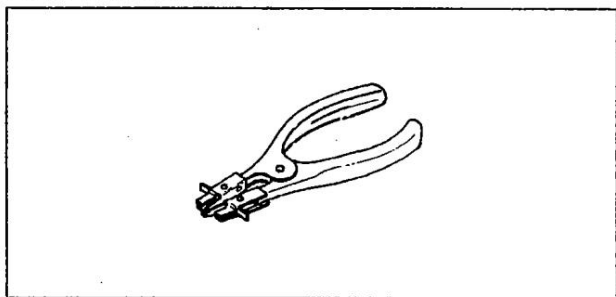
Compression Gauge Assembly, M14 x 1.25: 57001-123



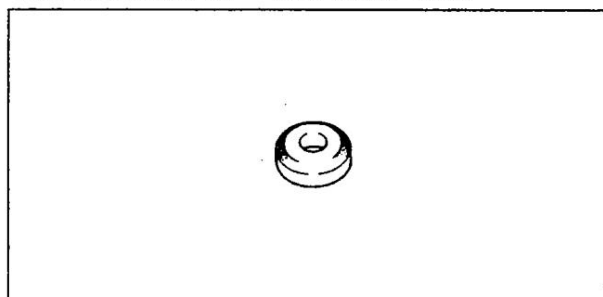
Valve Seat Cutter Holder,  $\phi 6$ : 57001-1360



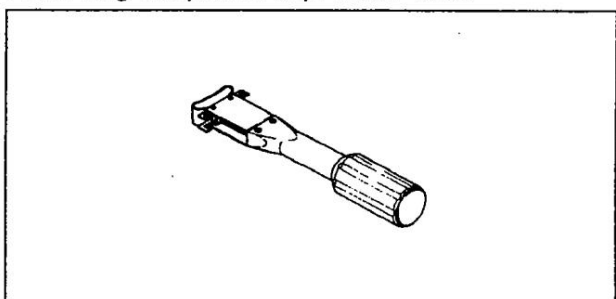
Piston Ring Pliers: 57001-115



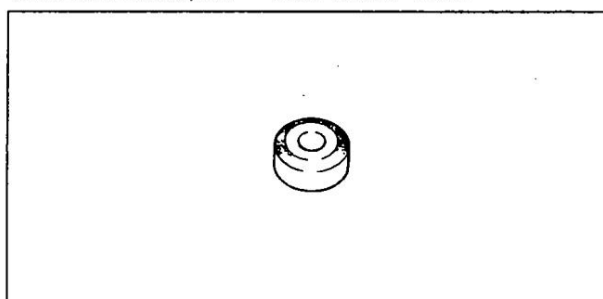
Valve Seat Cutter, 45° -  $\phi 35$ : 57001-1116



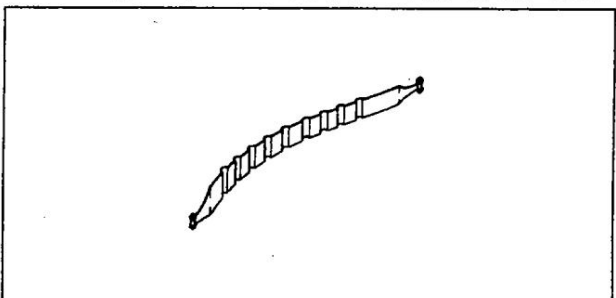
Piston Ring Compressor Grip: 57001-1095



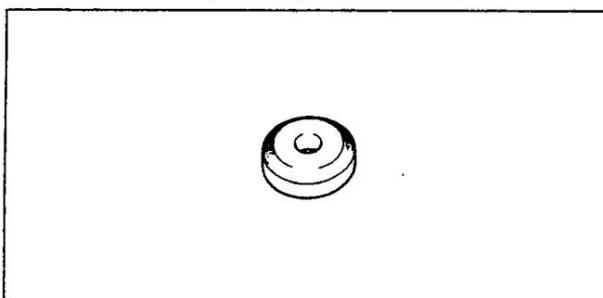
Valve Seat Cutter, 32° -  $\phi 33$ : 57001-1199



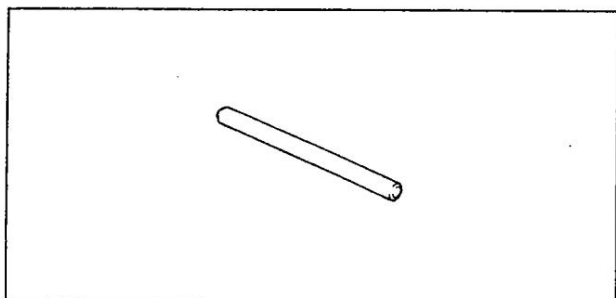
Piston Ring Compressor Belt,  $\phi 67 \sim \phi 79$ : 57001-1097



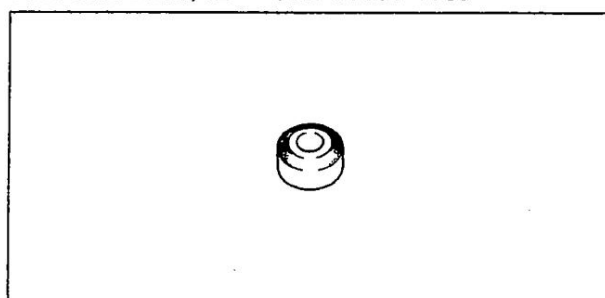
Valve Seat Cutter, 45° -  $\phi 30$ : 57001-1187



Valve Seat Cutter Holder Bar: 57001-1128



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



## Cylinder Head

### Compression Measurement

- Before measuring compression, do the following.
  - Be sure the battery is fully charged.
  - Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help seal 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 (Special Tool: 57001-123) firmly into the one plug hole.
- Ground the spark plugs to the engine.

#### ⚠ WARNING

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

- Using the starter motor, turn the engine over with the throttle fully open until the compression gauge stops rising; the compression reading obtainable.
- Repeat the measurement to the other cylinder.

#### Cylinder Compression (MIN)

1171 kPa (170 psi)

- ★ 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 head and cylinder head - clean off any carbon on the piston head and cylinder head.
  - (2) Cylinder head gasket - use only the proper gasket. The use of a gasket of incorrect thickness will change the compression.
  - (3) Valve guides and piston rings - rapid carbon accumulation in the combustion chamber may be caused worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.
- ★ If cylinder compression is lower than the (MIN), check the following:
  - (1) Gas leakage around the cylinder head - replace the damaged gasket and check the cylinder head warp.
  - (2) Condition of the valve seating.
  - (3) Valve clearance.
  - (4) Piston/cylinder wear, piston seizure.
  - (5) Piston ring, piston ring groove.

### Cylinder Head Assembly Removal

- Remove:
  - Radiator and Air Cleaner
  - Top and Bottom Half Air Ducts
  - Muffler
  - Intake Manifold
  - Thermostat (No. 2 Cylinder)
  - Spark Plug
- Unscrew the rocker cover mounting bolts, and remove the cover and gasket (o-ring). Do not lose the distance collars in the bolt holes.

## 4-8 ENGINE TOP END

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

### CAUTION

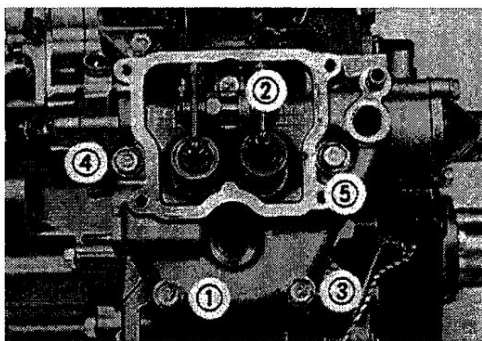
If the above procedure is not followed, the cylinder head may be warped during removal.

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

### NOTE

- Mark the push-rods so they can be installed in their original position during assembly.

(No.2 Cyl. shown)



### Installation Notes

- Clean the mating surfaces of the cylinder heads and cylinder.
- Install the push rods in their original positions on each cylinder. (see Push Rod Installation)
- Put a new gaskets and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms.

### NOTE

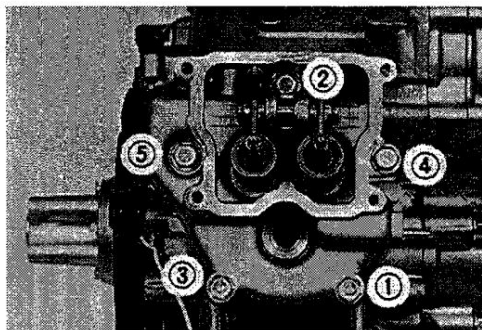
- As the head gaskets are coated with sealing agents, be careful not to injure the surfaces of them.

(NO.1 Cyl. shown)

- Install the intake manifold onto cylinder heads (see Intake Manifold Installation Note).
- Then tighten the head bolts to the specification (see Exploded View).
- Follow the sequence shown, tighten the head bolts to 21 N-m (2.1 kg-m, 15 ft-lb).
- Tighten the bolts in sequence 3.0 N-m (0.3 kg-m, 27 in-lb) at a time until torque on each bolt is 21 N-m (2.1 kg-m, 15 ft-lb).

### CAUTION

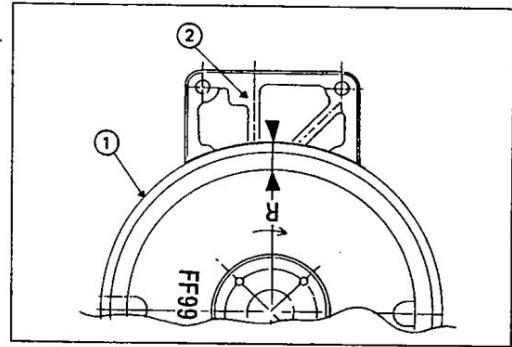
A torque wrench must be used to prevent loose or overtight the head bolts which may result in warping of the cylinder head.





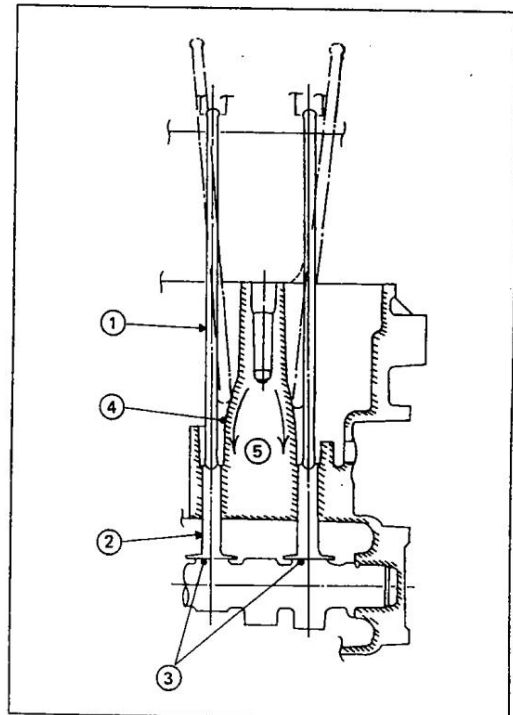
**Push Rod Installation Notes**

- Align (R) mark on the flywheel (1) with (▲) mark on the breather chamber cover (2) turning the flywheel clockwise.



- Install the push rods in their original positions on each cylinder.
- To install the push rod in a correct position on the tappet, insert the push rod so end of the push rod is sliding down along inside wall of the crankcase and position the push rod end on to the tappet.
- Check both intake and exhaust push rods on each cylinder are lowest position on the cam lobes. If not, turn the flywheel clockwise one turn (360°) and align both marks on the flywheel and breather chamber cover again.
- Be sure the end of the push rods are correctly seated on the tappets.

- |                     |                 |
|---------------------|-----------------|
| 1. Push Rods        | 4. Inside Walls |
| 2. Tappets          | 5. Sliding Down |
| 3. Lowest Cam Lobes |                 |

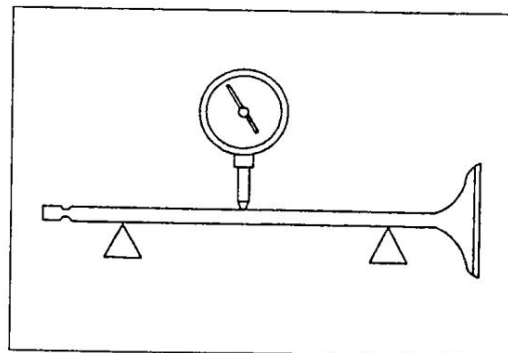
**Push Rod Inspection**

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

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

**Rocker Arm Push Rod Runout**

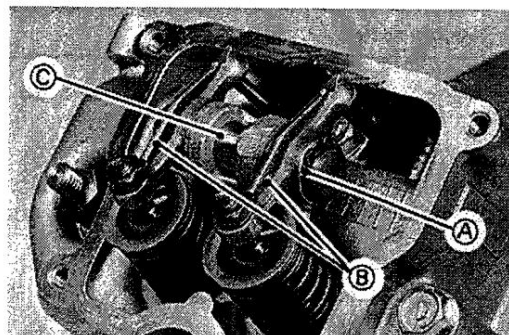
**Service Limit: 0.8 mm (0.03 in)**

**Disassembly and Assembly**

(Valve Mechanism Removal and Installation)

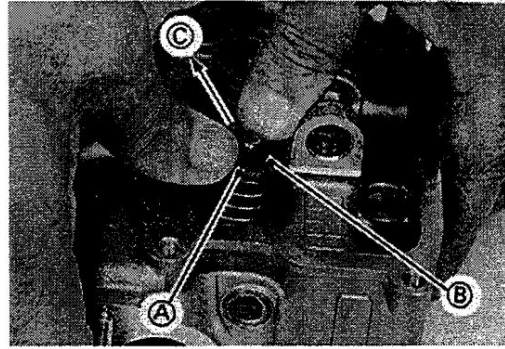
**NOTE**

- When removing the valve mechanism parts, note the position of them so that they may be reinstalled in their original position during assembly.
- Remove one of the rockershaft circlip (A) with a circlip pliers.
- Remove the rocker arms (B) by pushing the rocker shaft (C) out the side from which the circlip was removed.



## 4-10 ENGINE TOP END

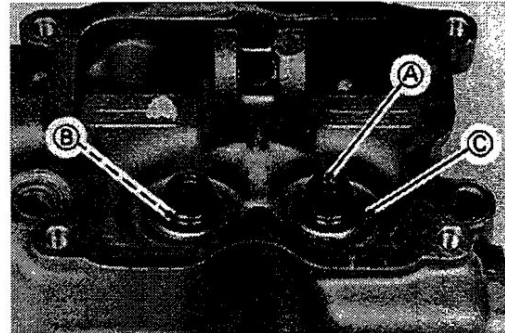
- Support the valve head in the combustion chamber with a suitable block.
- To remove the spring retainer (A), push down the retainer with thumbs and shift (C) the retainer to a side hole (B) on the retainer.
- Remove the spring and valve.



- Remove the stem seals (A) and bottom spring retainers (C).

### NOTE

- It is not necessary to remove the stem seal unless it is being replaced.
- Bottom spring retainer can only be removed with stem seal.
- Valve guide (B) is not replaceable, do not remove it.



- Valve Installation
  - Apply engine oil to the valve stem to avoid damaging the stem seal.
  - Check to see that the valve moves smoothly up and down in the guide.
  - Check to see that the valve seats properly in the valve seat. If it does not, repair the valve seat.
- Rocker Arm Installation
  - Apply engine oil to the bearing surface of rocker arm.
  - Put engine oil to the rocker arm where it touches the push rod and valve stem end.
  - Install the rocker arm.

### Cleaning and Inspection

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

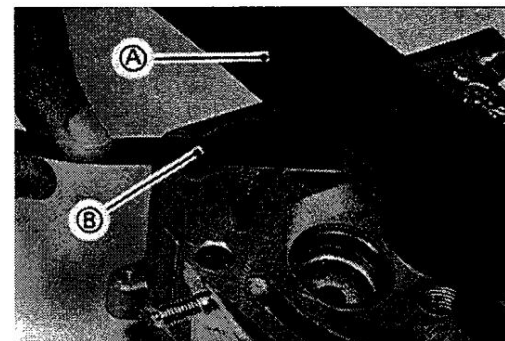
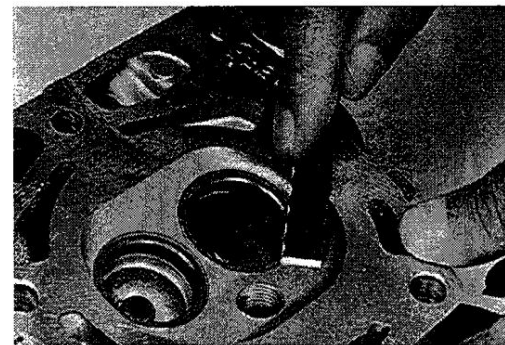
#### ⚠ WARNING

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 straightedge (A) across the gasket surface of the head at several different points, and measure warp by inserting a thickness gauge (B) between the straightedge and head.
- ★ If warp exceeds the service limit, repair the gasket surface. Replace the cylinder head if the mating surface is badly damaged.

#### Cylinder Head Warp

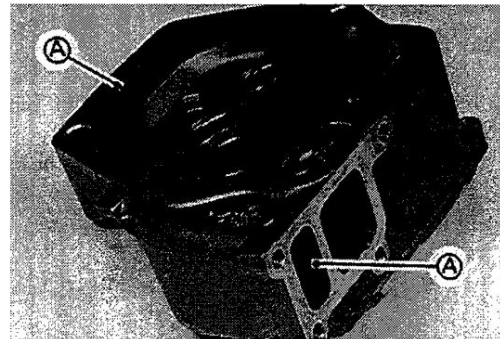
Service Limit: 0.06 mm (0.002 in)





- 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% kelosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a cracks is present, the coating will become discolored at the defective area.
- ★ If a cracks is present in the cylinder head, replace it.
- Inspect the gasket surface for burrs and nicks.

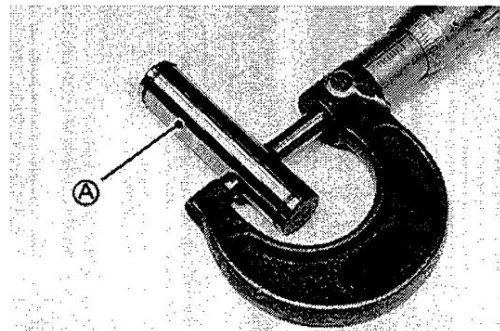
- Inspect the cylinder head for accumulation of rust, scale and lime in the water jacket (A).
- ★ If this accumulation is observed, flush the cooling system (see Flushing in Cooling System chapter).



- Clean and measure the diameter of the rocker shaft (A) with a micrometer at several points.
- ★ If the outside diameter is less than the service limit, replace the shaft.

**Rocker Shaft Outside Diameter**

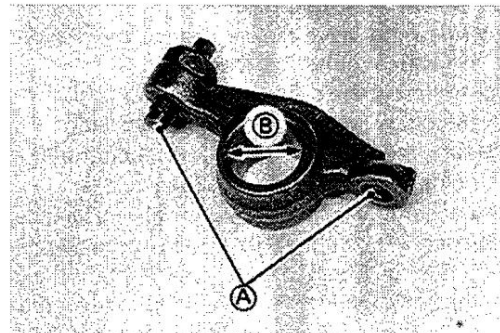
**Service Limit: 11.949 mm (0.4704 in)**



- Clean and inspect the rocker arm where it touches the push rod and valve stem.
- ★ If the contact points (A) are worn or damaged, replace the rocker arm.
- Measure the inside diameter of the rocker arm bearing (B) at several points using a dial bore gauge or inside micrometer.
- ★ If the inside diameter is more than the service limit, replace the rocker arm.

**Rocker Arm Bearing Inside Diameter**

**Service Limit: 12.074 mm (0.4754 in)**





## 4-12 ENGINE TOP END

### Valves

#### Clearance Inspection

#### NOTE

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

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

#### No. 1 Cylinder:

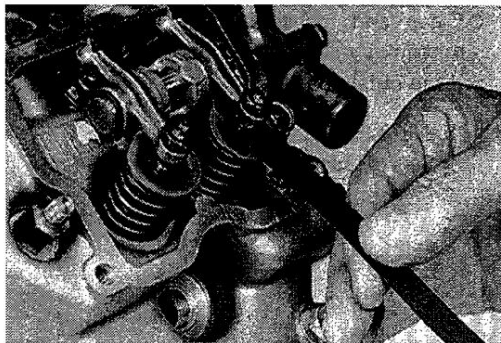
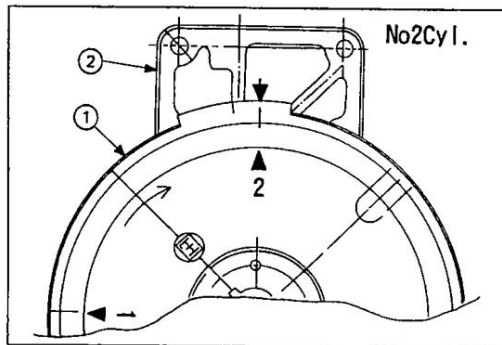
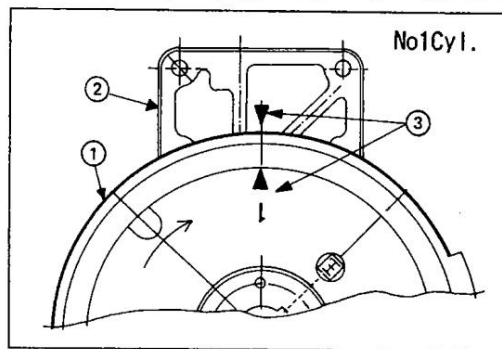
- Align (1) mark on the flywheel (1) with (▲) mark on the breather chamber cover (2) as shown.
- Check the intake and exhaust valves are closed completely, if not turn the flywheel one turn (360°) clockwise and align both marks on the flywheel and cover again.

#### No. 2 Cylinder:

- Align (2) mark on the flywheel with (▲) mark on the breather chamber cover. Follow No. 1 Cylinder alignment procedure described above.
- Then check the clearance.
- Using a thickness gauge (A), measure the valve clearance between the rocker arm and the valve stem end.
- ★ If the valve clearance is incorrect, adjust it.

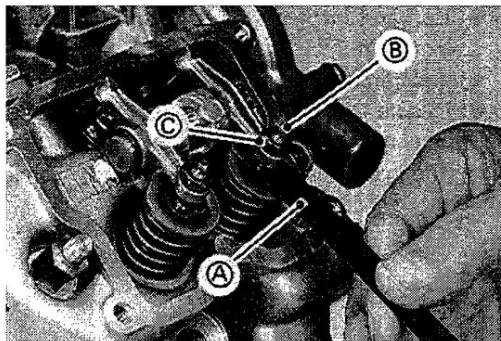
#### Valve Clearance (when cold)

**Intake, Exhaust: 0.25 mm (0.01 in)**



#### Clearance Adjustment

- Since the valve repairs change the valve clearance, adjust the valve clearance to the specification.
- Assemble the cylinder head and install the cylinder head assembly on the block (see cylinder Head Installation Notes).
- Turn the crankshaft proper direction until the piston is at TDC of the compression stroke (described above).
- Loosen the locknut (C) and valve clearance adjusting screws (B).
- Insert a 0.25 mm (0.01 in) thickness gauge (A) between the adjusting screw and valve stem, and tighten the adjusting screw until the thickness gauge begins to bind between the rocker arm and valve stem end. Use a sweeping motion with the thickness gauge while making this adjustment.
- Holding the adjusting screw with a spanner, tighten the locknut to the specified torque (see Exploded View).
- Do not overtighten.



**Valve Seat Inspection**

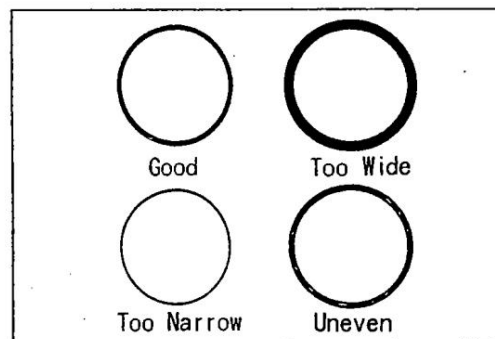
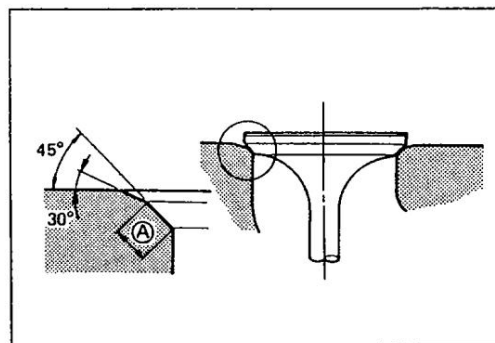
- Remove the valve.
- Inspect the valve seats (A) for damage.
- ★ If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
- Pitted or worn the valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the 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 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 (IN, EX)**

Service Limit: 0.5 ~ 1.1 mm (0.02 ~ 0.043 in)

**Valve Seat Repair**

- Follow the manufacturer's instructions for use of valve seat cutters (special tools).

**Use these Cutters****Intake Valve**

Seat Cutter	45° - $\Phi 35.0$	57001-1116
Outside Cutter	30° - $\Phi 33.0$	57001-1199

**Exhaust Valve**

Seat Cutter	45° - $\Phi 30.0$	57001-1187
Outside Cutter	30° - $\Phi 30.0$	57001-1120

**Use this Holder and Bar**

Holder - $\Phi 6.0$	57001-1360
Bar	57001-1128

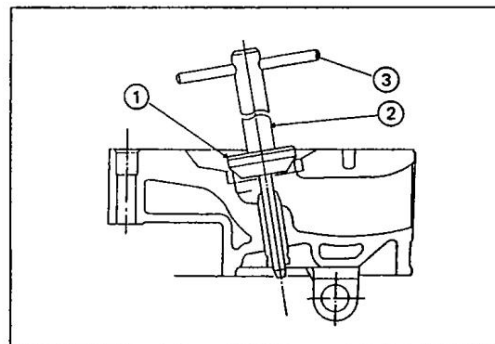
- ★ If the manufacturer's instructions are not available, use the following procedure.

**Seat Cutter Operating Cares:**

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

**NOTE**

- Do not use a wire brush to remove the metal particles from the cutter. It will take off the diamond particles.
- 4. Setting the valve seat cutter holder in position, operate the cutter with one hand. Do not apply too much force to the diamond portion.





## 4-14 ENGINE TOP END

### 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.

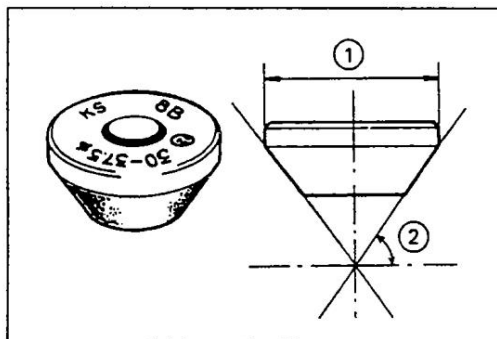
1. Cutter
  2. Cutter Holder
  3. Bar
5. After use wash the cutter with washing oil and apply a thin layer of engine oil before storing.

#### Marks Stamped on the Cutter:

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

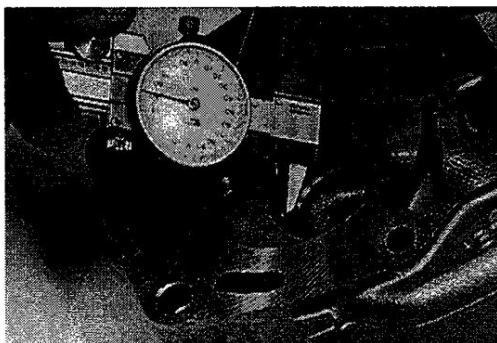
- 1 .....Cutter number, selected from 1 to 12  
 30° .....Cutter angle  
 37.5 .....Outer diameter of cutter  
 KS8B .....Manufactured lot number

1. Cutter Outside Diameter
2. Cutter Angle

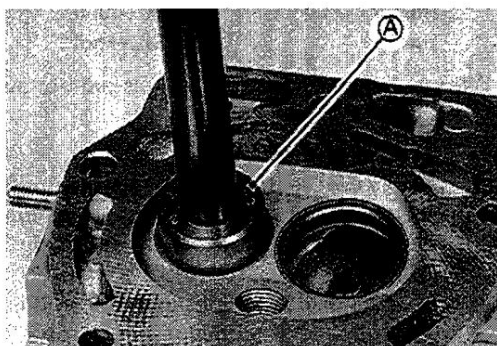


#### Operating Procedures:

- 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.
- ★ If it is more than 1.1 mm (0.043 in), the seating surface should be refaced.
- ★ If the valve seating pattern is not correct, repair the seat.



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

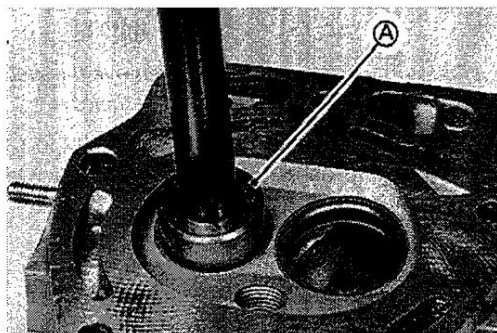


#### CAUTION

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

**Do not turn the cutter counterclockwise or drop it against the seat, or it will be dulled.**

- Use a 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.



#### CAUTION

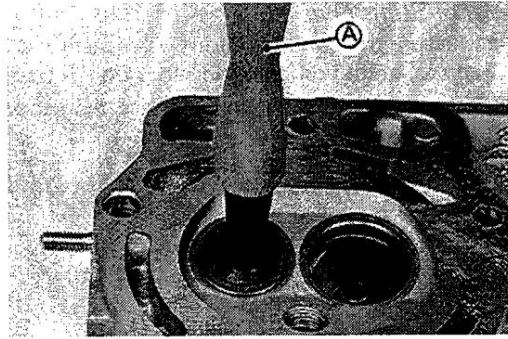
**The 30° cutter removes material very quickly. Check the seat width frequently to prevent over grinding.**



**NOTE**

○ Keep the seat width as closely as possible to 0.8 mm (0.03 in).

- Make a light pass 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 (A).
- Coat the face of valve sparingly with a fine lapping compound.
- Use the vacuum cup tool, to grip top of the valve. 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).

**Valve Head Thickness**

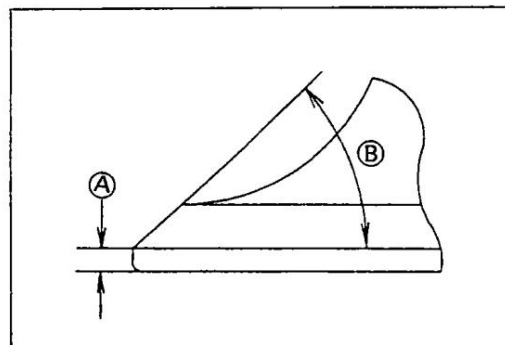
- Remove the valve.
- Measure the thickness of the valve head.
- ★ If the valve head thickness (valve margin) (A) is less than the service limit, replace the valve.

**Valve Head Thickness (Valve Margin) (IN, EX)****Service Limit:**

0.5 mm (0.020 in) .....FD440V/FD501V

0.6 mm (0.024 in) .....FD590V

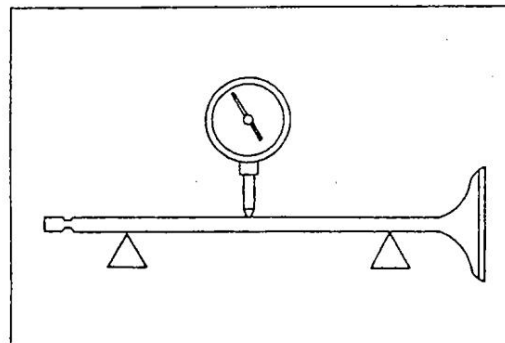
**B. 45°**

**Valve Stem Run Out**

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

**Valve Stem Run Out (IN, EX)**

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



## 4-16 ENGINE TOP END

### Valve Stem Diameter

● Measure the diameter of the valve stem (A) in two directions at right angles, at four different positions on the stem.

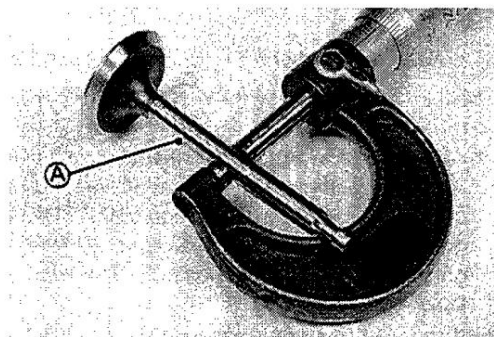
★ If any single measurement is less than the service limit, replace the valve.

#### Valve Stem Diameter

##### Service Limit:

Intake: 5.945 mm (0.2341 in)

Exhaust: 5.925 mm (0.2332 in)



### Valve Guide Inside Diameter

● Use a small bore gauge or a micrometer to measure the inside diameter of the valve guide a three places down the length of the guide.

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

#### Valve Guide Inside Diameter (IN, EX)

##### Service Limit:

5.06 mm (0.199 in) .....FD440V/FD501V

6.05 mm (0.238 in) .....FD590V

### Valve Spring Inspection

● Inspect the valve spring for pitting, cracks, rusting, and burrs. Replace the spring if necessary.

● Measure the free length of the spring.

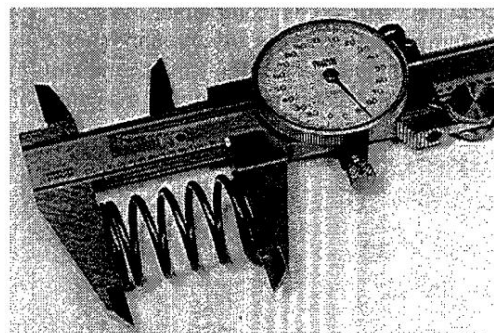
★ If the measurement is less than the service limit, replace the spring.

#### Valve Spring Free Length (IN, EX)

##### Service Limit:

27.30 mm (1.074 in) .....FD440V/FD501V

29.70 mm (1.170 in) .....FD590V



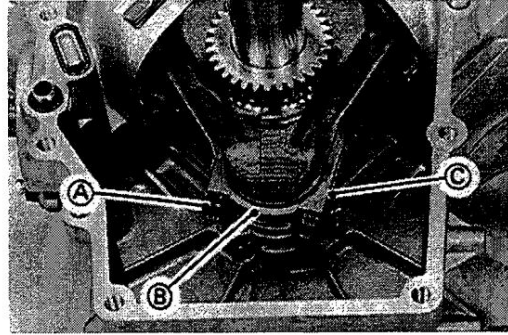


## Cylinder, Piston

### 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.
- Remove the bolts and take off the connecting rod caps.

- A. Cap Bolts                      C. Pry Points  
B. Caps

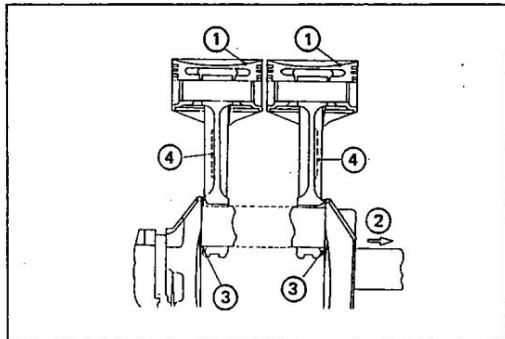


- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.

#### CAUTION

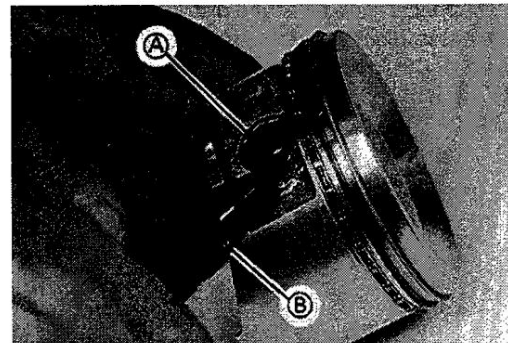
Note a location of the arrow match mark on the piston head in relation to **MADE IN JAPAN** on the connecting rod. No. 1 cyl. piston is opposite of No. 2 cyl. piston. Keep parts together as a set.

1. Arrow Match Marks              3. Large Chamfers  
2. Flywheel Side                  4. Raised Letters  
(MADE IN JAPAN)



- Remove one of the piston pin snap rings with needle nose pliers.

- A. Piston Pin Snap Rings  
B. Pliers



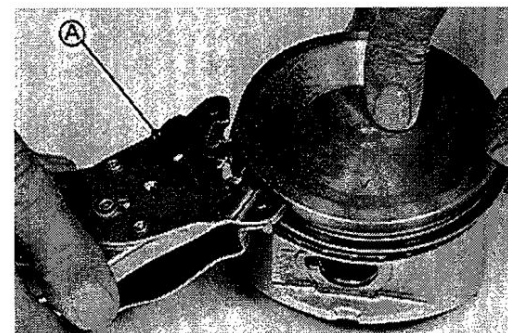
- Remove the piston by pushing the piston pin out the side from which the snap ring was removed.

- A. Piston Pin



- Remove the top and second rings with a piston ring pliers (special tool: 57001-115). If the special tool is not available, carefully spread the ring opening with your thumbs and then push up on the opposite side of the ring to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.

- A. Piston Ring Pliers



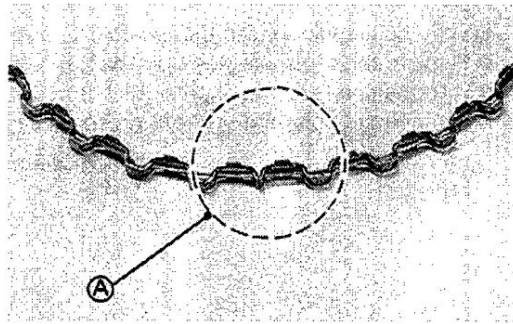


## 4-18 ENGINE TOP END

### Piston Installation Notes

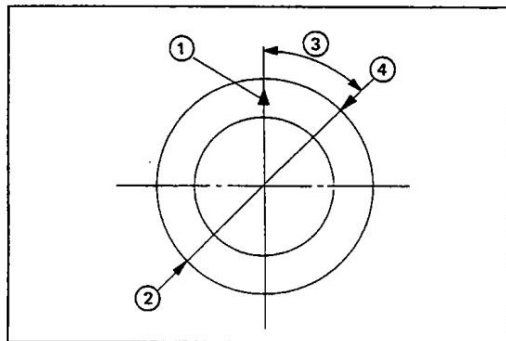
- Oil Ring Installation:
  - First install the expander in the piston oil ring groove so that the expander ends butt together.
  - Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.

A. Expander ends



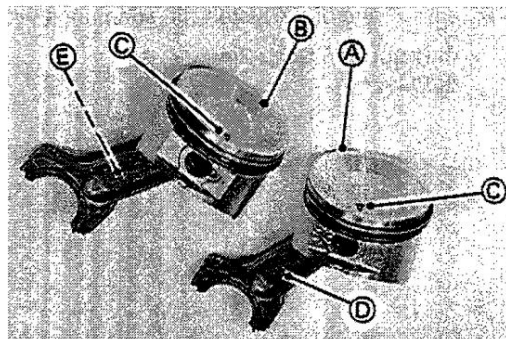
- Install the chrome-plated top ring and second ring with "N" mark facing up. The rings should turn freely in the grooves.
- Align the piston and rings with the piston ring end gap as shown.

1. Arrow Match Mark
2. Top Ring End Gap, Upper Side Rail End Gap
3. 45°
4. Second Ring End Gap, Lower Side Rail End Gap



- Apply engine oil to the piston pins.
- Assemble the pistons onto the connecting rods as follow:
  - No. 1 Cyl. piston, align the arrow match mark on the piston head with the raised letters (MADE IN JAPAN) on the connecting rod.
  - No. 2 Cyl. piston, align the arrow match mark on the piston head with opposite MADE IN JAPAN on the connecting rod.

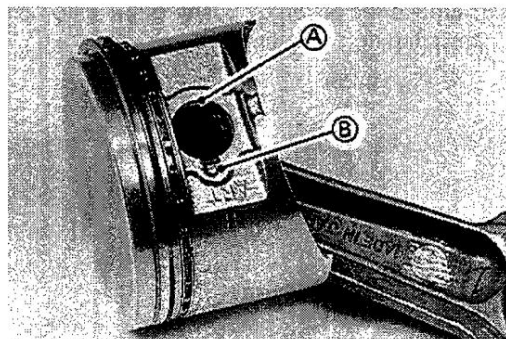
- |                      |                           |
|----------------------|---------------------------|
| A. No. 1 Cyl. Piston | D. MADE IN JAPAN          |
| B. No. 2 Cyl. Piston | E. Opposite MADE IN JAPAN |
| C. Arrow Match Marks |                           |



- When installing a piston pin snap ring, compress it only enough to install it and no more.
- Fit a new piston pin snap ring into the side of the piston so that the ring opening (A) does not coincide with the notch (B) in the edge of the piston pin hole.

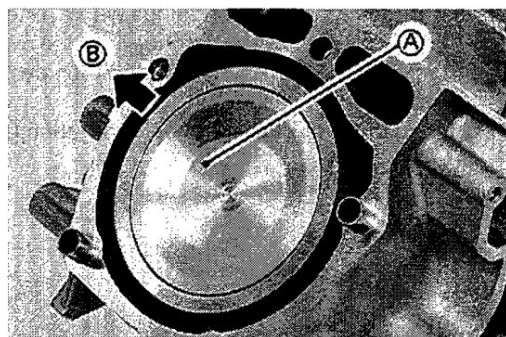
#### CAUTION

**Do not reuse 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 (special tool: 57001-1095) and the belt (special tool: 57001-1097), insert the piston and connecting rod into the cylinder.
- Insert the piston and connecting rod so that the arrow match mark on the top of the piston facing the flywheel side.

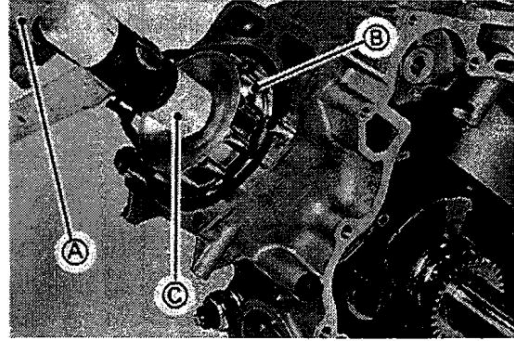
- |                       |
|-----------------------|
| A. Arrow Match Mark   |
| B. Flywheel Side      |
| No. 1. Cylinder Shown |





○ Lightly tap the top of the piston with a plastic mallet to insert the piston and connecting rod into the cylinder.

- A. Grip
  - B. Belt
  - C. Plastic Mallet
- No. 1. Cylinder Shown



### *Piston/Cylinder Seizure*

- In case of seizure, remove the piston.
- Visually inspect the cylinder and piston damage.
- ★ If there is only light damage, smooth the piston 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 oversize and an oversized pistons installed.

### *Piston Cleaning*

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

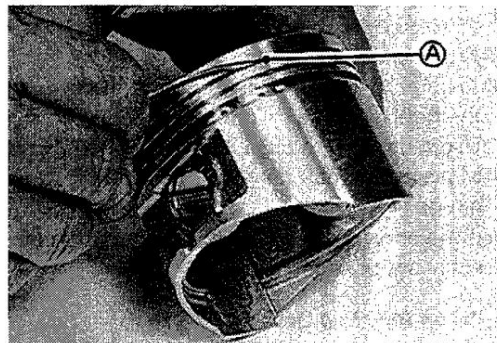
#### CAUTION

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

- Scrape the carbon off (A) the piston head.
- Use the scraping tools carefully. Do not gouge the piston head. To avoid gouging, use scrapers that are made of a material that will not cause damage.
- Clean the piston ring grooves (A) with a broken piston ring or other suitable tools.

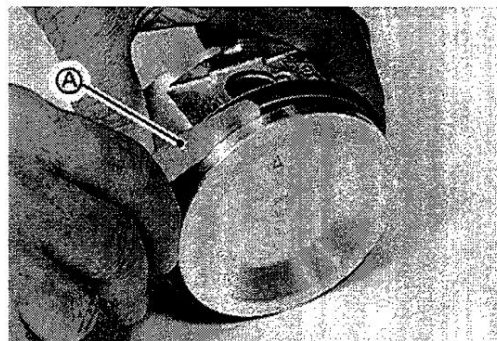
#### CAUTION

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



### *Piston Ring and Ring Groove Wear*

- Clean the piston (see Piston Cleaning).
- Visually inspect the piston rings and ring grooves.
- ★ If the piston rings are worn unevenly or damaged, replace them.
- ★ If the ring grooves are worn unevenly or damaged, replace both the piston and piston rings.
- 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).



## 4-20 ENGINE TOP END

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★ If the piston ring/groove clearance is greater than the specified value, replace the piston.

### Piston Ring/Groove Clearance

	Service Limit
Top and Second	0.10 mm (0.004 in)
Oil	Not Measured

### NOTE

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

● Measure the piston ring thickness.

○ Use a micrometer to measure at several points around the rings.

★ If any of the measurement are less than the service limit, replace the entire set of rings.

### Piston Ring Thickness

	Service Limit
Top and Second	1.200 mm (0.047 in)
Oil	Not Measured

### NOTE

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



### 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.

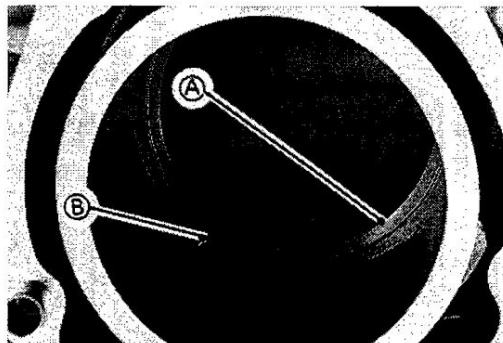
○ Use the piston to push it in to be sure it is square.

● Measure the gap between the ends of the ring (A) with a thickness gauge (B).

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

### Piston Ring End Gap

	Service Limit
Top and Second	1.00 mm (0.040 in)
Oil	not Measured





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

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

#### **Piston Pin Outside Diameter**

##### **Service Limit:**

15.980 mm (0.629 in).....FD440V/FD501V

16.980 mm (0.668 in).....FD590V

- Measure the inside diameter of the piston pin hole at several points on both side. Use a dial bore gauge.
- ★ If the inside diameter is more than the service limit, replace the piston.

#### **Piston Pin Hole Inside Diameter**

##### **Service Limit:**

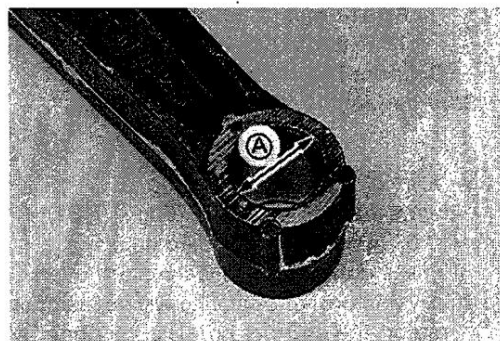
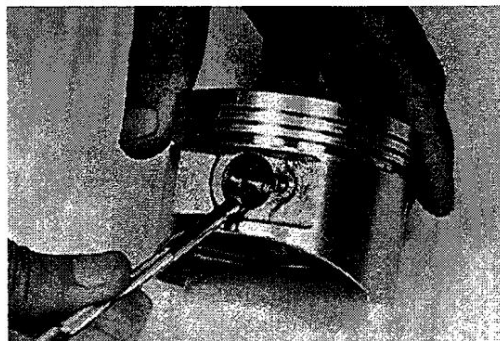
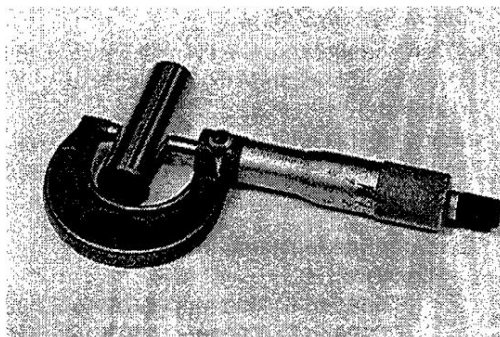
16.040 mm (0.631 in).....FD440V/FD501V

17.040 mm (0.670 in).....FD590V

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

#### **Connecting Rod Small End Inside Diameter**

**Service Limit:** 17.051 mm (0.6713 in)



### *Piston Diameter*

- Measure the outside diameter of the piston perpendicular to the piston pin bore at approximate specified height (H) from the bottom of the piston skirt.
- ★ If the measurement is less than the service limit, replace the piston.

H. 13.50 mm (0.531 in) .....FD440V/FD501V

11.00 mm (0.433 in) .....FD590V

#### **Piston Diameter**

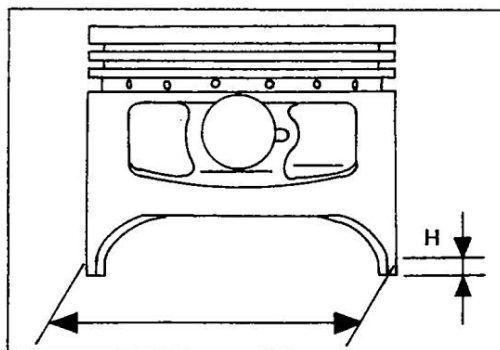
##### **Service Limit:**

66.950 to 66.965 mm

(2.6358 to 2.6364 in) .....FD440V/FD501V

73.935 to 73.950 mm

(2.910 to 2.911 in) .....FD590V



## 4-22 ENGINE TOP END

### Cylinder Inside Diameter

- Clean and measure the cylinder inside diameter.
- Use a dial bore gauge to measure front-to-back and side-to-side at the points shown below.
- ★ If any of the cylinder bore measurements 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:

66.980 to 67.000 mm (2.637 to 2.638 in)..... FD440V/FD501V  
73.980 to 74.000 mm (2.915 to 2.916 in)..... FD590V

#### Service Limit:

67.060 mm (2.640 in.)..... FD440V/FD501V  
74.070 mm (2.918 in.)..... FD590V

#### 0.25 mm Oversize:

#### Service Limit:

67.310 mm (2.650 in.)..... FD440V/FD501V  
74.320 mm (2.925 in.)..... FD590V

#### 0.5 mm Oversize:

#### Service Limit

67.560 mm (2.659 in.)..... FD440V/FD501V  
74.570 mm (2.935 in.)..... FD590V

#### 0.75 mm Oversize:

#### Service Limit

67.810 mm (2.669 in.)..... FD440V/FD501V  
74.820 mm (2.945 in.)..... FD590V

### Cylinder Bore Out-of-Round

Service Limit: 0.056 mm (0.0022 in.)

### Cylinder Boring and Honing

Always resize to exactly 0.25 mm (0.01 in), or 0.5 mm (0.02 in), 0.75 mm (0.03 in) over the standard bore size.

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

Resizing the cylinder bore can be done by reliable repair shop or by using a drill press and honing tool.

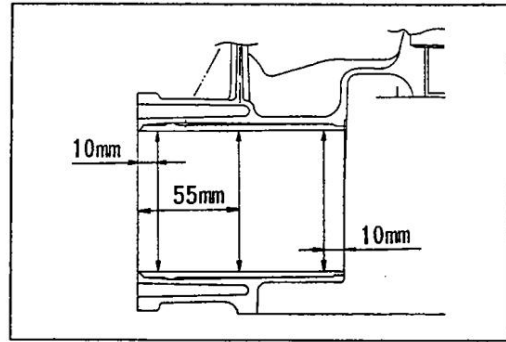
Use the stone recommended by the hone manufacturers to produce correct cylinder wall finish.

Machine-bore first, the bore diameters should be shown in the table.

Change to a honing stone for finishing, the final bore diameter should be as shown in the table.

Be sure the correct stone is used and the stone is not worn.

- Clean the cylinder at the top and bottom of the cylinder to remove burrs 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 cylinder wall at the narrowest point. "Do not Force."
- Turn the stone by hand. If you cannot turn it, the stone is too tight. Loosen the hone until it can be turned by hand.
- Be sure that the cylinder and hone are centered and aligned with the drive shaft and drill spindle.
- Pour honing oil inside of the cylinder during the honing operation. Start the drill press. Move the hone up and down in the cylinder approximately 20 cycles-per-minute.



### Initial Bore Diameter-FD440V/FD501V

Oversize	Bore Diameter
0.25 mm	67.258 to 67.280 mm (2.647 to 2.648 in)
0.50 mm	67.508 to 67.530 mm (2.657 to 2.658 in)
0.75 mm	67.758 to 67.780 mm (2.667 to 2.668 in)

### Initial Bore Diameter-FD590V

Oversize	Bore Diameter
0.25 mm	74.258 to 74.280 mm (2.923 to 2.924 in)
0.50 mm	74.508 to 74.530 mm (2.933 to 2.934 in)
0.75 mm	74.758 to 74.780 mm (2.943 to 2.944 in)

### Final Bore Diameter-FD440V/FD501V

Oversize	Bore Diameter
0.25 mm	67.230 to 67.250 mm (2.646 to 2.647 in)
0.50 mm	67.480 to 67.500 mm (2.656 to 2.657 in)
0.75 mm	67.730 to 67.750 mm (2.666 to 2.667 in)

### Final Bore Diameter-FD590V

Oversize	Bore Diameter
0.25 mm	74.230 to 74.250 mm (2.922 to 2.923 in)
0.50 mm	74.480 to 74.500 mm (2.932 to 2.933 in)
0.75 mm	74.730 to 74.750 mm (2.942 to 2.943 in)



- Check the diameter of the cylinder bore regularly during honing, using an inside micrometer.

**CAUTION**

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

**NOTE**

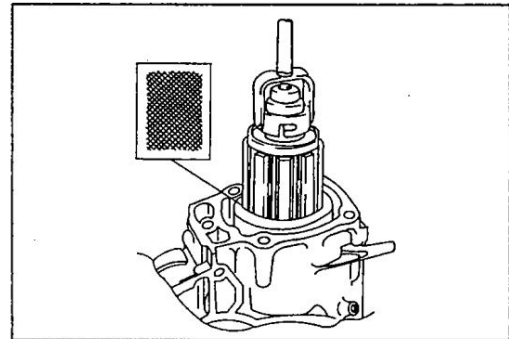
- *The finish should not be smooth, but have a 40 to 60 degree crosshatch pattern.*
- Hone the cylinder until it is about 0.007 to 0.009 mm (0.0003 to 0.0004 in) large to allow for shrinkage when the cylinder cools.

**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.*
- Clean the cylinder thoroughly. Use soap warm water and clean rags. Clean the cylinder wall for "white glove" inspection. A clean white rag should not show soil from the cylinder wall.
- Dry the cylinder and coat with a engine oil.

**CAUTION**

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







# Lubrication System

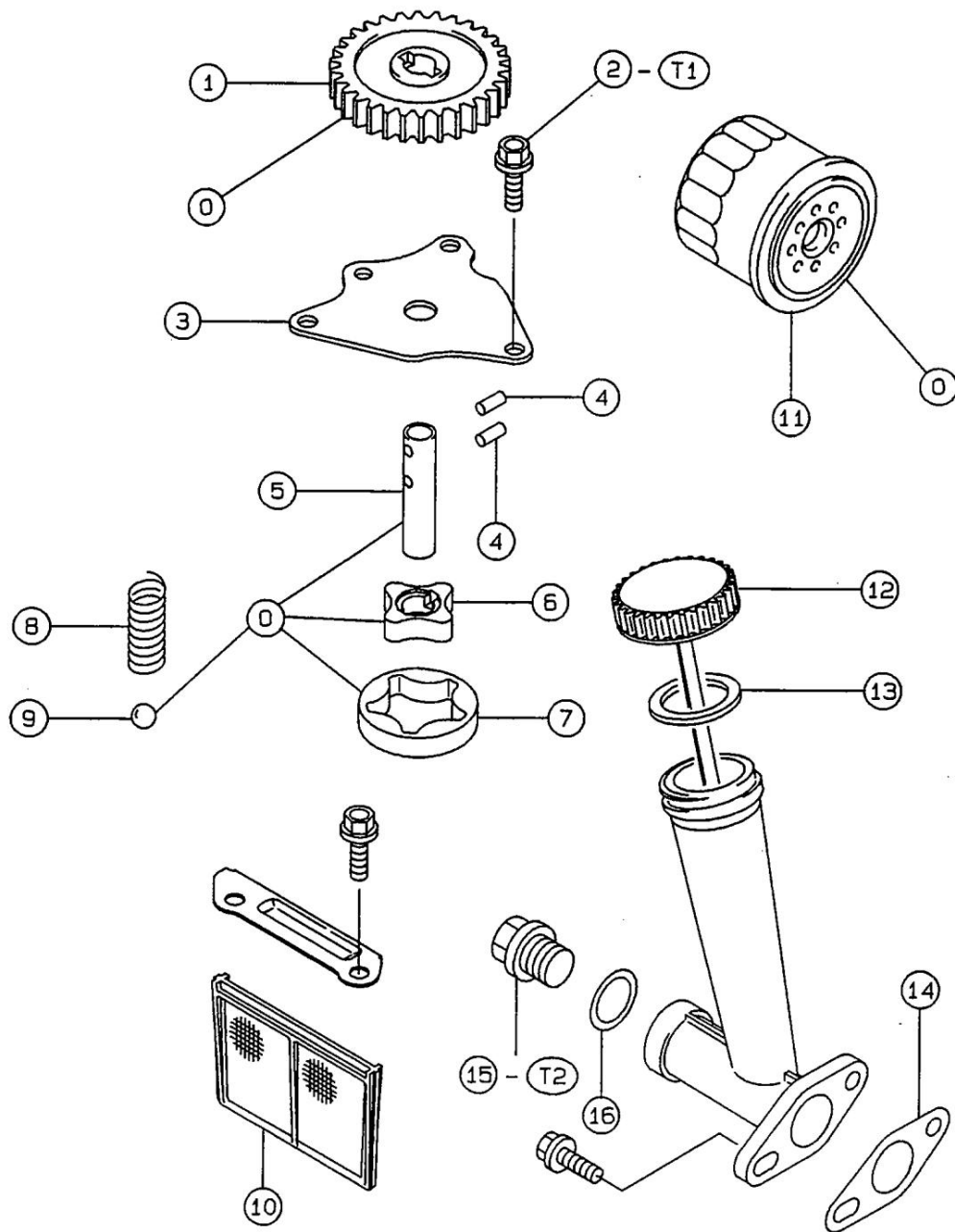
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## 5-2 LUBRICATION SYSTEM

### Exploded View



- 1. Pump Gear
- 2. Oil Pump Cover Bolts
- 3. Oil Pump Cover
- 4. Pins
- 5. Shaft
- 6. Pump Rotor (Inner)
- 7. Pump Rotor (Outer)
- 8. Relief Valve Spring
- 9. Relief Valve (Steel Ball)
- 10. Oil Screen

- 11. Oil Filter
- 12. Oil Gauge
- 13. Gasket
- 14. Gasket
- 15. Oil Drain Bolt
- 16. Gasket

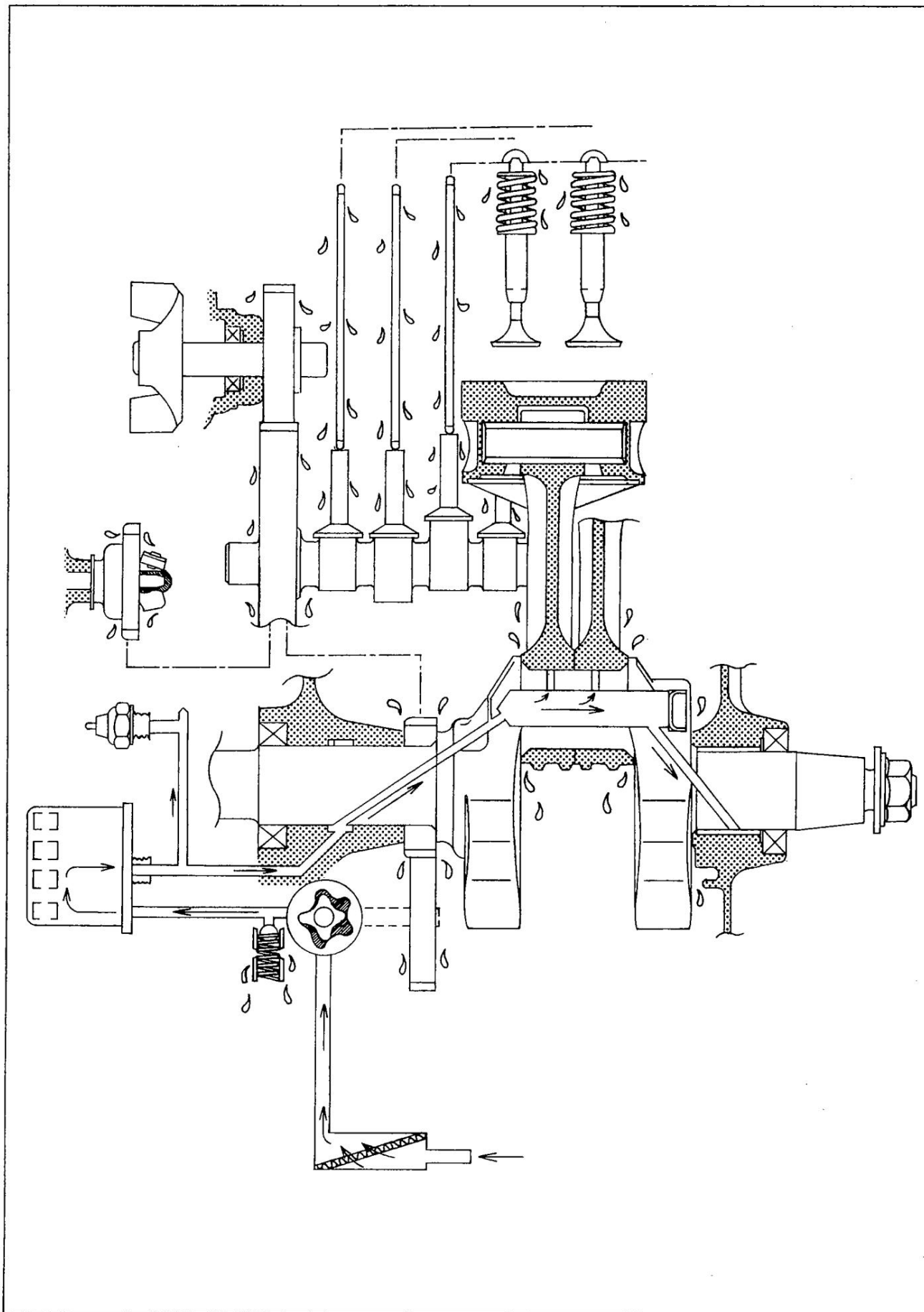
T<sub>1</sub> : 7.8N-m (0.8kg-m, 69in-lb)

T<sub>2</sub> : 25N-m (2.5kg-m, 18in-lb)

O : Apply engine oil



Engine Oil Flow Chart - FD590V



1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

## 5-4 LUBRICATION SYSTEM

### Specifications

| Item                                     | Standard  |
|--|---|
| <b>Engine Oil:</b>                       |   |
| Capacity                                 | 1.8 L (3.80 US pt) - FD440V/FD501V<br>2.1 L (4.43 US pt) - FD590V |
| Oil pressure sensor activates            | 69 ~ 127 kPa (10 ~ 18.5 psi)                                      |
| Oil Pressure (minimum)                   | 276 kPa (40 psi)  |
| Oil Filter bypass valve opening pressure | 78.4 ~ 117.6 kPa (11.4 ~ 17.1 psi)                                |

| Item                             | Service Limit  |
|----------------------------------|--|
| <b>Oil Pump:</b>                 |  |
| Minimum Rotor Shaft O.D.         | 10.92 mm (0.430 in.)   |
| Maximum Rotor Shaft Bearing I.D. | 11.07 mm (0.436 in.)   |
| Minimum Outer Rotor O.D.         | 40.43 mm (1.592 in.)   |
| Maximum Outer Rotor Bearing I.D. | 40.80 mm (1.606 in.)   |
| Minimum Valve Spring Free Length | 19 mm (0.748 in.) - FD440V/FD501V<br>19.50 mm (0.770 in.) - FD590V |

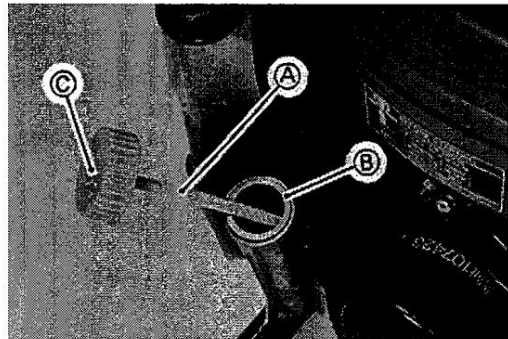
## Engine Oil and Oil Filter

### CAUTION

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

### Oil Level Inspection

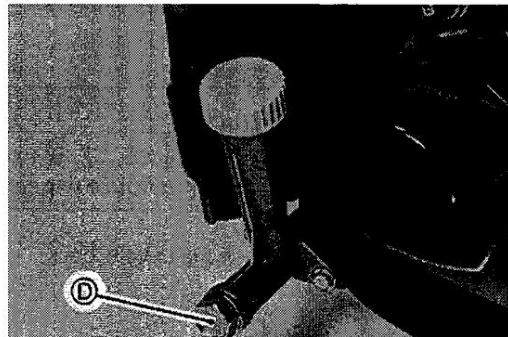
- Place the engine on a level surface and check the oil level.
  - Clean area around the dipstick (A) before removing it.
  - Remove the dipstick and wipe it with a clean cloth.
  - Insert the dipstick into the filler (B) but do not screw it in then check the oil level.
  - The oil level should be between the "FULL" and "ADD" marks on the dipstick.
- ★ If the oil level is near or below the "ADD" mark, remove the oil filler cap (C) and add enough engine oil to bring oil level to the "FULL" mark.



### CAUTION

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

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



### CAUTION

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

- Fill fresh engine oil to the specified level.
- Run the engine at slow speed for 2 minutes.
- Stop the engine and check the oil level.
- Add oil only to the "FULL" mark on the dipstick. Avoid mixing different brands, grades, or types of oil.

### 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.
- Oil manufacturers blend additive in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

FD590V Shown



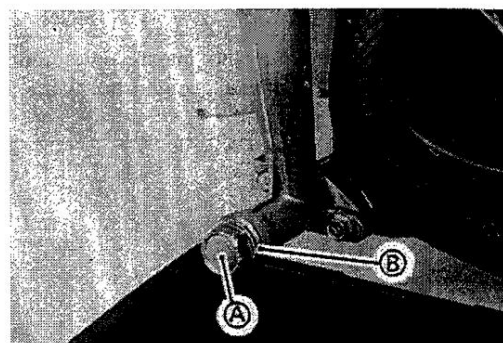
## 5-6 LUBRICATION SYSTEM

### Oil Change

- Change oil after first 20 hours of operation. Thereafter change oil every 100 hours.
- Check that there is oil in the crankcase.
- Start and warm up the engine so the oil will drain easily. Stop the engine.
- Place the engine on a level surface.
- Tilt the engine and place a suitable container under the engine.
- Remove the drain plug (A), and let the oil drain completely.

**▲ WARNING**

**Be careful with hot oil being drained. It may be hot enough to burn you severely.**



- Check the gasket (B) at the drain plug for damage. Replace the gasket with a new one if it is damaged.
- Install the drain plug with the gasket and tighten it to the specified torque (see Exploded View).

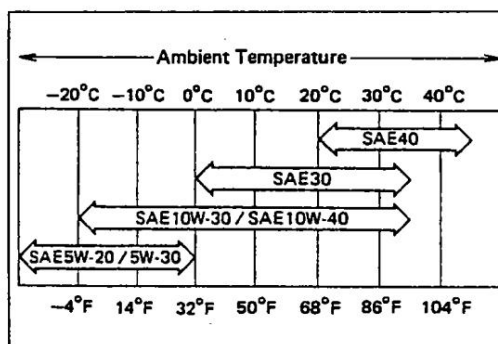
#### FD590V Shown

- Remove the oil filler cap and refill the engine with a high quality oil of recommended viscosity in the chart.

**CAUTION**

**Use a good quality SC, SD, SE, SF, SG or SH class oil. Choose the viscosity of oil for temperature expected.**

- Check the oil level (see Oil Level Check).



### NOTE

○ Some increase in oil consumption may be expected when a multi grade engine oil is used. Check the oil level frequently.

#### Engine Oil Capacity with Filter

1.5 L (3.2 U.S. Pt) .....FD440V/FD501V

2.1 L (4.4 U.S. Pt) .....FD590V

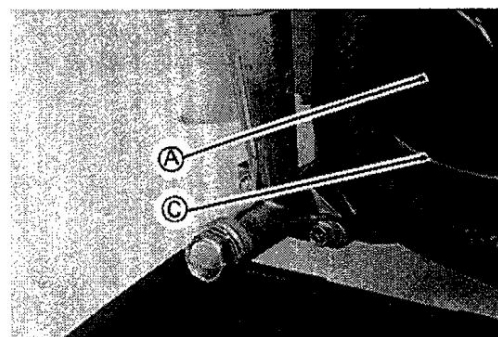
#### Engine Oil Level

Between upper and lower level line

### Oil Filter Removal

- Using a strap wrench (B), remove the oil filter.
- When unscrewing the oil filter (A), place a suitable container beneath the oil drip tray (C) to receive oil from the oil filter and oil passages in the engine. Turn the filter counterclockwise to remove it.

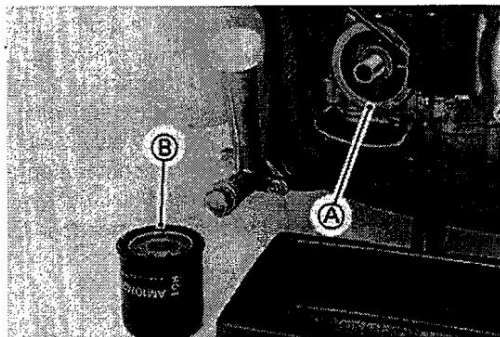
#### FD590V Shown



***Oil Filter Installation Notes***

- Apply a thin coat of grease to the seal (A).
- Install a new filter.
- Turn the filter until the seal contacts mounting surface (B) of the engine. Then turn the filter BY HAND(S) 3/4 turn more.
- Run the engine at slow idle speed 2 minutes. Check for leaks around the engine.
- Stop the engine. Check the oil level (see Oil Level Check). Add oil only to the "FULL" mark on the dipstick.

**FD590V Shown**



## 5-8 LUBRICATION SYSTEM

### Pressurized Lubrication System

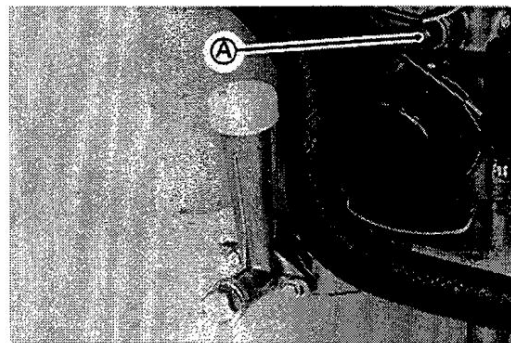
The engine lubrication circuit is a pressurized system consisting of a positive displacement pump which picks up oil through a filter screen from the crankcase. The oil is pumped to a replaceable oil filter cartridge, through the engine's oil passages to lubricate internal components, and return to the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

#### *Oil Pressure Measurement*

- Remove the oil pressure switch (A) from the crankcase.
- Install an appropriately sized oil pressure gauge adapter and oil pressure gauge.
- Run the engine and allow warm up completely.
- Run the engine at fast idle speed and read the oil pressure gauge.
- Stop the engine.
- Remove the oil pressure gauge and adapter.
- Apply a non-permanent locking agent to the taper threads of the pressure switch and install the switch.
- ★ If the oil pressure is below the specification, inspect the oil pump and relief valve.
- ★ If the oil pump and relief valve are not at fault, inspect the rest of the lubrication system.

**Oil Pressure (Minimum)**  
**276 kPa (40 psi)**

**Oil Pressure Switch**  
**PT 1/8 (Taper Pipe Threads)**



#### *Oil Pressure Switch Inspection*

When the oil pressure falls below 69 kPa (10 psi), the oil pressure switch activates the oil warning lamp to alert the operator or lubricating problem.

- To check the oil warning system, insert the switch key into the "OFF" position of the engine switch, then turn it to the "RUN" position. The warning light must be illuminated.
- Whenever start the engine, make sure the warning light is not on in started engine.
- ★ If the warning light comes on, stop the engine immediately and check the oil level.
- When starting the engine, note the warning light on dash carefully.
- ★ If the warning light is on in the started engine in spite of adequate oil level, check the lead from the pressure switch to the warning light for short circuit and/or check the pressure switch and replace damaged part.
- ★ If the light is not on at the moment of the engine switch operation, check all leads of the warning light circuit or bulb and replace damaged parts.

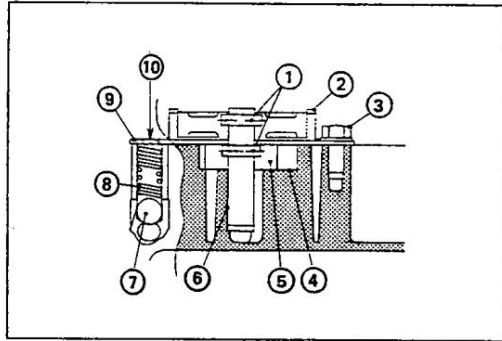


## Oil Pump and Relief Valve

### Removal

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

- |                   |                      |
|-------------------|----------------------|
| 1. Pins           | 6. Pump Shaft        |
| 2. Pump Gear      | 7. Relief Valve Ball |
| 3. Mounting Bolts | 8. Spring            |
| 4. Outer Rotor    | 9. Pump Cover Plate  |
| 5. Inner Rotor    | 10. 6mm DIA Hole     |

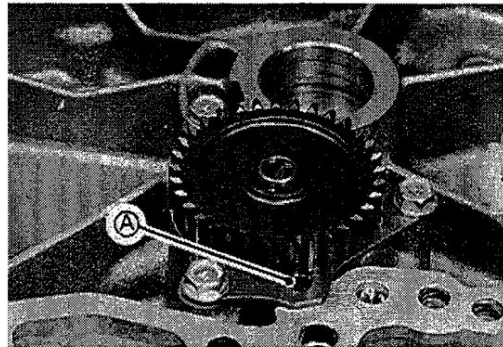


### Installation Notes

- Fill the rotor housing with 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 6mm DIA hole (A) on the cover plate with center of the relief valve.
- Install the mounting bolts and tighten them securely.



### Inspection

- Remove the oil pump.
- Visually inspect the pump gear, outer and inner rotor, and cover plate.
- ★ If there is any damage or uneven wear, replace them.
- Check the clearance (A) between the inner and outer rotor with a feeler gauge. Measure the clearance between the high point of the inner rotor and the high point of the outer rotor.
- ★ If the measurement exceed the service limit, replace the rotors as a set.

#### Inner and Outer Rotor Clearance

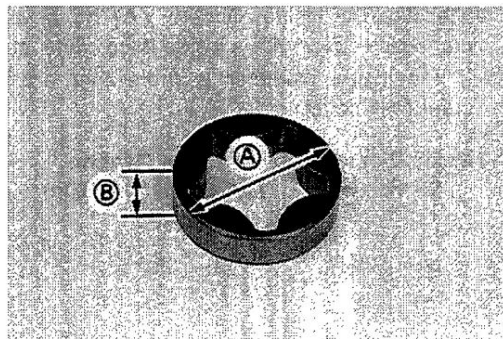
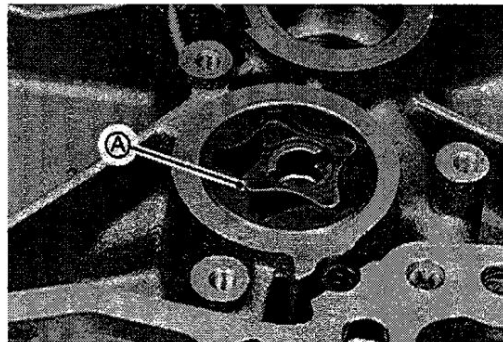
**Service Limit: 0.3mm (0.012 in)**

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

#### Outer Rotor 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.



#### Outer Rotor Thickness

**Service Limit: 9.830 mm (0.3870 in)**

## 5-10 LUBRICATION SYSTEM

- Measure the inside diameter (A) of the pump housing with a inside micrometer at several points.
- ★ If the inside diameter is more than the service limit, replace the crankcase cover.

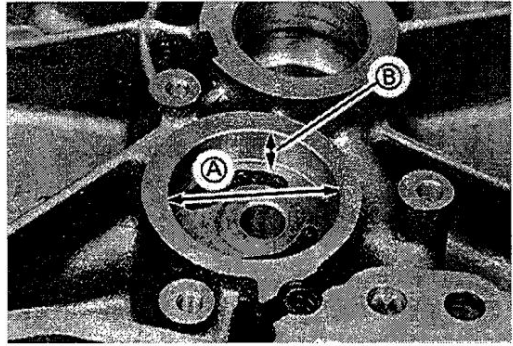
### Pump Housing Inside Diameter

**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.

### Pump Housing Depth

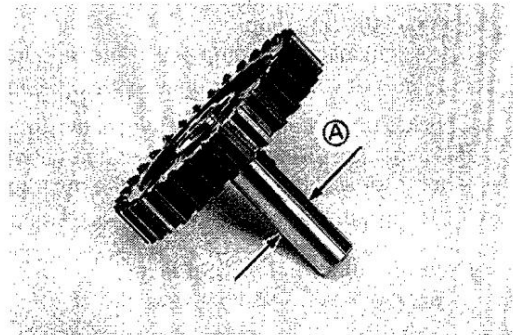
**Service Limit: 10.230 mm (0.4028 in)**



- 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.

### Pump Shaft Diameter

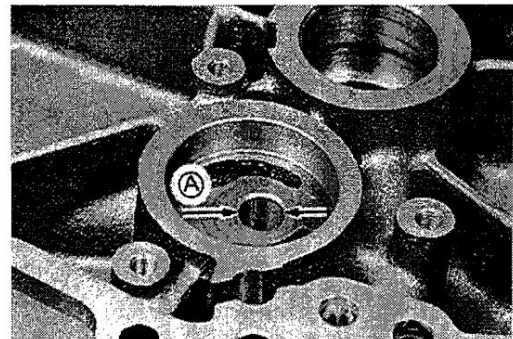
**Service Limit: 10.923 mm (0.4300 in)**



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

### Inside Diameter of Pump Shaft Bearing

**Service Limit: 11.072 mm (0.4359 in)**



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

### ▲WARNING

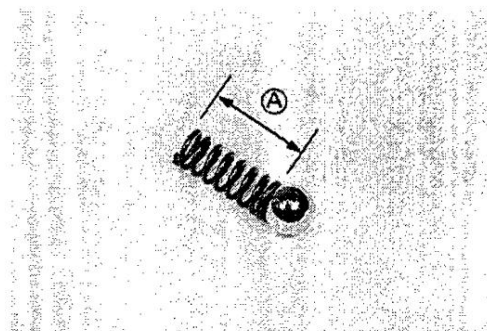
Clean the parts in a well ventilated areas and take care that there is no spark or flame anywhere near the working areas. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents.



- ★ If cleaning does not solve the problem, replace the relief valve parts.
- ★ If necessary, put the ball in position and lightly tap the ball with a suitable tool to form a perfect seat.
- Measure 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.

**Free Length of Spring**

**Service Limit: 19.50 mm (0.77 in)**



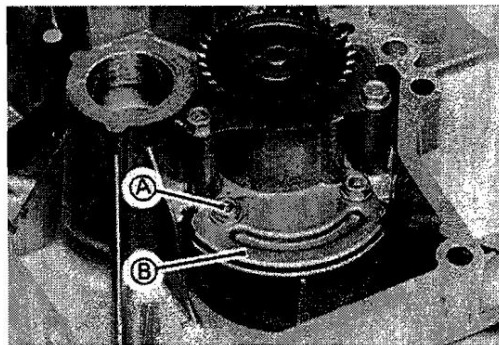


## 5-12 LUBRICATION SYSTEM

### Oil Screen Filter

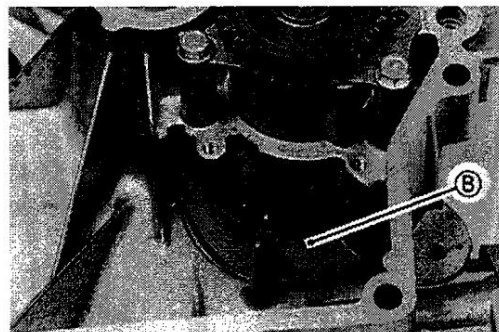
#### Removal

- Split the crankcase and remove the crankcase cover (see Camshaft/Crankcase chapter).
- Unscrew the mounting screws (A) and remove the filter chamber cover (B) with oil induction pipe.
- Pick up the filter screen.



#### Installation Notes

- Clean the oil filter screen (A) thoroughly whenever it is removed for any reason.
- Insert the screen in position and install the chamber cover.
- Install the screws and tighten them securely.



#### Cleaning and Inspection

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

#### ⚠ WARNING

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

#### NOTE

- While cleaning the screen, check for any metal particles that might indicate internal engine damage.
- Check the screen carefully for any damage: holes and broken wire.
- ★ If the screen is damaged, replace it.

# Camshaft/Crankshaft

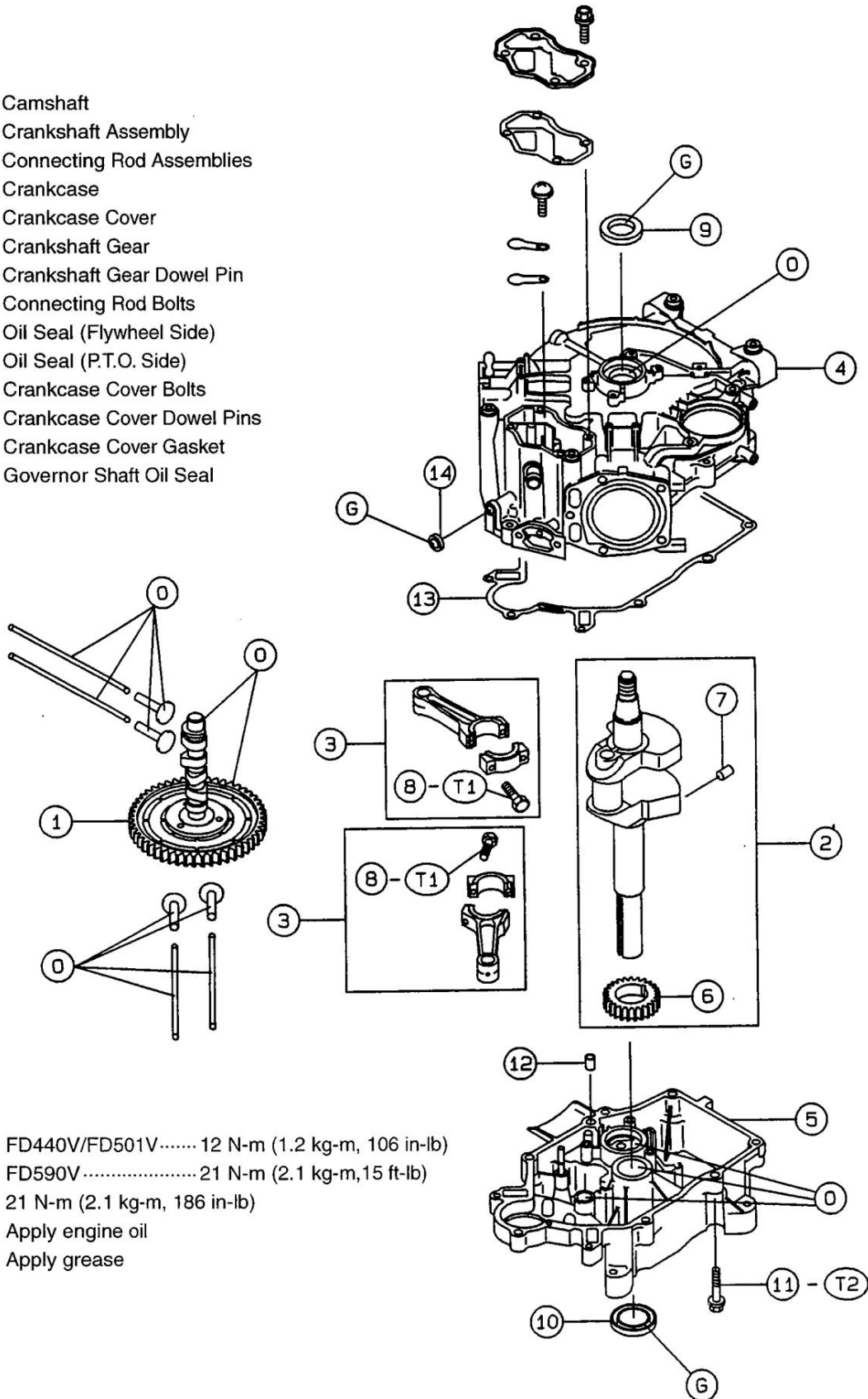
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## 6-2 CAMSHAFT/CRANKSHAFT

### Exploded View

1. Camshaft
2. Crankshaft Assembly
3. Connecting Rod Assemblies
4. Crankcase
5. Crankcase Cover
6. Crankshaft Gear
7. Crankshaft Gear Dowel Pin
8. Connecting Rod Bolts
9. Oil Seal (Flywheel Side)
10. Oil Seal (P.T.O. Side)
11. Crankcase Cover Bolts
12. Crankcase Cover Dowel Pins
13. Crankcase Cover Gasket
14. Governor Shaft Oil Seal



T1: FD440V/FD501V..... 12 N-m (1.2 kg-m, 106 in-lb)  
 FD590V ..... 21 N-m (2.1 kg-m, 15 ft-lb)

T2: 21 N-m (2.1 kg-m, 186 in-lb)

O: Apply engine oil

G: Apply grease



**CAMSHAFT/CRANKSHAFT 6-3****Specifications - FD440V/FD501V**

| Item   | Standard/Service Limit   |
|--|--|
| <b>CAMSHAFT, CONNECTING ROD, AND CRANKSHAFT</b><br><b>camshaft</b><br>Minimum End Journals O.D.<br>Minimum Lobe O.D.<br>Minimum Fuel Pump Lobe Height<br>Maximum Cover Bearing I.D.<br>Maximum Crankcase Bearing I.D.<br><br><b>Connecting Rod</b><br>Maximum Crankshaft Bearing I.D.<br>Maximum Piston Pin Bearing I.D.<br>End-Cap Screw Torque | <br><br><br><br><br><br><br><br><br><br><br>13.91 mm (0.548 in.)<br>24.43 mm (0.962 in.)<br>19.50 mm (0.760 in.)<br>14.05 mm (0.553 in.)<br>14.07 mm (0.554 in.)<br><br>31.06 mm (1.223 in.)<br>16.05 mm (0.632 in.)<br>12 N-m (106 in-lb) |
| <b>Crankshaft</b><br>Minimum Side Journal O.D.<br>Minimum Connecting Rod Journal O.D.<br>Maximum T.I.R. (Total Indicated Runout)   | <br><br><br>29.92 mm (1.178 in.)<br>30.93 mm (1.218 in.)<br>0.05 mm (0.002 in.)  |

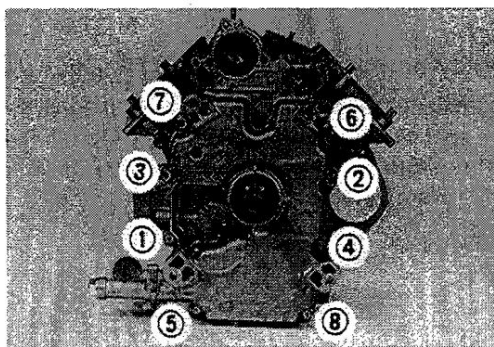
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## Crankcase

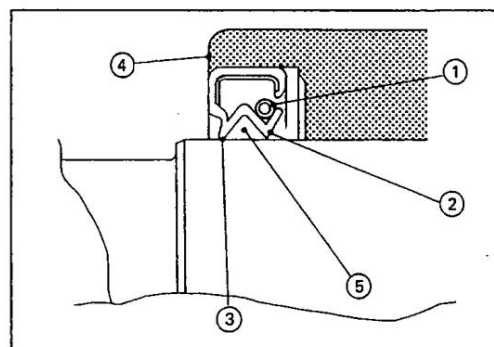
### Splitting

- Set the engine on a clean surface while parts are being removed.
- Remove (see appropriate chapter).
  - Muffler Assembly
  - Air Cleaner Assembly
  - Carburetor Assembly
  - Throttle Control panel
  - Radiator
  - Radiator Hoses and Bypass Tube
  - Water pump Assembly
  - Cooling Fan and Brackets
  - Cylinder Head Assemblies
  - Intake Manifold
  - Flywheel
  - Stator coil
  - Pulser coils
  - Ignition coils
  - Igniter
  - Starter Motor
  - Igniter and Bracket
  - Oil Drip Tray
  - Oil Filter
- Unscrew the mounting bolts in the order shown and pull the crankcase cover from the crankcase.
- There are two knock pins on the crankcase mating surface. A wooden or plastic mallet may be used to gently tap loose the crankcase cover.



### Assembly

- Before fitting the cover onto the crankcase, note the following.
  - Chip the old gasket off the mating surfaces of the crankcase and cover, and clean off the crankcase, crankshaft and other internal components. After cleaning apply engine oil to any rubbing surface of these components.
  - Be sure to replace any oil seal removed with a new one. The oil seal must be assembled with spring (1) loaded lip toward inside of the engine.
  - Pack some amount of a high temperature grease (5) into the space between the seal lip (2) and dust lip (3). Press in the new oil seal using a press or suitable tools until it is flush with flange surface (4). Do not damage the seal lips.

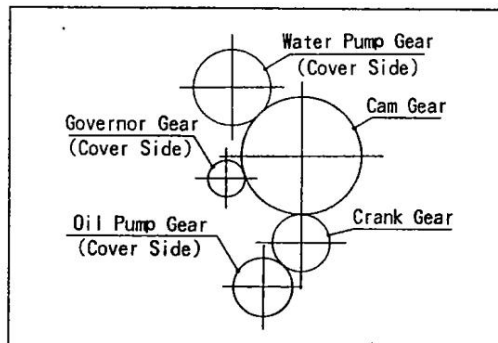




## 6-6 CAMSHAFT/CRANKSHAFT

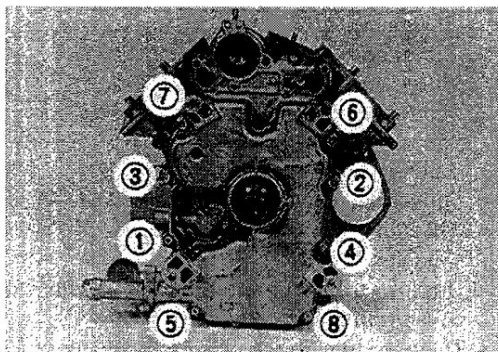
- Check that the governor weights are closed.
- Be sure to suitably set the governor gear to be meshed with the cam gear and the oil pump gear to be meshed with the crank gear when installing crankcase cover. Do not force the crankcase cover into position.

**Gear train: viewed from PTO side**



### NOTE

- Note the position of different length of the bolts.
- Install the crankcase cover and tighten the case cover bolts to the specified torque (see Exploded View) in the sequence as shown. Do not turn one screw down completely before the others, as it may cause a warped the crankcase cover.



### Inspection

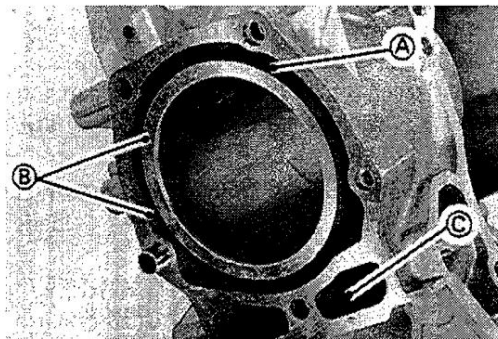
- Clean up the crankcase and cover with a high flush-point solvent, and blow out any foreign particles that may be in the pockets inside of the crankcase with compressed air.

### ⚠ 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 flush-point solvents.

- Inspect the crankcase for accumulation of rust, scale and lime in the water jacket.
- ★ If this accumulation is observed, flush the cooling system (see Flushing in Cooling System chapter).
- Inspect the crankcase for coolant leakage out side water jacket. Small leaks may appear only as rust, corrosion or stains, due to evaporation.
  - Gaskets: Tighten a parts or install a new gasket. Use a sealing compound when required.
  - Bolts: Apply sealing compound when required.
- Inspect the crankcase for coolant leakage into the engine.
 

|                    |                         |
|--------------------|-------------------------|
| A. Water Jacket    | C. Push Rod Compartment |
| B. Gasket Surfaces |                         |
- A coolant leaks into the engine through:
  - A loose cylinder head
  - A cracked or porous casting
  - The push rod compartment
- Give special attention to the cylinder head gasket.
- ★ If coolant leaks from the gasket surfaces:
  - Check the gasket surfaces for burn and traces of the gas leakage, replace the gasket if necessary.
  - Check the cylinder head and block surfaces are clean, level and smooth. (see Engine Top End chapter)
  - Check the cylinder head for correct installation (see Engine Top End chapter).

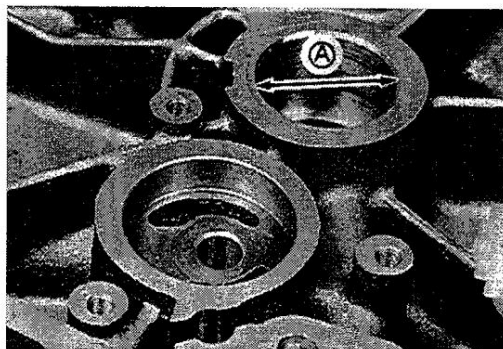


- A cracked or porous casting are not visible to eye, an evidence of leakage of the coolant from suspected area are found, replace the crankcase (block).
- ★ If a coolant leakage from the push rod compartment is appeared replace the crankcase (block).

- 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 if the inside diameter is more than the service limit.

#### PTO Shaft Bearing Inside Diameter

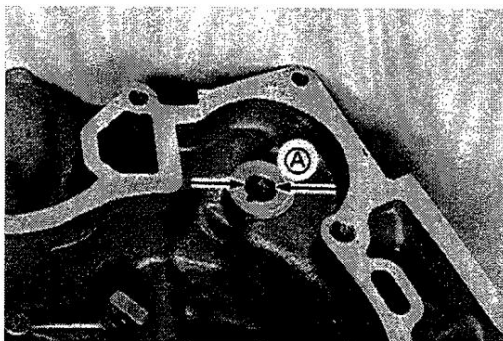
Service Limit: 30.09 mm (1.185 in.) .....FD440V/FD501V  
34.07 mm (1.341 in.) .....FD590V



- Measure the inside diameter (A) of the water pump shaft bearing on the crankcase at several points. This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

#### Water Pump Shaft Bearing Inside Diameter

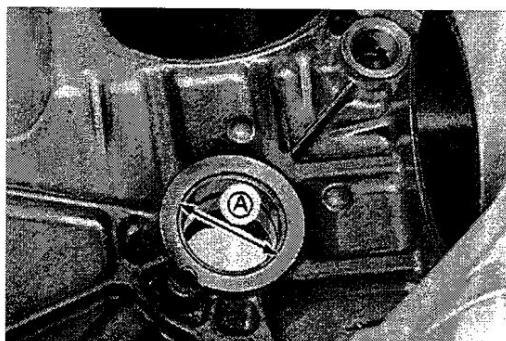
Service Limit: 10.088 mm (0.3972 in.)



- Measure the inside diameter (A) of the crankshaft journal bearing on the crankcase at several points. Replace the journal Bushing if the inside diameter is more than the service limit.

#### Crankshaft Journal Bearing Inside Diameter

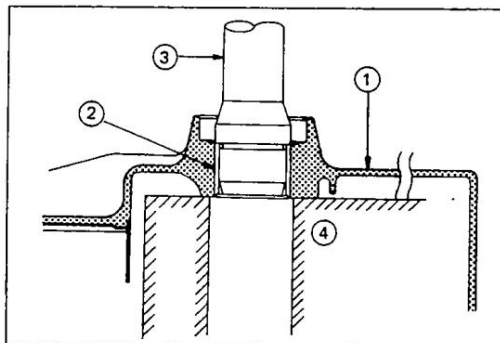
Service Limit: 30.09 mm (1.185 in.) .....FD440V/FD501V  
34.07 mm (1.341 in.) .....FD590V



#### Journal Bushing Replacement - FD590V

The journal bushing (2) is press fit into the crankcase (1).

- Remove the oil seal on the crankcase.  
The oil seal should not be reused once removed.
- Place the crankcase on a support block (4) with the oil seal side up.
- Using a bushing tool (3), drive out the bushing as shown.

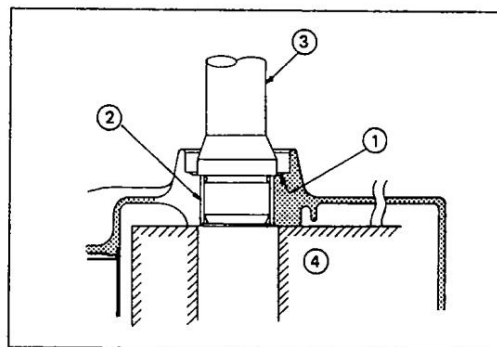




## 6-8 CAMSHAFT/CRANKSHAFT

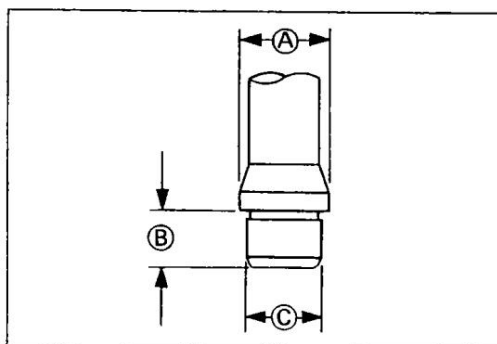
- The service bushing is to be reinstalled using a bushing tool as shown.
- Coat the bushing and flange surface with light film of oil, press in the new bushing flush with the flange surface.
- No finish reaming is required.

- |                   |                  |
|-------------------|------------------|
| 1. Flange Surface | 3. Bushing Tool  |
| 2. New Bushing    | 4. Support Block |



### *For Designing Bushing Tool*

- A. 40 mm (1.575 in.)
- B. 26 mm (1.024 in.)
- C. 33.8 mm (1.331 in.)



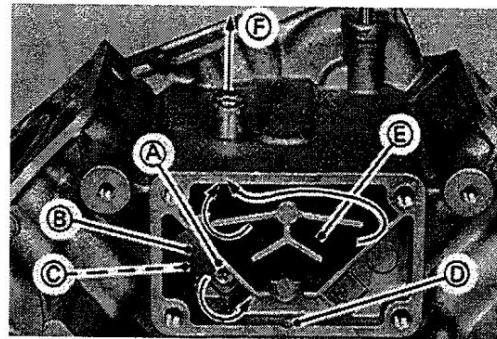


## Breather

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

Oil laden air in the crankcase passes through the reed valve and expand into the breather chamber. Here most oil separates from the air and drains back to the crankcase. The air passes through a maze (E) and vents to the air cleaner (F).

### FD590V Shown



### Removal

- Remove the breather chamber cover.
- Unscrew the mounting screw (A), and remove the back plate (B) and reed valve.

### Installation Notes

- Be sure the drain back hole (D) does not accumulate with slugs before installing the breather valve.
- Align center of the valve seat with center of the reed valve and back plate, then tighten the mounting screw.

### NOTE

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

### Inspection

- Inspect the reed valve for breakage, hair cracks or distortion, replace it if necessary.
- Inspect the back plate for damage or rough contact surface, replace it if necessary.
- Inspect the valve seating surface. The surface should be free of nicks or burrs.

## 6-10 CAMSHAFT/CRANKSHAFT

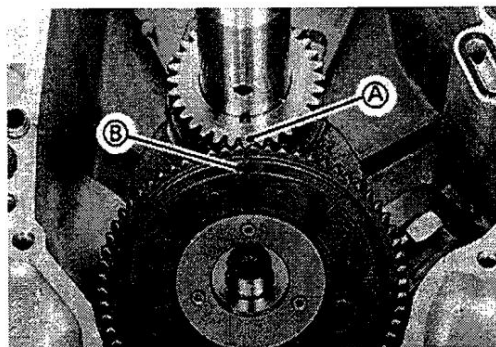
### Camshaft Tappet

#### Removal

- split the crankcase (see Crankcase Splitting).
- Turn the crankcase up side down so that the tappets will fall away from the cam lobes.
- Pull the camshaft out of the crankcase.

#### NOTE

- Before removing, align the punch mark (A) on the crankgear with the projection (B) on the camgear.
- Remove the tappets and mark them so they can be installed in their original positions during assembly.

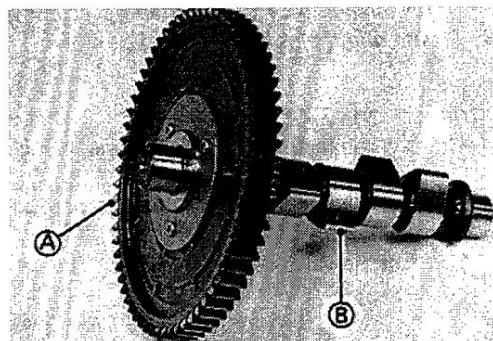


#### Installation Notes

- Apply engine oil to the following.
  - Tappet Journal
  - Camshaft Journal
  - Cam Lobe Surface
  - Cam shaft Gear
- Align the punch mark on the crankgear with the projection on the camgear.

#### Inspection

- Check the camshaft gear (A) for pitting, fatigue cracks, burrs or an evidence of improper tooth contact. Replace the shaft if necessary.
- Check the top of the cam lobes (B) for wear, burrs or uneven contact. Replace the shaft if necessary.



#### Camshaft Bearing/Journal Wear

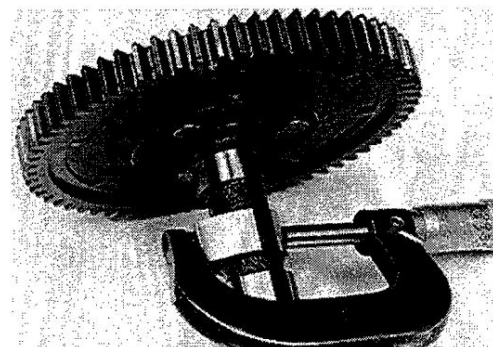
- Measure the height of each cam lobe.
- ★ If the cam height is less than the service limit for either lobe, replace the camshaft.

##### Cam Lobe Height (IN., EX.)

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 22.43 mm (0.954 in.) | ..... | FD440V/FD501V |
| 25.23 mm (0.993 in.)                | ..... | FD590V        |

##### Fuel Pump Cam Lobe Height

Service Limit: 19.50 mm (0.760 in.)



- With a micrometer, measure both camshaft journals at several points around the journal circumference.

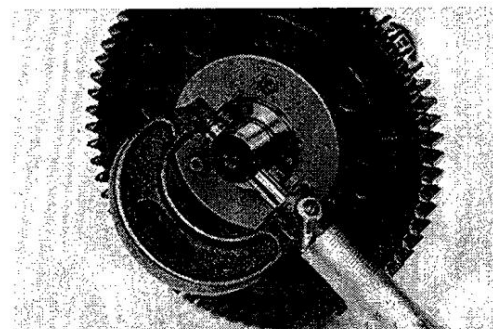
- ★ If the journal diameter is less than the service limit, replace the camshaft.

##### PTO Side Journal Diameter

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 14.05 mm (0.553 in.) | ..... | FD440V/FD501V |
| 16.07 mm (0.633 in.)                | ..... | FD590V        |

##### Flywheel Side Journal Diameter

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 14.07 mm (0.554 in.) | ..... | FD440V/FD501V |
| 16.07 mm (0.633 in.)                | ..... | FD590V        |

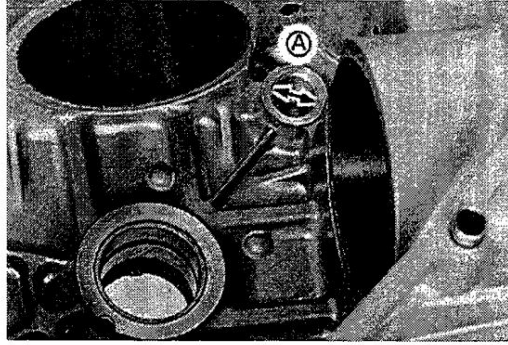




- Measure the inside diameter of the camshaft bearing (A) on the crankcase at several points. This bearing is not replaceable. Replace the crankcase if the inside diameter more than the service limit.

**Camshaft Bearing Inside Diameter**

**Service Limit:** 14.07 mm (0.554 in.) .....FD440V/FD501V  
16.07 mm (0.633 in.) .....FD590V



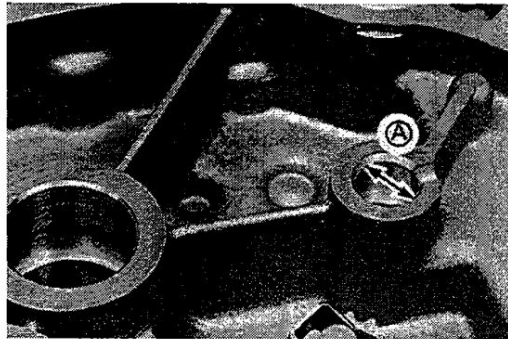
- Measure the inside diameter of the camshaft bearing (A) on the crankcase cover at several points.

This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

16.07 mm (0.633 in.) FD590V

**Camshaft Bearing Inside Diameter**

**Service Limit:** 14.05 mm(0.553 in.) .....FD440V/FD501V  
16.07 mm (0.633 in.) .....FD590V





## 6-12 CAMSHAFT/CRANKSHAFT

### Crankshaft, Connecting Rod

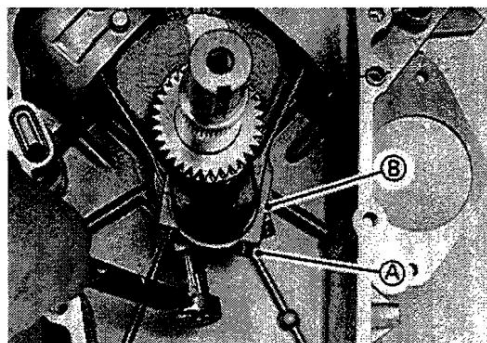
#### Crankshaft, Connecting Rod Removal/Installation:

##### Connecting Rod Removal

- Remove the connecting rod during the piston removal (see Piston Removal in the Engine Top End chapter).

##### Connecting Rod Installation Notes

- See Piston Installation Notes in the Engine Top End chapter for assembling the piston onto the connecting rod and insert the assembly into the cylinder.
- Turn the crankshaft until the crankpin is lowest position.
- Apply engine oil to the bearing portion of each connecting rod big end and cap.
- Install each connecting rod big end onto the crankpin.
- Place the connecting rod caps over the crankpin so the pilot grooves (B) on the caps and rods are aligned.
- Be sure the large chamfers on the connecting rods facing toward each crank web.
- Coat a light film of oil on the threads of connecting cap bolts (A).
- Install cap bolts and tighten them to the specified torque (see Exploded View)



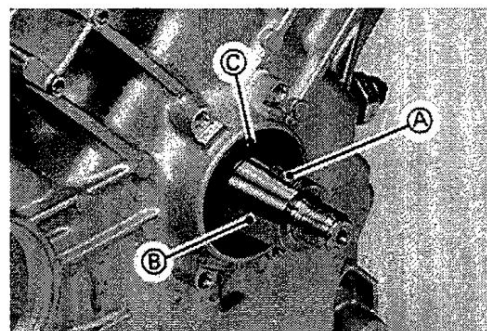
##### Crankshaft Removal/Installation Notes

- Remove
  - Flywheel
  - Camshaft
  - Connecting rod and piston assembly
- Pull the crankshaft out of the crankcase. Tap gently with a wooden or plastic mallet if necessary to loosen the crankshaft.
- 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 oil seal in the crankcase, if necessary, cover the key way on the crankshaft taper with a tape to avoid damaging these parts.
- Be sure to fit the woodruff key correctly on the crankshaft taper.

A. Woodruff Key

C. Oil Seal

B. Crankshaft Taper



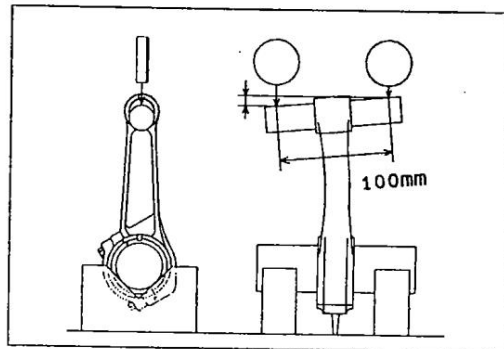
## Crankshaft, Connecting Rod Inspection/Maintenance:

### Cleaning/Inspection

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

### Connecting Rod Bend/Twist

- Measure connecting rod bend.
  - Select an arbor of the same diameter as the connecting rod big end, and insert the arbor through the connecting rod big end.
  - Select an arbor of the same diameter as the piston pin and at least 100 mm 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 difference in the height of the small end arbor above the surface plate over a 100 mm length to determine the amount of connecting rod bend.
- ★ If connecting rod bend exceeds the service limit, the connecting rod must be replaced.



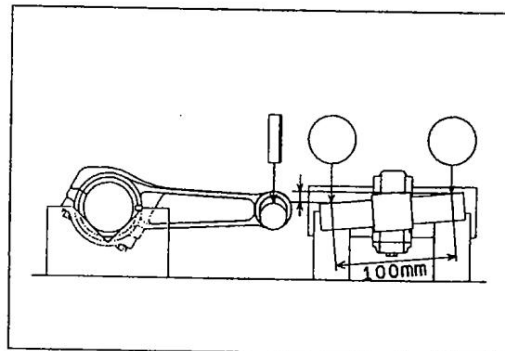
#### Connecting Rod Bend

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

- Measure connecting rod twist.
  - With the big-end arbor still on the V blocks, hold the connecting rod horizontally and measure the amount that the small end arbor varies from being parallel with the surface plate over a 100 mm length of length of the arbor to determine the amount of connecting rod twist.
- ★ If connecting rod twist exceeds the service Limit, the connecting rod must be replaced.

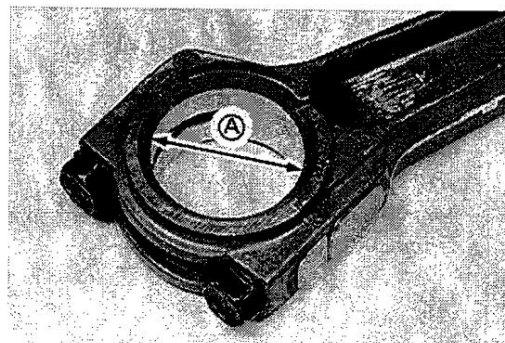
#### Connecting Rod Twist

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



### Connecting Rod Big End Bearing/Crankpin Wear

- Place the connecting rod cap over its big end to align the pilot grooves on the cap and rod.
- Coat a light film of oil on the thread of the cap bolts.
- Install the cap bolts and tighten bolts to the specified torque (see Exploded View).
- Measure the inside diameter (A) of both ends at several points with a telescoping gauge or inside micrometer.
- ★ If either measurement is more than specifications, replace the connecting rod with a new one.





## 6-14 CAMSHAFT/CRANKSHAFT

### Connecting Rod Big End Inside Dia.

|                       |                      |       |               |
|-----------------------|----------------------|-------|---------------|
| <b>Service Limit:</b> | 31.06 mm (1.223 in.) | ..... | FD440V/FD501V |
|                       | 34.06 mm (1.341 in.) | ..... | FD590V        |

### Connecting Rod Small End Inside Dia.

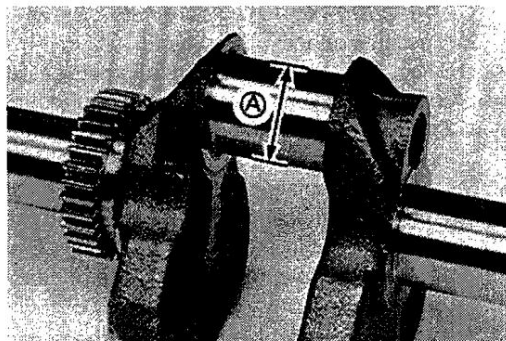
|                       |                      |       |               |
|-----------------------|----------------------|-------|---------------|
| <b>Service Limit:</b> | 16.05 mm (0.632 in.) | ..... | FD440V/FD501V |
|                       | 17.05 mm (0.671 in.) | ..... | FD590V        |

- Measure the crankpin outside diameter.
- 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

|                       |                      |       |               |
|-----------------------|----------------------|-------|---------------|
| <b>Service Limit:</b> | 30.93 mm (1.218 in.) | ..... | FD440V/FD501V |
|                       | 33.91 mm (1.335 in.) | ..... | FD590V        |

#### A. Outside Diameter

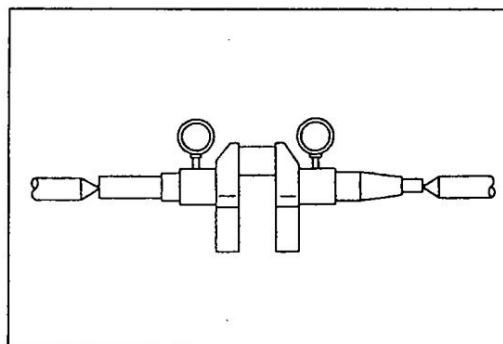


### Crankshaft Runout

- 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 lowest dial gauge readings (TIR) is the amount of runout.
- ★ If the measurement exceeds the service limit, replace the crankshaft.

### Crankshaft Runout

|                       |                        |
|-----------------------|------------------------|
| <b>Service Limit:</b> | 0.05 mm (0.002 in) TIR |
|-----------------------|------------------------|



### Crankshaft Main Journal/Wear

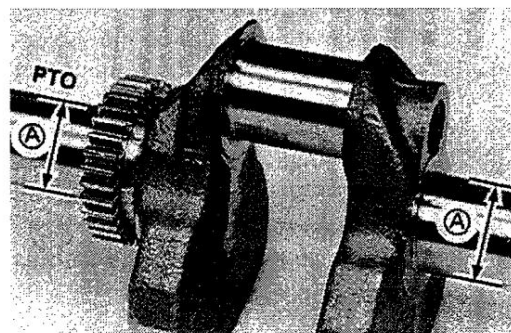
- With a micrometer, measure the both main journals at several points around the journal circumference.
- ★ If either measurement (A) is less than specifications, replace the crankshaft with a new one.

### Crankshaft Main Journal Diameter

|                       |                      |       |               |
|-----------------------|----------------------|-------|---------------|
| <b>Service Limit:</b> | 29.92 mm (1.178 in.) | ..... | FD440V/FD501V |
|                       | 33.91 mm (1.335 in.) | ..... | FD590V        |

### Flywheel Side Journal Diameter

|                       |                       |
|-----------------------|-----------------------|
| <b>Service Limit:</b> | 33.909 mm (1.3350 in) |
|-----------------------|-----------------------|



### Crankpin Resizing

#### NOTE

- Under size connecting rod is not available for FD440V/FD501V engines. Replace the crankshaft if measurements are less than specifications.
- On FD590V engine, connecting rod journal can be resized to accept under-sized connecting rod. Have grinding done by a reliable repair shop.



Crankpin can be to accept 33.5 mm (1.3189 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.

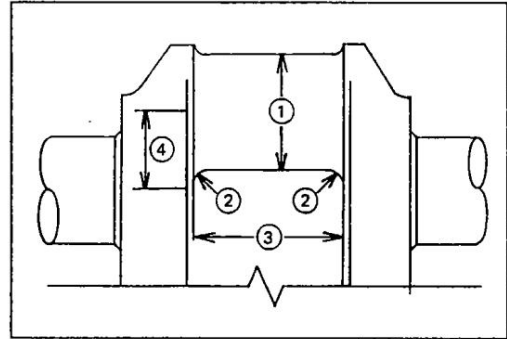
● Before sending the crankshaft, inspect the crankpin for cracks.

★ 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 – FD590V

|    |   |
|----|---|
| 1. | <u>33.480 to 33.467 mm</u><br>(1.318 to 1.3176 in)  |
| 2. | <u>2.30 to 2.70 mm</u><br>(0.09 to 0.11 in)         |
| 3. | <u>44.40 mm MAX</u><br>(1.748 in MAX)               |
| 4. | <u>34.000 to 33.950 mm</u><br>(1.3386 to 1.3366 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.

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# Electrical System

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## 7-2 ELECTRICAL SYSTEM

### Exploded View

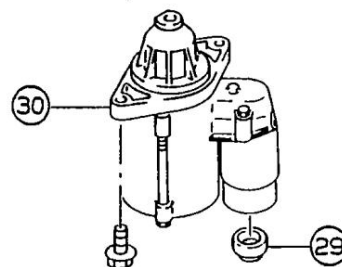
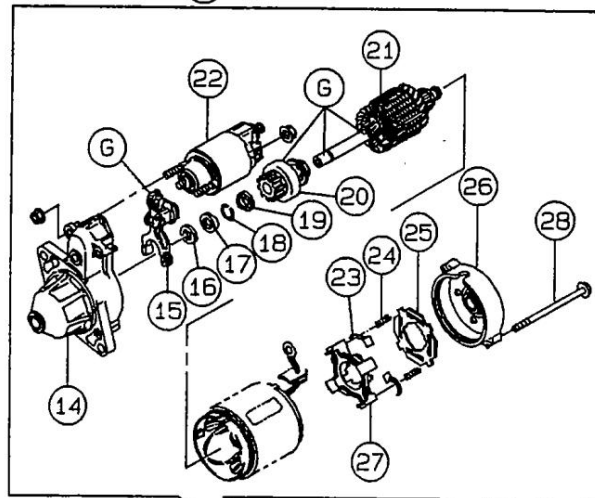
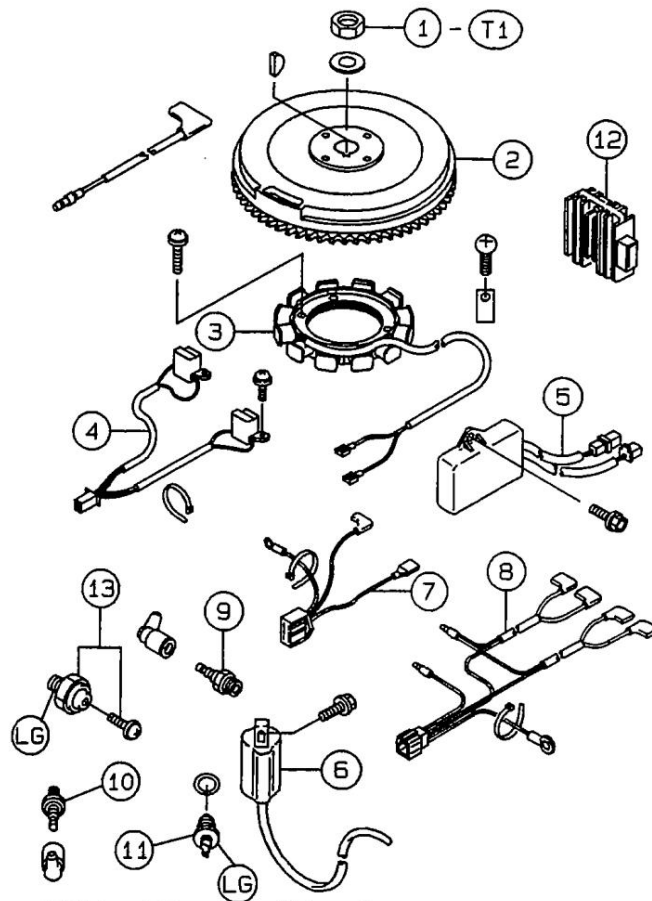
1. Alternator-Rotor Nut (Flywheel Nut)
2. Alternator Rotor (Flywheel)
3. Alternator Stator (Charging Coil)
4. Pulser Coil
5. Igniter
6. Ignition Coils
7. Wire Harness
8. Wire Harness
9. Spark Plug
10. Spark Plug
11. Thermo Switch
12. Voltage Regulator (Shipped Loose)
13. Oil Pressure Switch

14. Front Cover
15. Shift Lever
16. Washer
17. Pinion Stopper Half
18. Retaining Clip
19. Pinion Stopper Half
20. Pinion
21. Armature
22. Solenoid
23. Brushes
24. Brush Springs
25. Insulator
26. End Cover
27. Brush Holder
28. Retaining Bolts
29. Cover
30. Electric Starter Assembly

T<sub>1</sub> : FD440V/FD501V...88N-m(9kg-m, 65ft-lb)  
 FD590V.....120N-m(12kg-m, 87ft-lb)

G : Apply grease

LG : Apply liquid gasket



1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30.

## Specifications

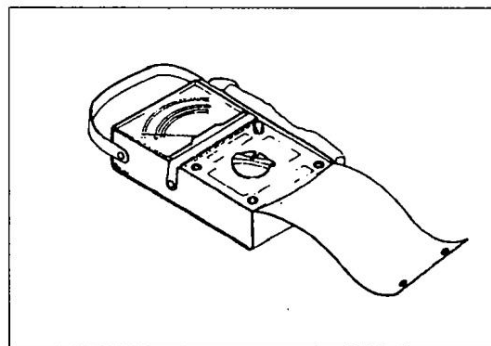
| Item                              | Standard  | Service Limit      |
|-----------------------------------|---|--------------------|
| <b>Chargine System:</b>           |   |                    |
| Regulated output voltage          | Batery voltage to 15V DC                              | ---                |
| Alternator stator coil resistance | 0.11 to 0.18 $\Omega$                                 | ---                |
| Unregulated stator output         | ---   | 26VAC/3 000 rpm    |
| Regulator resistance              | See charging system                                   |                    |
| <b>Ignition System:</b>           |   |                    |
| <b>Pulser Coil:</b>               |   |                    |
| Coil air gap                      | 0.3 to 1.2 mm (0.012 to 0.05 in.)<br>(not adjustable) | ---                |
| Coil resistance                   | 85 to 170 $\Omega$                                    | ---                |
| Igniter resistance                | See ignition system                                   | ---                |
| <b>Ignition coil:</b>             |   |                    |
| Primary winding resistance        | 3.4 to 4.6 $\Omega$                                   | ---                |
| Secondary winding resistance      | 10.4 to 15.6 k $\Omega$                               | ---                |
| Spark plug                        | NGK BMR4A   | ---                |
| Plug gap                          | 0.6 to 0.7 mm (0.024 to 0.028 in.)                    | ---                |
| <b>Electric Starter System:</b>   |   |                    |
| <b>Starter motor:</b>             |   |                    |
| Carbon brush length               | 10 mm (0.394 in.)                                     | 6.0 mm (0.24 in.)  |
| Commutator groove depth           | 0.5 to 0.8 mm (0.02 to 0.031 in.)                     | 0.2 mm (0.008 in.) |
| Commutator diameter               | 28 mm (1.102 in.)                                     | 2.7 mm (1.06 in.)  |
| Commutator runout                 | ---   | 0.4 mm (0.016 in.) |

## 7-4 ELECTRICAL SYSTEM

### Special Tools

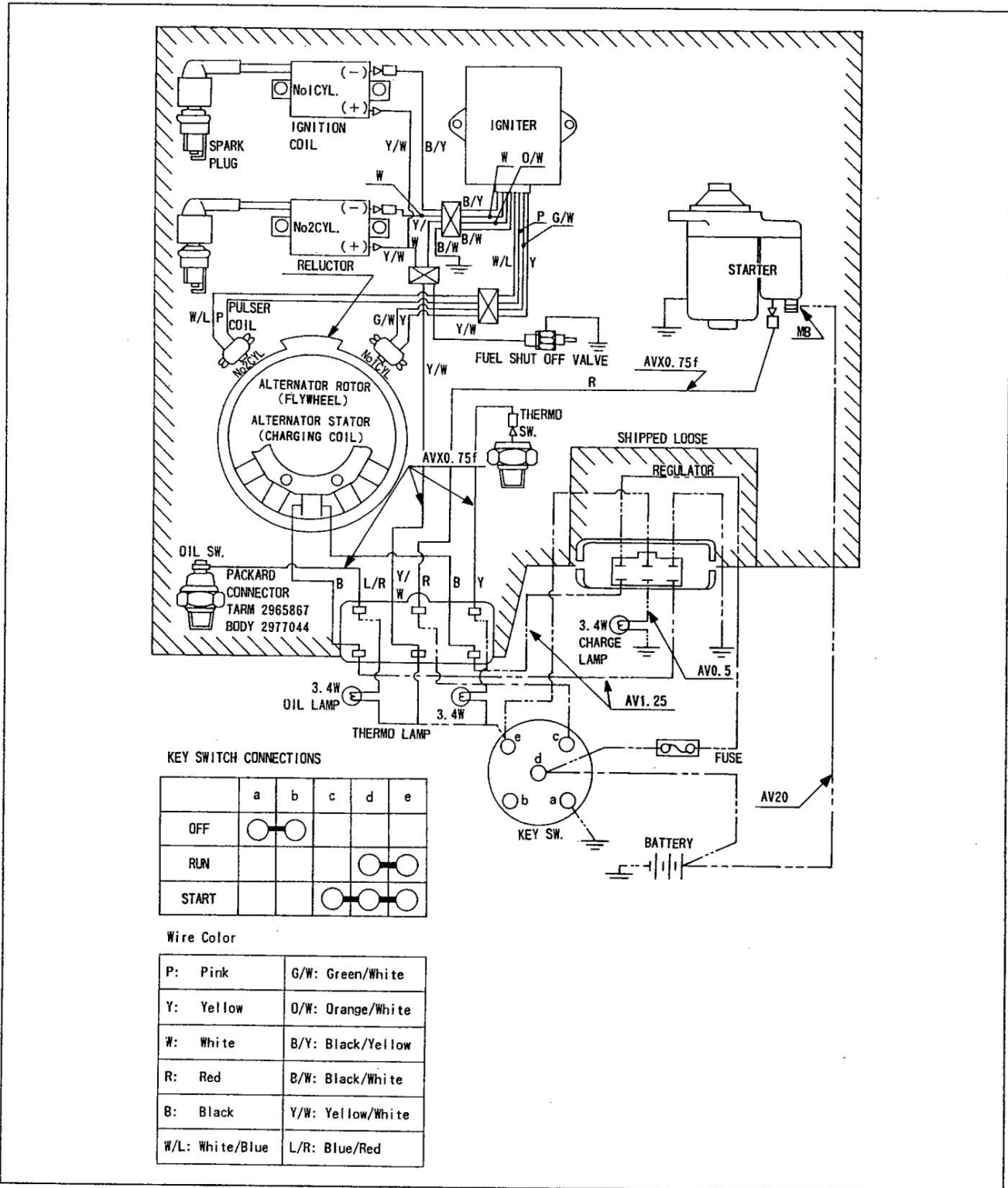
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Kawasaki Hand Tester (P/N 57001-1394)





Wiring Diagram

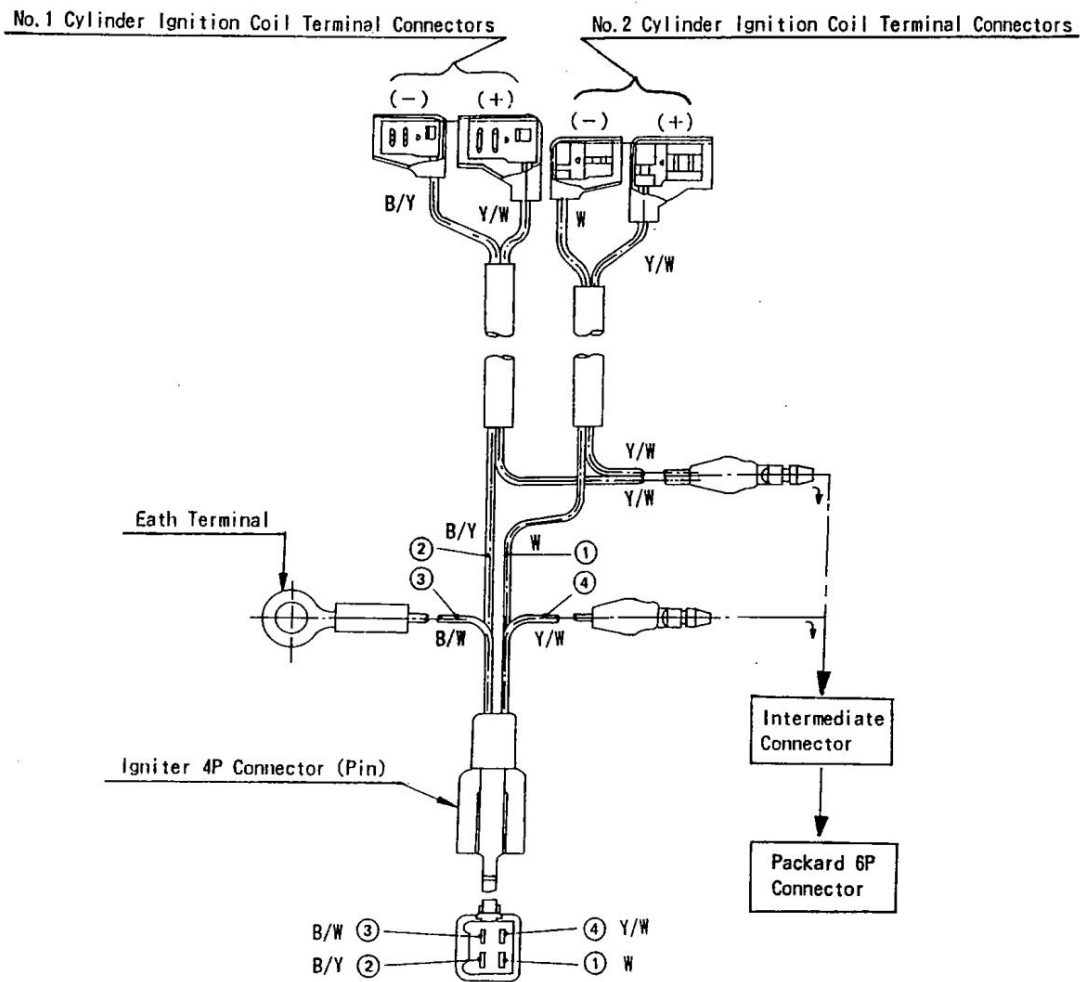


Note: PORTION SURROUNDED BY // SHOWS KAWASAKI PROCURMENT PARTS  
 FUEL SHUT-OFF VALVE WITH WHICH FD501V IS EQUIPPED

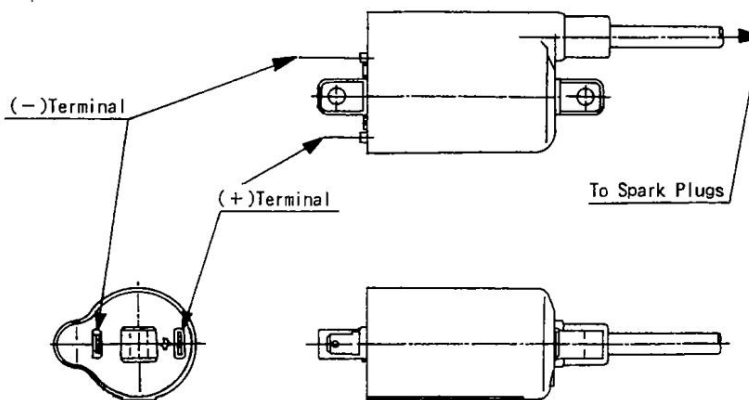
# 7-6 ELECTRICAL SYSTEM

## Wire Harness

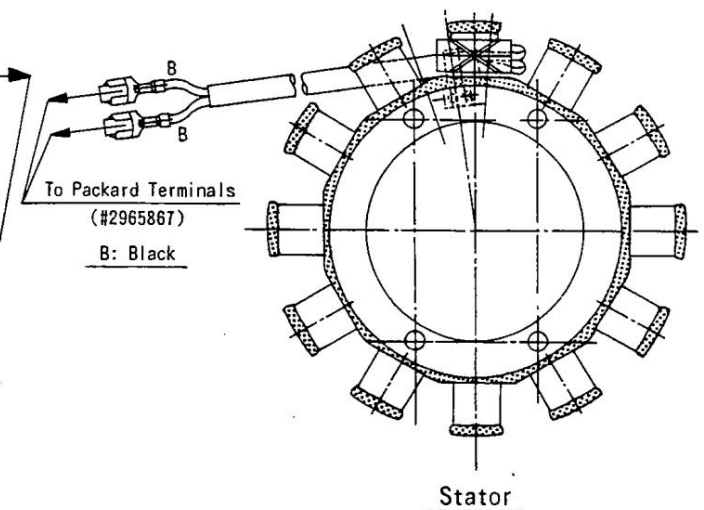
### WIRE-HARNESS



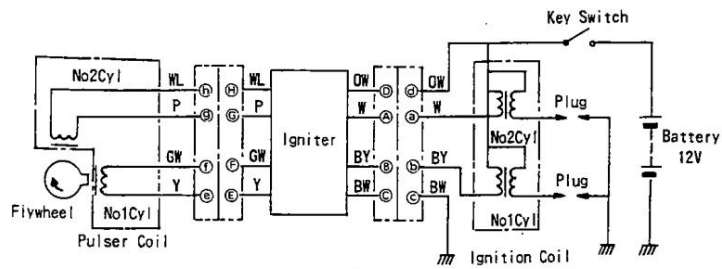
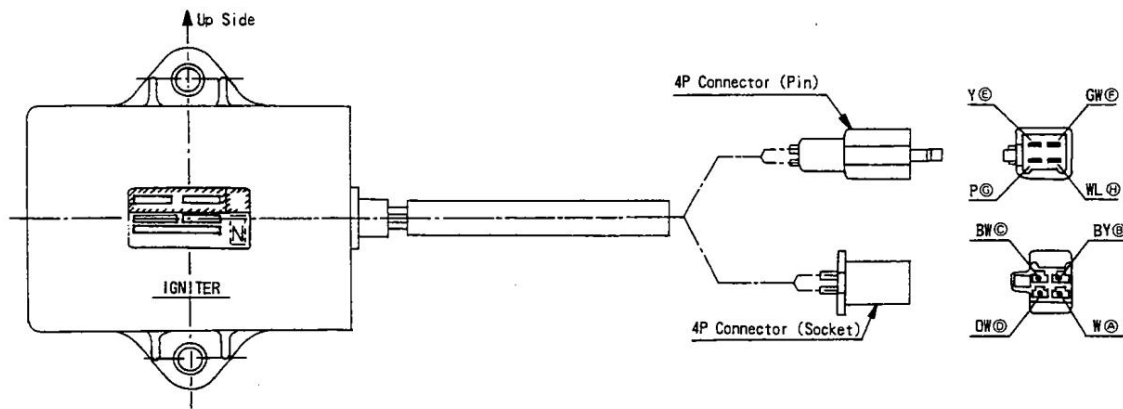
### IGNITION COILS



### CHARGING COIL

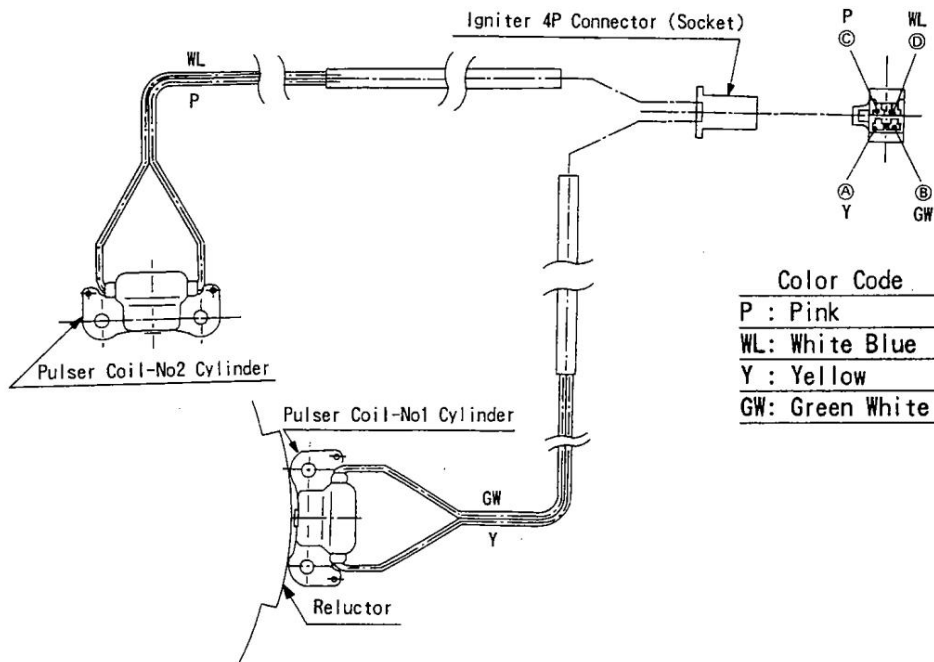


IGNITER



Wiring Diagram

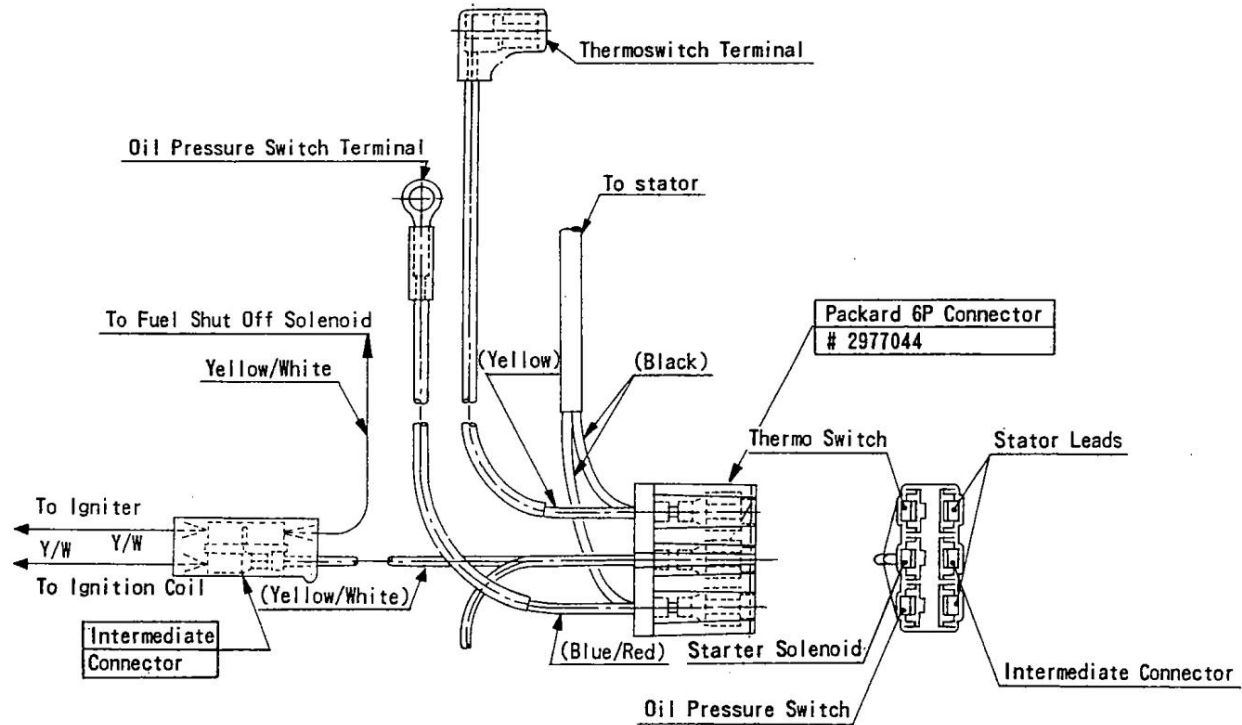
PULSER COILS





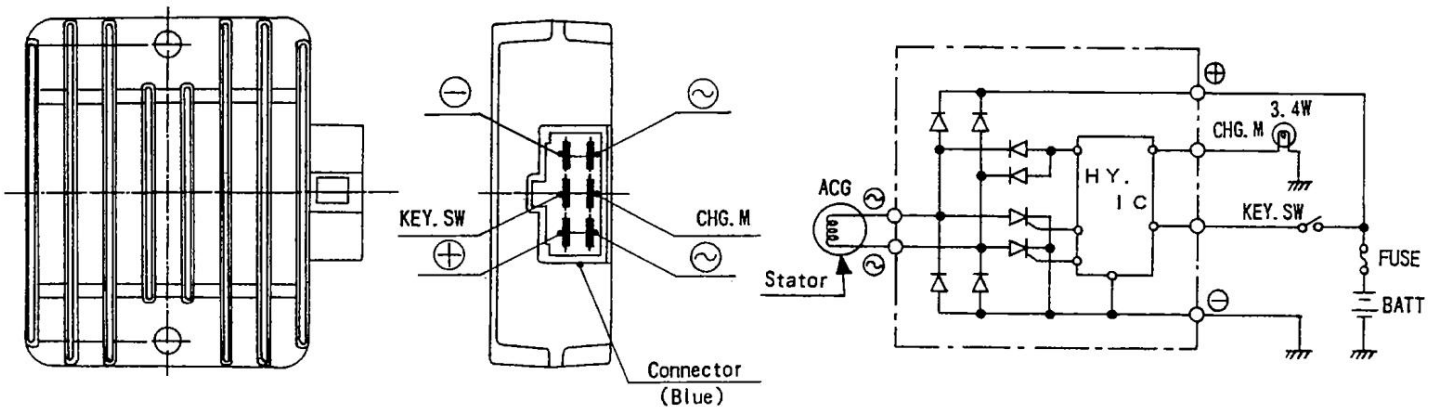
## 7-8 ELECTRICAL SYSTEM

### WIRE-HARNESS



### VOLTAGE REGULATOR

CHG Monitor Lamp (MAX): 12V-3.4W

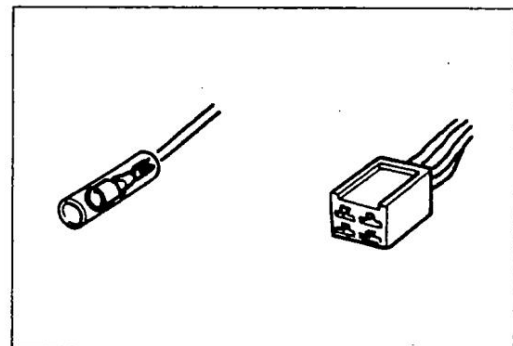


## Precautions

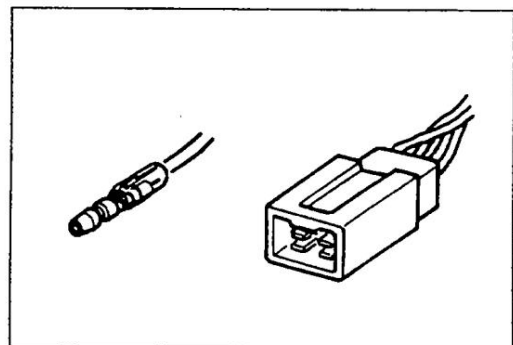
There are a number of important precautions that are musts when servicing electrical systems. Learn and observe all the rules below.

- Do not reverse the battery lead connections. This will burn out the diodes in the electrical parts.
- Always check battery condition before condemning other parts of an electrical system. A fully charged battery is a must for conducting accurate electrical system tests.
- The electrical parts should never be struck sharply, as with a hammer, or allowed to fall on a hard surface. Such a shock to the parts can damage them.
- To prevent damage to electrical parts, do not disconnect the battery leads 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 turn over, 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 in some cases all items. Never replace a defective part without determining what CAUSED the failure. If the failure was brought on by some other item or items, they too must be repaired or replaced, or the replacement part will soon fail again.
- Make sure all connectors in the circuit are clean and tight, and examine wires for signs of burning, fraying, etc. Poor wires and bad connections will affect electrical system operation.
- Measure coil and winding resistance when the part is cold (at room temperature).
- Electrical Connectors:

### Female Connectors



### Male Connectors

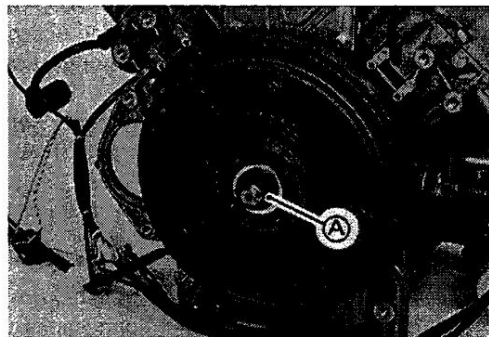


## 7-10 ELECTRICAL SYSTEM

### Charging System

#### Alternator Rotor and Stator Removal

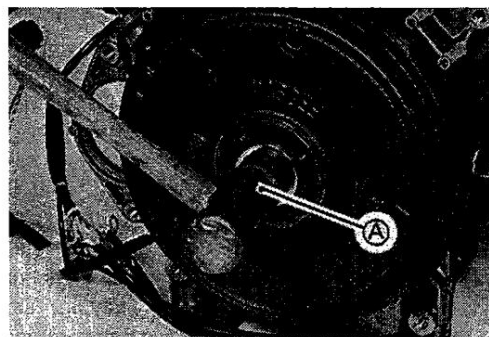
- Remove the followings.
  - Radiator
  - Cooling Fan
  - Starter Motor
  - Pulser Coils
  - Cooling Fan Extension
- Hold the rotor (flywheel) with a suitable tools, remove the flywheel mounting nut.
  - Alternator rotor (Flywheel):
- Using a flywheel puller, remove the flywheel.
  - A. Flywheel Nut



#### NOTE

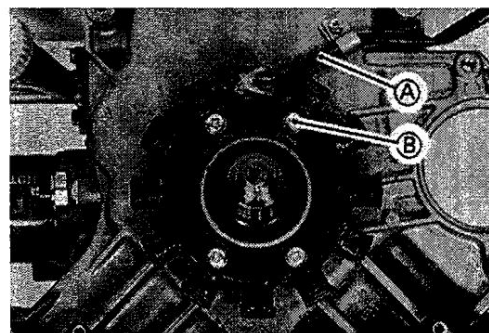
- If a flywheel puller is not available, screw the flywheel mounting nut flush with the shaft end to prevent damaged shaft end threads and tap sharply and squarely on the nut to break the flywheel loose. Flywheel will loosen.

- A. Tap sharply and Squarely



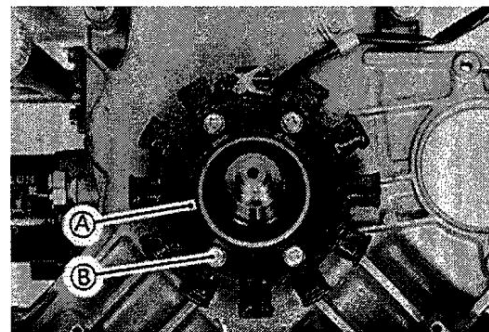
#### Alternator Stator (Charging Coil):

- Note the charging coil output leads position for reinstalling the charging coil.
- Unscrew the coil mounting screws and remove the charging coil.
  - A. Charging Coil Output Leads
  - B. Mounting Screws



#### Alternator Rotor and Stator Installation

- Clean the inside of the flywheel and end of the crankshaft or the taper will not fit snugly.
- Fit the flywheel onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.
- Torque the following.
  - Alternator Rotor Nut
- Tighten the nut to the specified torque once, loosen it, and then retighten it to the specified torque (see Exploded View).
  - Alternator Stator
- To reset the charging coil core onto the mounting flanges, firmly push the charging coil assembly against the mounting flanges and tighten the screws securely.
  - A. Mounting Flanges
  - B. Mounting Screws





**Charging System Operational Inspection**

- Check battery condition.

**NOTE**

○ Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.

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

**Regulated Output Voltage**  
**Battery Voltage to 15 VDC**

**Stator Coil Resistance**

- Disconnect the PACKARD 6P connector.
- Measure the stator coil resistance.
- Connect an ohmmeter between stator pins.

**Stator Coil Resistance**  
**0.1232 to 0.1848  $\Omega$**

- ★ If the meter does not read as specified, replace the alternator stator.
- ★ If the coil has normal resistance, but the voltage inspect showed the alternator to be defective; the rotor magnets have probably weakened, and the rotor must be replaced.

1. To Stator
2. Ohm Meter
3. PACKARD 6P connector

- 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.

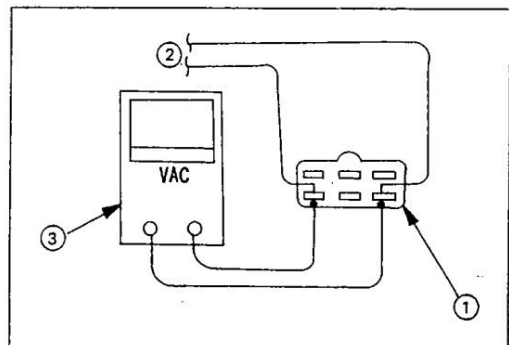
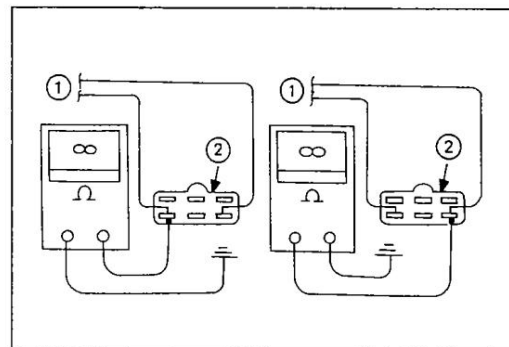
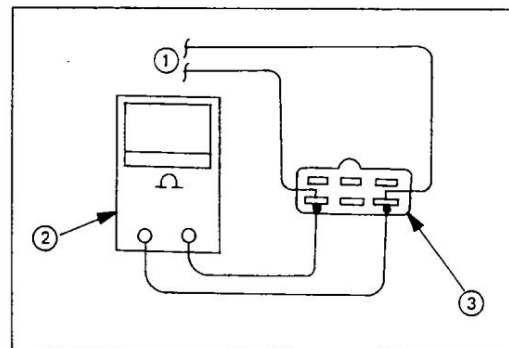
1. To Stator
2. PACKARD 6P Connector

**Unregulated Stator Output**

- Disconnect the PACKARD 6P connector.
- Connect AC voltmeter to the stator pins.
- Start the engine. Run the engine at the 3 000 rpm speed.
- Voltage reading should be minimum 26 VAC/3 000 rpm.
- ★ If the AC voltage reading is less than the specification replace the stator.

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

1. PACKARD 6P Connector
2. To Stator
3. AC Voltmeter



## 7-12 ELECTRICAL SYSTEM

### Regulator Resistance

- Set the hand tester to the R x 1 k $\Omega$  position.
- Connect the test leads to the points shown on the chart and read the resistance.
- ★ If the resistance is not as specified replace the regulator.

#### NOTE

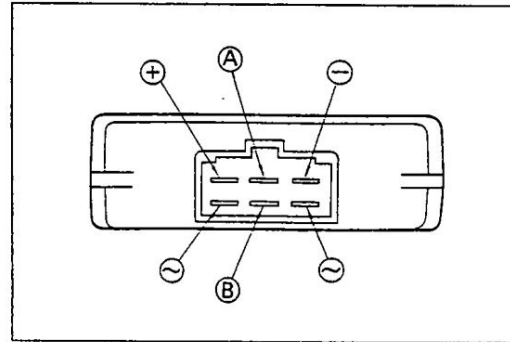
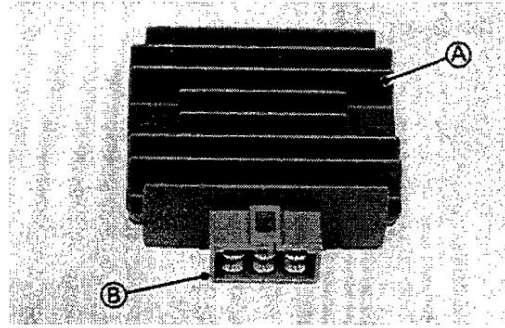
○ This voltage regulator is an open type.

A. Regulator

B. 6P Connector

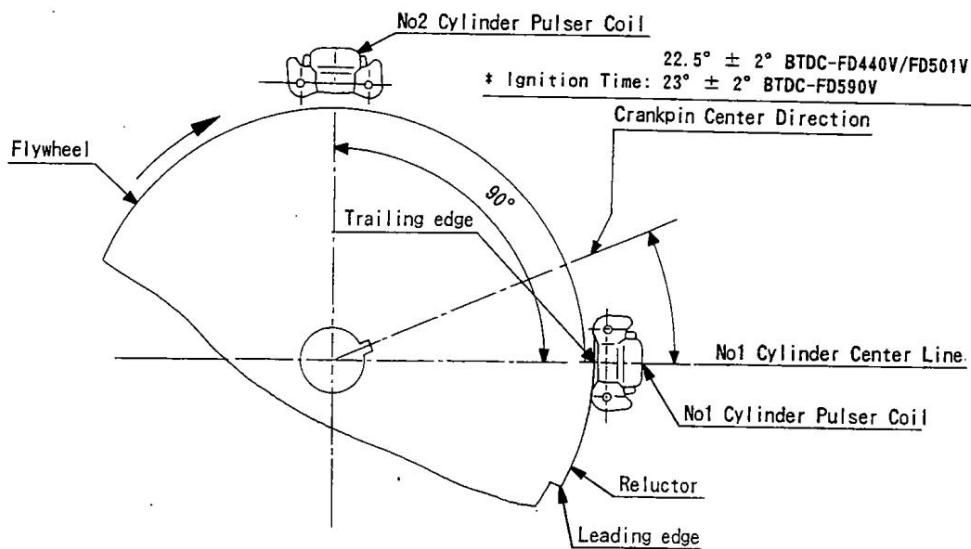
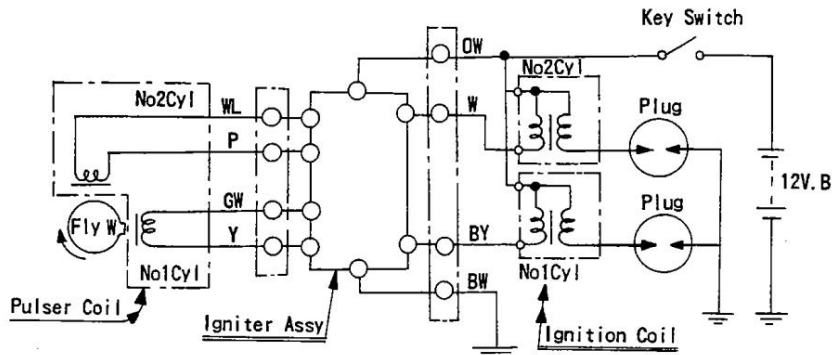
#### NOTE

○ Resistance value may vary with individual meters.



| (C)<br>(-) | (+)                            | (A)                           | -                                | ~                             | ~                             | (B)                         |
|------------|--------------------------------|-------------------------------|----------------------------------|-------------------------------|-------------------------------|-----------------------------|
| +          |                                | $\infty$                      | $\infty$                         | $\infty$                      | $\infty$                      | $\infty$                    |
| (A)        | 4k $\Omega$ ~<br>20k $\Omega$  |                               | 200 $\Omega$<br>~ 1 k $\Omega$   | 1k $\Omega$ ~<br>5k $\Omega$  | 1k $\Omega$ ~<br>5k $\Omega$  | 200k $\Omega$<br>~ $\infty$ |
| -          | 3k $\Omega$ ~<br>15k $\Omega$  | 200 $\Omega$<br>~ 1k $\Omega$ |                                  | 1k $\Omega$ ~<br>5k $\Omega$  | 1k $\Omega$ ~<br>5k $\Omega$  | 200k $\Omega$<br>~ $\infty$ |
| ~          | 1k $\Omega$ ~<br>5k $\Omega$   | $\infty$                      | $\infty$                         |                               | $\infty$                      | $\infty$                    |
| ~          | 1k $\Omega$ ~<br>5k $\Omega$   | $\infty$                      | $\infty$                         | $\infty$                      |                               | $\infty$                    |
| (B)        | 10k $\Omega$ ~<br>50k $\Omega$ | 1k $\Omega$ ~<br>5k $\Omega$  | 1.5k $\Omega$ ~<br>7.5k $\Omega$ | 4k $\Omega$ ~<br>20k $\Omega$ | 4k $\Omega$ ~<br>20k $\Omega$ |                             |

## Ignition System



Transistor controlled battery ignition system is used in this engine. The ignition system is a transistor-controlled battery-ignition and controls the current for the primary circuit by use of a electronic switching unit integrated into the igniter. The switching unit is triggered by the pulser coils (pick up coils) on each cylinder and contains no mechanical parts. This system consists of the following components.

- Ignition coil units
- Igniter (ignition Control Unit)
- Pulser coils (pick up coils)
- 12 V Battery
- Spark plugs

As the starter turns the flywheel, the reluctor in the flywheel runs past the pulser coils, this creates a magnetic field in the pulser coils and close the switching unit in the igniter and allow the current flow through the primary circuit in the ignition coils.

As the flywheel turns, the trailing reluctor passes under pulser coils, opening switching unit in the igniter and causing the primary coil current to stop suddenly. This creates an induced high voltage in a secondary coil windings, which fire the spark plugs.

Each spark plug fires every time the piston rises. When a spark does jump across the electrodes during the exhaust stroke, it will not affect engine operation, since there is no compression and no combustible fuel/air mixture. The transistor controlled ignition system contains no mechanical parts, no wear occurs and no periodic maintenance is required except for the spark plug.

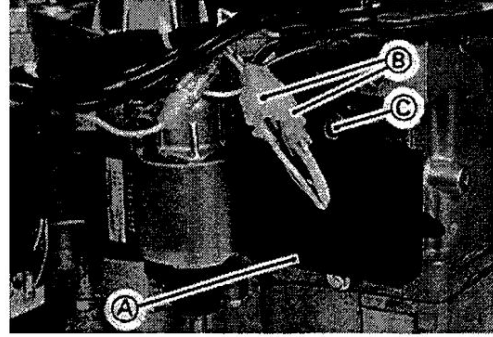




**Igniter Inspection**

- Remove the igniter.
- Unfasten the igniter lead connectors.
- Unscrew the mounting screws and remove the igniter.

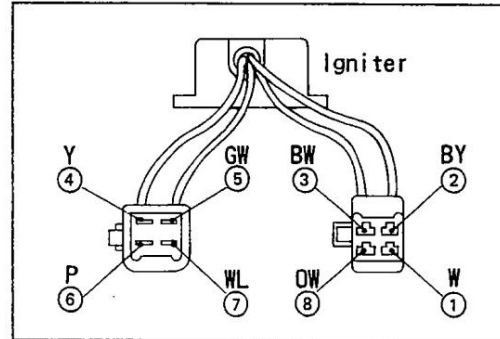
- A. Igniter
- B. Lead Connectors (4P Couplers)
- C. Mounting Screws



- To inspect the igniter resistance, perform the following.
- Set the hand tester to the  $R \times 1 \text{ k}\Omega$  position.
- Connect the test leads to the points shown on the chart and drawing and read the resistance.
- ★ If the meter readings are not as specified, replace the igniter.

**CAUTION**

Use only Kawasaki hand tester (special tool: 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 igniter will be damaged.



| k $\Omega$ | Terminal | Tester (+) Terminal (Red) |          |                 |        |         |        |         |         |
|------------|----------|---------------------------|----------|-----------------|--------|---------|--------|---------|---------|
|            |          | 1                         | 2        | 3               | 4      | 5       | 6      | 7       | 8       |
| (-)*       | 1        | -                         | $\infty$ | 1 ~ 8k $\Omega$ | 4 ~ 16 | 2 ~ 8   | 4 ~ 16 | 2 ~ 8   | 2 ~ 10  |
|            | 2        | $\infty$                  | -        | 1 ~ 8           | 4 ~ 16 | 2 ~ 8   | 4 ~ 16 | 2 ~ 8   | 2 ~ 10  |
|            | 3        | $\infty$                  | $\infty$ | -               | 1 ~ 6  | 0       | 1 ~ 6  | 0       | 0.5 ~ 2 |
|            | 4        | $\infty$                  | $\infty$ | 1 ~ 6           | -      | 0       | 3 ~ 12 | 1 ~ 6   | 2 ~ 8   |
|            | 5        | $\infty$                  | $\infty$ | 0               | 1 ~ 6  | -       | 1 ~ 6  | 0       | 0.5 ~ 2 |
|            | 6        | $\infty$                  | $\infty$ | 1 ~ 6           | 3 ~ 15 | 0.5 ~ 2 | -      | 1 ~ 6   | 1 ~ 6   |
|            | 7        | $\infty$                  | $\infty$ | 0               | 1 ~ 6  | 2 ~ 8   | 1 ~ 6  | -       | 0.5 ~ 2 |
|            | 8        | $\infty$                  | $\infty$ | 0.5 ~ 2         | 2 ~ 8  | 0.5 ~ 2 | 2 ~ 8  | 0.5 ~ 2 | -       |

(-)\*: Tester (-) Terminal (Black)

○ Resistance value may vary with individual meters.

| Wire Color |              |
|------------|--------------|
| W:         | White        |
| BY:        | Black/yellow |
| BW:        | Black/White  |
| Y:         | Yellow       |
| GW:        | Green/White  |
| P:         | Pink         |
| WL:        | White/Blue   |
| OW:        | Orange/White |

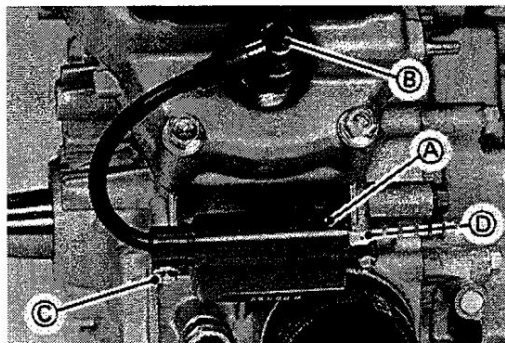


## 7-16 ELECTRICAL SYSTEM

### Ignition Coil Inspection

- Remove the ignition coils.
- Disconnect the plug caps.
- Disconnect the primary coil lead terminals.
- Unscrew the mounting bolts and take off the ignition coils.

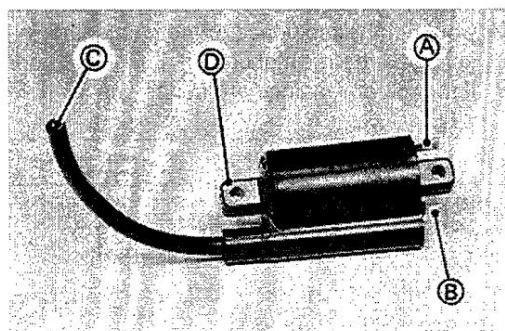
- A. Ignition Coils
  - B. Plug Caps
  - C. Mounting Bolts
  - D. Primary Coil Lead Terminals
- (Not Cylinder's Ignition Coil Shown)



- Unfasten the plug cap from the high tension lead.
- Set the hand tester to the specified range.
- Connect the test leads to the points shown on the chart and drawing and read the resistance. If the meter reading falls within the values shown in the chart, the coil is functioning properly.

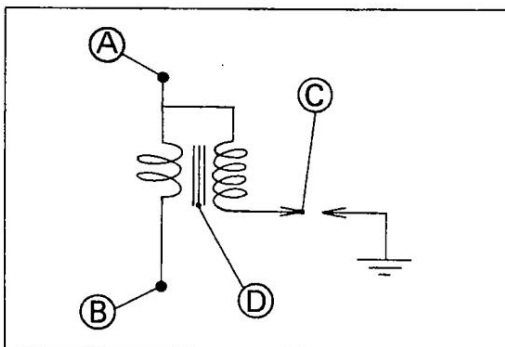
| Resistance Between  |                                  |
|---|----------------------------------|
| [A] and [B]   | [A] and [C]                      |
| 3.4 $\Omega$ to 4.6 $\Omega$  | 10.4 $\Omega$ to 15.6 k $\Omega$ |
| $\leftarrow$ ----- R x 1 $\Omega$ ----- $\rightarrow$ $\leftarrow$ ----- R x 1 k $\Omega$ ----- $\rightarrow$ |                                  |

- Resistance value may vary with individual meters.



| Resistance Between                                      |             |
|---|-------------|
| [A (or[B]) and [D]                                      | [C] and [D] |
| $\infty$  | $\infty$    |
| $\leftarrow$ ----- R x 1 k $\Omega$ ----- $\rightarrow$ |             |

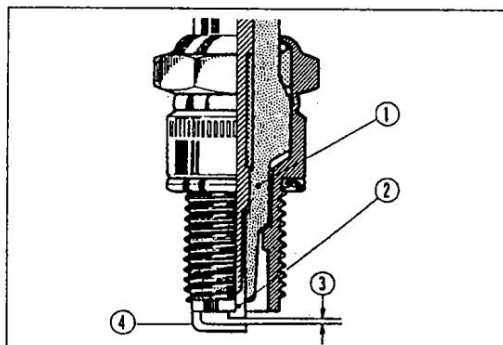
- ★ If the meter does not read as specified, replace the coil.
- ★ If the meter reads as specified, the ignition coil windings are probably good. However, if the ignition system still does not perform as it should after all other components have been checked, replace the coil with one known to be good.
- Check the spark plug lead for visible damage.
- ★ If the spark plug lead is damaged, replace the coil.



### Spark Plug 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 tool.
- ★ If the spark plug electrodes are corroded or damaged, or if the insulator is cracked replace the plug. Use the standard spark plug or its equivalent.

- 1. Insulator
- 2. Center Electrode
- 3. Plug Gap
- 4. Side Electrode





***Spark Plug Gap Inspection***

- Measure the gap with a wire-type thickness gauge.
- ★ If the gap is incorrect, carefully bend the side electrode with a suitable tool to obtain the correct gap.

**Spark Plug Gap**

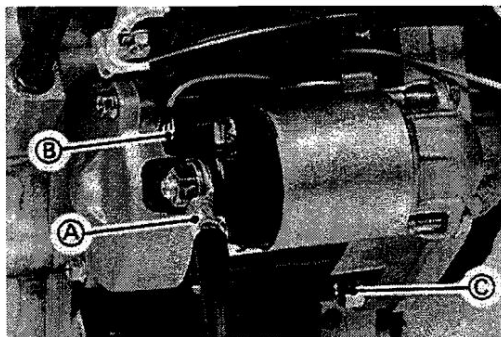
**Standard:      0.6 to 0.7 mm (0.024 to 0.028 in)**

## 7-18 ELECTRICAL SYSTEM

### Electric Starter System

#### Starter Motor Removal

- Disconnect the wires shown (A).
- Remove the mounting bolts (C) and pull the starter motor from the engine with the switch lead (B) attached.



#### Starter Motor Installation

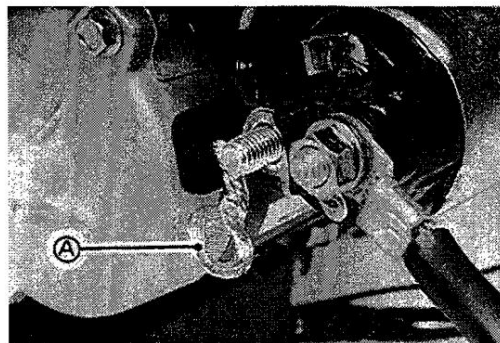
- Clean the starter motor and engine mounting flanges to ensure good electrical contact and tighten the mounting bolts to the specified torque (see Exploded View).

#### Starter Solenoid and Circuit Test

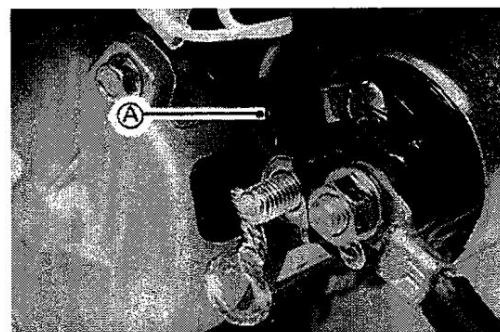
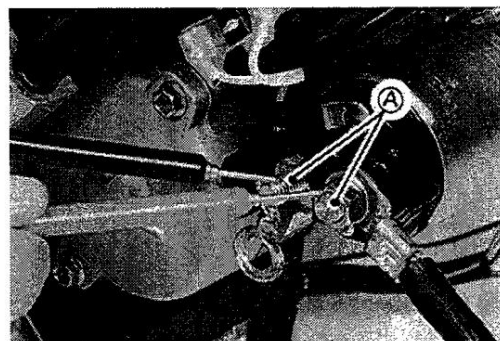
##### NOTE

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

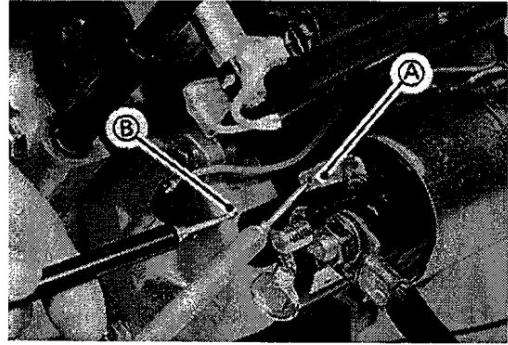
- Disconnect the starter motor lead (A) from the solenoid terminal as shown and keep the lead away from the solenoid terminal.



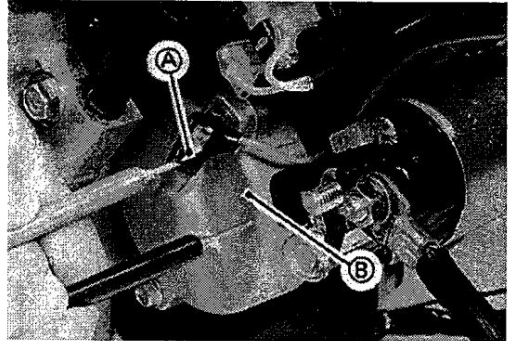
- Measure the continuity of the solenoid when activated.
- Set the hand tester to the  $R \times 1 \Omega$  position and connect the leads across the large terminals (A) as shown.
- Turn the engine switch to the START (II) position and read the meter.
- ★ If the solenoid does not click or if the meter reads more than  $0 \Omega$  the solenoid is faulty. Replace it.
- ★ If the solenoid makes a single clicking sound, the meter reads  $0 \Omega$  and the pinion gear moves outward the solenoid and the rest of the starter circuit is good.
- ★ If solenoid clicks once but the meter does not read  $0 \Omega$ , the solenoid is faulty. Replace it.
- ★ If the solenoid does not click at all, proceed with the following.
- Disconnect the switch lead (A) shown.



- Set the hand tester to the  $R \times 1 \Omega$  position and connect the leads as shown.
- ★ If the meter does not read close to  $0 \Omega$ , the solenoid is faulty. Replace it.
- ★ If the meter reads close to  $0 \Omega$ , the solenoid may be good. Check the voltage to the solenoid from the engine switch.
  - A, Switch Terminal
  - B, To Ground



- Set the hand tester to the 25 VDC position and connect it as shown.
- Turn the engine switch to the START (II) position and read the meter.
- ★ If the meter reads battery voltage, the circuit is good. If the solenoid would not click in the previous test, it is faulty. Replace it.
- ★ If the meter reads much less than battery voltage or no voltage at all, either the wiring or the engine switch is bad. Check the engine switch or the wiring for damaged or broken wires and replace as required.
  - A, Switch Lead Connector
  - B, To Ground

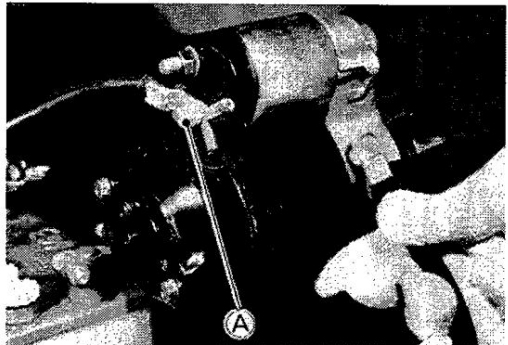


### Starter Motor Test

#### CAUTION

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

- Remove the starter motor.
- Hold the starter motor with a vice as shown.
- Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal (A) on the solenoid.
- Connect the second jumper cable to the battery (-) terminal.
- Touch the starter body with the other end of the second jumper cable intermittently for one second intervals.
- The pinion should rotate freely.
- ★ If the pinion does not rotate freely, replace the starter motor.



### No-Load Starter Draw Bench Test

Needed for the test are;

- A tachometer capable of reading 15 000 r/min (rpm.)
- 12 V, 32 AH battery or more.
- An ammeter capable of reading 100 A.

#### ⚠ WARNING

Battery electrolyte is poisonous and corrosive. It is injurious to eyes, skin and clothing. Handle it carefully. If electrolyte is spilled, flush immediately with a solution of one part baking soda to four parts water.



## 7-20 ELECTRICAL SYSTEM

- Connect the starter motor, battery and ammeter as shown.

### NOTE

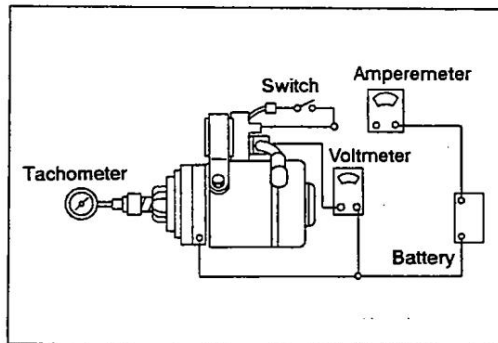
○ Starter motor should not be loaded. The test should be quickly conducted, as the rating is 30 seconds.

- Active the starter motor. The starter motor in good condition will be within following specifications.

|                   |             |
|-------------------|-------------|
| Terminal Voltage  | 11.5 V      |
| Starter Motor RPM | 6 000 (MIN) |
| Current Draw (A)  | 50 (MAX)    |

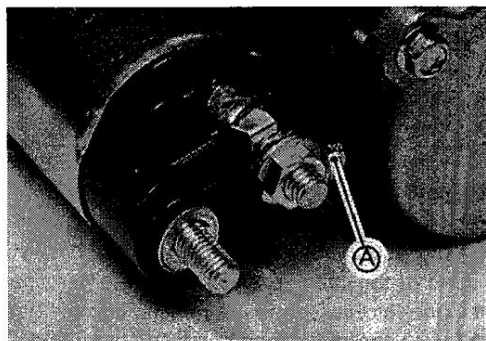
- ★ If not, check for the following and correct if necessary.

- A binding or seizing condition in the starter motor bearings.
- Starter Motor brushes sticking in the brush holders.
- A dirty or worn armature commutator or brushes.
- A shorted, open, or grounded armature or field coil.
- A defective starter motor switch.

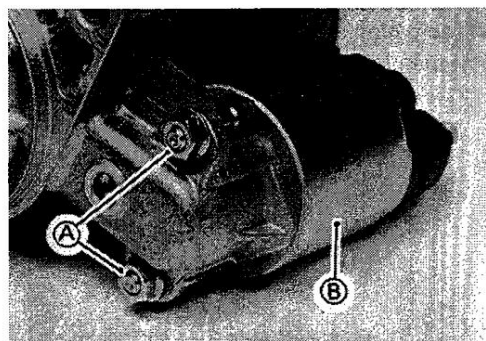


### Starter Motor Disassembly

- Pull back the rubber boot and remove the lead (A) from the starter motor to the solenoid.



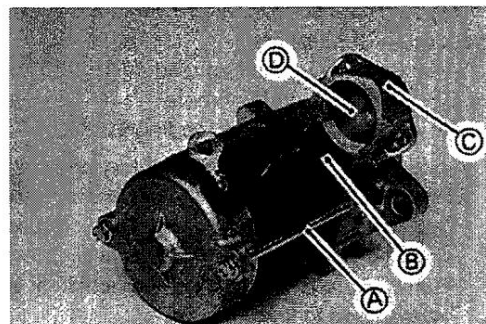
- Unscrew the mounting nuts (A) and remove the solenoid assembly (B).



- Pull the rubber insert from the starter motor and remove the pinion gear cover as shown.

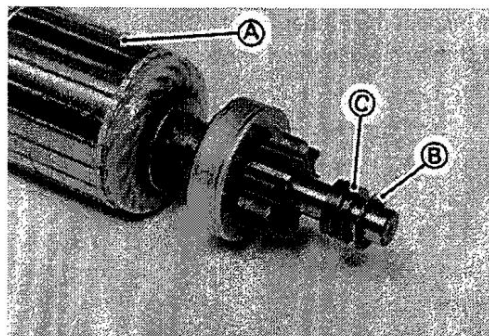
- Slip the actuating arm from the pinion gear.

- |                  |                      |
|------------------|----------------------|
| A. Through Bolts | C. Pinion Gear Cover |
| B. Rubber Insert | D. Actuating Arm     |



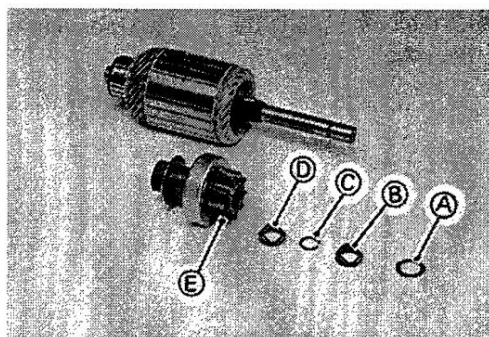
- Pull the armature from the yoke.

A. Armature  
B. Thrust Washer  
C. Front Stopper

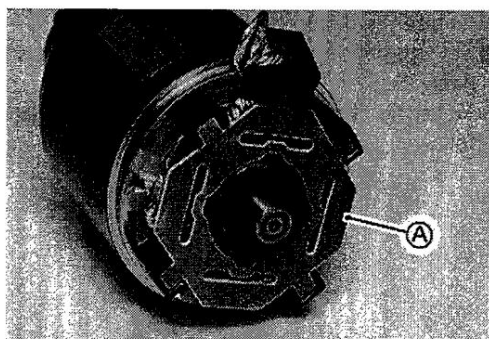


- Slide the thrust washer from the front of the shaft.
- Separate the front and rear stoppers each other using a screw driver and remove the front stopper.
- Push the rear stopper down the shaft and remove the snap ring.
- Slide the stopper and pinion gear from the armature shaft.

A. Thrust Washer  
B. Front Stopper  
C. Snap Ring  
D. Rear Stopper  
E. Pinion Gear

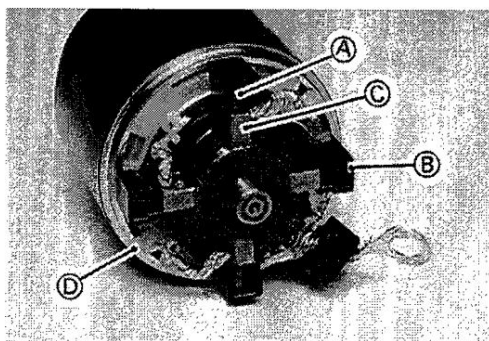


- Gently pull the end cover from the yoke and remove the insulator (A).



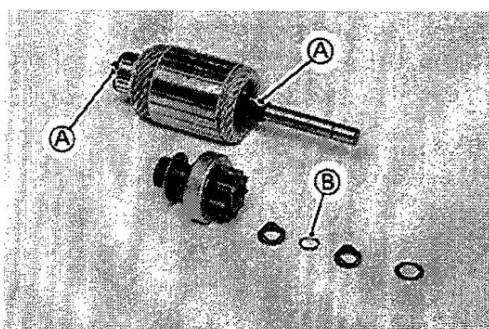
- Using a needle nose pliers, remove the brush springs from the brush holder.
- Separate the brushes from the holder and remove the holder from the yoke.

A. Brush Spring  
B. Brush Holder  
C. Brush  
D. Yoke



### Starter Motor Assembly Notes

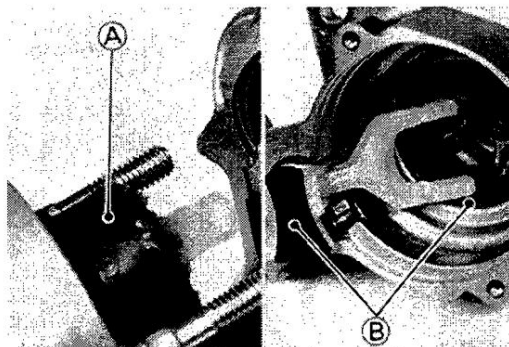
- Apply a small amount of grease to the armature shaft (A) as shown.
- Do not reuse the snap ring (B). Replace it with a new one.



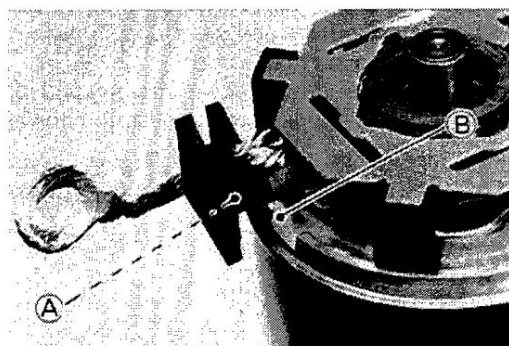


## 7-22 ELECTRICAL SYSTEM

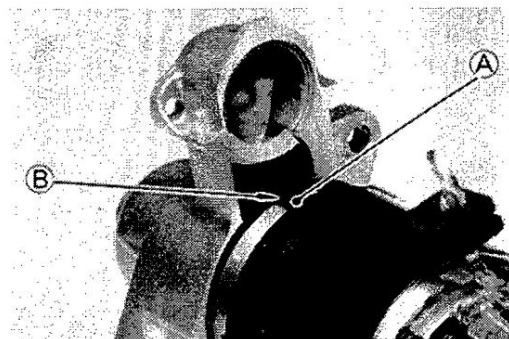
- Inspect the rubber insert (B) and/or boot (A) for visible damage.
- ★ If they are damaged, replace them.



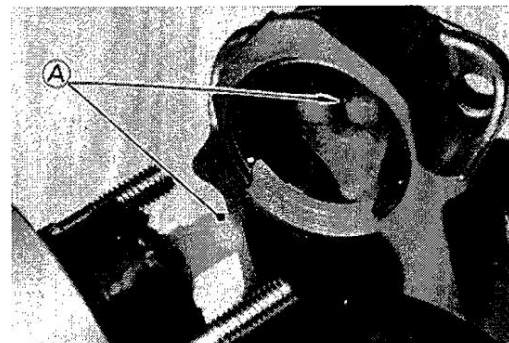
- Fit the notch (A) in the (-) lead grommet onto the projection (B) on the yoke.



- Grease the pinion gear fork fingers.
- Set the pinion gear fork so that the fingers fit into the groove in the gear.
- Fit the notch (A) in the yoke onto the projection (B) on the pinion gear fork.



- Engage the hook (A) on the starter solenoid with the hook (A) on the pinion gear fork.

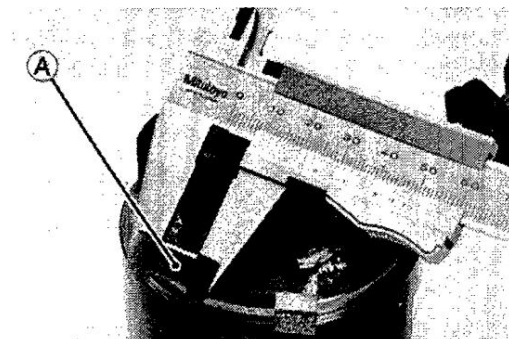


### *Starter Motor Brush Inspection*

- Measure the overall length of each brush (A).
- ★ If the brushes are shorter than the service limit, replace them.

#### **Brush Length**

**Service Limit: 6.0 mm (0.24 in)**



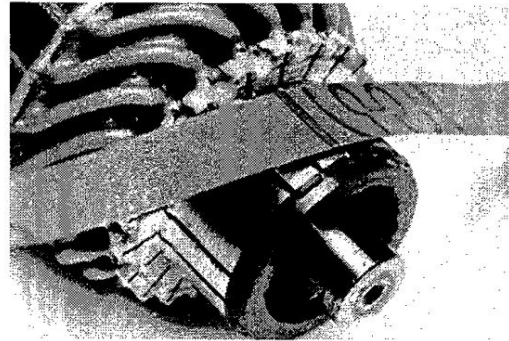


**Brush Spring Inspection**

- Inspect the brush springs for pitting, cracks, rusting and burrs. Replace the spring if necessary.
- Inspect the springs for weakened conditions and distortion. Replace the springs if necessary.
- ★ If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them.

**Armature Inspection**

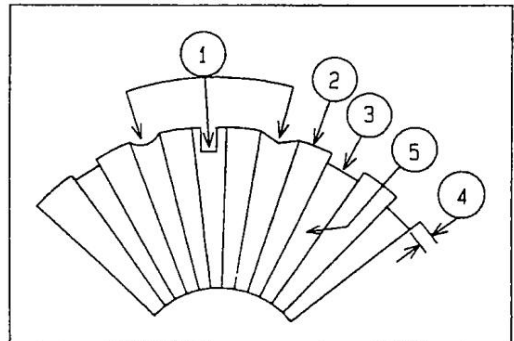
- Inspect the surface of the commutator.
- ★ If it is scratched or dirty, polish it with a piece of very fine emery cloth, and clean out the grooves.



- Measure the depth of the grooves between the commutator segments.
- ★ If the grooves are shallower than the specified limit, undercut the insulating material to the standard depth 0.5 to 0.8 mm (0.012 to 0.031 in) using a thin file.
- ★ If the grooves are only dirty, clean them carefully.

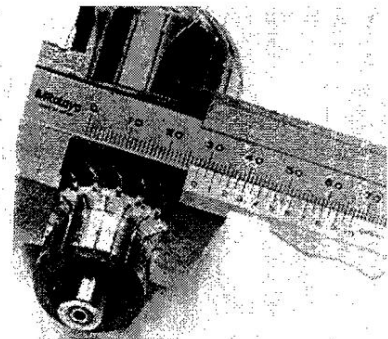
**Commutator Groove Depth Limit**  
**Less than 0.2 mm (0.008 in)**

- |            |                            |
|------------|----------------------------|
| 1. Bad     | 4. 0.2 mm (0.008 in) limit |
| 2. Segment | 5. Mica                    |
| 3. Good    |                            |



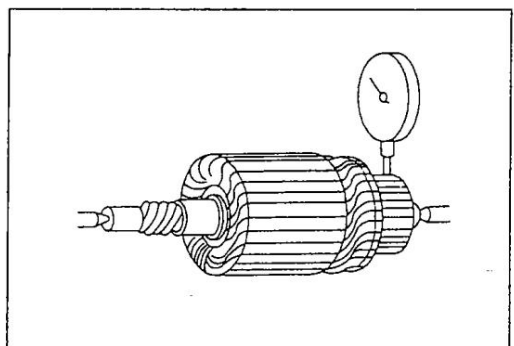
- Measure the commutator outside diameter at several points.
- ★ If the diameter is less than the service limit, replace the armature with a new one.

**Commutator Outside Diameter**  
**Service Limit: 27 mm (1.06 in)**



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

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

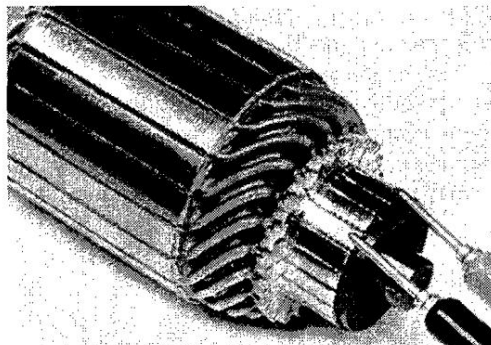


## 7-24 ELECTRICAL SYSTEM

- Measure the armature winding resistance.
- Set the hand tester to the  $R \times 1 \Omega$  position and check the resistance between each segment and all the others.
- ★ If the resistance is too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

### Armature Winding Resistance

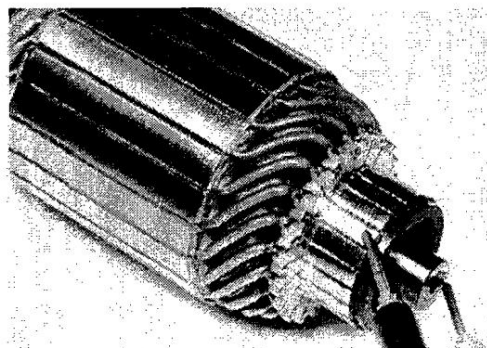
Close to  $0 \Omega$



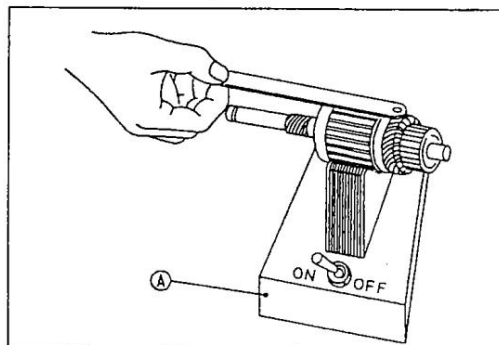
- Set the hand tester to the  $R \times 1 k\Omega$  position and measure the resistance between the commutator and the armature shaft.
- ★ If the resistance is less than infinite, the armature is shorted.

### Commutator to Shaft Resistance

( $\infty$ )



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

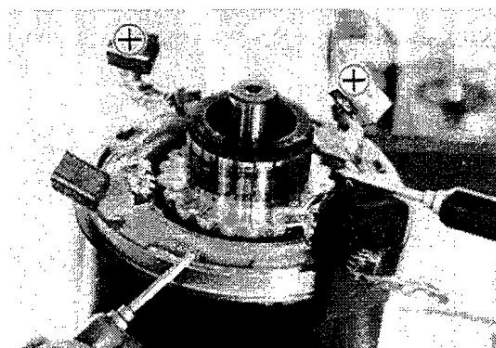


### Yoke Assembly Inspection

- Set the hand tester to the  $R \times 1 k\Omega$  position and measure the resistance between the positive brush(es) and the stator motor yoke.
- ★ If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

### Positive Brush to Ground Resistance

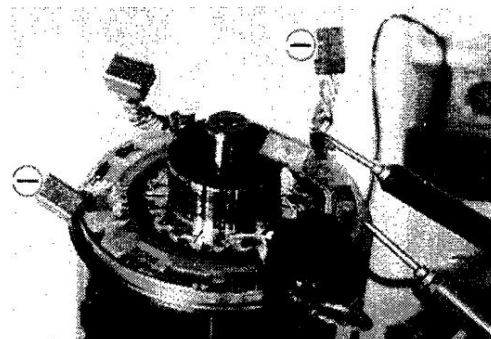
( $\infty$ )



- Set the hand tester to the  $R \times 1 \Omega$  position and measure the resistance between the negative brush(es) and the starter motor yoke.
- ★ If the meter does not read close to  $0 \Omega$ , the yoke assembly is faulty. Replace it.

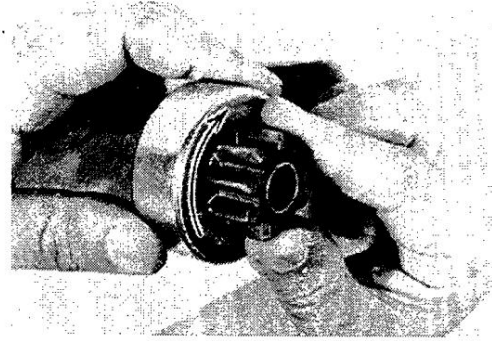
### Negative Brush to Ground Resistance

Close to  $0 \Omega$



*Pinion Clutch Inspection*

- Remove the pinion clutch.
- Turn the pinion gear by hand. The pinion gear should turn counter-clockwise freely, but should not turn clockwise (→).
- ★ If the pinion clutch does not operate as it should, or if it makes noise, replace the pinion clutch.



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# Troubleshooting

## Table of Contents

|   |     |
|---|-----|
| Engine Troubleshooting Guide .....        | 8-2 |
| Starter Motor Troubleshooting Guide ..... | 8-7 |



## 8-2 TROUBLESHOOTING

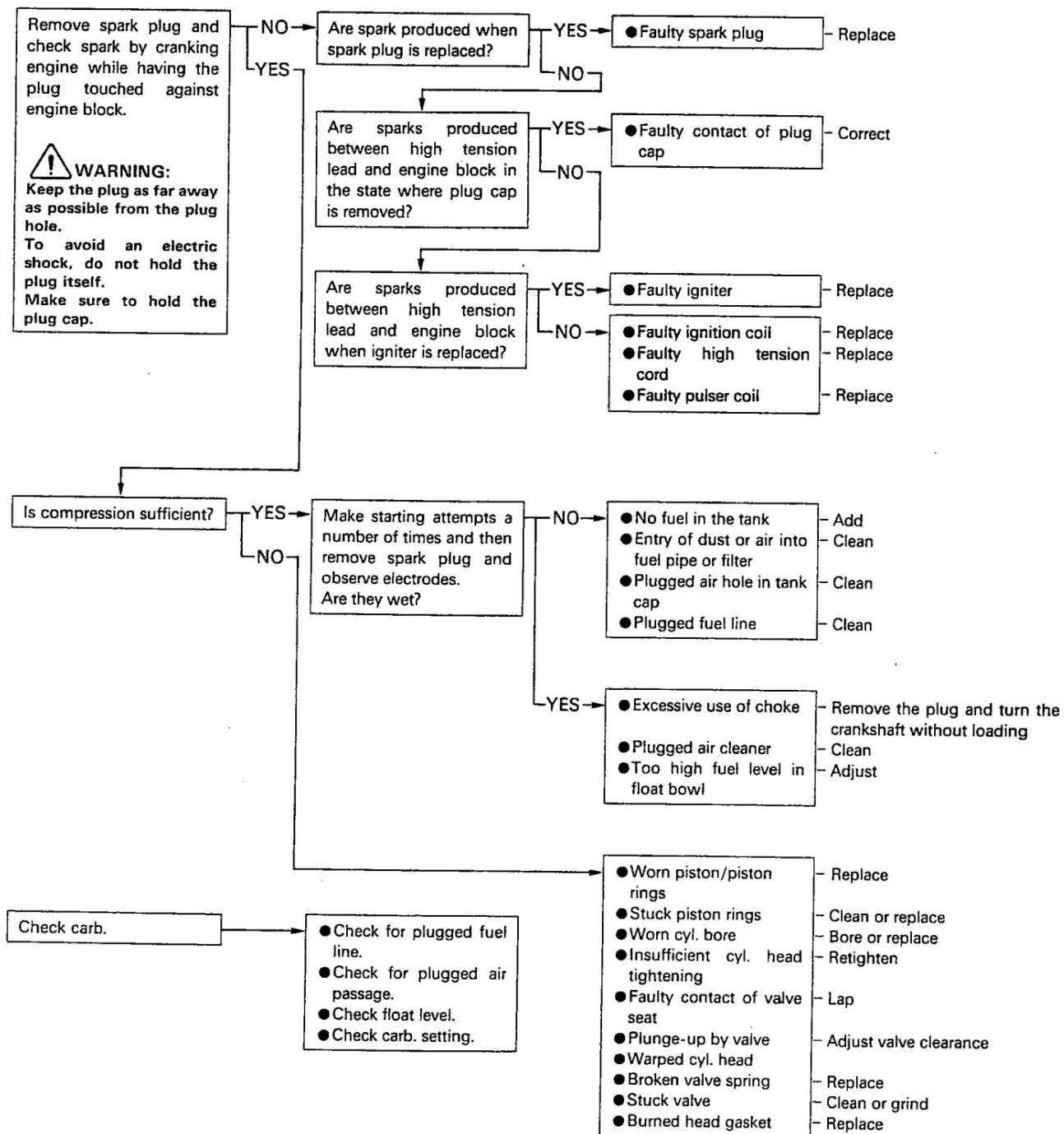
### Engine Troubleshooting Guide

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

This chart describes typical troubleshooting procedures.

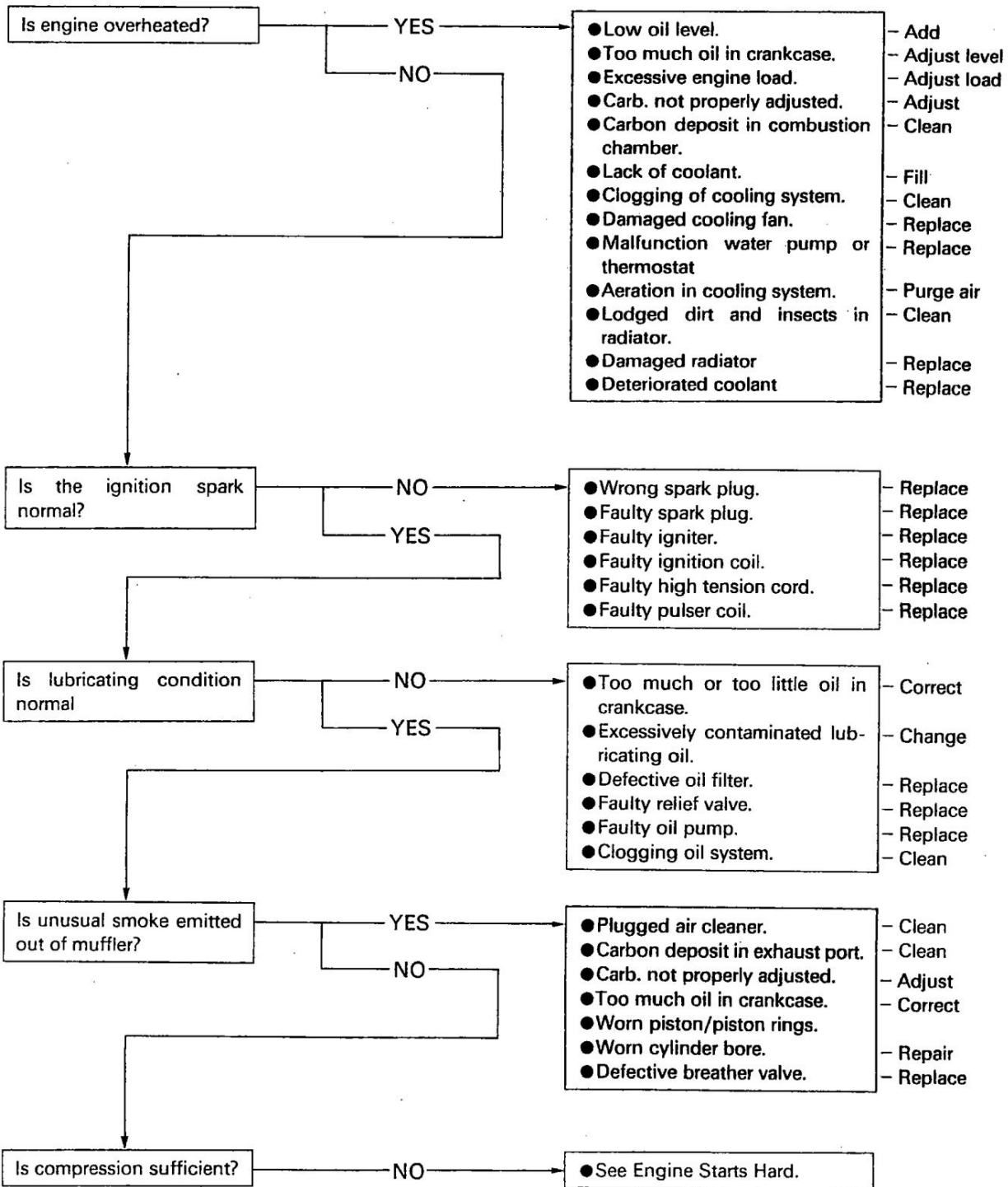
Do not unnecessarily disassemble carburetor, magneto or engine unless it has been found to be the cause of malfunctioning.

#### [Engine hard to start]

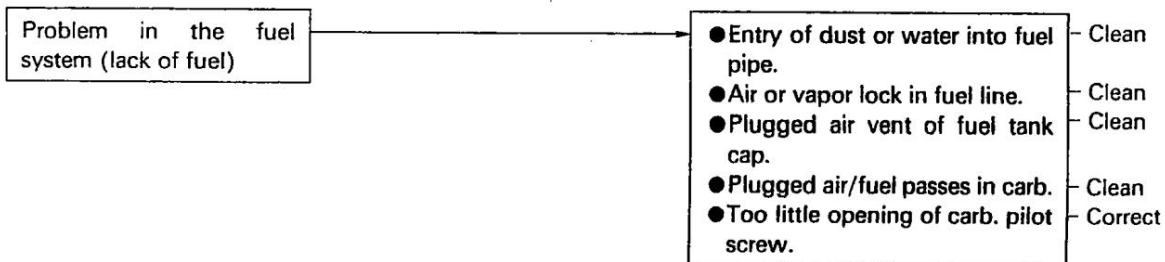




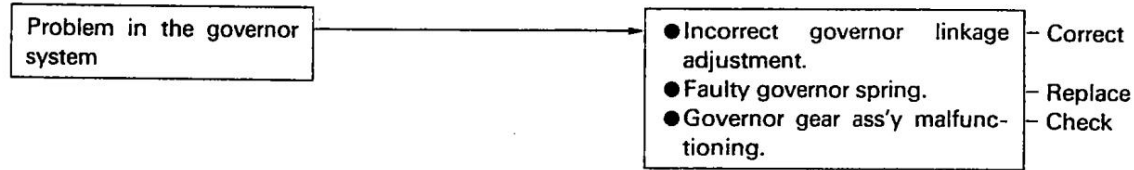
**[Engine loss power]**



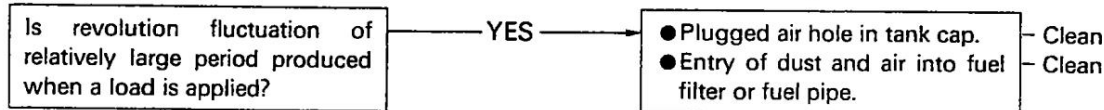
**[Engine runs erratically]**



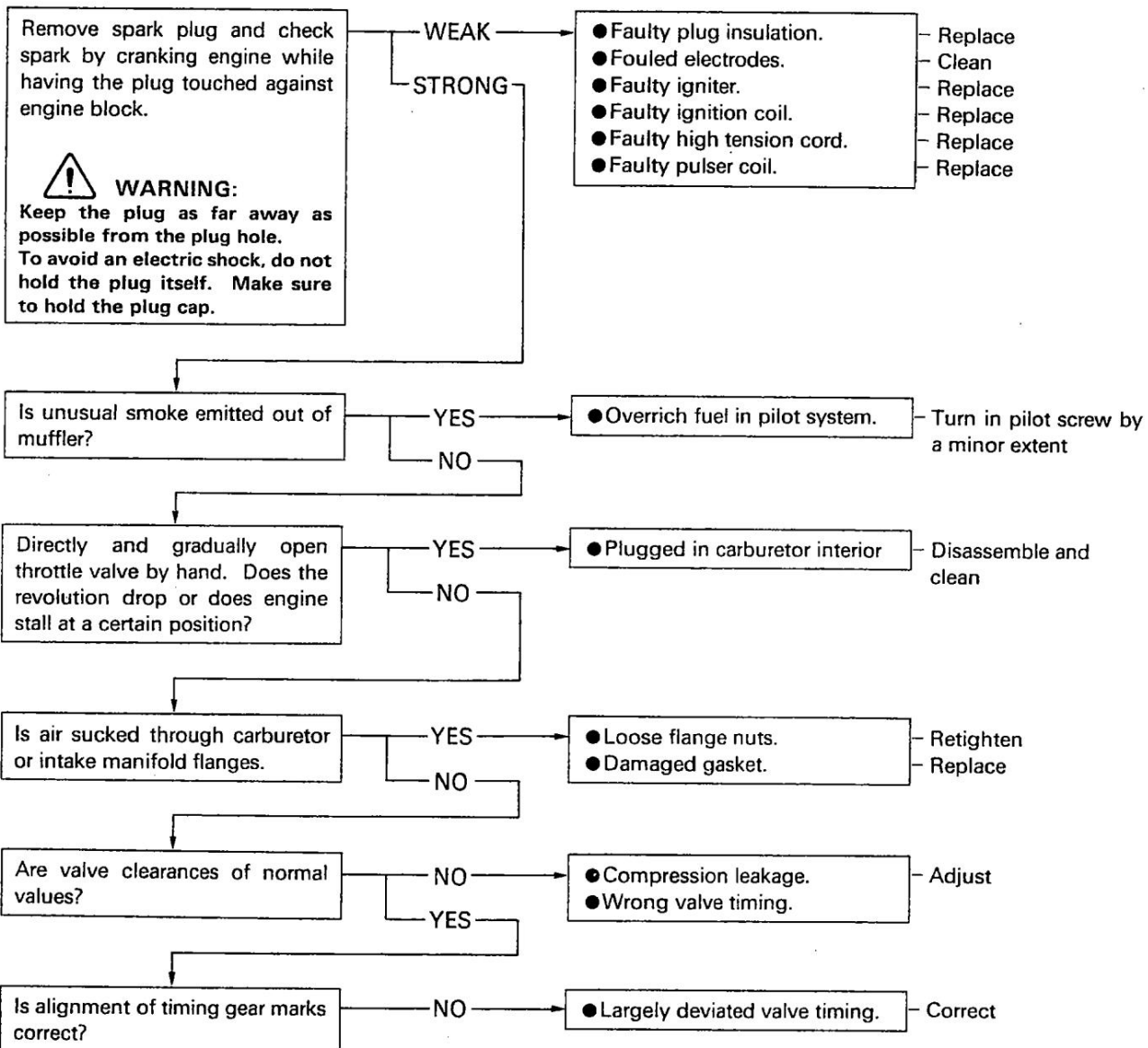
## 8-4 TROUBLESHOOTING



### [Engine malfunctions at high speed]



### [Engine malfunctions at low speed]



## [Fuel consumption is excessive]

Is compression sufficient?

YES

NO

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

Adjust  
Replace  
Adjust  
Open  
Adjust

- Worn piston/piston rings.
- Stuck piston.
- Worn cylinder bore.
- Insufficient cyl. 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 grind

## [Oil consumption is excessive]

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.
- Drain-back hole in breather chamber plugged.
- Incorrect oil viscosity.

Clean  
Adjust  
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 runs erratically]

- Dirt or water in fuel line.
- Carb. not properly adjusted.
- Spark plug fouled, pitted, or gapped incorrectly.
- Carb. flange leaking at gasket.
- Carb. body and throttle shaft worn.
- Restricted gas tank vent.
- Governor malfunctioning.

Clean  
Adjust  
Replace or adjust  
Tighten or replace  
Replace  
Clean  
Adjust

## [Engine backfires]

- Loose carb. or intake manifold.
- Loose cyl. head or leaking head gasket.
- Burned or sticking intake valve.
- Faulty puser coil.
- Carb. not properly adjusted.

Tighten  
Tighten  
Replace  
Replace  
Adjust

## [Engine knocks]

- Stale fuel.
- Excessive carbon deposit in engine.
- Excessive engine load.
- Engine overheating.
- Faulty igniter.

Change  
Clean  
Adjust  
See engine loss power  
Replace



## 8-6 TROUBLESHOOTING

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[Coolant leakage]

|                                   |                         |
|-----------------------------------|-------------------------|
| ● Deteriorated radiator hose.     | - Replace               |
| ● Mechanical failure of radiator. | - Repair or Replace     |
| ● Loose cylinder head.            | - Tighten               |
| ● Cracked or porous casting.      | - Replace               |
| ● Loose stud bolts and cap screw. | - Repair                |
| ● Engine overheating.             | - See engine loss power |
| ● Damaged water pump sealings.    | - Replace               |
| ● Improperly installed gasket.    | - Correct or Replace    |
| ● Multifunction radiator cap.     | - Replace               |

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## Starter Motor Troubleshooting Guide

1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn engine switch to "START" position and check condition.

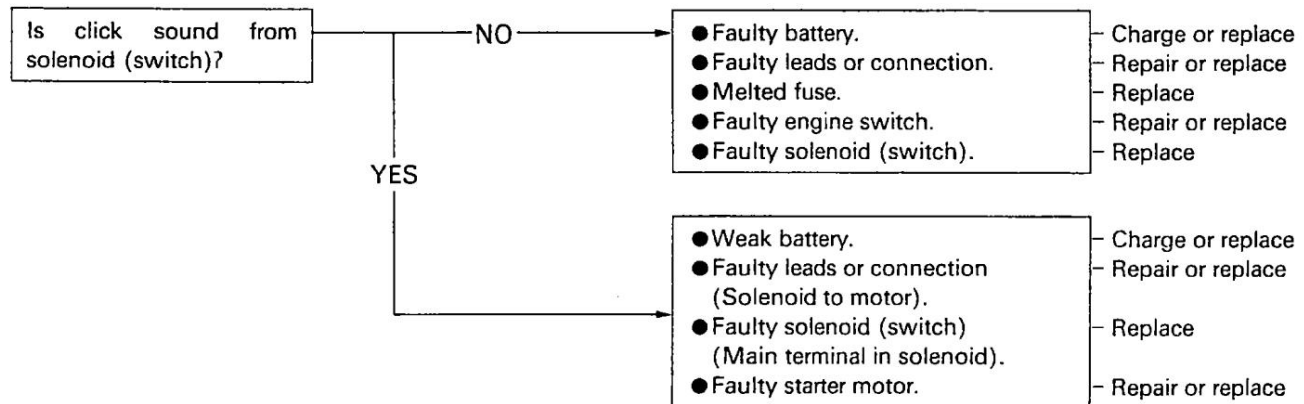
### ⚠ WARNING

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

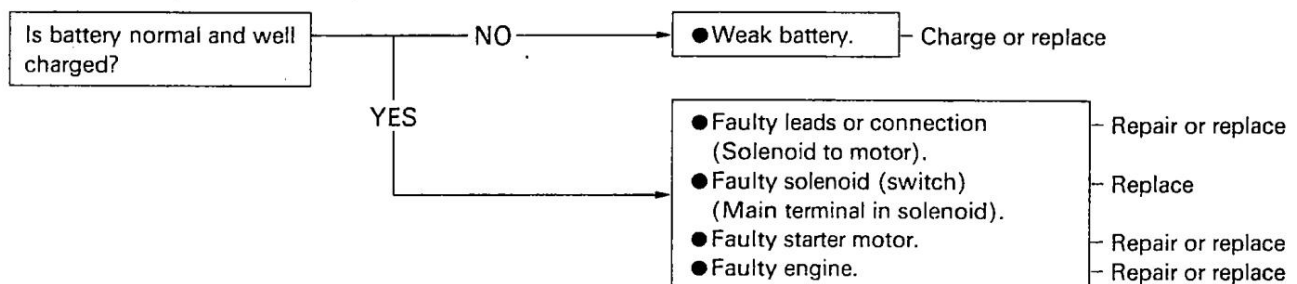
### CAUTION

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

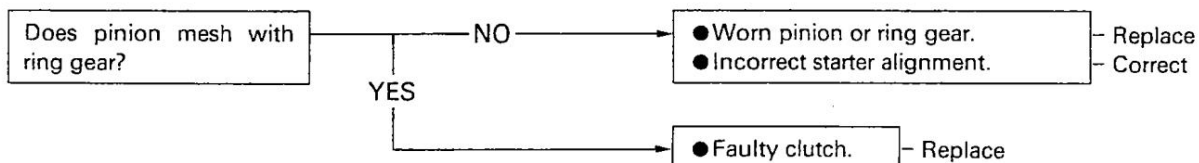
#### [STARTER DOES NOT ROTATE]



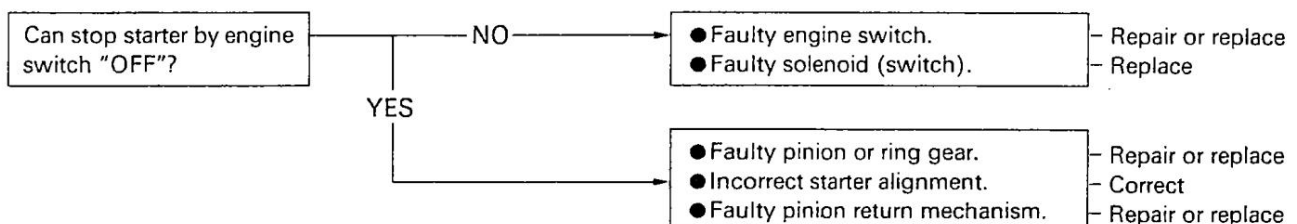
#### [STARTER ROTATES BUT SLOW]



#### [STARTER ROTATES BUT CAN NOT CRANK ENGINE]



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



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| 93  | 93  |
| 94  | 94  |
| 95  | 95  |
| 96  | 96  |
| 97  | 97  |
| 98  | 98  |
| 99  | 99  |
| 100 | 100 |



# Supplement – FD440V ~ FD611V

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## 9-2 SUPPLEMENT – FD440V ~ FD611V

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### Foreword

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#### How to Use this Manual

This "Supplement FD440V ~ FD611V Models" designed to be used in conjunction with the front part of this manual (up to P8-7). The specifications and maintenance procedures described in this chapter are only those that are unique to the FD440V/FD501V/FD590V/FD611V models.

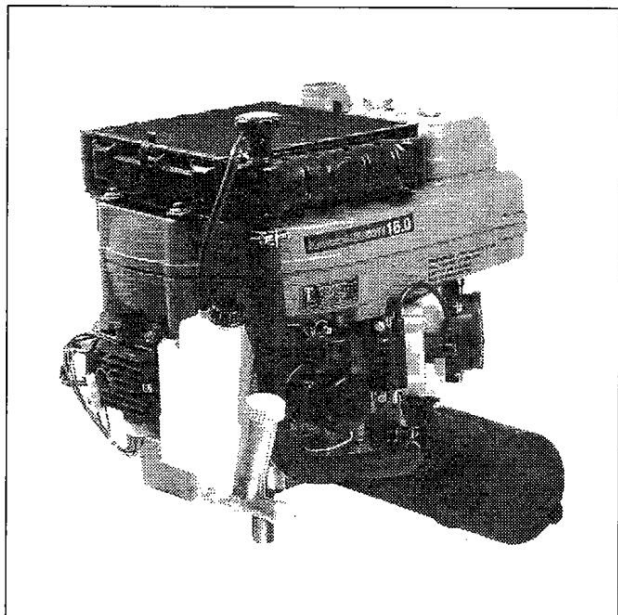
Complete and proper servicing of the FD440V/FD501V/FD590V/FD611V models therefore requires mechanics to read both this chapter and the front of this manual.

## General Information

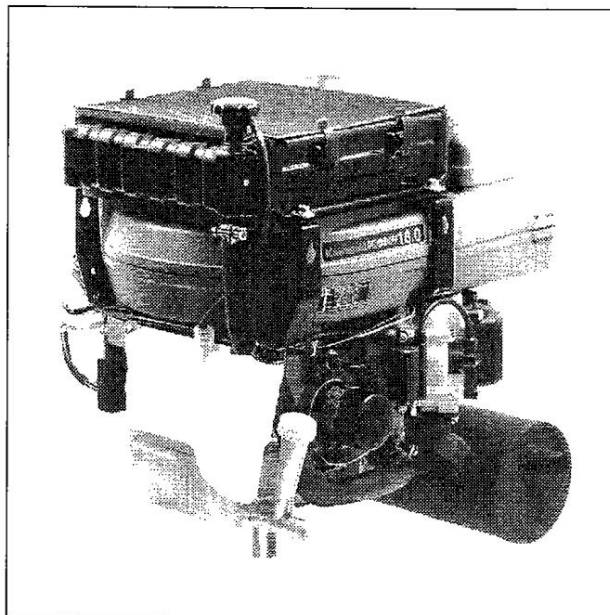
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### Model Identification

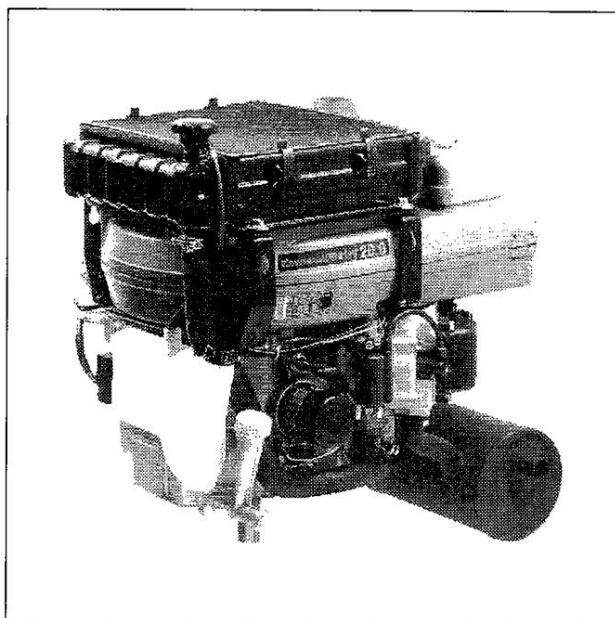
**FD501V Model**



**FD590V Model**



**FD611V Model**





**9-4 SUPPLEMENT – FD440V ~ FD611V****General Information***General Specifications*

| Items   | FD440V  | FD501V | FD590V   | FD611V |
|---|---|--------|--|--------|
| <b>Type of engine</b>                               | Liquid-cooled, Vertical shaft, OHV, 4-stroke, 90°V-twin, Gasoline engine. |        |  |        |
| <b>Bore × Stroke</b>                                | 67 × 62 mm (2.64 in. × 2.44 in.)  |        | 74 × 68 mm (2.90 × 2.66 in.)                   |        |
| <b>Piston displacement</b>                          | 437 mL (26.7 cu-in.)  |        | 585 mL (35.7 cu-in.)                           |        |
| <b>Direction of rotation</b>                        | Counterclockwise facing PTO shaft end                                     |        |  |        |
| <b>Low idle speed</b>                               | 1550 rpm  |        |  |        |
| <b>Fast idle speed</b>                              | 3600 rpm  |        |  |        |
| <b>Ignition system</b>                              | Battery, Full transistor, Fixed timing                                    |        |  |        |
| <b>RFI</b>  | Per Canada and U.S.A. requirements  |        |  |        |
| <b>Starting system</b>                              | Solenoid shift type electric starter                                      |        |  |        |
| <b>Charging system (with regulator)</b>             | 12 V - 15 A   |        | 12 V - 17 A                                    |        |
| <b>Carburetor</b>                                   | Horizontal draft type, Fixed main jet                                     |        |  |        |
| <b>Fuel pump</b>                                    | Mechanical Diaphragm Type   |        |  |        |
| <b>Air cleaner</b>                                  | Dual stage element  |        |  |        |
| <b>Governor</b>                                     | All speed mechanical fly weights  |        |  |        |
| <b>Lubrication system</b>                           | Pressure feed by positive displacement pump                               |        |  |        |
| <b>*Oil filter</b>                                  | Cartridge type full flow filter   |        |  |        |
| <b>*Oil pressure switch</b>                         | ON - OFF switch   |        |  |        |
| <b>Cooling system</b>                               | Pressurized forced circulation type                                       |        |  |        |
| <b>*Radiator</b>                                    | 3 - rows with louverless corrugated fin                                   |        |  |        |
| <b>Dimensions (L × W × H)<br/>(without Muffler)</b> | 485 × 358 × 440 mm<br>(19.1 × 14.1 × 17.3 in.)                            |        | 510 × 400 × 478 mm<br>(20.1 × 15.8 × 18.8 in.) |        |
| <b>Dry weight (with Muffler)</b>                    | 35.2 kg (77.6 lb)   |        | 43.1 kg (95.0 lb)                              |        |

\*Specifications are subject to change without notice.

## General Information

### 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.

### ⚠ WARNING

Always remove the spark plug cap from spark plug when servicing the engine to prevent accidental starting.

| MAINTENANCE  | INTERVAL |             |              |              |               |               |               |               |
|--|----------|-------------|--------------|--------------|---------------|---------------|---------------|---------------|
|  | Daily    | First 8 hr. | Every 25 hr. | Every 50 hr. | Every 100 hr. | Every 200 hr. | Every 300 hr. | Every 400 hr. |
| Check and add engine oil                                   | ●        |             |              |              |               |               |               |               |
| Check for loose or lost nuts and screws                    | ●        |             |              |              |               |               |               |               |
| Check for fuel and oil leakage                             | ●        |             |              |              |               |               |               |               |
| Check battery electrolyte level                            | ●        |             |              |              |               |               |               |               |
| Check or clean air intake screen                           | ●        |             |              |              |               |               |               |               |
| Tighten nuts and screws                                    |          |             | ●            |              |               |               |               |               |
| ★ Clean air cleaner foam element                           |          |             | ●            |              |               |               |               |               |
| ★ Clean air cleaner paper element                          |          |             |              |              | ●             |               |               |               |
| Clean fuel filter element                                  |          |             |              | ●            |               |               |               |               |
| Change engine oil (without oil filter)                     |          | ●           |              | ●            |               |               |               |               |
| Change engine oil (with oil filter)                        |          | ●           |              |              | ●             |               |               |               |
| Clean and regap spark plug                                 |          |             |              |              | ●             |               |               |               |
| Change oil filter  |          |             |              |              |               | ●             |               |               |
| ★ Replace air cleaner paper element                        |          |             |              |              |               |               | ●             |               |
| ★ Clean dust and dirt from cylinder and cylinder head fins |          |             |              |              |               |               | ●             |               |
| Clean combustion chamber                                   |          |             |              |              |               |               | ●             |               |
| Check and adjust valve clearance                           |          |             |              |              |               |               | ●             |               |
| Clean and lap valve seating surface                        |          |             |              |              |               |               | ●             |               |
| Inspect radiator and hoses                                 |          |             |              |              |               | ●             |               |               |
| Check fan belt conditions and tension                      |          |             |              |              |               | ●             |               |               |
| Change coolant   |          |             |              |              |               |               |               | ●             |

Note: The service intervals indicated are to be used as a guide. Service should be performed more frequently as necessary by operating condition.

★: Service more frequently under dusty conditions.

**9-6 SUPPLEMENT – FD440V ~ FD611V****General Information***Torque and Locking Agent*

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

Letters used in the "Remarks" column mean\*

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.

| Fastener                                     | Torque |      |               | Remarks |
|--|--------|------|---------------|---------|
|  | N-m    | kg-m | ft-lb / in-lb |         |
| <b>Fuel System:</b>                          |        |      |               |         |
| Carburetor Mounting Nuts                     | 17     | 1.7  | 12            |         |
| Governor Arm Nut                             | 7.8    | 0.8  | 69 in-lb      |         |
| Fuel Shut-Off Solenoid Valve (FD501V/FD590V) | 3.9    | 0.4  | 35 in-lb      |         |
| Intake Manifold                              | 7.8    | 0.8  | 69 in-lb      |         |
| <b>Cooling System:</b>                       |        |      |               |         |
| Cooling Fan Extension Bolts                  | 5.9    | 0.6  | 52 in-lb      |         |
| Water Pump Cover Bolts                       | 7.8    | 0.8  | 69 in-lb      |         |
| M6: (FD440V/FD501V)                          | 8.8    | 0.9  | 78 in-lb      |         |
| (FD590V/FD611V)                              | 9.8    | 1.0  | 87 in-lb      |         |
| M8: (FD440V/FD501V)                          | 22     | 2.2  | 16            |         |
| (FD590V/FD611V)                              | 25     | 2.6  | 19            |         |
| Thermo Switch                                | 27     | 2.8  | 20            | L       |
| <b>Engine Top End:</b>                       |        |      |               |         |
| Cylinder Head Bolts and Nuts                 | 21     | 2.1  | 15            | S       |
| Valve Clearance Adjust Nuts                  | 8.8    | 0.9  | 78 in-lb      |         |
| Spark Plugs                                  | 17     | 1.7  | 12            |         |
| <b>Lubrication System:</b>                   |        |      |               |         |
| Oil Drain Plug                               | 23     | 2.3  | 17            |         |
| Oil Pressure Switch                          | 9.8    | 1.0  | 87 in-lb      | L       |
| <b>Camshaft/Crankshaft:</b>                  |        |      |               |         |
| Case Cover to Block Bolts (FD440V/FD501V)    | 21     | 2.1  | 15            | S       |
| (FD590V/FD611V)                              | 25     | 2.6  | 19            | S       |
| Con-Rod Cap Bolts (FD440V/FD501V)            | 12     | 1.2  | 104 in-lb     | O       |
| (FD590V/FD611V)                              | 21     | 2.1  | 15            | O       |
| <b>Electrical System:</b>                    |        |      |               |         |
| Flywheel Nut (FD440V/FD501V)                 | 88     | 9.0  | 65            |         |
| (FD590V/FD611V)                              | 118    | 12.0 | 86.8          |         |

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.

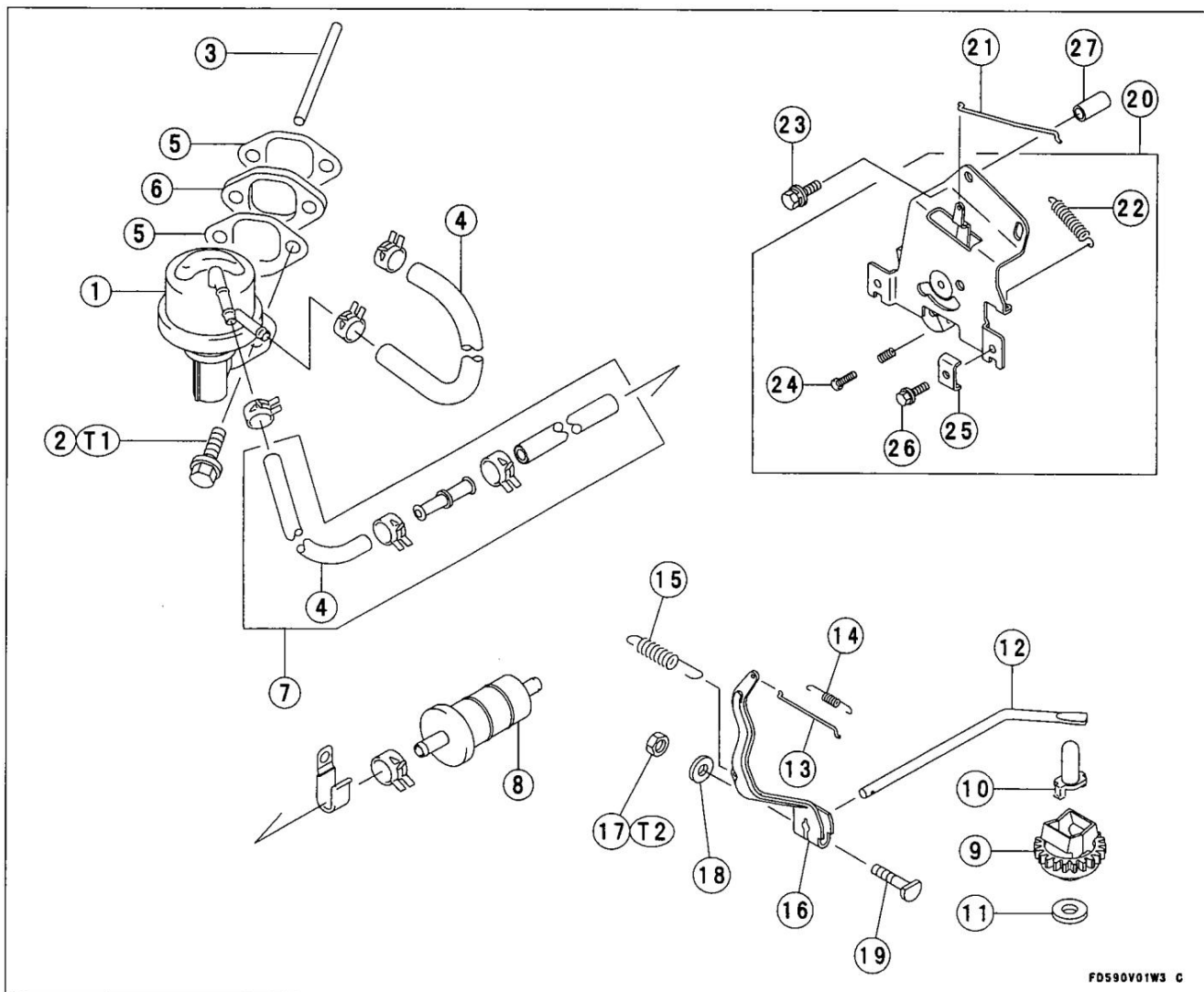
**Basic Torque for General Fasteners**

| Threads dia. (mm) | Torque    |             |               |
|-------------------|-----------|-------------|---------------|
|                   | N-m       | kg-m        | ft-lb         |
| 4                 | 1.2 ~ 2.2 | 0.12 ~ 0.22 | 10 ~ 19 in-lb |
| 5                 | 3.4 ~ 4.9 | 0.35 ~ 0.50 | 30 ~ 43 in-lb |
| 6                 | 5.9 ~ 7.8 | 0.60 ~ 0.80 | 52 ~ 69 in-lb |
| 8                 | 14 ~ 19   | 1.4 ~ 1.9   | 10 ~ 14       |



## Fuel System

## Exploded View



- |   |                             |                                       |
|---|-----------------------------|---------------------------------------|
| 1. Fuel Pump (Mechanical)                 | 11. Thrust Washer           | 22. Choke Control Lever Return Spring |
| 2. Fuel Pump Bolts                        | 12. Governor Shaft          | 23. Control Panel Fixing Bolts        |
| 3. Push Rod                               | 13. Throttle Link           | 24. Choke Adjustment Screw (FD440V)   |
| 4. Pump-to-Carburetor Hose                | 14. Throttle Link Spring    | 25. Throttle Cable Clamp              |
| 5. Gaskets                                | 15. Governor Spring         | 26. Throttle Cable Clamp Bolt         |
| 6. Insulator                              | 16. Governor Arm            | 27. Collar (FD590V, FD611V)           |
| 7. Tube Assembly (FD501V, FD590V, FD611V) | 17. Governor Arm Clamp Nut  | T1: 17 N-m (1.7 kg-m, 12 ft-lb)       |
| 8. Fuel Filter (FD501V, FD590V, FD611V)   | 18. Plain Washer            | T2: 7.8 N-m (0.8 kg-m, 69 in-lb)      |
| 9. Governor Flyweight Assembly            | 19. Governor Arm Clamp Bolt | O: Apply engine oil                   |
| 10. Sleeve                                | 20. Control Panel           |                                       |
|   | 21. Choke Link              |                                       |

**9-8 SUPPLEMENT – FD440V ~ FD611V****Fuel System***Specifications*

| Item   | Standard                                     |                  |                  |                  |
|--|--|------------------|------------------|------------------|
|  | FD440V                                       | FD501V           | FD590V           | FD611V           |
| <b>Carburetor Specifications:</b>                            |  |                  |                  |                  |
| Make/type  | MIKUNI/BV20-15                               | MIKUNI/BV24-18   | MIKUNI/BV24-18   | MIKUNI/BV26-18   |
| Main bore diameter   | 20 mm (0.78 in.)                             | 24 mm (0.94 in.) | 24 mm (0.94 in.) | 26 mm (1.02 in.) |
| Venturi diameter   | 15 mm (0.59 in.)                             | 18 mm (0.70 in.) | 18 mm (0.70 in.) | 18 mm (0.70 in.) |
| Main jet (MJ)  | #85  | #110             | #112.5           | #120             |
| Pilot jet (PJ)   | #37.5  | #43.8            | #37.5            | #50              |
| Main air jet (MAJ)   | ø 1.5  | ø 1.7            | ø 1.3            | ø 1.4            |
| Pilot air jet (PAJ)  | ø 0.9  | ø 1.0            | ø 1.0            | ø 1.1            |
| Pilot Screw turns out (PS)<br>(Idle mixture screw turns out) | 1-11/16                                      | 1-3/8            | 1-3/8            | 1-5/8            |
| Float level  | Float parallel to carburetor body            |                  |                  |                  |
| <b>Idle Speed:</b>   |  |                  |                  |                  |
| Low idle speed   | 1500 rpm ~ 1650 rpm                          |                  |                  |                  |
| Fast idle speed  | 3575 rpm ~ 3650 rpm                          |                  |                  |                  |
| <b>Air Cleaner:</b>  |  |                  |                  |                  |
| Type   | Dual stage filtration system                 |                  |                  |                  |
| Pre-cleaner  | Foam element                                 |                  |                  |                  |
| Second-stage cleaner   | Paper element                                |                  |                  |                  |
| <b>Fuel:</b>   |  |                  |                  |                  |
| Fuel requirement   | Leaded or unleaded automotive grade gasoline |                  |                  |                  |
| <b>Fuel Pump:</b>  |  |                  |                  |                  |
| Type   | Mechanical Diaphragm Type                    |                  |                  |                  |
| Delivery (MIN)   | 800 mL (0.8 qt)/at 1 550 rpm                 |                  |                  |                  |
| Shut-off delivery pressure                                   | 2.45 kPa (0.36 psi)                          |                  |                  |                  |
| <b>Governor:</b>   |  |                  |                  |                  |
| Type   | Flyweight all speed governor                 |                  |                  |                  |

## Fuel System

### Carburetor Theory

#### Slow Idle Speed Adjustment

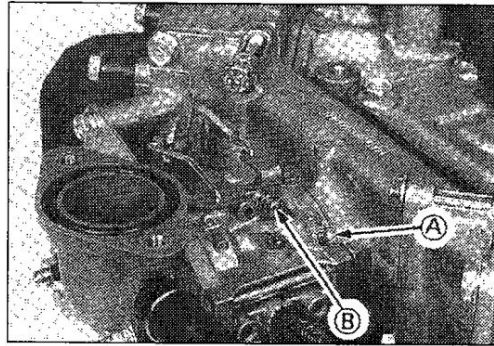
##### CAUTION

Do not attempt to adjust the pilot air screw with the air cleaner removed.

##### CAUTION

Do not turn the pilot air screw in too far or the carburetor body will be damaged and require replacement.

- Turn the pilot air screw (A) clockwise until lightly seated, then turn counterclockwise specified values.
- Start and let the engine running at medium idle speed.
- Move the throttle lever to the slow idle position.
- Check engine speed using a tachometer.
- Turn the throttle stop screw (B) on the carburetor until slow idle speed is  $1400 \pm 50$  rpm.
- Turn the pilot air screw (A) clockwise until the engine speed drops, then counterclockwise the engine speed increases and begins to drop again.
- Adjust the pilot air screw (A) for the highest engine speed between drops, then turn the screw counterclockwise an additional 1/4 turn.
- Turn the throttle stop screw (B) on the carburetor to get the specified slow idle speed.



#### Pilot Air Screw Turns Out

|                        |               |
|------------------------|---------------|
| Standard: 1-11/16..... | FD440V        |
| 1-3/8.....             | FD501V/FD590V |
| 1-5/8.....             | FD611V        |

#### Slow Idle Speed

Standard: 1500 rpm ~ 1650 rpm

#### FD590V Shown

#### Fast Idle Speed Adjustment

- Start and let the engine turning at medium idle.

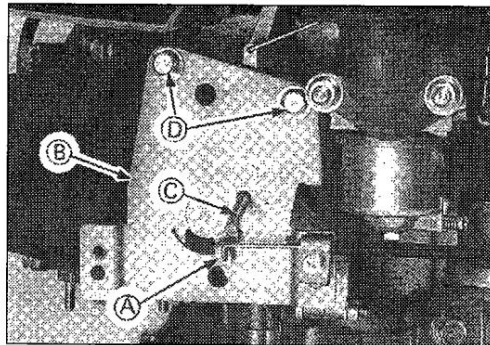
##### ⚠ WARNING

Always keep your hands clear of the moving parts.

##### ⚠ WARNING

Engine will be hot. Be careful not to burn hands.

- Move the throttle lever to the fast idle position.
- Align the hole in the throttle control plate (A) with the hole in the throttle control plate (B). Put a 6 mm (15/64-in.) drill bit (C) through both holes to keep the throttle control lever from moving. Be sure the drill bit is perpendicular to the throttle control plate.
- Check engine speed using a tachometer.
- If the fast idle speed does not meet the specifications, loosen the fixing screws (D).
- Move the throttle control plate (B) left to increase speed until fast idle speed for specified values.
- Hold the throttle control plate and tighten the fixing bolts.



#### Fast Idle Speed

Standard: 3575 rpm ~ 3650 rpm

#### FD590V Shown



**9-10 SUPPLEMENT – FD440V ~ FD611V****Fuel System****High Altitude Operation**

At high altitude, the standard carburetor air-fuel mixture will be excessively rich. Performance will decrease, and fuel consumption will increase. High altitude performance can be improved by installing a smaller diameter main-jet in the carburetor and readjusting the pilot screw (idle mixture screw) to meet good idling and idle speed is the specified rpm.

**NOTE**

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

**High Altitude Main Jet**

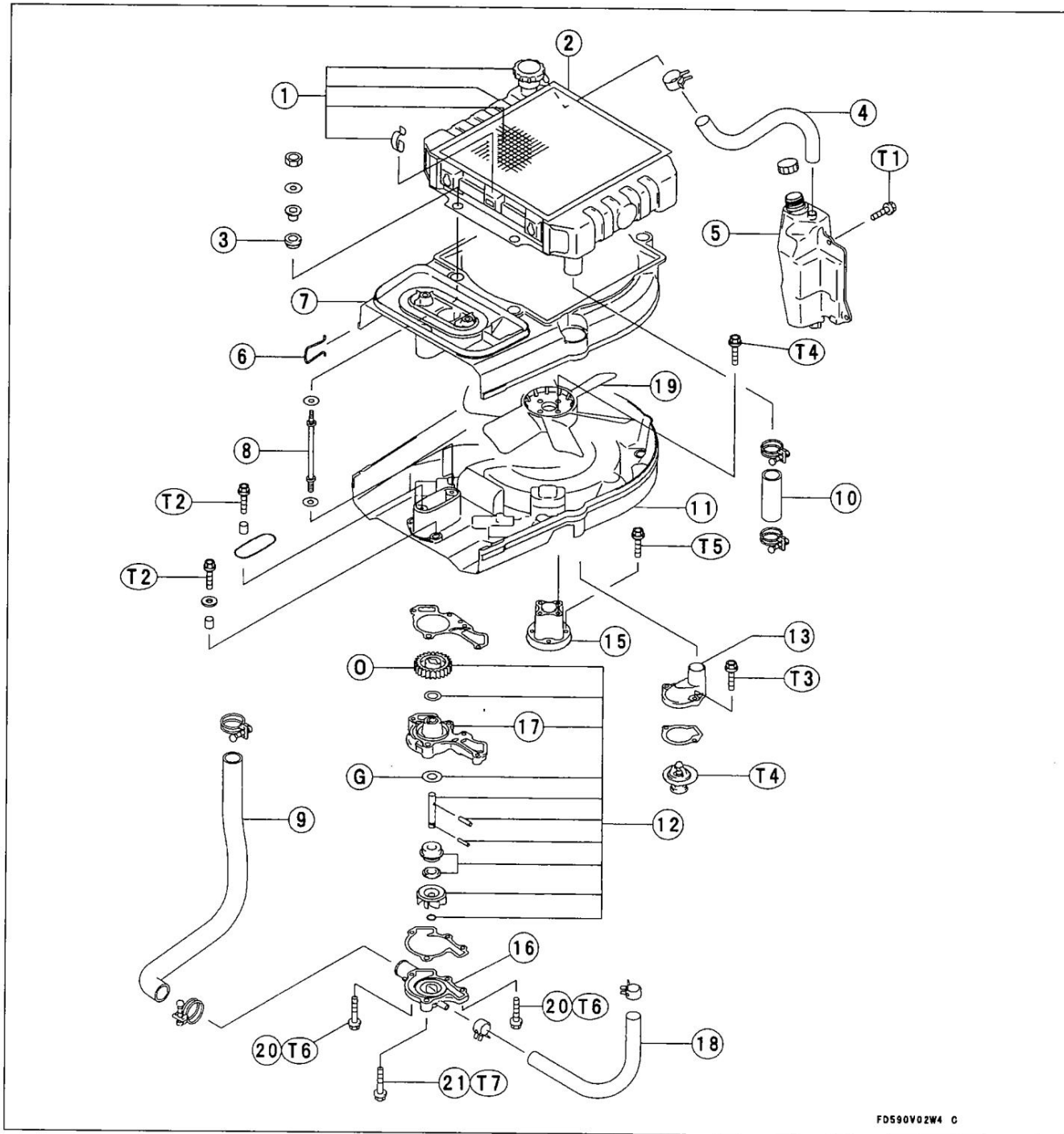
|                                       | FD440V | FD501V | FD590V | FD611V |
|---------------------------------------|--------|--------|--------|--------|
| <b>0 ~ 1000 m (0 ~ 3000 ft) (STD)</b> | #85    | #110   | #112.5 | #120   |
| <b>1000 ~ 2000 m (3000 ~ 6000 ft)</b> | #82.5  | #107.5 | #110   | #117.5 |
| <b>2000 m (6000 ft) and higher</b>    | #80    | #105   | #107.5 | #115   |

**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 to disassemble the carburetor (see Carburetor Disassembly-Assembly Notes).
- Using a proper blade screw driver, carefully replace the main jet with a new one for altitude expected.
- Tighten the main jet to the specification (see Carburetor Disassembly Assembly Notes).

## Cooling System

## Exploded View – FD440V/FD501V



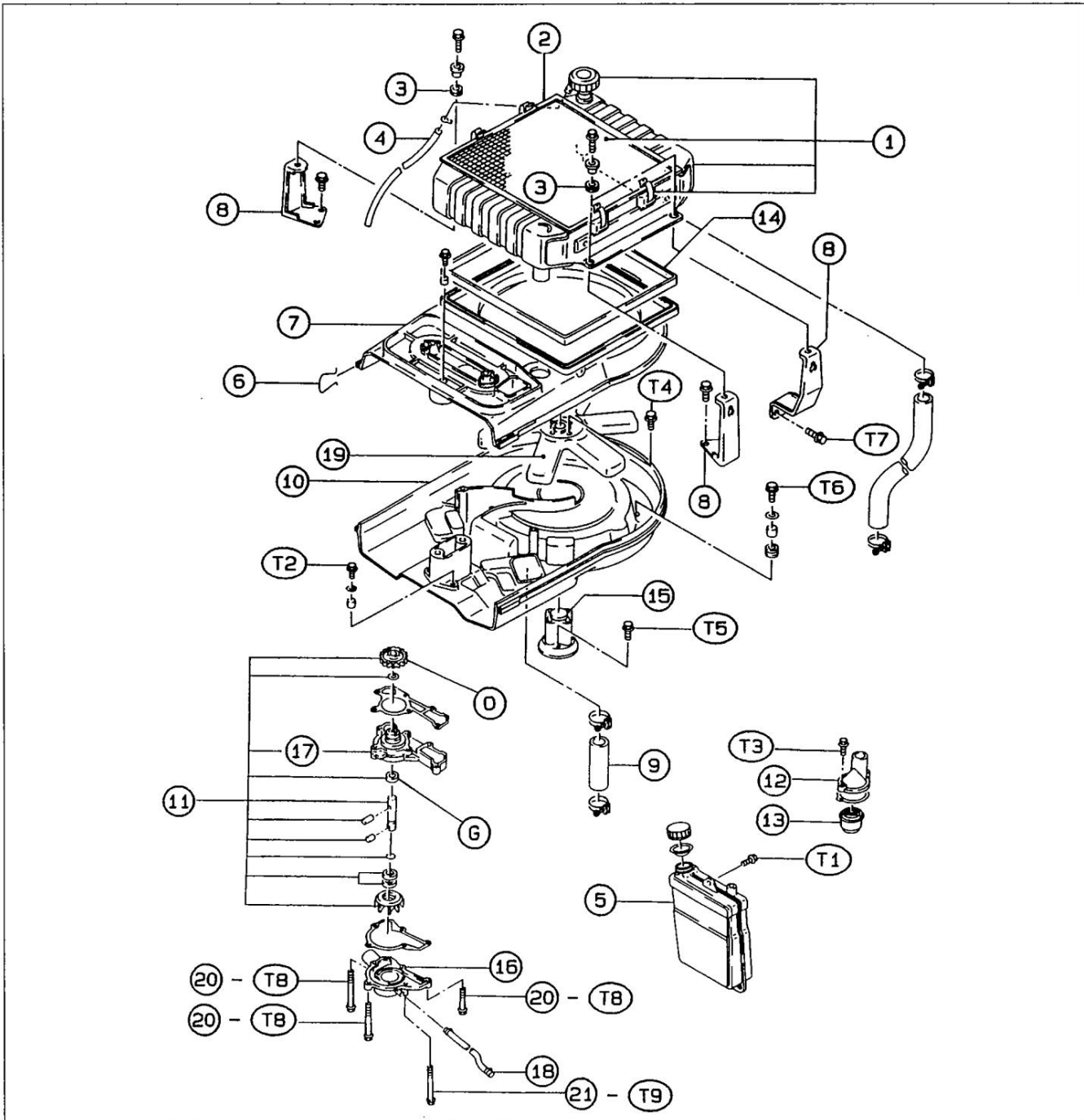
FD590V02W4 C

- |                      |                          |                                  |
|----------------------|--------------------------|----------------------------------|
| 1. Radiator          | 11. Bottom Half Air Duct | 21. Water Pump M8 Bolt           |
| 2. Screen            | 12. Water Pump           | T1: 3.9 N-m (0.4 kg-m, 35 in-lb) |
| 3. Dumper Bushings   | 13. Thermostat Housing   | T2: 5.9 N-m (0.6 kg-m, 52 in-lb) |
| 4. Over Flow Tube    | 14. Thermostat           | T3: 5.9 N-m (0.6 kg-m, 52 in-lb) |
| 5. Reservoir         | 15. Fan Extension        | T4: 5.9 N-m (0.6 kg-m, 52 in-lb) |
| 6. Retaining Clips   | 16. Water Pump Cover     | T5: 5.9 N-m (0.6 kg-m, 52 in-lb) |
| 7. Top Half Air Duct | 17. Water Pump Case      | T6: 8.8 N-m (0.9 kg-m, 78 in-lb) |
| 8. Studs             | 18. Bypass Hose          | T7: 22 N-m (2.2 kg-m, 16 ft-lb)  |
| 9. Outlet Hose       | 19. Cooling Fan          | O: Apply engine oil              |
| 10. Return Hose      | 20. Water Pump M6 Bolt   | G: Apply grease                  |

## 9-12 SUPPLEMENT – FD440V ~ FD611V

### Cooling System

Exploded View– FD590V/FD611V



- 1. Radiator
- 2. Screen
- 3. Dumper Bushings
- 4. Cover Flow Tube
- 5. Reservoir
- 6. Retaining Clips
- 7. Top Half Air Duct
- 8. Radiator Brackets
- 9. Return Hose
- 10. Bottom Half Air Duct
- 11. Water Pump

- 12. Thermostat Housing
- 13. Thermostat
- 14. Seal
- 15. Fan Extension
- 16. Water Pump Cover
- 17. Water Pump Case
- 18. Bypass Hose
- 19. Cooling Fan
- 20. Water Pump M6 Bolts
- 21. Water Pump M8 Bolt

- T1: 3.9 N-m (0.4 kg-m, 35 in-lb)
- T2: 5.9 N-m (0.6 kg-m, 52 in-lb)
- T3: 5.9 N-m (0.6 kg-m, 52 in-lb)
- T4: 5.9 N-m (0.6 kg-m, 52 in-lb)
- T5: 5.9 N-m (0.6 kg-m, 52 in-lb)
- T6: 5.9 N-m (0.6 kg-m, 52 in-lb)
- T7: 15N-m (1.5 kg-m, 11 ft-lb)
- T8: 9.8N-m (10 kg-m, 87 in-lb)
- T9: 25N-m (2.6 kg-m, 19 ft-lb)
- O: Apply engine oil
- G: Apply grease



## Cooling System

### Specifications

| Item                                 | FD440V/FD501V   | FD590V/FD611V   |
|--------------------------------------|---|-----------------|
| <b>*Coolant:</b>                     |   |                 |
| Type                                 | Permanent type of antifreeze for aluminum engine and radiator |                 |
| Color                                | Green   |                 |
| Mixed ratio                          | 50 % solution of ethylene glycol                              |                 |
| Freezing point                       | -35°C (-31°F)   |                 |
| Total amount                         | 2.10 L (2.2 qt).  | 3.04 L (3.2 qt) |
| <b>Radiator Cap Relief Pressure:</b> |   |                 |
| Pressure valve (positive)            | 78.2 to 97.8 kPa (11.3 to 14.2 psi)                           |                 |
| Vacuum Valve (negative)              | 4.90 kPa (0.71 psi)   |                 |
| <b>Thermostat:</b>                   |   |                 |
| Begin opening temperature            | 82°C (180°F)  |                 |
| Fully open temperature               | 95°C (203°F)  |                 |
| <b>Thermo Switch:</b>                |   |                 |
| Detect Temperature                   | 108 to 114°C (226 to 237°F)                                   |                 |

\*Coolant is not installed in the cooling system when shipped.

## 9-14 SUPPLEMENT – FD440V ~ FD611V

### Cooling System

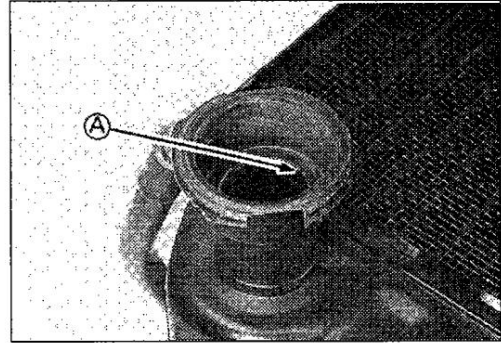
#### Coolant

##### Coolant Filling

- Install the drain plugs. Always replace the gaskets with a new ones, if they are damaged.
- Tighten the drain screws to the specification (see Exploded Views.
- Fill the radiator up to the radiator filler neck bottom (A) with coolant, and install the cap turning it clockwise.

#### NOTE

- Pour in the coolant slowly so that it can expel the air from the engine and radiator.
- To install the radiator cap, push down it and then turn the cap clockwise to the rest of the way.



#### CAUTION

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

#### NOTE

- Choose a suitable mixture ratio by referring to the coolant manufacturer's instructions.

#### Original Coolant

|                 |   |
|-----------------|---|
| Type:           | Permanent type antifreeze for aluminum engine and radiator              |
| Color:          | Green   |
| Mixed ratio:    | 50% solution of ethylene glycol   |
| Freezing Point: | -35°C (-31°F)   |
| Total amount:   | 2.1 L (2.2 qt)..... FD440V/FD501V<br>3.04 L (3.2 qt)..... FD590V/FD611V |

## Cooling System

### Coolant Pump

#### Coolant Pump Removal

- Drain the coolant (see Coolant Draining).
- Loosen the tube clamp, and pull off the coolant bypass tube.
- Unscrew the coolant pump mounting bolts, and remove the coolant pump assembly.

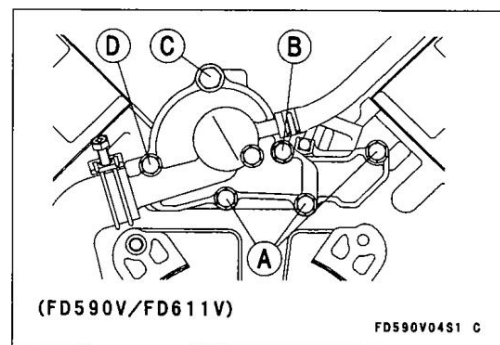
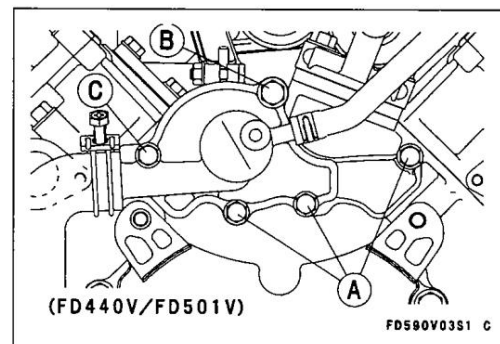
#### NOTE

- Note the position of different length of bolts so they can be installed in their original positions.

#### Installation Notes

- Chip the old gasket off the mating surfaces of the casecover and pump housing.
- Put a new gasket on the pump housing.
- Be sure to suitable set the pump gear to be meshed with the cam gear when installing the pump assembly. Do not force the pump into position.
- Install the mounting bolts and tighten them to the specification (see Torque Table or Exploded View).
- Note the position of different length of bolts.

| Bolt dimensions | FD440V/FD501V    | FD590V/FD611V    |
|-----------------|------------------|------------------|
| A. Bolt M6      | 45 mm (1.77 in.) | 45 mm (1.77 in.) |
| B. Bolt M8      | 75 mm (2.95 in.) | 70 mm (2.76 in.) |
| C. Bolt M6      | 80 mm (3.15 in.) | 65 mm (2.56 in.) |
| D. Bolt M6      | –                | 75 mm (2.95 in.) |







**Engine Top End***Specifications – FD440V/FD501V*

| Item                             | Service Limit                      |
|----------------------------------|------------------------------------|
| <b>CYLINDER HEAD AND VALVES</b>  |                                    |
| Valve Clearance                  | 0.15 mm (0.006 in.)                |
| <b>Rocker Arm</b>                |                                    |
| Minimum Shaft O.D.               | 11.95 mm (0.470 in.)               |
| Maximum Bearing I.D.             | 12.07 mm (0.475 in.)               |
| Push Rod Maximum Bend            | 0.80 mm (0.031 in.)                |
| <b>Valves and Springs</b>        |                                    |
| Minimum Valve Spring Free Length | 28.1 mm (1.11 in.) (FD440V)        |
| Minimum Valve Stem O.D.          | 30.8 mm (1.21 in.) (FD501V)        |
| Intake                           | 4.93 mm (0.194 in.)                |
| Exhaust                          | 4.92 mm (0.193 in.)                |
| Maximum Valve Guide I.D.         | 5.06 mm (0.199 in.)                |
| Maximum Valve Stem Bend          | 0.03 mm (0.001 in.)                |
| Standard Valve Seating Surface   | 0.80 mm (0.031 in.)                |
| Valve Seating Width Tolerance    | 0.50 ~ 1.10 mm (0.020 ~ 0.034 in.) |
| Valve Seat and Face Angle        | 45°                                |
| Minimum Valve Margin             | 0.50 mm (0.020 in.)                |
| Valve Narrowing Angle            | 30°                                |

*Specifications – FD590V/FD611V*

| Item                            | Service Limit                      |
|---------------------------------|------------------------------------|
| <b>CYLINDER HEAD AND VALVES</b> |                                    |
| Valve Clearance                 | 0.25 mm (0.010 in.)                |
| <b>Rocker Arm</b>               |                                    |
| Minimum Shaft O.D.              | 11.95 mm (0.470 in.)               |
| Maximum Bearing I.D.            | 12.07 mm (0.475 in.)               |
| <b>Push Rod</b>                 |                                    |
| Maximum Bend                    | 0.80 mm (0.031 in.)                |
| <b>Valves and Springs</b>       |                                    |
| Minimum Spring Free Length      | 32.6 mm (1.28 in.)                 |
| Minimum Valve Stem O.D.         |                                    |
| Intake                          | 5.94 mm (0.234 in.)                |
| Exhaust                         | 5.92 mm (0.233 in.)                |
| Maximum Valve Guide I.D.        | 6.05 mm (0.238 in.)                |
| Maximum Valve Stem Bend         | 0.03 mm (0.001 in.)                |
| Standard Valve Seating Surface  | 0.80 mm (0.031 in.)                |
| Valve Seating Width Tolerance   | 0.50 ~ 1.10 mm (0.020 ~ 0.043 in.) |
| Valve Seat and Face Angle       | 45°                                |
| Minimum Valve Margin            | 0.60 mm (0.024 in.)                |
| Valve Narrowing Angle           | 30°                                |

**9-18 SUPPLEMENT – FD440V ~ FD611V****Engine Top End****Valves****Clearance Inspection****NOTE**

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

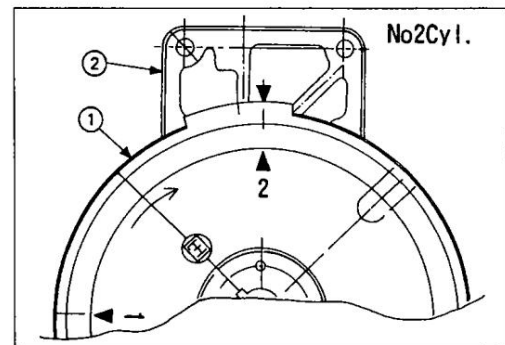
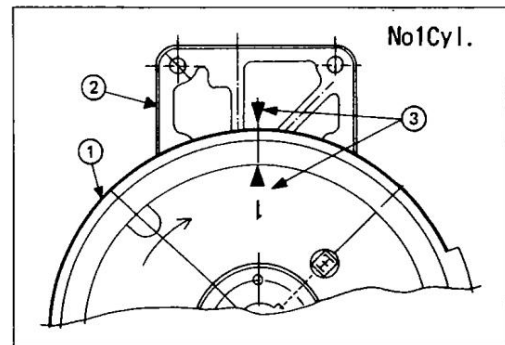
- Remove the rocker chamber cover (see Cylinder Head Removal).
- Place the piston at top dead center (TDC) of the compression stroke turning the crankshaft clockwise facing the flywheel.

**No. 1 Cylinder:**

- Align (1) mark on the flywheel (⊙) with (▲) mark on the breather chamber cover (2) as shown.
- Check the intake and exhaust valves are closed completely, if not turn the flywheel one turn (360°) clockwise and align both marks on the flywheel and cover again.

**No. 2 Cylinder:**

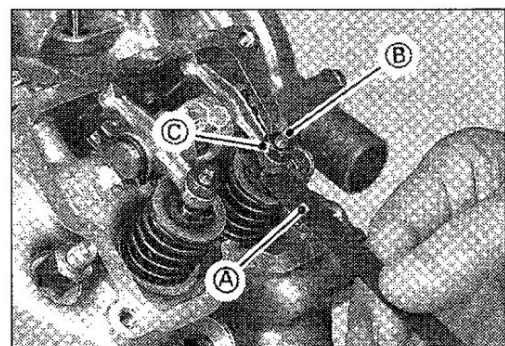
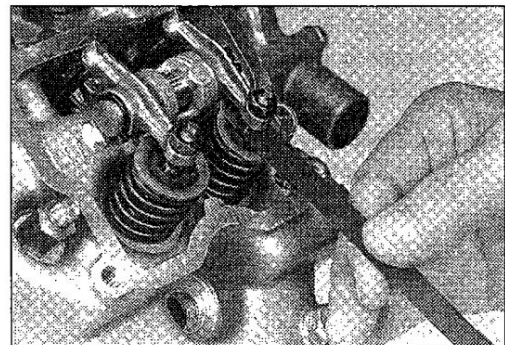
- Align (2) mark on the flywheel with (▲) mark on the breather chamber cover. Follow No. 1 Cylinder alignment procedure described above.
- Then check the clearance.
- Using a thickness gauge (A), measure the valve clearance between the rocker arm and the valve stem end.
- ★ If the valve clearance is incorrect, adjust it.

**Valve Clearance (when cold)**

Intake, Exhaust: 0.15 mm (0.006 in.) (FD440V/FD501V)  
0.25 mm (0.01 in.) (FD590V/FD611V)

**Clearance Adjustment**

- Since the valve repairs change the valve clearance, adjust the valve clearance to the specification.
- Assemble the cylinder head and install the cylinder head assembly on the block (see cylinder Head Installation Notes)
- Turn the crankshaft proper direction until the piston is at TDC of the compression stroke (described above).
- Loosen the locknut (C) and valve clearance adjusting screws (B)
- Insert specified valves thickness gauge (A) between the adjusting screw and valve stem, and tighten the adjusting screw until the thickness gauge begin to bind between the rocker arm and valve stem end. Use a sweeping motion with the thickness gauge while making this adjustment.
- Holding the adjusting screw with a spanner, tighten the locknut to the specified torque (see Exploded View).
- Do not overtighten.





## Engine Top End

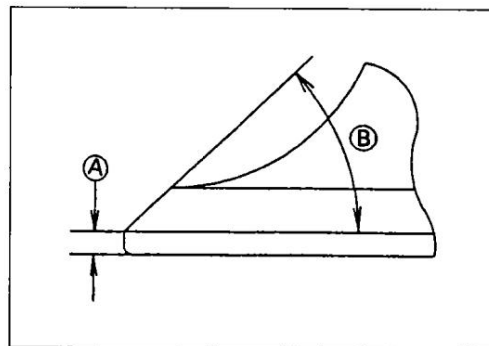
### Valve Head Thickness

- Remove the valve.
- Measure the thickness of the valve head.
- ★ If the valve head thickness (valve margin) (A) is less than the service limit, replace the valve.

#### Valve Head Thickness (Valve Margin) (IN., EX.)

##### Service Limit:

|                         |               |
|-------------------------|---------------|
| 0.5 mm (0.020 in.)..... | FD440V/FD501V |
| 0.6 mm (0.024 in.)..... | FD590V/FD611V |



B. 45°

### Valve Stem Diameter

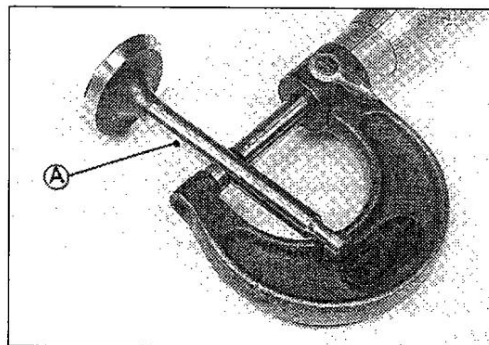
- Measure the diameter of the valve stem (A) in two directions at right angles, at four different positions on the stem.
- ★ If any single measurement is less than the service limit, replace the valve.

#### Valve Stem Diameter

##### Service Limit: FD440V/FD501V

##### FD590V/FD611V

|                                |                       |
|--------------------------------|-----------------------|
| Intake: 4.945 mm (0.1947 in.)  | 5.945 mm (0.2341 in.) |
| Exhaust: 4.925 mm (0.1937 in.) | 5.925 mm (0.2332 in.) |



### Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter of the valve guide a three places down the length of the guide.
- ★ If the measurement is more than the service limit, replace the cylinder head with a new one.

#### Valve Guide inside Diameter (IN., EX.)

##### Service Limit:

|                          |               |
|--------------------------|---------------|
| 5.06 mm (0.199 in.)..... | FD440V/FD501V |
| 6.05 mm (0.238 in.)..... | FD590V/FD611V |

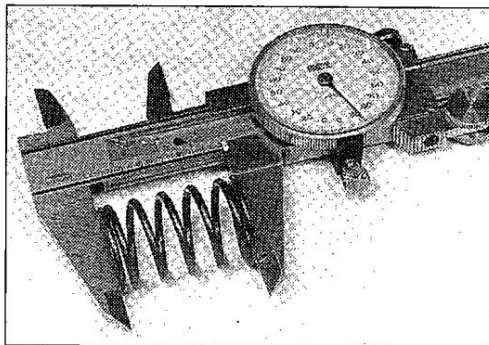
### Valve Spring Inspection

- Inspect the valve spring for pitting, cracks, rusting, and burrs. Replace the spring if necessary.
- Measure the free length of the spring.
- ★ If the measurement is less than the service limit, replace the spring.

#### Valve Spring Free Length (IN., EX.)

##### Service Limit:

|                         |               |
|-------------------------|---------------|
| 28.1 mm (1.11 in.)..... | FD440V        |
| 30.8 mm (1.21 in.)..... | FD501V        |
| 32.6 mm (1.28 in.)..... | FD590V/FD611V |



## 9-20 SUPPLEMENT – FD440V ~ FD611V

### Engine Top End

#### Cylinder, Piston

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

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

##### Piston Pin Outside Diameter

###### Service Limit:

|                       |       |               |
|-----------------------|-------|---------------|
| 15.980 mm (0.629 in.) | ..... | FD440V/FD501V |
| 16.980 mm (0.668 in.) | ..... | FD590V/FD611V |

- Measure the inside diameter of the piston pin hole at several points on both side. Use a dial bore gauge.
- ★ If the inside diameter is more than the service limit, replace the piston.

##### Piston Pin Hole Inside Diameter

###### Service Limit:

|                       |       |               |
|-----------------------|-------|---------------|
| 16.040 mm (0.631 in.) | ..... | FD440V/FD501V |
| 17.040 mm (0.670 in.) | ..... | FD590V/FD611V |

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

##### Connecting Rod Small End Inside Diameter

###### Service Limit:

|                       |       |               |
|-----------------------|-------|---------------|
| 16.05 mm (0.6319 in.) | ..... | FD440V/FD501V |
| 17.05 mm (0.6713 in.) | ..... | FD590V/FD611V |

##### Piston Diameter

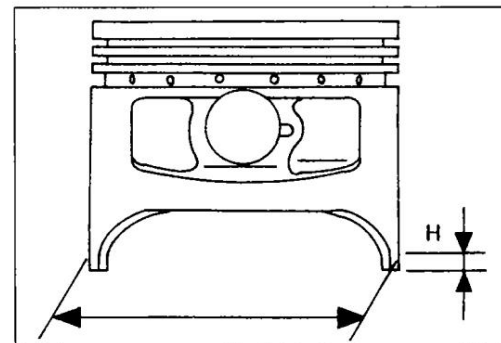
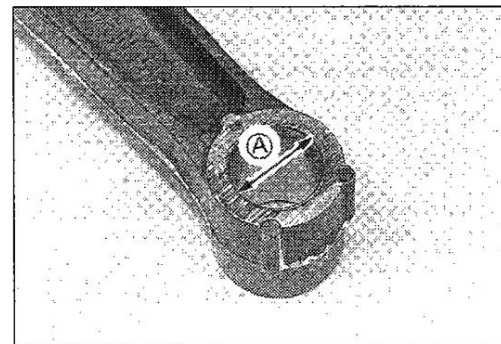
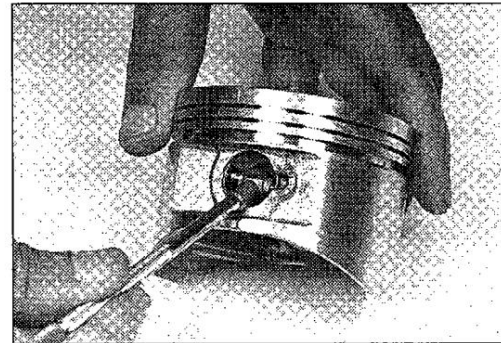
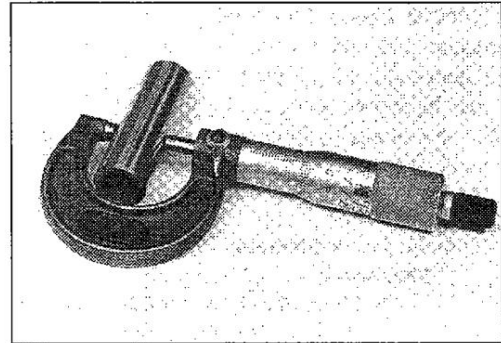
- Measure the outside diameter of the piston perpendicular to the piston pin bore at approximate specified height (H) from the bottom of the piston skirt.
- ★ If the measurement is less than the service limit, replace the piston.

|                         |       |               |
|-------------------------|-------|---------------|
| H. 13.50 mm (0.531 in.) | ..... | FD440V/FD501V |
| 11.00 mm (0.433 in.)    | ..... | FD590V/FD611V |

##### Piston Diameter

###### Service Limit:

|                     |                        |       |                |
|---------------------|------------------------|-------|----------------|
| 66.950 to 66.965 mm | (2.6358 to 2.6364 in.) | ..... | FD440V/FD501 V |
| 73.935 to 73.950 mm | (2.910 to 2.911 in.)   | ..... | FD590V/FD611V  |





## Engine Top End

### Cylinder Inside Diameter

- Clean and measure the cylinder inside diameter.
- Use a dial bore gauge to measure front-to-back and side-to-side at the points shown below.
- ★ If any of the cylinder bore measurements 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:

66.980 to 67.000 mm (2.637 to 2.638 in.)... FD440V/FD501V

73.980 to 74.000 mm (2.915 to 2.916 in.)... FD590V/FD611V

#### Service Limit:

67.060 mm (2.640 in.)..... FD440V/FD501V

74.070 mm (2.918 in.)..... FD590V/FD611V

#### 0.25 mm Oversize:

##### Service Limit:

67.310 mm (2.650 in.)..... FD440V/FD501V

74.320 mm (2.925 in.)..... FD590V/FD611V

#### 0.5mm Oversize:

##### Service Limit:

67.560 mm (2.659 in.)..... FD440V/FD501V

74.570 mm (2.935 in.)..... FD590V/FD611V

#### 0.75mm Oversize:

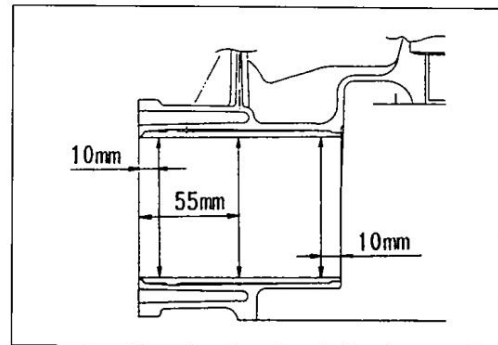
##### Service Limit:

67.810 mm (2.669 in.)..... FD440V/FD501V

74.820 mm (2.945 in.)..... FD590V/FD611V

### Cylinder Bore Out-Of-Round

Service Limit: 0.056 mm (0.0022 in.)



### Initial Bore Diameter-FD440V/FD501V

| Oversize | Bore Diameter                               |
|----------|---|
| 0.25 mm  | 67.258 to 67.280 mm<br>(2.647 to 2.648 in.) |
| 0.50 mm  | 67.508 to 67.530 mm<br>(2.657 to 2.658 in.) |
| 0.75 mm  | 67.758 to 67.780 mm<br>(2.667 to 2.668 in.) |

### Initial Bore Diameter-FD590V/FD611V

| Oversize | Bore Diameter                               |
|----------|---|
| 0.25 mm  | 74.258 to 74.280 mm<br>(2.923 to 2.924 in.) |
| 0.50 mm  | 74.508 to 74.530 mm<br>(2.933 to 2.934 in.) |
| 0.75 mm  | 74.758 to 74.780 mm<br>(2.943 to 2.944 in.) |

### Final Bore Diameter-FD440V/FD501V

| Oversize | Bore Diameter                               |
|----------|---|
| 0.25 mm  | 67.230 to 67.250 mm<br>(2.646 to 2.647 in.) |
| 0.50 mm  | 67.480 to 67.500 mm<br>(2.656 to 2.657 in.) |
| 0.75 mm  | 67.730 to 67.750 mm<br>(2.666 to 2.667 in.) |

### Final Bore Diameter-FD590V/FD611V

| Oversize | Bore Diameter                               |
|----------|---|
| 0.25 mm  | 74.230 to 74.250 mm<br>(2.922 to 2.923 in.) |
| 0.50 mm  | 74.480 to 74.500 mm<br>(2.932 to 2.933 in.) |
| 0.75 mm  | 74.730 to 74.750 mm<br>(2.942 to 2.943 in.) |

### Cylinder Boring and Honing

Always resize to exactly 0.25 mm (0.01 in.), or 0.5 mm (0.02 in.), 0.75 mm (0.03 in.) over the standard bore size.

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

Resizing the cylinder bore can be done by reliable repair shop or by using a drill press and honing tool.

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

Machine-bore first, the bore diameters should be shown in the table.

Change to a honing stone for finishing, the final bore diameter should be as shown in the table.

Be sure the correct stone is used and the stone is not worn.

- Clean the cylinder at the top and bottom of the cylinder to remove burrs 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 cylinder wall at the narrowest point. "Do not Force".
- Turn the stone by hand. If you cannot turn it, the stone is too tight. Loosen the hone until it can be turned by hand.
- Be sure that the cylinder and hone are centered and aligned with the drive shaft and drill spindle.
- Pour honing oil inside of the cylinder during the honing operation. Start the drill press, Move the hone up and down in the cylinder approximately 20 cycles-per-minute.



**9-22 SUPPLEMENT – FD440V ~ FD611V****Lubrication System***Specifications*

| Item                                     | Service  |
|--|--|
| <b>Engine Oil:</b>                       |  |
| Grade                                    | API Service Classification; SC, SD, SE, SF, SG, or SH                |
| Viscosity                                | SAE40, SAE30, SAE10W-30 / SAE10W-40, or SAE5W-20 (see Oil Change)    |
| Capacity                                 | 1.5L (3.2 US pt) – FD440V/FD501V<br>1.7L (3.6 US pt) – FD590V/FD611V |
| Oil pressure sensor activates            | 69 ~ 127 kPa (10 ~ 18.5 psi)   |
| Oil Pressure (minimum)                   | 276 kPa (40 psi)   |
| Oil Filter bypass valve opening pressure | 78.4 ~ 117.6 kPa (11.4 ~ 17.1 psi)                                   |

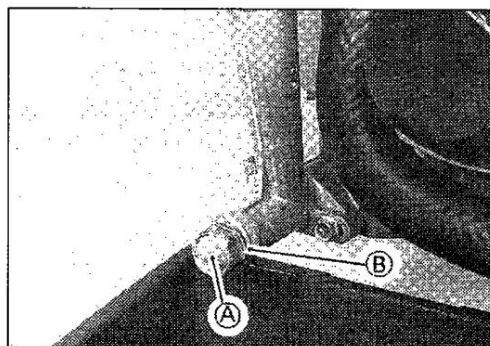
| Item                             | Service Limit        |
|----------------------------------|----------------------|
| <b>Oil Pump:</b>                 |                      |
| Minimum Rotor Shaft O.D.         | 10.92 mm (0.430 in.) |
| Maximum Rotor Shaft Bearing I.D. | 11.07 mm (0.436 in.) |
| Minimum Outer Rotor O.D.         | 40.43 mm (1.592 in.) |
| Maximum Outer Rotor Bearing I.D. | 40.80 mm (1.606 in.) |
| Minimum Valve Spring Free Length | 20.87 mm (0.822 in.) |

## Lubrication System

### Engine Oil and Oil Filter

#### Oil Change

- Change oil after first 8 hours of operation. Thereafter change oil every 100 hours.
- Check that there is oil in the crankcase.
- Start and warm up the engine so the oil will drain easily. Stop the engine.
- Place the engine on a level surface.
- Tilt the engine and place a suitable container under the engine.
- Remove the drain plug (A), and let the oil drain completely.



#### ⚠ WARNING

Be careful with hot oil being drained. It may be hot enough to burn you severely.

- Check the gasket (B) at the drain plug for damage. Replace the gasket with a new one if it is damaged.
- Install the drain plug with the gasket and tighten it to the specified torque (see Exploded View).

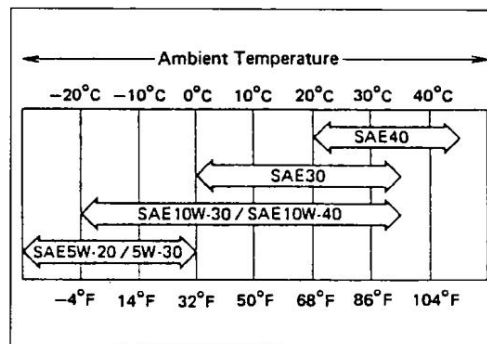
#### FD590V Shown

- Remove the oil filler cap and refill the engine with a high quality oil of recommended viscosity in the chart.

#### CAUTION

Use a good quality SC, SD, SE, SF, SG or SH class oil. Choose the viscosity of oil for temperature expected.

- Check the oil level (see Oil Level Check).



#### NOTE

- Some increase in oil consumption may be expected when a multi grade engine oil is used. Check the oil level frequently.

#### Engine Oil Capacity with Filter

1.5 L (3.2 U.S. Pt)..... FD440V/FD501V  
 1.7 L (3.6 U.S. Pt)..... FD590V/FD611V

#### Engine Oil Level

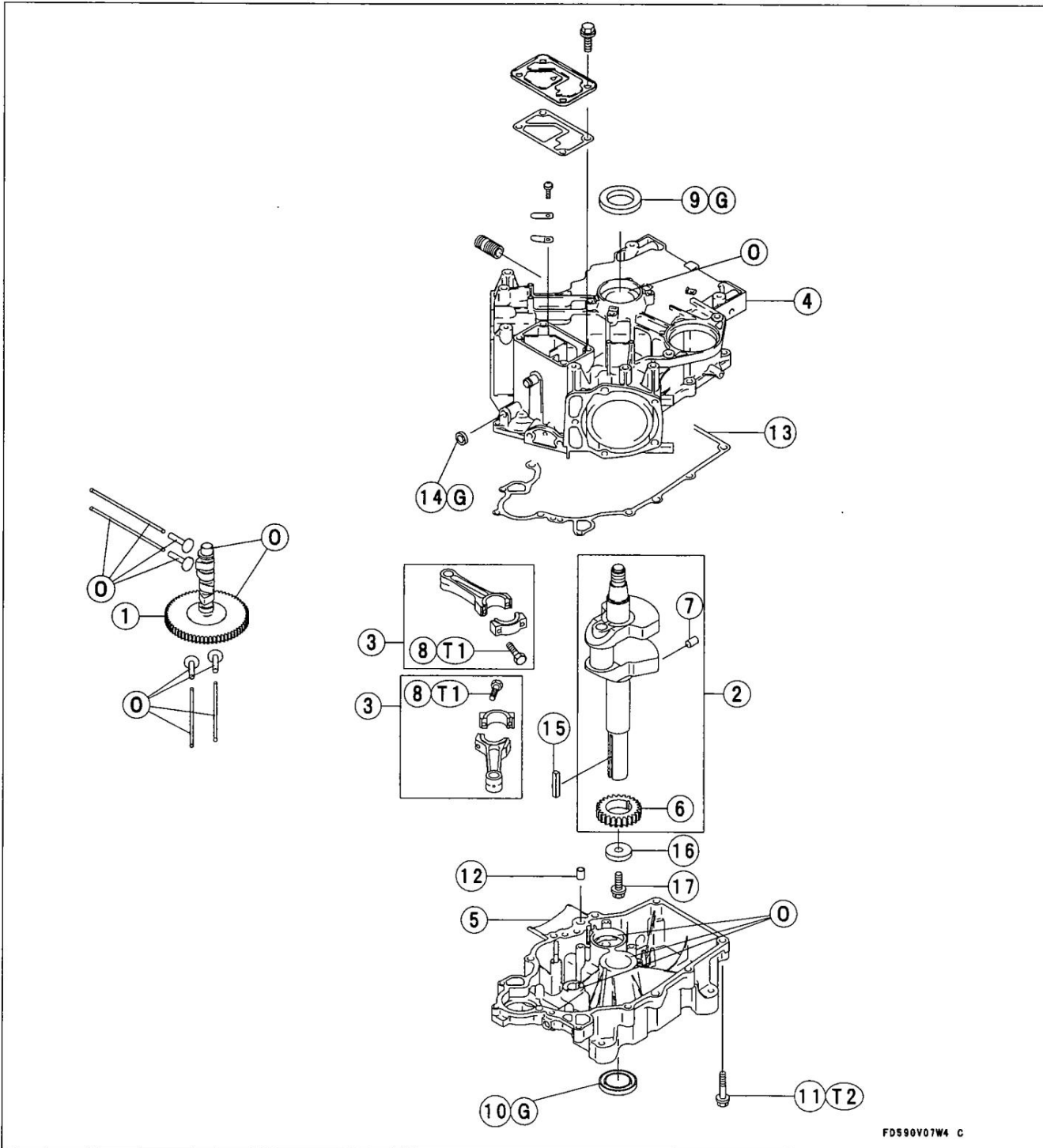
Between upper and lower level line





## Camshaft / Crankshaft

## Exploded View



1. Camshaft
2. Crankshaft Assembly
3. Connecting Rod Assemblies
4. Crankcase
5. Crankcase Cover
6. Crankshaft Gear
7. Crankshaft Gear Dowel Pin
8. Connecting Rod Bolts
9. Oil Seal (Flywheel Side)
10. Oil Seal (P.T.O. Side)

11. Crankcase Cover Bolts
12. Crankcase Cover Dowel Pins
13. Crankcase Cover Gasket
14. Governor Shaft Oil Seal
15. Key (FD501V/ FD590V/FD611V)
16. Washer  
(FD501V/FD590V/FD611V)
17. Bolt  
(FD501V/FD590V/FD611V)

- T1: FD440V/FD501V...12 N-m  
(1.2 kg-m, 106 in-lb)  
FD590V/FD611V...21 N-m  
(2.1 kg-m, 15 ft-lb)
- T2: FD440V/FD501V...21 N-m  
(2.1 kg-m, 15 in-lb)  
FD590V/FD611V...25 N-m  
(2.6 kg-m, 19 ft-lb)
- O: Apply engine oil  
G: Apply grease

FD590V07W4 C

**9-26 SUPPLEMENT – FD440V ~ FD611V****Camshaft / Crankshaft***Specifications – FD590V/FD611V*

| Item  | Standard / Service Limit |
|---|--------------------------|
| <b>CAMSHAFT, CONNECTING ROD, AND CRANKSHAFT</b> |                          |
| <b>Camshaft</b>                                 |                          |
| Minimum End Journals O.D.                       | 15.91 mm (0.626 in.)     |
| Minimum Lobe O.D.                               | 25.23 mm (0.993 in.)     |
| Minimum Fuel Pump Lobe Height                   | 19.50 mm (0.760 in.)     |
| Maximum Cover and Crankcase Bearing I.D.        | 16.07 mm (0.633 in.)     |
| <b>Connecting Rod</b>                           |                          |
| Maximum Crankshaft Bearing I.D.                 | 34.06 mm (1.341 in.)     |
| Maximum Piston Pin Bearing I.D.                 | 17.05 mm (0.671 in.)     |
| End-Cap Screw Torque                            | 21 N-m (186 in-lb)       |
| <b>Crankshaft</b>                               |                          |
| Minimum Side Journal O.D.                       | 33.91 mm (1.335 in.)     |
| Minimum Connecting Rod Journal                  | 33.93 mm (1.336 in.)     |
| Maximum T.I.R.                                  | 0.05 mm (0.002 in.)      |

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## Camshaft / Crankshaft

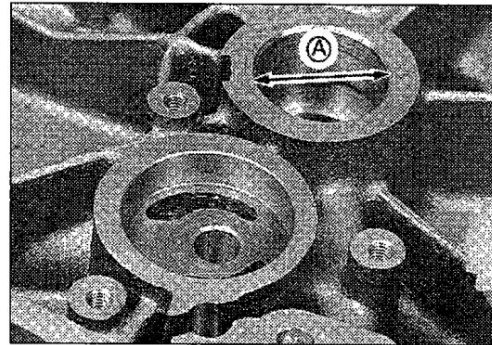
### Crankcase

#### 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 if the inside diameter is more than the service limit.

#### PTO Shaft Bearing Inside Diameter

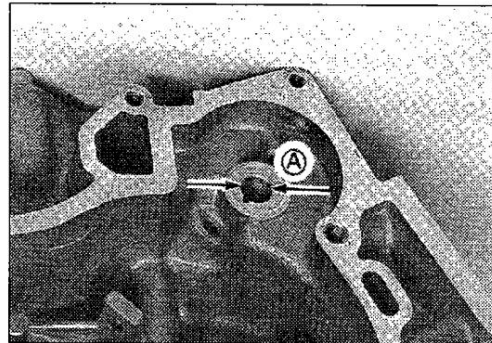
Service Limit: 30.09 mm (1.185 in.) ..... FD440V/FD501V  
34.07 mm (1.341 in.) ..... FD590V/FD611V



- Measure the inside diameter (A) of the water pump shaft bearing on the crankcase at several points. This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

#### Water Pump Shaft Bearing Inside Diameter

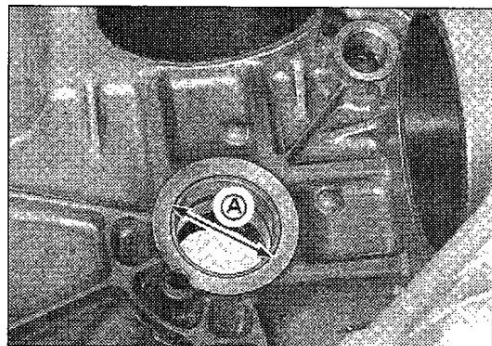
Service Limit: 10.088 mm (0.3972 in.)



- Measure the inside diameter (A) of the crankshaft journal bearing on the crankcase at several points. Replace the journal Bushing if the inside diameter is more than the service limit.

#### Crankshaft Journal Bearing Inside Diameter

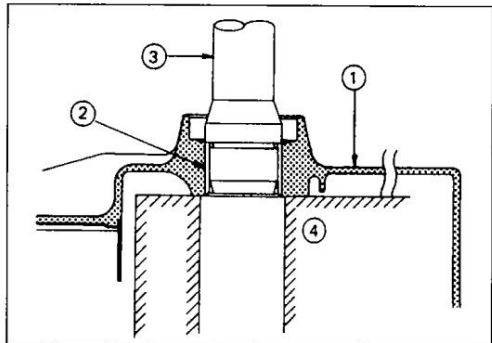
Service Limit: 30.09 mm (1.185 in.) ..... FD440V/FD501V  
34.07 mm (1.341 in.) ..... FD590V/FD611V



### Journal Bushing Replacement – FD590V/FD611V

The journal bushing (2) is press fit into the crankcase (1).

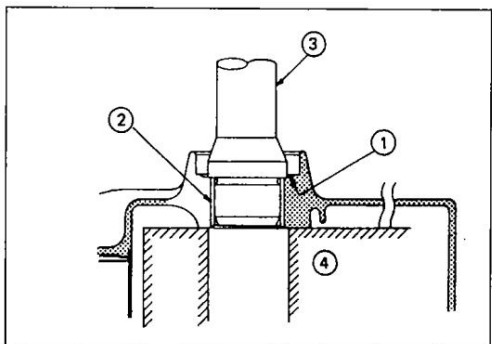
- Remove the oil seal on the crankcase.  
The oil seal should not be reused once removed.
- Place the crankcase on a support block (4) with the oil seal side up.
- Using a bushing tool (3), drive out the bushing as shown.



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

1. Flange Surface  
2. New Bushing

3. Bushing Tool  
4. Support Block





**9-28 SUPPLEMENT – FD440V ~ FD611V****Camshaft / Crankshaft****Camshaft Tappet****Removal**

- Split the crankcase (see Crankcase Splitting).
- Turn the crankcase up side down so that the tappets will fall away from the cam lobes.
- Pull the camshaft out of the crankcase.

**NOTE**

- Before removing, align the punch mark (A) on the crankgear with the punch mark (B) on the camgear.

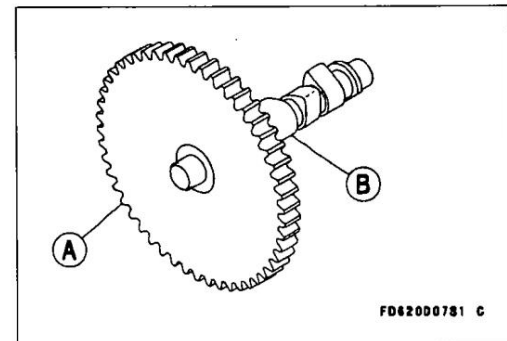
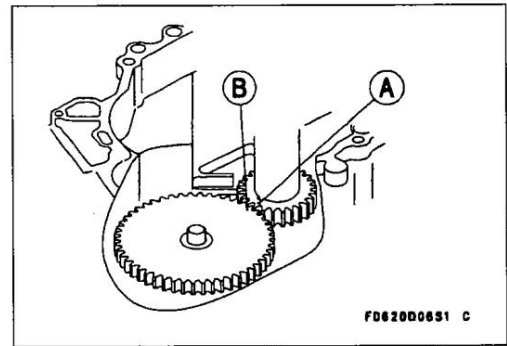
- Remove the tappets and mark them so they can be installed in their original positions during assembly.

**Installation Notes**

- Apply engine oil to the following.
  - Tappet Journal
  - Camshaft Journal
  - Cam Lobe Surface
  - Camshaft Gear
- Align the punch mark on the crankgear with the projection on the camgear.

**Inspection**

- Check the camshaft gear (A) for pitting, fatigue cracks, burrs or an evidence of improper tooth contact. Replace the shaft if necessary.
- Check the top of the cam lobes (B) for wear, burrs or uneven contact. Replace the shaft if necessary.

**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.

**Cam Lobe Height (IN., EX.)**

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 22.43 mm (0.954 in.) | ..... | FD440V/FD501V |
| 25.23 mm (0.993 in.)                | ..... | FD590V/FD611V |

**Fuel Pump Cam Lobe Height**

Service Limit: 19.50 mm (0.760 in.)

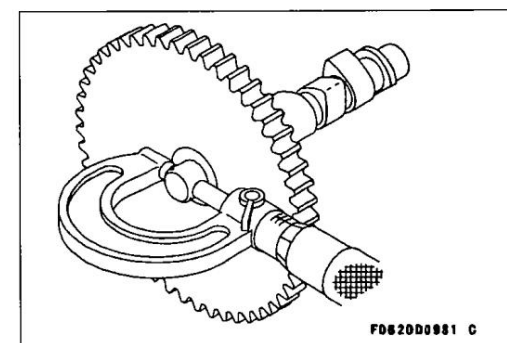
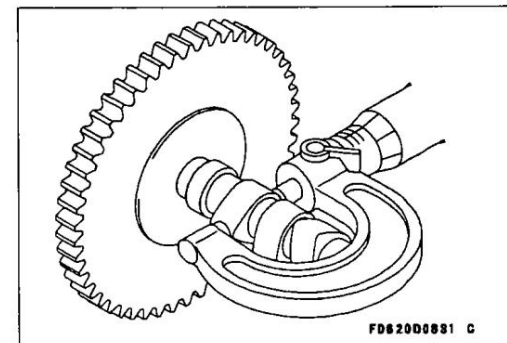
- With a micrometer, measure both camshaft journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the camshaft.

**PTO Side Journal Diameter**

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 14.05 mm (0.553 in.) | ..... | FD440V/FD501V |
| 16.07 mm (0.633 in.)                | ..... | FD590V/FD611V |

**Flywheel Side Journal Diameter**

|                                     |       |               |
|-------------------------------------|-------|---------------|
| Service Limit: 14.07 mm (0.554 in.) | ..... | FD440V/FD501V |
| 16.07 mm (0.633 in.)                | ..... | FD590V/FD611V |

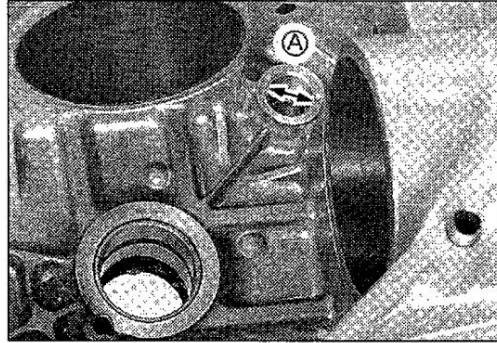


## Camshaft / Crankshaft

- Measure the inside diameter of the camshaft bearing (A) on the crankcase at several points. This bearing is not replaceable. Replace the crankcase if the inside diameter more than the service limit.

### Camshaft Bearing Inside Diameter

Service Limit: 14.07 mm (0.554 in.) ..... FD440V/FD501V  
16.07 mm (0.633 in.) ..... FD590V/FD611V



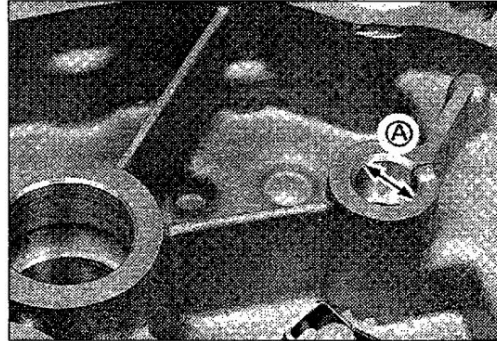
- Measure the inside diameter of the camshaft bearing (A) on the crankcase cover at several points.

This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

16.07 mm (0.633 in.) FD590V

### Camshaft Bearing Inside Diameter

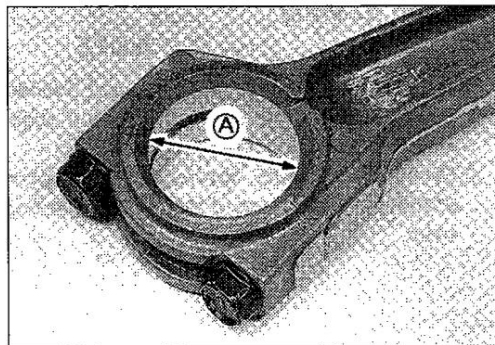
Service Limit: 14.05 mm (0.553 in.) ..... FD440V/FD501V  
16.07 mm (0.633 in.) ..... FD590V/FD611V





**9-30 SUPPLEMENT – FD440V ~ FD611V****Camshaft / Crankshaft***Crankshaft, Connecting Rod Inspection / Maintenance:***Connecting Rod Big End Bearing/Crankpin Wear**

- Place the connecting rod cap over its big end to align the pilot grooves on the cap and rod.
- Coat a light film of oil on the thread of the cap bolts.
- Install the cap bolts and tighten bolts to the specified torque (see Exploded View).
- Measure the inside diameter (A) of both ends at several points with a telescoping gauge or inside micrometer.
- ★ If either measurement is more than specifications, replace the connecting rod with a new one.

**Connecting Rod Big End Inside Dia.**

**Service Limit:** 31.06 mm (1.223 in.) ..... FD440V/FD501V  
 34.06 mm (1.341 in.) ..... FD590V/FD611V

**Connecting Rod Small End Inside Dia.**

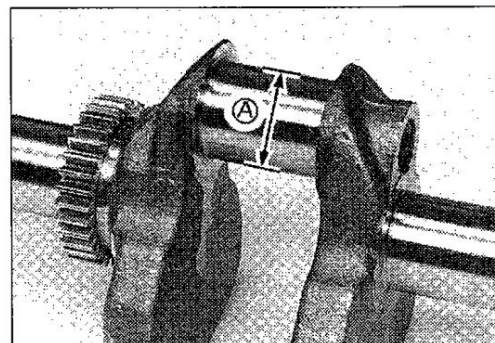
**Service Limit:** 16.05 mm (0.632 in.) ..... FD440V/FD501V  
 17.05 mm (0.671 in.) ..... FD590V/FD611V

- Measure the crankpin outside diameter.
- 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:** 30.93 mm (1.218 in.) ..... FD440V/FD501V  
 33.91 mm (1.335 in.) ..... FD590V/FD611V

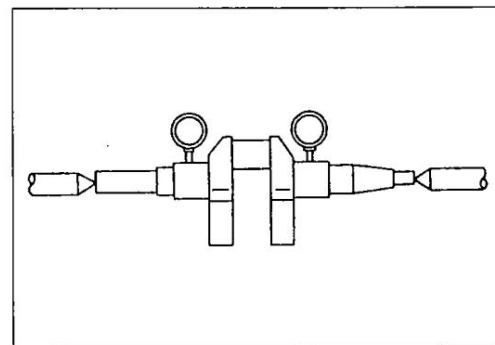
A. Outside Diameter

**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 lowest dial gauge readings (TIR) is the amount of runout.
- ★ If the measurement exceeds the service limit, replace the crankshaft.

**Crankshaft Runout**

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

**Crankshaft Main Journal/Wear**

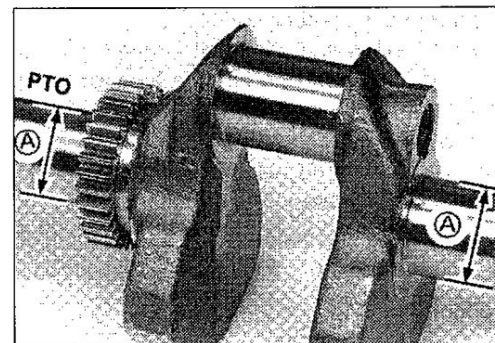
- With a micrometer, measure the both main journals at several points around the journal circumference.
- ★ If either measurement (A) is less than specifications, replace the crankshaft with a new one.

**Crankshaft Main Journal Diameter**

**Service Limit:** 29.92 mm (1.178 in.) ..... FD440V/FD501V  
 33.91 mm (1.335 in.) ..... FD590V/FD611V

**Flywheel Side Journal Diameter**

**Service Limit:** 33.909 mm (1.3350 in.)





## Camshaft / Crankshaft

### Crankpin Resizing

#### NOTE

- Under size connecting rod is not available for FD440V/FD501V engines. Replace the crankshaft if measurements are less than specifications.
- On FD590V/FD611V engines, connecting rod journal can be resized to accept under-sized connecting rod. Have grinding done by a reliable repair shop.

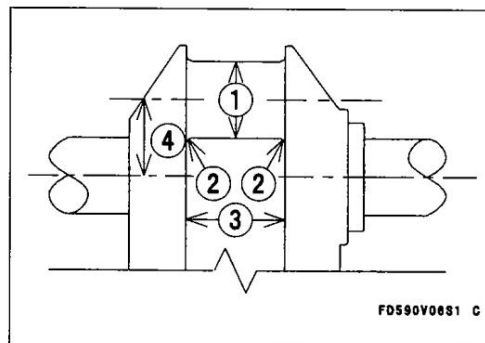
Crankpin can be to accept 33.5 mm (1.3189 in.) dia under size connecting rod. The crankpin should be reground if the crankpin is so much undersize and so much scored that a lapping operation will prove unsatisfactory. Reground can be done by a reliable repair shop.

- 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 – FD590V/FD611V

|    |  |
|----|--|
| 1. | <u>33.480 to 33.467 mm</u><br>(1.318 to 1.3176 in.)  |
| 2. | <u>2.30 to 2.70 mm</u><br>(0.09 to 0.11 in.)         |
| 3. | <u>44.40 mm MAX</u><br>(1.748 in. MAX)               |
| 4. | <u>34.000 to 33.950 mm</u><br>(1.3386 to 1.3366 in.) |

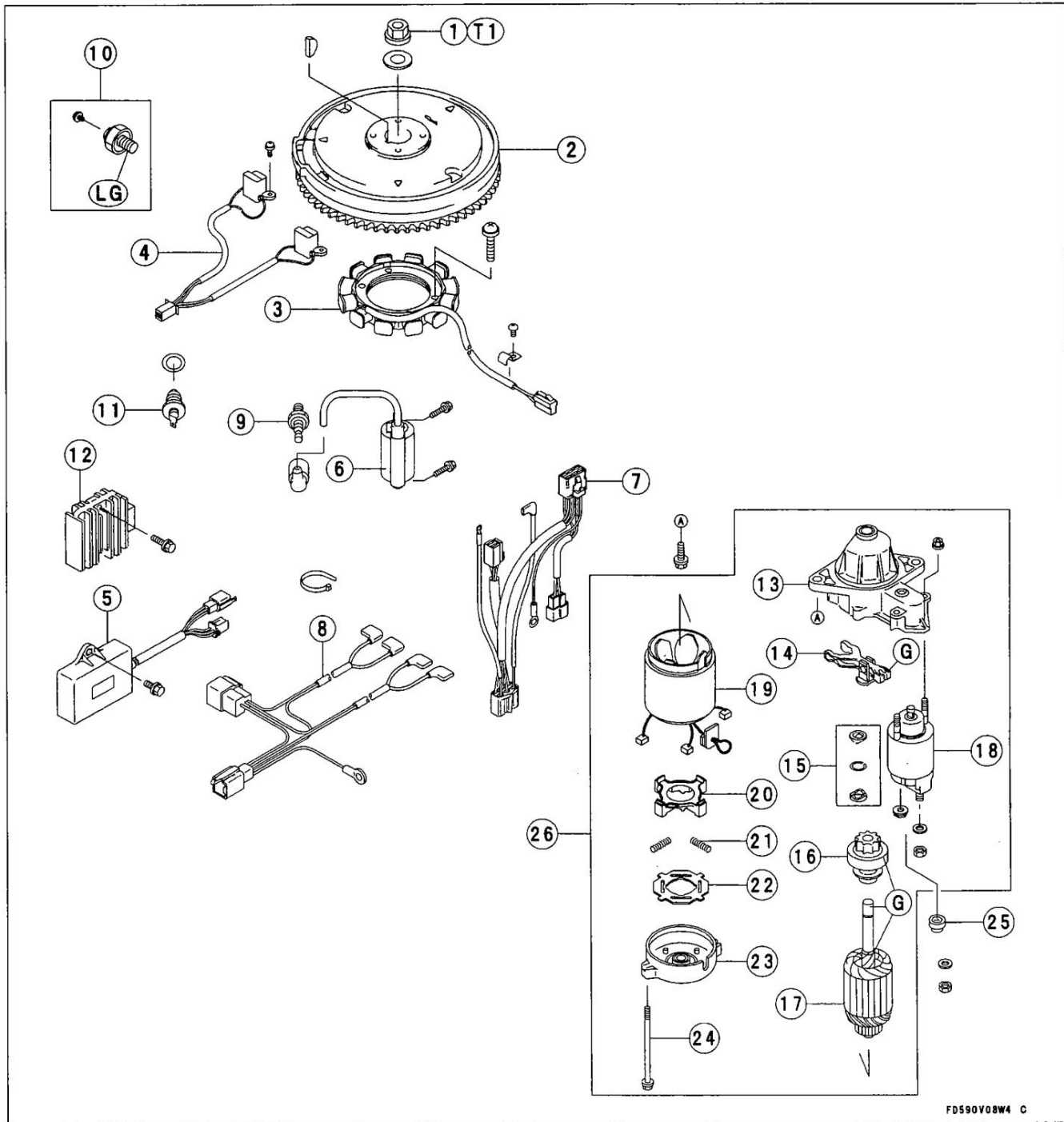
- The crankpin surface should be concentric and parallel to each other within 0.006 mm (0.0002 in.) full indicator reading.
- Finish the crankpin surface with a super finishing stone.



## 9-32 SUPPLEMENT – FD440V ~ FD611V

### Electrical System

#### Exploded View



- 1. Alternator-Rotor Nut (Flywheel Nut)
- 2. Alternator Rotor (Flywheel)
- 3. Alternator Stator (Charging Coil)
- 4. Pulser Coil
- 5. Igniter
- 6. Ignition Coils
- 7. Wire Harness
- 8. Wire Harness
- 9. Spark Plug
- 10. Oil Pressure Switch

- 11. Thermo Switch
- 12. Voltage Regulator
- 13. Front Cover
- 14. Shift Lever
- 15. Stopper
- 16. Pinion
- 17. Armature
- 18. Solenoid
- 19. Brushes
- 20. Brush Holder
- 21. Brush Springs

- 22. Insulator
- 23. End Cover
- 24. Retaining Bolts
- 25. Cover
- 26. Electric Starter Assembly
- T1: FD440V/FD501V...88 N-m (9.0 kg-m, 65ft-lb)  
FD590V/FD611V...118 N-m (12 kg-m, 86.8 ft-lb)
- G: Apply grease
- LG: Apply liquid gasket

FD590V08W4 C

## Electrical System

### Specifications

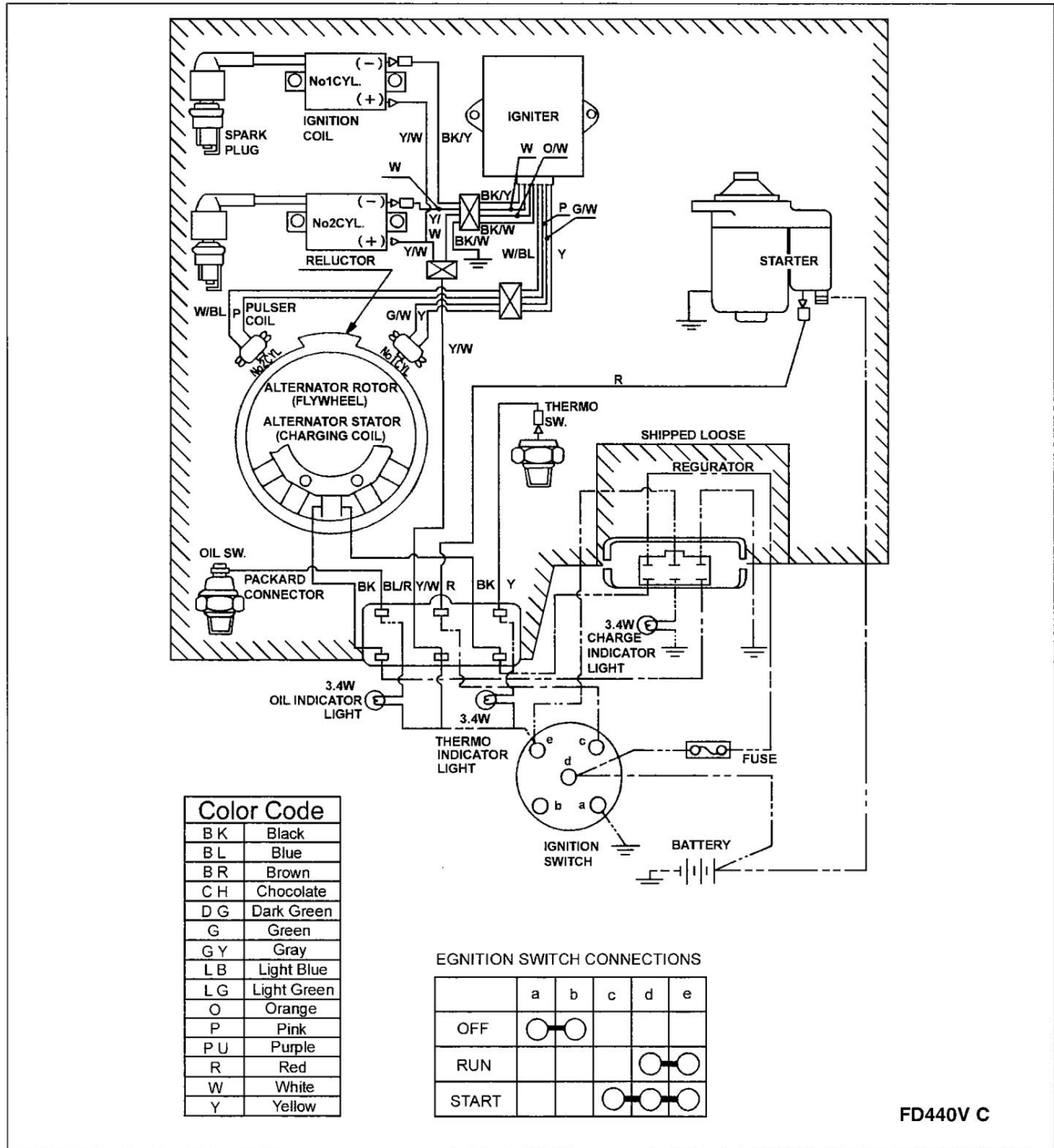
| Item                              | Standard   | Service Limit      |
|-----------------------------------|--|--------------------|
| <b>Chargine System:</b>           |  |                    |
| Regulated output voltage          | Battery voltage to 14 ~ 15 V DC @3000 rpm                | ---                |
| Alternator stator coil resistance | 0.12 to 0.18 $\Omega$                                    | ---                |
| Unregulated stator output         | ---  | 26 VAC/3000 rpm    |
| Regulator resistance              | See charging system                                      |                    |
| <b>Ignition System:</b>           |  |                    |
| Pulser Coil:                      |  |                    |
| Coil air gap                      | 0.45 to 0.95 mm (0.018 to 0.037 in.)<br>(not adjustable) | ---                |
| Coil resistance                   | 88 to 132 $\Omega$                                       | ---                |
| Igniter resistance                | See ignition system                                      | ---                |
| Ignition coil:                    |  |                    |
| Primary winding resistance        | 3.4 to 4.6 $\Omega$                                      | ---                |
| Secondary winding resistance      | 10.4 to 15.6 k $\Omega$                                  | ---                |
| Spark plug                        | NGK BMR6A (FD440V/FD590V/FD611V)<br>NGK BPR2ES (FD501V)  | ---                |
| Plug gap                          | 0.6 to 0.7 mm (0.024 to 0.028 in.)                       | ---                |
| <b>Electric Starter System:</b>   |  |                    |
| Starter motor:                    |  |                    |
| Carbon brush length               | 10 mm (0.394 in.)  | 6.0 mm (0.24 in.)  |
| Commutator groove depth           | 0.5 to 0.8 mm (0.02 to 0.031 in.)                        | 0.2 mm (0.008 in.) |
| Commutator diameter               | 28 mm (1.102 in.)  | 2.7 mm (1.06 in.)  |
| Commutator runout                 | ---  | 0.4 mm (0.016 in.) |



## 9-34 SUPPLEMENT – FD440V ~ FD611V

### Electrical System

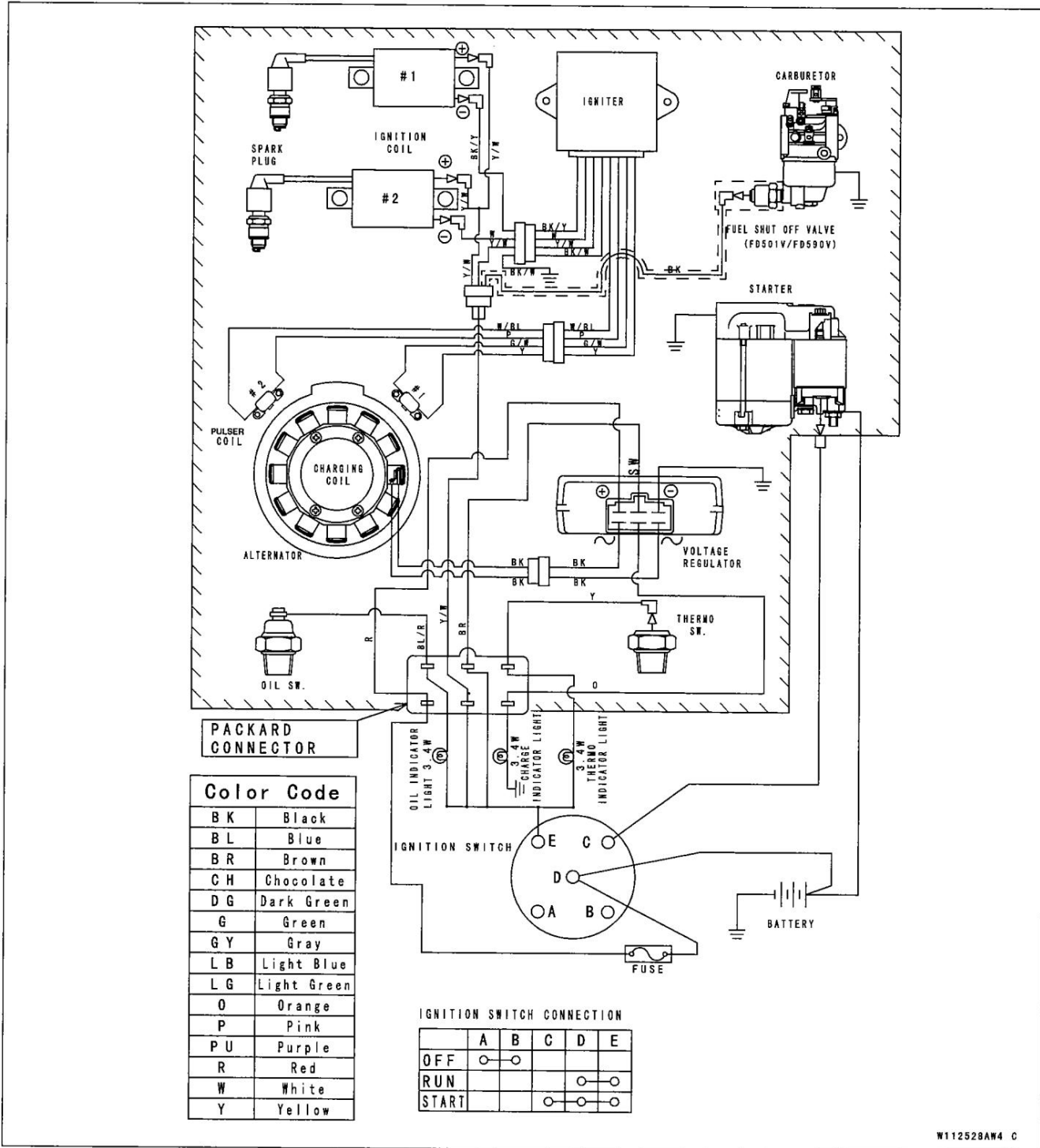
#### Wiring Diagram (FD440V)



Note: PORTION SURROUNDED BY *///* SHOWS KAWASAKI PROCURMENT PARTS

**Electrical System**

*Wiring Diagram (FD501V/FD590V/FD611V)*



**9-36 SUPPLEMENT – FD440V ~ FD611V****Electrical System***Charging System***Charging System Operational Inspection**

- Check battery condition.

**NOTE**

- *Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.*

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

**Regulated Output Voltage****Battery Voltage to 14 ~ 15 VDC****Charging Coil Resistance (FD501V/FD590V/FD611V)**

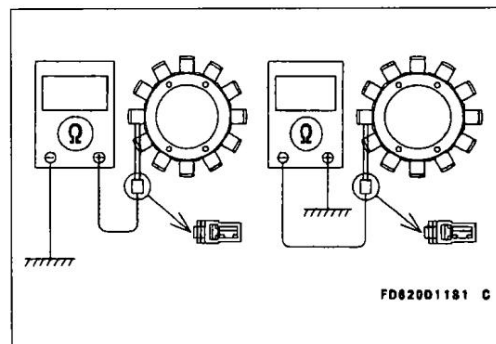
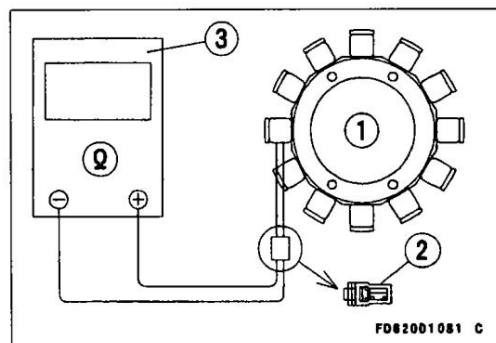
- Disconnect the 2P connector of charging coil.
- Measure the charging coil resistance.
- Connect a hand tester to the 2P connector Pins.

**Charging Coil Resistance****0.12 to 0.18  $\Omega$** 

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

1. Charging Coil
2. 2P Connector
3. Hand Tester

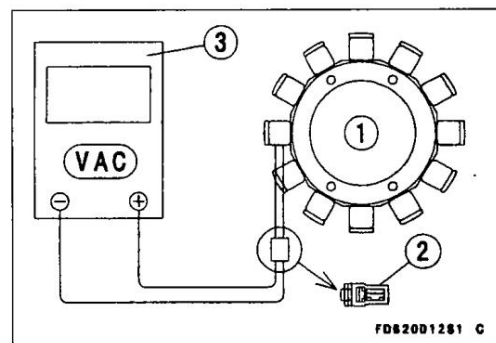
- Check for continuity between each 2P connector pin and ground. There should be no continuity (infinite ohm).
- ★ If the charging coil fails any of these tests, replace the charging coil with a new one.

**Unregulated Stator Output (FD501V/FD590V/FD611V)**

- Disconnect the 2P connector of charging coil.
- Connect AC voltmeter to the 2P connector pins.
- Start the engine. Run the engine at the 3000 rpm speed.
- Voltage reading should be minimum 26 VAC/3000 rpm.
- ★ If the AC voltage reading is less than the specification replace the stator.

**Unregulated Stator Output (MIN)****26 VAC/3000 rpm**

1. Charging coil
2. 2P Connector
3. AC Voltmeter





## Electrical System

### Regulator Resistance

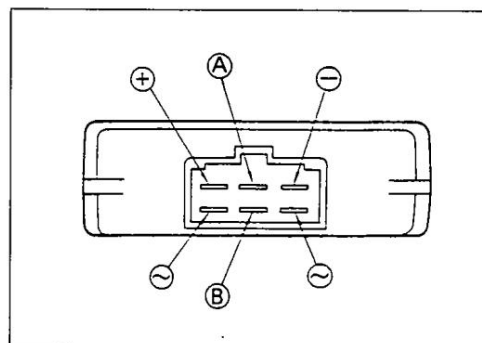
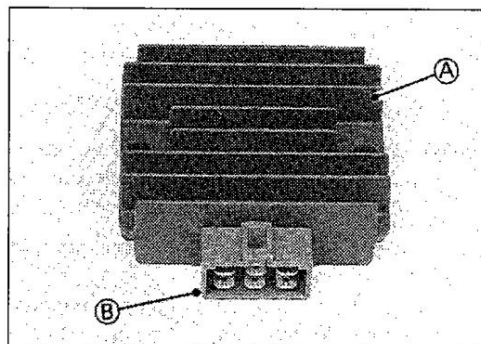
- Set the hand tester to the  $R \times 1 \text{ k}\Omega$  or  $R \times 100 \Omega$  position.
- Connect the test leads to the points shown on the chart and read the resistance.
- ★ If the resistance is not as specified replace the regulator.

### NOTE

- This voltage regulator is an open type.

A. Regulator

B. 6P Connector



### FD440V

Range  $R \times 1 \text{ k}\Omega$ 

| (+)<br>(-) | +                                | (A)                             | -                                  | ~                               | ~                               | (B)                            |
|------------|----------------------------------|---------------------------------|------------------------------------|---------------------------------|---------------------------------|--------------------------------|
| +          |                                  | $\infty$                        | $\infty$                           | $\infty$                        | $\infty$                        | $\infty$                       |
| (A)        | 4 k $\Omega$ ~<br>20 k $\Omega$  |                                 | 200 $\Omega$ ~<br>~1 k $\Omega$    | 1 k $\Omega$ ~<br>5 k $\Omega$  | 1 k $\Omega$ ~<br>5 k $\Omega$  | 200 k $\Omega$ ~<br>~ $\infty$ |
| -          | 3 k $\Omega$ ~<br>15 k $\Omega$  | 200 $\Omega$ ~<br>~1 k $\Omega$ |                                    | 1 k $\Omega$ ~<br>5 k $\Omega$  | 1 k $\Omega$ ~<br>5 k $\Omega$  | 200 k $\Omega$ ~<br>~ $\infty$ |
| ~          | 1 k $\Omega$ ~<br>5 k $\Omega$   | $\infty$                        | $\infty$                           |                                 | $\infty$                        | $\infty$                       |
| ~          | 1 k $\Omega$ ~<br>5 k $\Omega$   | $\infty$                        | $\infty$                           | $\infty$                        |                                 | $\infty$                       |
| (B)        | 10 k $\Omega$ ~<br>50 k $\Omega$ | 1 k $\Omega$ ~<br>5 k $\Omega$  | 1.5 k $\Omega$ ~<br>7.5 k $\Omega$ | 4 k $\Omega$ ~<br>20 k $\Omega$ | 4 k $\Omega$ ~<br>20 k $\Omega$ |                                |

### FD501V/FD590V/FD611V

Range  $R \times 100 \Omega$ 

| (+)<br>(-) | +        | (A)                              | -                             | ~                               | ~                               | (B)                               |
|------------|----------|----------------------------------|-------------------------------|---------------------------------|---------------------------------|-----------------------------------|
| +          |          | $\infty$                         | $\infty$                      | $\infty$                        | $\infty$                        | $\infty$                          |
| (A)        | $\infty$ |                                  | $\infty$                      | $\infty$                        | $\infty$                        | $\infty$                          |
| -          | $\infty$ | 500 $\Omega$ ~<br>~50 k $\Omega$ |                               | 10 k $\Omega$ ~<br>1 M $\Omega$ | 10 k $\Omega$ ~<br>1 M $\Omega$ | 500 $\Omega$ ~<br>~ 50 k $\Omega$ |
| ~          | $\infty$ | 1 k $\Omega$ ~<br>200 k $\Omega$ | 50 $\Omega$ ~<br>5 k $\Omega$ |                                 | 10 k $\Omega$ ~<br>1 M $\Omega$ | 1 k $\Omega$ ~<br>200 k $\Omega$  |
| ~          | $\infty$ | 1 k $\Omega$ ~<br>200 k $\Omega$ | 50 $\Omega$ ~<br>5 k $\Omega$ | 10 k $\Omega$ ~<br>1 M $\Omega$ |                                 | 1 k $\Omega$ ~<br>200 k $\Omega$  |
| (B)        | $\infty$ | 1 k $\Omega$ ~<br>200 k $\Omega$ | 50 $\Omega$ ~<br>5 k $\Omega$ | 10 k $\Omega$ ~<br>1 M $\Omega$ | 10 k $\Omega$ ~<br>1 M $\Omega$ |                                   |

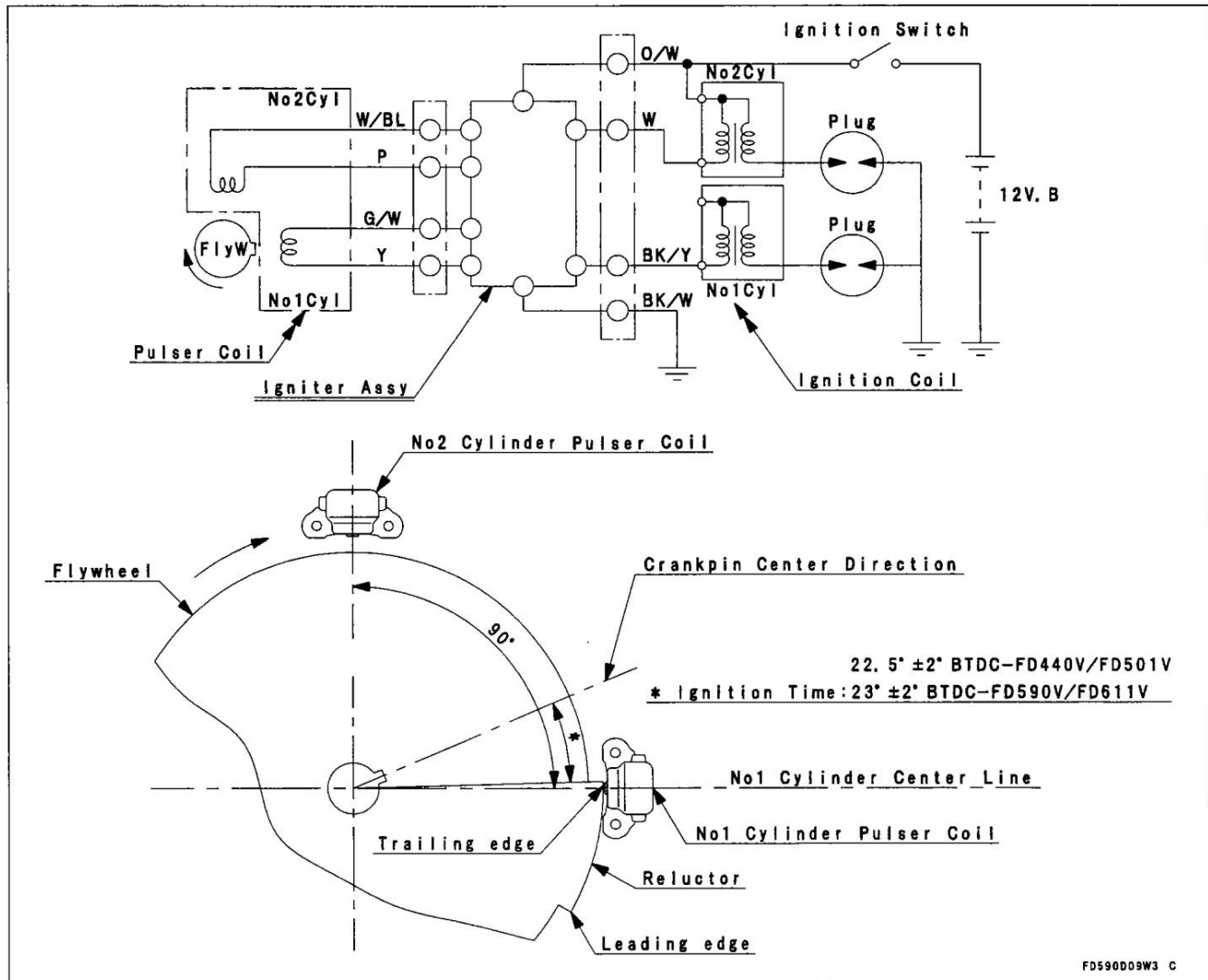
### NOTE

- Resistance value may vary with individual meters.

## 9-38 SUPPLEMENT – FD440V ~ FD611V

## Electrical System

## Ignition System



Transistor controlled battery ignition system is used in this engine. The ignition system is a transistor-controlled battery-ignition and controls the current for the primary circuit by use of an electronic switching unit integrated into the igniter. The switching unit is triggered by the pulser coils (pickup coils) on each cylinder and contains no mechanical parts. This system consists of the following components.

- Ignition coil units
- Igniter (ignition Control Unit)
- Pulser coils (pickup coils)
- 12 V Battery
- Spark plugs

As the starter turns the flywheel, the reluctor in the flywheel runs past the pulser coils, this creates a magnetic field in the pulser coils and close the switching unit in the igniter and allow the current flow through the primary circuit in the ignition coils.

As the flywheel turns, the trailing reluctor passes under pulser coils, opening switching unit in the igniter and causing the primary coil current to stop suddenly. This creates an induced high voltage in a secondary coil windings, which fire the spark plugs.

Each spark plug fires every time the piston rises. When a spark does jump across the electrodes during the exhaust stroke, it will not affect engine operation, since there is no compression and no combustible fuel/air mixture. The transistor controlled ignition system contains no mechanical parts, no wear occurs and no periodic maintenance is required except for the spark plug.

FD590D09W3 C

## Electrical System

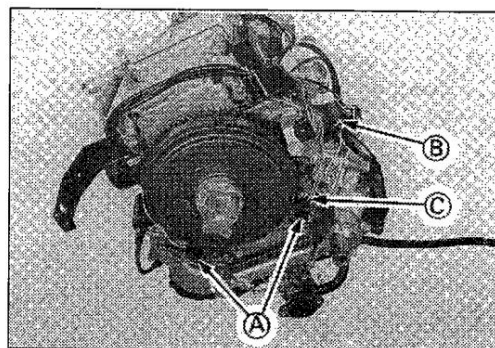
### Pickup Coil Removal

- Remove:
  - Radiator and its Brackets
  - Flywheel Cover
  - Cooling Fan and its Brackets
- Disconnect the wire ties.
- Unscrew the pulser coil mounting screws and pull the pulser coils out of the cylinder block and leave them there.
- Disconnect the 4P coupler of the pulser coil leads end.
- Take off the pickup coils and its wire leads together.

A. Pulser Coils

C. Mounting Screws

B. Wire Tie



### Installation Notes

- Installation is the reverse of removal.
- The pulser coils are mounted in a fixed position on each cylinder. No adjustment of the coil air gaps are required.
- When installing the coils on each cylinder, do not take the coil for another noting the wire color (see Wiring Diagram in this chapter).

### Pulser Coil Air Gap (STD)

0.45 to 0.95 mm (0.018 to 0.037 in.)

### Pulser Coil Resistance

- Set the hand tester to the  $R \times 1 \Omega$  position.
- Connect the test leads to the points shown on the chart and read the resistance.
- ★ If the resistance is not as specified replace the pulser coil.

| Resistance Between                  |                               |
|-------------------------------------|-------------------------------|
| [A] and [B]                         | [C] and [D]                   |
| 88 $\Omega$ to 132 $\Omega$         | 88 $\Omega$ to 132 k $\Omega$ |
| ←----- R $\times$ 1 $\Omega$ -----> |                               |

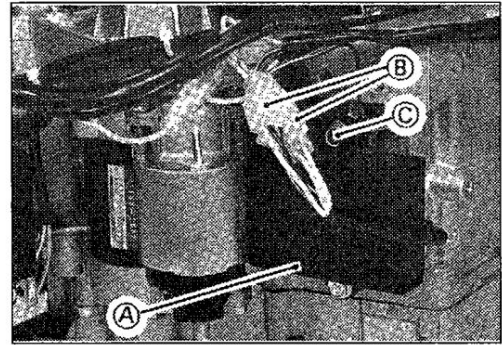
### NOTE

- Resistance value may vary with individual meters.



**9-40 SUPPLEMENT – FD440V ~ FD611V****Electrical System****Igniter Inspection**

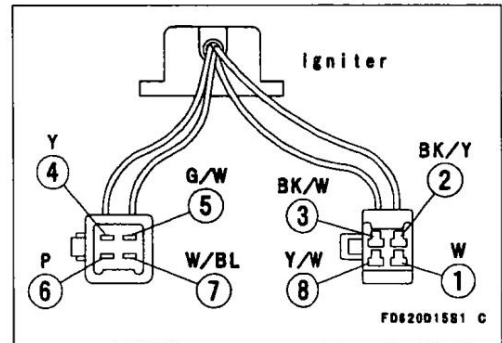
- Remove the igniter.
- Unfasten the igniter lead connectors.
- Unscrew the mounting screws and remove the igniter.
  - A. Igniter
  - B. Lead Connectors (4P Couplers)
  - C. Mounting Screws



- To inspect the igniter resistance, perform the following.
- Set the hand tester to the  $R \times 1 \text{ k}\Omega$  position.
- Connect the test leads to the points shown on the chart and drawing and read the resistance.
- ★ If the meter readings are not as specified, replace the igniter.

**CAUTION**

Use only Kawasaki hand tester (special tool: 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 igniter will be damaged.



| k $\Omega$ | Tester (+) Terminal (Red) |          |          |                  |        |         |        |         |         |
|------------|---------------------------|----------|----------|------------------|--------|---------|--------|---------|---------|
|            | Terminal                  | 1        | 2        | 3                | 4      | 5       | 6      | 7       | 8       |
| (-)*       | 1                         | —        | $\infty$ | 1 ~ 8 k $\Omega$ | 4 ~ 16 | 2 ~ 8   | 4 ~ 16 | 2 ~ 8   | 2 ~ 10  |
|            | 2                         | $\infty$ | —        | 1 ~ 8            | 4 ~ 16 | 2 ~ 8   | 4 ~ 16 | 2 ~ 8   | 2 ~ 10  |
|            | 3                         | $\infty$ | $\infty$ | —                | 1 ~ 6  | 0       | 1 ~ 6  | 0       | 0.5 ~ 2 |
|            | 4                         | $\infty$ | $\infty$ | 1 ~ 6            | —      | 0       | 3 ~ 12 | 1 ~ 6   | 2 ~ 8   |
|            | 5                         | $\infty$ | $\infty$ | 0                | 1 ~ 6  | —       | 1 ~ 6  | 0       | 0.5 ~ 2 |
|            | 6                         | $\infty$ | $\infty$ | 1 ~ 6            | 3 ~ 15 | 0.5 ~ 2 | —      | 1 ~ 6   | 1 ~ 6   |
|            | 7                         | $\infty$ | $\infty$ | 0                | 1 ~ 6  | 2 ~ 8   | 1 ~ 6  | —       | 0.5 ~ 2 |
|            | 8                         | $\infty$ | $\infty$ | 0.5 ~ 2          | 2 ~ 8  | 0.5 ~ 2 | 2 ~ 8  | 0.5 ~ 2 | —       |

(-)\*: Tester (-) Terminal (Black)

- Resistance value may vary with individual meters.

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