

# **Kawasaki**

**FC290V FC400V FC401V**

**FC420V FC540V**

**OHV**

**4-stroke air-cooled gasoline engine**


**WORKSHOP MANUAL**

For Kawasaki Discount Parts Call 606-678-9623 or 606-561-4983

## FOREWORD

This manual is designed for use by trained mechanics in a properly equipped shop. 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 equipments 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.

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

 **WARNING:** This safety alert symbol identifies important safety messages in this manual and on the equipment. When you see this symbol, read the message that follows very carefully to avoid fire, personal injury, or loss of life.

**CAUTION:** This identifies special instructions or procedures to avoid equipment damage or destruction.

**NOTE:** Indicates message or points of particular interest for more efficient and convenient operation.


The term "Replace" and some abbreviations are used as follows:


Replace = Usually means replace with a new part  
MIN = Minimum  
MAX = Maximum  
Assy = Assembly  
STD = Standard  
PTO = Power take off  
Approx. = Approximately (Approximate)  
Carb. = Carburetor  
Con-rod = Connecting rod  
Cyl. = Cylinder  
Dia. = Diameter


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## SAFETY

 **WARNING:** Gasoline is extremely flammable and can be explosive under certain conditions. Stop the engine. 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.

 **WARNING:** When servicing the engine or equipment, always stop the engine and remove the spark plug wire from the spark plug to avoid accidental starting.

 **WARNING:** Protect your hands with gloves or a piece of thick cloth from edges and heat in servicing the product.

 **WARNING:** Before performing any disassembly operations on the equipment with the electric starter, disconnect the negative (-) lead from the battery to avoid the possibility of accidentally cranking the engine while partially disassembled.

 **WARNING:** Always minimize shock hazards when working on the electrical equipment. Work in a clean, dry environment with dry hands. For maximum shock hazard protection, connect the equipment ground terminal to an earth ground.

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## GENERAL INFORMATION

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### MECHANICAL SYSTEM

Be familiar with OPERATOR'S MANUAL before service.

#### Lubrication

Supply engine oil as specified even for a short test running to avoid any score in the engine, which may destroy the engine in the field use. Use clean engine oil in the case specified as just "coat oil" in this manual.

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. 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.

#### Fuel

Unleaded gasoline is preferably recommended because of the less deposit in the combustion chamber. Alcohol mixed gasoline is not recommended due to bad influences of alcohol on the engine components in the fuel and combustion systems.

#### High Flash-point Solvent

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

#### Dirt

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

#### Liquid Gasket and 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).

#### Oil Seal, Grease Seal

Replace any oil or grease seals that were removed, because the removal generally damages seals. A seal guide is required for certain oil or grease seals during installation to avoid damage to the seal lips.

#### Gasket, O-ring

When in doubt as to the condition of a gasket or O-ring, replace it. The mating surfaces around the gasket should be free from foreign matter and smooth to avoid leakage.

#### Circlip, Retaining Ring

Replace any circlips and retaining rings that were removed, because the removal weakens and deforms them. When installing circlips and retaining rings, take care to compress or expand them only enough to install them.

## GENERAL INFORMATION

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### 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 check 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.

### Press

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

### Ball Bearing Installation

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.

### Torque

The torque values given in this manual should always be adhered to. Either too little or too much torque may lead to serious damage. Use a good quality, reliable torque wrench.

### Tightening Sequence

Follow the tightening sequence shown in this manual. When installing a part with several bolts, nuts or screws, they should all be started in their holes and tightened to a snug fit. Then tighten them evenly, according to the tightening sequence, to the specified torque. This is to avoid distortion of the part and/or leakage. Conversely, when loosening the bolts, nuts, or screws, loosen all of them about a quarter of a turn and then remove them.

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## GENERAL INFORMATION

### ELECTRICAL SYSTEM

#### No Shock

The electrical parts should never be sharply struck, with a hammer, or dropped on a hard surface. Such a shock to the parts may damage them.

#### Electrical Leads

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

#### Defective Component

Never replace a defective electrical component 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 new replacement will fail again.

#### Connectors

Make sure all connectors in the circuit are clean and tight, and examine leads for signs of burning, fraying, etc. Poor leads and bad connections will affect electrical system operation.

#### Coil Resistance

Measure coil and winding resistance when the part is cold (at room temperature).

#### Battery

Do not disconnect the battery leads or any other electrical connections when the ignition switch is on, or while the engine is running, unless specifically noted.

Do not reverse the battery lead connections. This will burn out the diodes or other parts in the electrical systems.

Always check battery condition before blaming other parts of an electrical system. A fully charged battery is a must for performing accurate electrical system check.

#### Starter

Never keep the starter engaged if the starter motor will not turn over, or the current may burn out the starter motor windings.

#### KAWASAKI Multimeter

KAWASAKI Multimeter (P/N 395100-9803A) is recommended for the electrical system check because a meter of other type may indicate different value.

### TWO-COLOR LEAD

Lead (cross-section)	
Name of Lead Color	yellow/red



## GENERAL SPECIFICATIONS

ITEM	FC290V	FC400V	FC420V	FC540V
Engine Type	Forced Air-cooled, Vertical Shaft, OHV, 4-Stroke Gasoline Engine			
Number of Cylinder	1			
Piston Displacement	286cc(17.5cub-in.)	404cc(24.8cub-in.)	423cc(25.8cub-in.)	535cc(32.6cub-in.)
Bore x Stroke	78 x 60 mm (3.07 x 2.36 in.)	87 x 68 mm (3.43 x 2.68 in.)	89 x 68 mm (3.50 x 2.68 in.)	89 x 86 mm (3.50 x 3.39 in.)
Direction of Rotation	Counterclockwise facing the PTO Shaft			
Fast Idle Speed	3275 ~ 3425 rpm cf. Note 5			
Low Idle Speed	1450 ~ 1650 rpm			
ACR	Mechanical Flyweight Type			
Lubricating Method	Splash	Pressurized		
Oil Pan Capacity	1.1 L (2.3 US pt)	1.3 L (2.7 US pt)		1.6 L (3.4 US pt)
Carburetor	Float Type Fixed Main Jet			
Choke Control	Automatic (with Throttle Control)			
Air Cleaner	Semi-cyclone Type with Dual Element			
Ignition	Transistorized Flywheel Magneto			
Charging Coil *	12 V - 3 A with Rectifier			
	12 V - 13 A with Regulator		12 V - 15 A with Regulator	
Spark Plug	Champion RN11YC or NGK BPR5BS			
RFI Suppressor *	Per Canada and USA Requirement			
Electric Starter	12 V - 0.6 kW Bendix Type *	12 V - 0.6 kW Shft Type*		12 V - 0.8 kW Shift Type
Cooling Air Inlet	Rotating Screen with Periphery Blade Protector			
Fuel Pump *	Diaphragm Type Pulse Pump			
Governor	Mechanical Flyweight			
Balancing	Reciprocating Balance Weight			
Recommended Battery	12 V - 200 CCA			12 V - 280 CCA
	12 V - 280 CCA			12 V - 510 CCA

- Note :
1. Specifications are subject to change without notice.
  2. ACR = Automatic Compression Release.
  3. Parts with \* are option.
  4. Recommended Batteries listed in upper column are for regular use and in lower column for low temperature application.
  5. Fast idle speed may vary depending on each equipment on which engine is used. Refer to the equipment specification.

# WIRING DIAGRAM

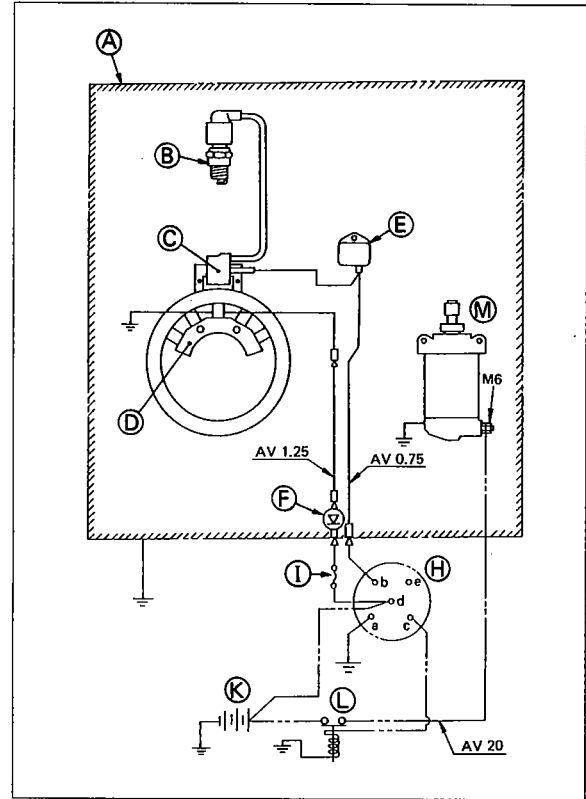
## FC290 ELECTRIC STARTER MODEL

12V-3A

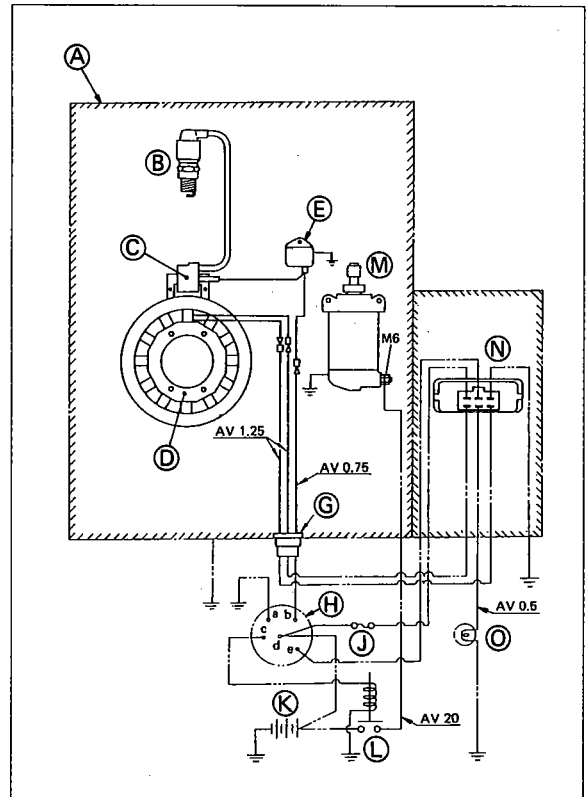
1. Charging coil outputs are shown above each diagram.
2. Portion surrounded by hatching shows KAWASAKI procurement parts.
3. Key switch connections are shown below.

	a	b	c	d	e
OFF	○—○				
RUN				○—○	
START			○—○	○—○	

- A: Engine
- B: Spark plug
- C: Ignition coil
- D: Charging coil
- E: Control unit
- F: Rectifier
- G: Connector (3P)
- H: Key switch
- I: Fuse (10 A)
- J: Fuse (20 A)
- K: Battery
- L: Solenoid switch
- M: Starter
- N: Regulator
- O: Charge light (12 V, 3.4 W)



12V-13A



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## WIRING DIAGRAM

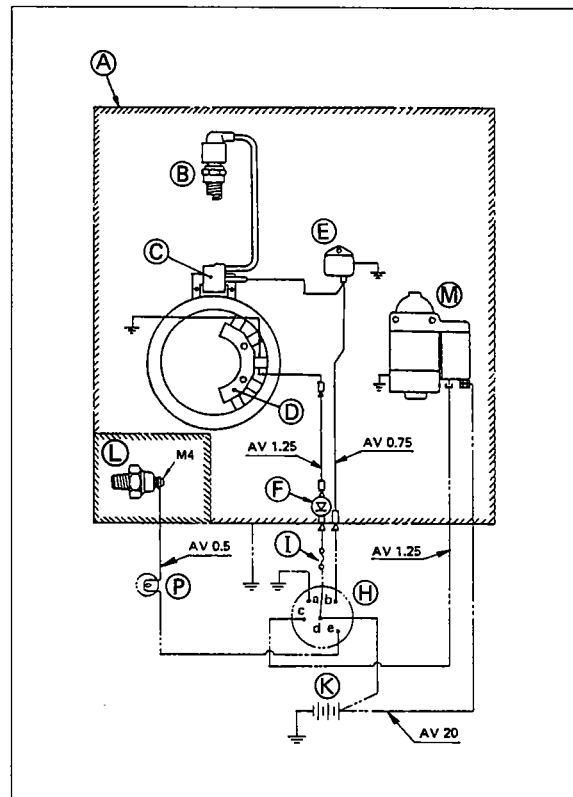
## FC400, FC420 &amp; FC540 ELECTRIC STARTER MODEL

1. Charging coil outputs are shown above each diagram.
2. Portion surrounded by hatching shows KAWASAKI procurement parts.
3. Key switch connections are shown below.

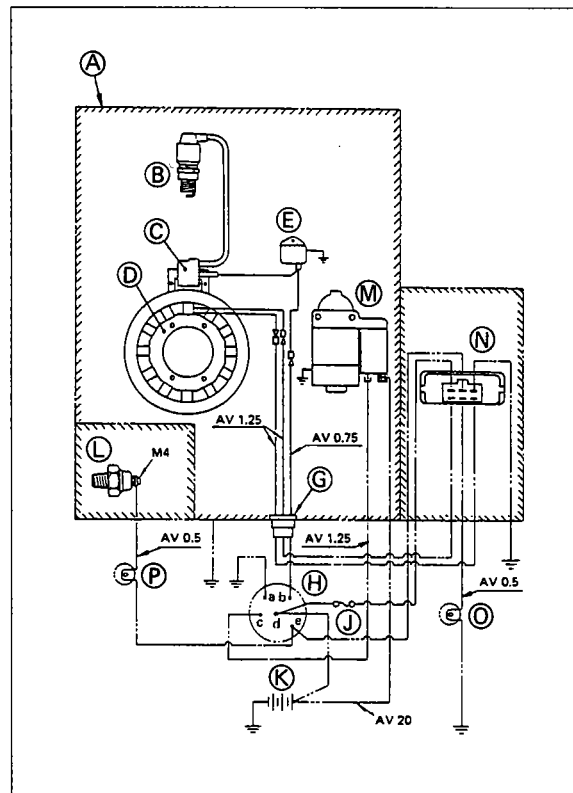
	a	b	c	d	e
OFF	○	○			
RUN				○	○
START			○	○	○

- A: Engine  
 B: Spark plug  
 C: Ignition coil  
 D: Charging coil  
 E: Control unit  
 F: Rectifier  
 G: Connector (3P)  
 H: Key switch  
 I: Fuse (10 A)  
 J: Fuse (20 A)  
 K: Battery  
 L: Oil pressure switch  
 M: Starter  
 N: Regulator  
 O: Charge light (12 V, 3.4 W)  
 P: Oil pressure light (12 V, 3.4 W)

12V-3A



12V-13A (FC400 · FC420)  
 12V-15A (FC540)



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## PERIODIC MAINTENANCE

To ensure satisfactory operation over extended period of time, engine requires normal maintenance at regular intervals.

Chart below shows periodic maintenance. Suitable interval is shown as (○).

MAINTENANCE	INTERVAL					
	Daily	Every 25 hr	Every 50 hr	Every 100 hr	Every 200 hr	Every 300 hr
Check and add engine oil.	○					
Check for loose or lost nuts and screws.	○					
Check for fuel and oil leakage.	○					
Check battery electrolyte level.	○					
Check or clean air intake screen.	○					
★★ Clean air cleaner foam element.		○				
Tighten nuts and screws.		○ (first)		○		
★★ Clean air cleaner paper element.			○			
Clean fuel valve.			○			
★ 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 cylinder and cylinder head fins.						○
Clean combustion chamber.						○
Check and adjust valve clearance.						○
Clean and lap valve seating surface.						○

★ Perform these maintenances after first 5 hours (FC290V) or 10 hours (FC400V•FC420V•FC540V) of use, then at recommended intervals.

★★ Service more frequently under dusty conditions.

# TROUBLE SHOOTING

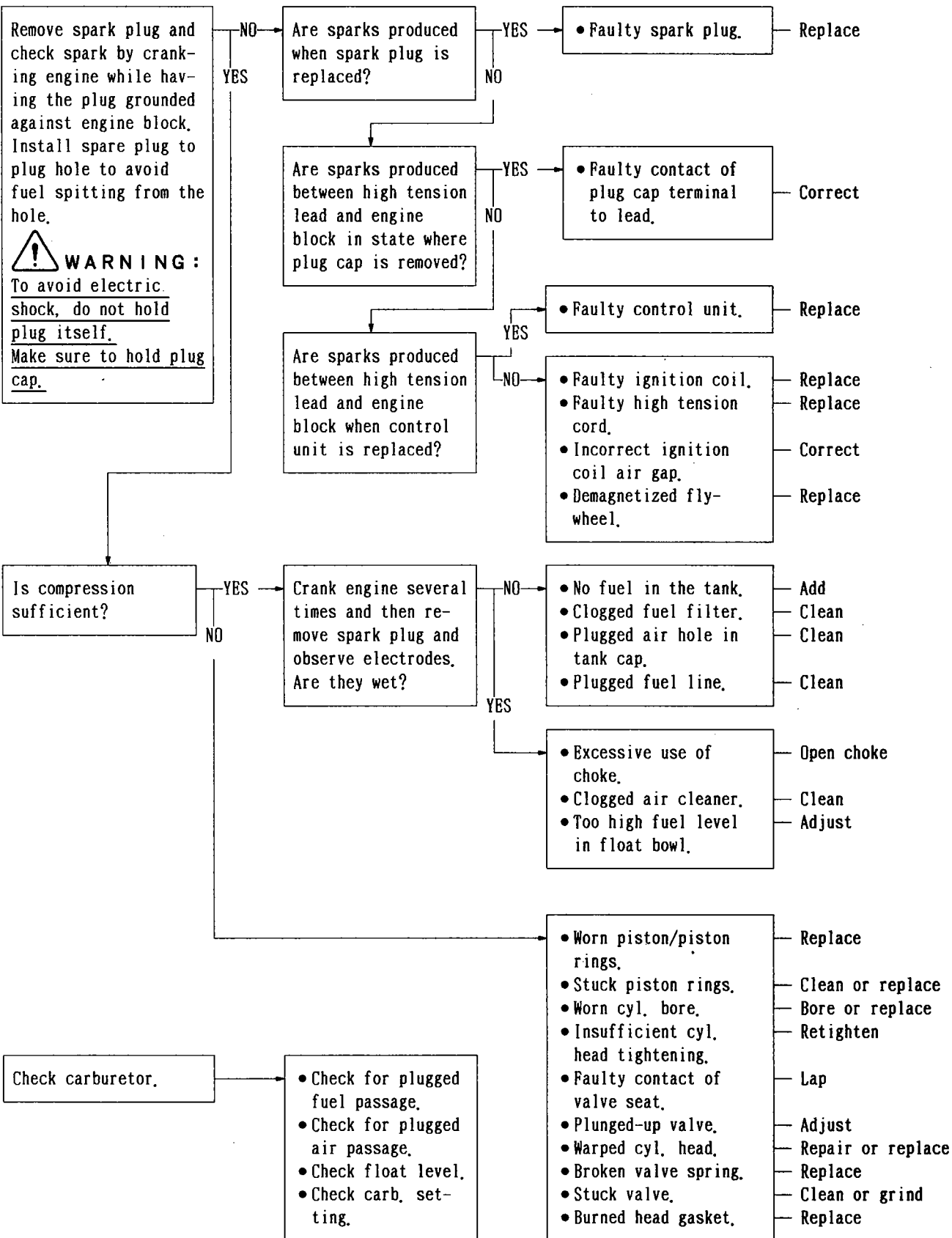
## ENGINE — HARD STARTING

Remove spark plug and check spark by cranking engine while having the plug grounded against engine block. Install spare plug to avoid fuel spitting from the hole.



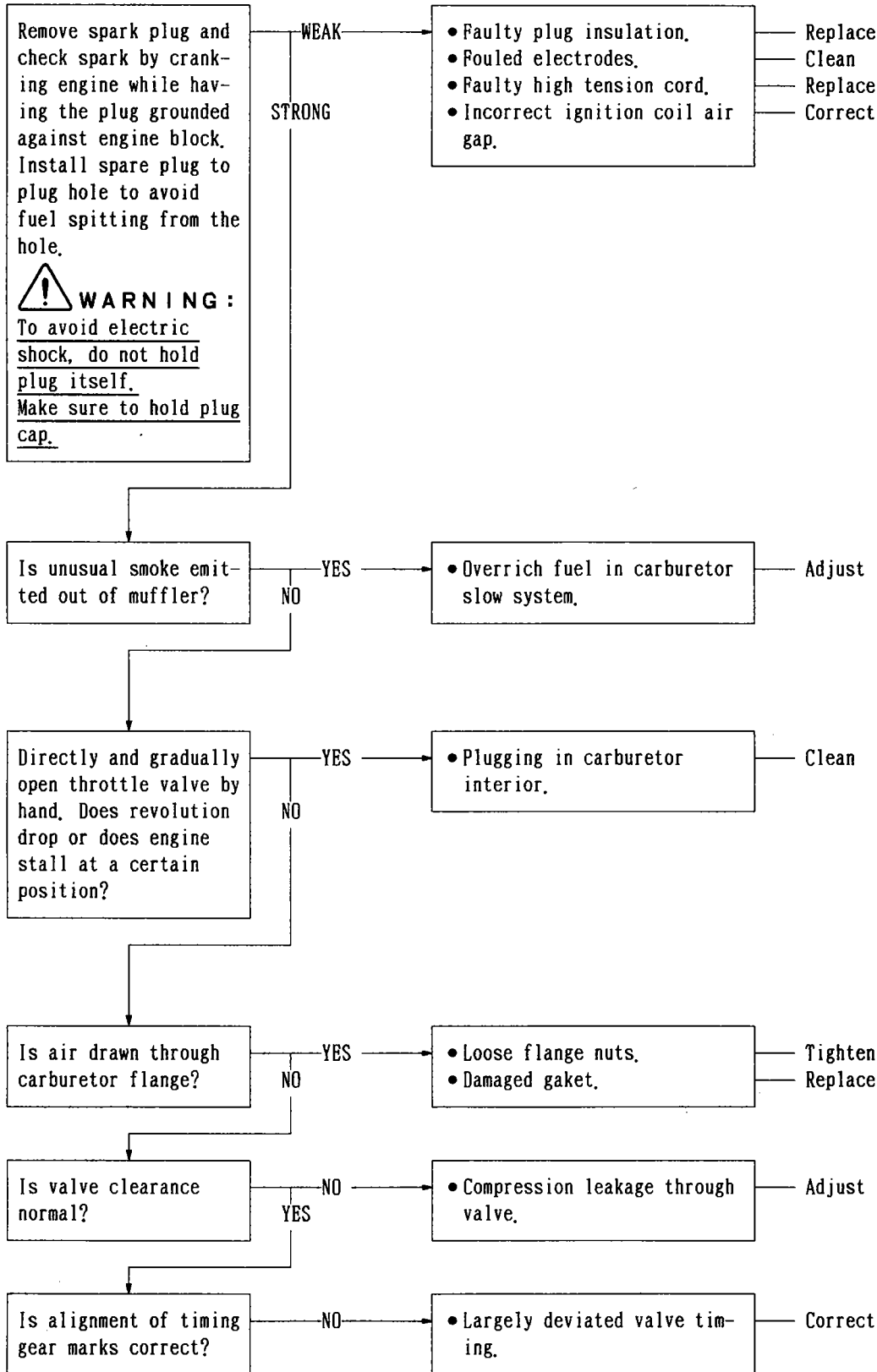
**WARNING :**

To avoid electric shock, do not hold plug itself. Make sure to hold plug cap.



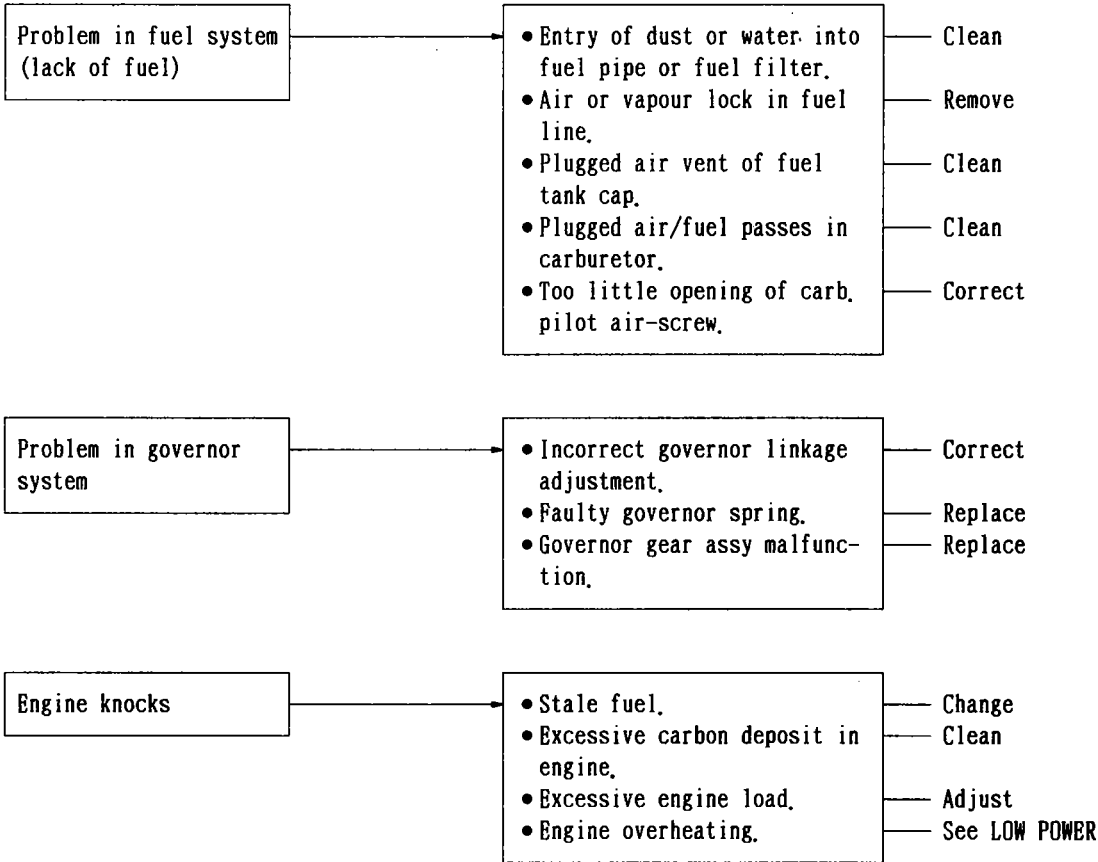
# TROUBLE SHOOTING

## ENGINE — MALFUNCTIONS AT LOW SPEED



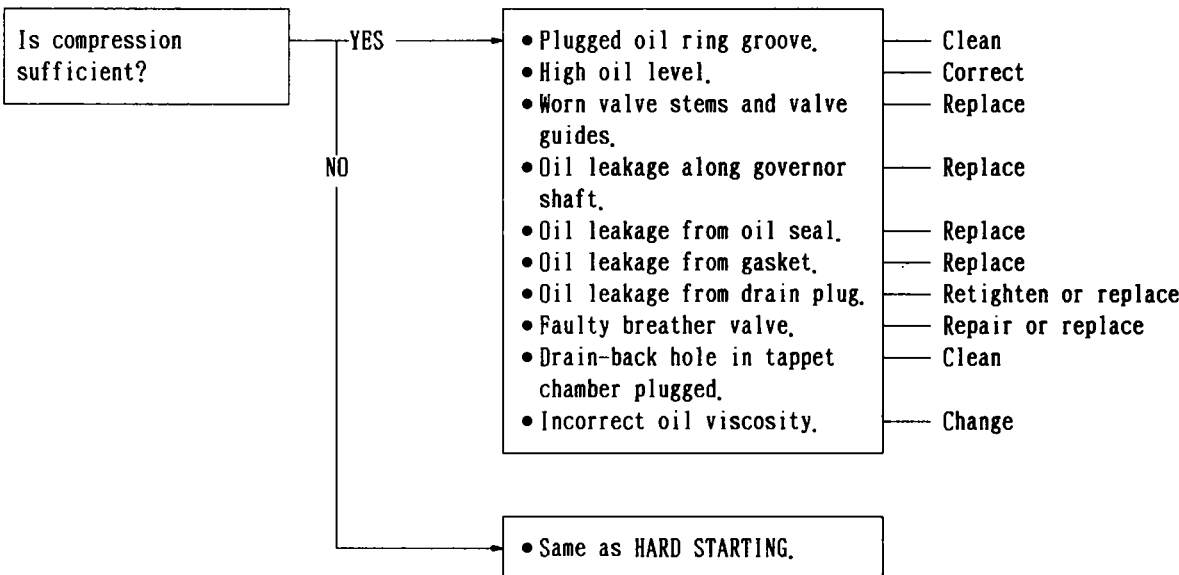
# TROUBLE SHOOTING

## ENGINE - ERRATICAL RUN



E08FC03W2

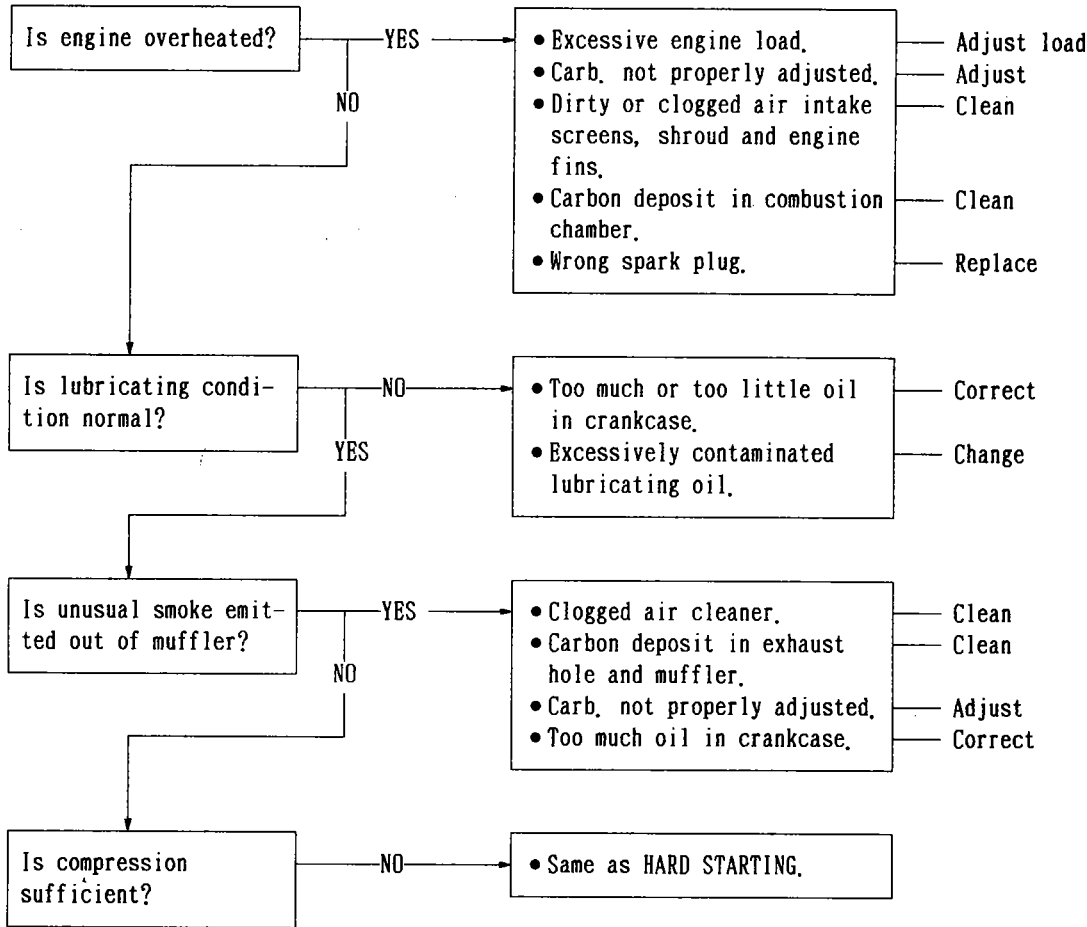
## ENGINE - EXCESSIVE OIL CONSUMPTION



E08FC08W2

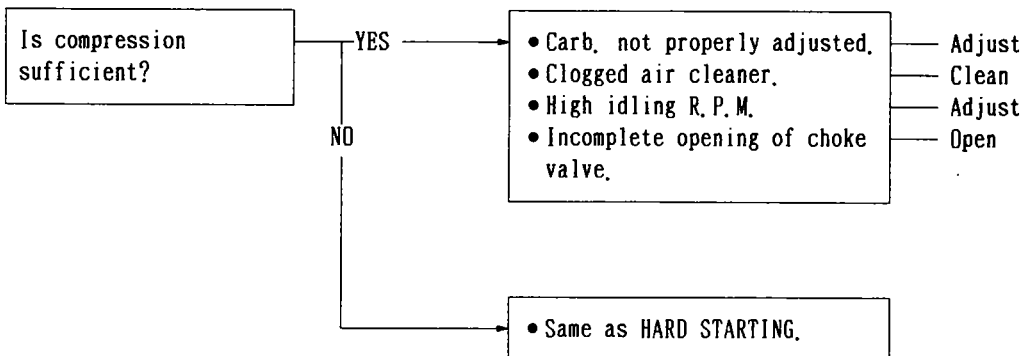
# TROUBLE SHOOTING

## ENGINE - LOW POWER



E08FC04W3

## ENGINE - EXCESSIVE FUEL CONSUMPTION



E08FC05W1



## TORQUE SPECIFICATIONS

ITEM	FC290	FC420	FC540
Con-rod bolt	20 N·m (180 lbf·in)		
Crankcase cover bolt	26 N·m (230 lbf·in)		
Valve clearance adjust nut	20 N·m (180 lbf·in)		
Cylinder head bolt and nut	24 N·m (220 lbf·in)	52 N·m (38 lbf·ft)	52 N·m (38 lbf·ft)
Flywheel nut	86 N·m (63 lbf·ft)	137 N·m (101 lbf·ft)	172 N·m (127 lbf·ft)
Electric starter to block bolt and nut	23 N·m (200 lbf·in)	16 N·m (140 lbf·in)	16 N·m (140 lbf·in)
Electric starter terminal nut	5 N·m (45 lbf·in)	9 N·m (80 lbf·in)	11 N·m (100 lbf·in)
Oil drain extension joint to block	Tighten firmly. Be careful not to over torque, to avoid thread damage.		
Oil drain plug	23 N·m (200 lbf·in)		
PTO side crankshaft end bolt (with plane washer) (if equipped)	38 N·m (340 lbf·in)		
Engine mounting flange bolt (M8) (if equipped)	20 N·m (180 lbf·in)		
General bolt ④	M 5	3.5 N·m (30 lbf·in)	
	M 6	6.0 N·m (50 lbf·in)	
	M 8	15 N·m (130 lbf·in)	

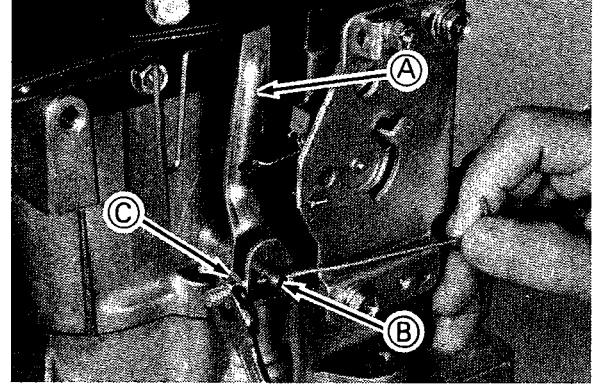
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## CONTROL SYSTEM

### GOVERNOR LEVER SETTING

Whenever carburetor or governor lever is removed from engine and then installed again, adjust governor lever position.

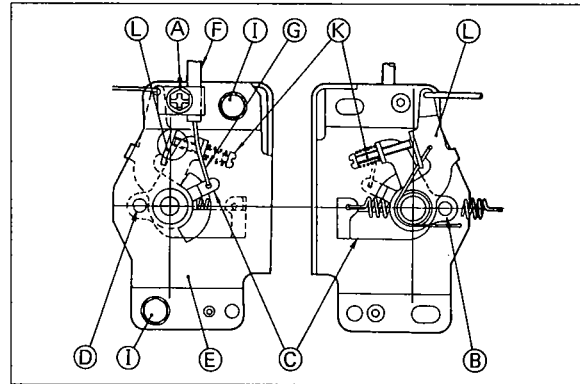
1. Install governor lever (A) on governor shaft (B) but do not tighten nut (C).  
Loosen nut (C) if it is tightened.
2. Turn governor lever (A) clockwise or place throttle lever on dash in "FAST" position to open carb. throttle valve fully.
3. Turn governor shaft (B) clockwise to end of travel.
4. Keeping governor lever position of throttle fully open, tighten nut (C).



E16FC01W2

### THROTTLE CABLE INSTALLATION

1. Link throttle cable (G) to speed control lever (C) and clamp throttle cable outer housing (F) temporarily.
2. With throttle lever on dash in "FAST" position, align hole (B) of speed control lever (C) with hole (D) of control plate (E) and insert 6 mm (0.24 in.) dia. pin or 6 mm bolt through two holes.
3. Pull out throttle cable outer housing (F) to remove any slack and tighten cable clamp bolt (A).
4. Remove 6 mm pin and set throttle lever on dash in "CHOKE" position. Make sure carb. choke valve is completely closed. (See CHOKE ADJUSTMENT)



E16FC02W2

## CONTROL SYSTEM

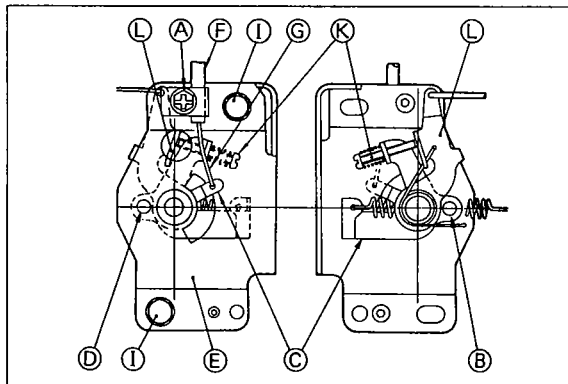
### FAST IDLE SPEED ADJUSTMENT

**NOTE :** Air cleaner must be installed to engine before starting.

1. Start and warm up engine without load.
2. Loosen two control plate bolts (I).
3. Align hole (B) of speed control lever (C) with hole (D) of control plate (E) and insert 6 mm (0.24 in.) dia. pin or 6 mm bolt through two holes.

**NOTE :** Make sure choke valve is fully opened.

4. Adjust fast idle speed for specified rpm (see GENERAL SPECIFICATIONS) by moving control plate (E).
5. Tighten two bolts (I) securely in a manner to avoid changing specified speed.
6. Stop engine, remove 6 mm pin, and set throttle lever on dash in "CHOKE" position.  
Make sure carb. choke valve is closed completely.

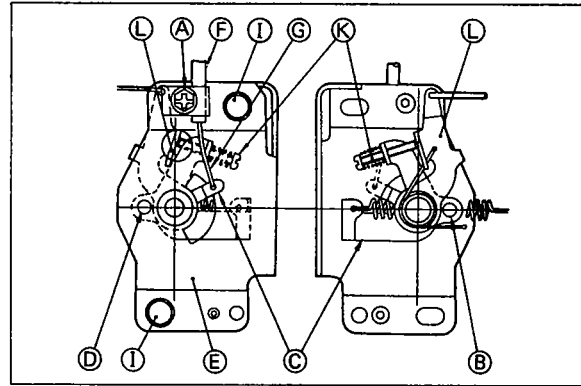


E16FC03W2

## CONTROL SYSTEM

### CHOKE ADJUSTMENT

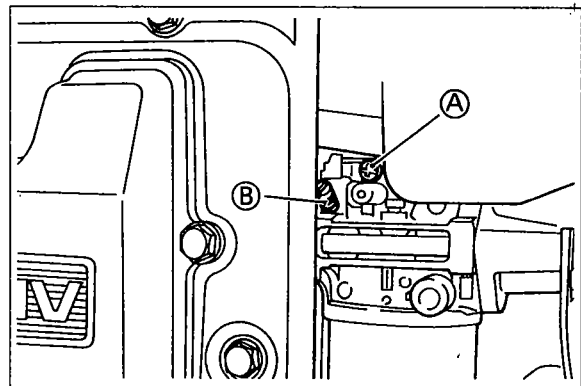
1. Align hole (B) of speed control lever (C) with hole (D) of control plate (E) and insert 6 mm (0.24 in.) dia. pin or 6 mm bolt through two holes.
2. Turn choke setting screw (K) counterclockwise until it is clear of choke control lever (L) and then turn choke setting screw clockwise until it just contacts choke control lever.
3. Remove 6 mm pin and set throttle lever on dash in "CHOKE" position.  
Make sure carb. choke valve is closed completely.



E16FC04W2

### SLOW IDLE SPEED ADJUSTMENT

1. Turn carb. pilot screw (B) in until it just seats and then back out 1-1/2 turns.
2. Start and warm up engine without load.
3. Move throttle lever on dash to "SLOW" position.
4. Adjust slow idle speed to specified rpm (see GENERAL SPECIFICATIONS) by moving throttle stop screw (A).
5. Adjust pilot screw (B) until engine idles at maximum speed and then turn pilot screw out additional 1/4 turn.
6. Re-adjust slow idle speed, to specified rpm.



E16FC05W2

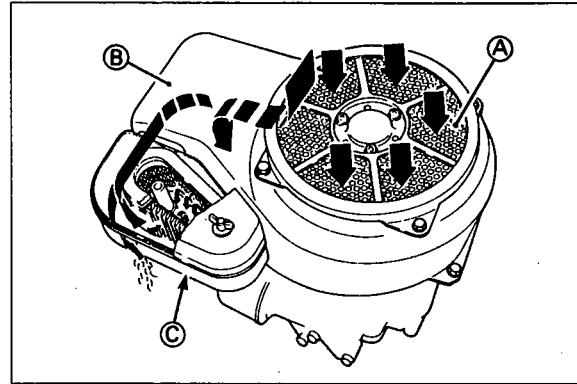
## AIR CLEANER

### "K" KLEEN SYSTEM

Intake air is inducted through rotary screen (A), fan housing (B), and air cleaner (C) to remove grass and rubbish from air.

Therefore, condition of air passages affects volume of intake air and carburetor functions.

1. Assemble related parts neatly to minimize air leakage.
2. Keep clearance between rotary screen and fan housing as shown in COOLING SYSTEM.
3. Do not remove any parts constructing air passages when running engine.
4. Keep air passages free from grass and rubbish.



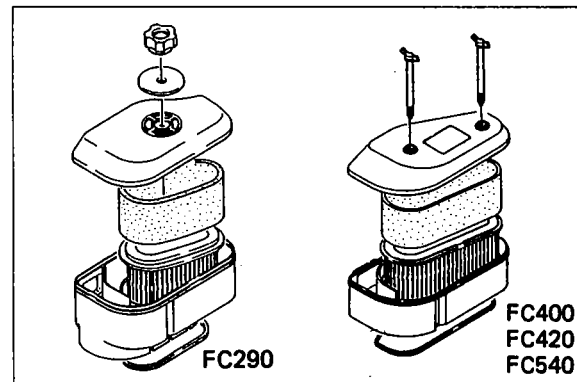
E22FC01W2

### MAINTENANCE

Air cleaner maintenance is one of the most important items to keep engine performing well.

Instruct users for following cautions.

1. FOAM ELEMENT must be lightly oiled to perform as intended. Make sure to soak element in engine oil and squeeze excessive oil, after washed.
2. PAPER ELEMENT is cleaned by gentle tapping or washing in detergent and water.  
Do not use pressurized air to paper element to avoid breakage.  
Do not oil paper element.



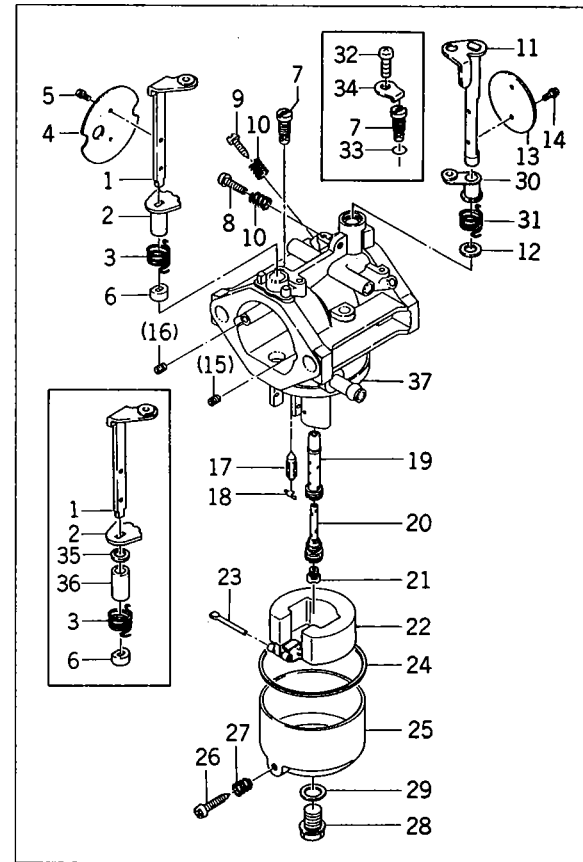
E22FC02W2

# CARBURETOR

## COMPONENTS

This carburetor is float type with adjustable pilot screw (idle mixture), fixed main jet, and float chamber drain screw.

Ref. No.	Part Name	Ref. No.	Part Name
1	Choke shaft	20	Bleed pipe
2	Collar	21	Main jet
3	Spring	22	Float
4	Choke valve	23	Float pin
5	Screw	24	Gasket
6	Ring	25	Float chamber
7	Pilot jet	26	Drain screw
8	Screw	27	Spring
9	Pilot screw	28	Bolt
10	Spring	29	Washer
11	Throttle shaft	30	Collar
12	Seal	31	Spring
13	Throttle valve	32	Screw
14	Screw	33	O-ring
15	Main air jet (FC290, FC400, FC420)	34	Plate
16	Pilot air jet (FC290, FC400, FC420)	35	Seal
17	Needle valve	36	Collar
18	Clip	37	Carb. body
19	Main nozzle		

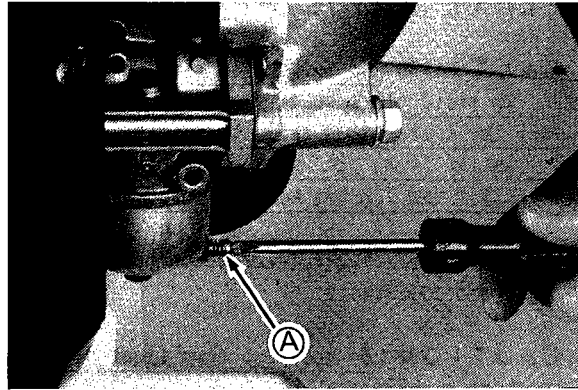


## CARBURETOR

### REMOVAL

**WARNING:** Gasoline is extremely flammable. Avoid fires due to smoking or careless practices.

Before removing carburetor from engine, drain fuel in float chamber to suitable container loosening drain screw (A).



E24FC02W1

### FLOAT CHAMBER REMOVAL

**NOTE:** Before removing float chamber, rotate float chamber clockwise and counterclockwise for 1/6 turns 2 or 3 times, pushing float chamber to carb. body to release sticking of float chamber and rubber gasket.



E24FC06W1

### CLEANING AND CHECK

**CAUTION:** Do not clean jet orifices with hard object.

**WARNING:** Follow instructions prepared by cleaner manufacturer when using cleaner.

1. Dip carb. components except non-metallic parts such as gasket into carb. cleaner until dirt is removed and rinse them with solvent.

**NOTE:** Rinse carb. aluminum components in hot water to neutralize corrosive action of cleaner, if so instructed by the manufacturer.

2. Dry components with compressed air. Make sure all orifices and passages are free from dirt or foreign object.

**CAUTION:** Do not use rags or paper to dry components to avoid plugging orifices by lint.

3. Check diaphragm for crack, tear, or pin hole.

- If defect is found, replace it.

E24FC03W2

## CARBURETOR

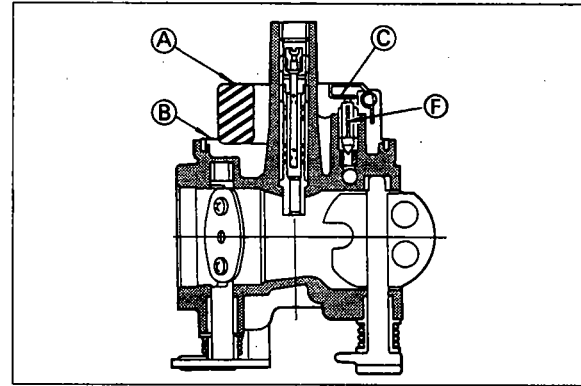
### FLOAT ADJUSTMENT

**CAUTION:** Do not strike float pin to remove or install it, to avoid breakage of pin holder. To remove float pin, pull the transformed end with pliers.

To install float pin, push float pin transformed end until the other end flushes with pin holder outer surface.

**NOTE:** WHITE FLOAT (made of polyacetal) does not require check and adjustment.

**CAUTION:** Do not push down float or needle valve when checking parallelism.



1. Check float angle and correct it as follows; Place carburetor upside down and check whether float surface (A) is parallel with carb. body (B) when float tang (C) just begins to come in contact with point of needle valve (F).
  - If not parallel, adjust float surface angle bending tang (C) with needle-nose pliers.

E24FC04W3

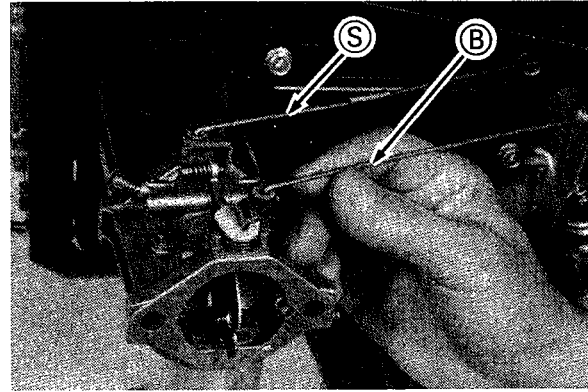


# CARBURETOR

## ASSEMBLY AND INSTALLATION

### CAUTIONS :

1. Do not over-tighten small carb. components. Finger-tighten pilot screw.
2. Do not bend throttle and choke shafts when assembling.
3. Apply screw locking agent to screws of throttle valve or choke valve. Do not allow agent to flow into shaft bearing surfaces.
4. Make sure movement of throttle and choke valves is smooth.
5. Before carburetor installation, install throttle linkage (S) and choke linkage (B) on carburetor.
6. Make sure to fasten fuel line at carb. inlet with clamp.



E24FC05W2

## CARBURETOR IDENTIFICATION

A portion of carb. part number is marked on carb. body.  
Example:

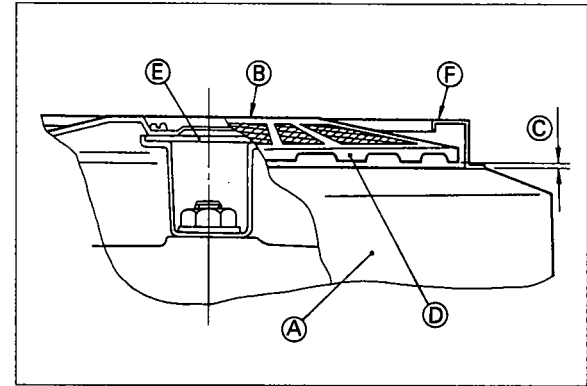
<u>Part Number</u>	<u>Stamp</u>
315510 - 6100C	5510C
15001 - 2541	12541

E24FA07W1

## COOLING SYSTEM

### BLADE GAP ADJUSTMENT

1. Install fan housing (A) and rotary screen (B).
2. Check gap (C) between contour blades (D) and fan housing and adjust it as near as 1.5 mm (0.06 in.) by changing number of shim (E) used.
3. Install guard (F) or recoil starter (including pulley).



E26FC01W1

## RECOIL STARTER

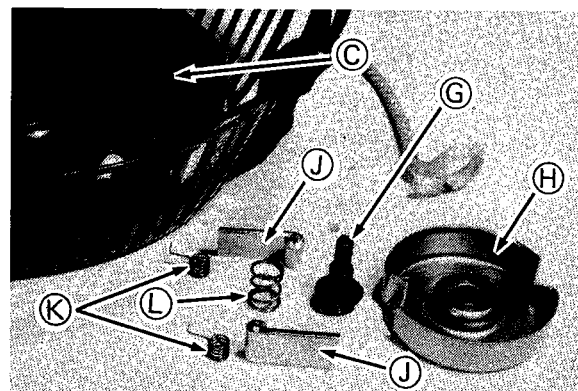
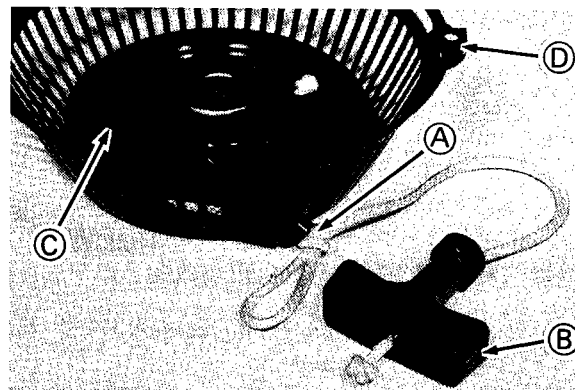
### DISASSEMBLY

**CAUTION:** Do not wedge rope between reel and case.

1. Pull handle out about 250 mm (10 in).  
Then hold rope in place with locking pliers or knot (A).
2. Pull knot in handle (B) out and untie it.

**WARNING:** Wear gloves during disassembling to avoid injury.

3. While carefully holding reel (C) and case (D), remove locking pliers or untie knot.
4. Unwind spring tension slowly.
5. Remove bolt (G) at center part and then retainer (H), pawls (J), pawl springs (K), and center spring (L) but not including reel (C).



**WARNING:** When removing reel (C), be careful that recoil spring under the reel does not fly loose and causes injury. The spring is under great pressure.

**NOTE:** There should be no spring tension on reel when removing reel. If tension is felt, push reel back into place and gently "wiggle" it until reel can be easily removed.

6. Rotate reel (C) one-quarter turn clockwise from rest position where no tension can be felt. Then, slowly lift reel straight up out of case.

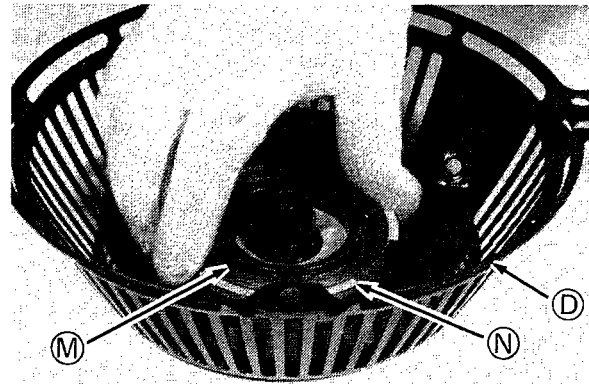
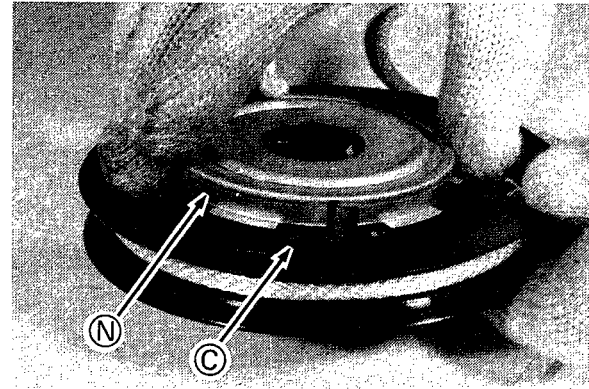
## RECOIL STARTER

### DISASSEMBLY

**WARNING:** If recoil spring cassette (N) is sticking with removed reel (C), be careful that the cassette does not drop.

**WARNING:** Be careful that recoil spring (M) does not fly loose from cassette (N) and causes injury. The spring is under great pressure.

7. Slowly lift recoil spring cassette (N), straight up out of case (D) or reel (C).
8. If recoil spring (M) must be removed from cassette (N), hold the cassette with opening side downward in suitable container and tap cassette to remove recoil spring.



E27FC02W2

### CHECK

1. Dip metal parts in bath of high flash-point solvent, if necessary.

**CAUTION:** Do not clean any non-metallic parts in solvent. They may be damaged by the solvent.

2. Check starter pawls for chips or excessive wear.
3. Check starter rope for excessive wear or fraying.
4. Check springs for break, rust, distortion, or weakened condition.

- If damage is found, replace the part.

**WARNING:** Do not throw away recoil spring as installed in cassette. Recoil spring may fly loose from cassette and cause injury.

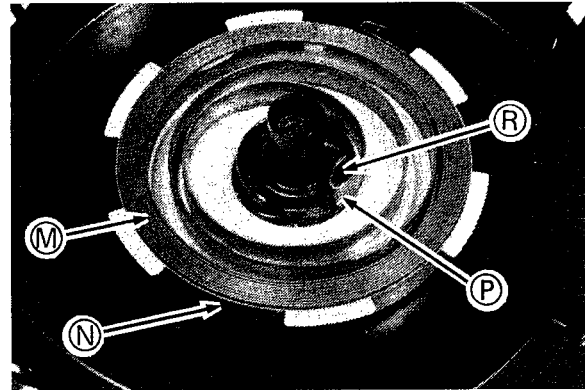
E27FC03W2

## RECOIL STARTER

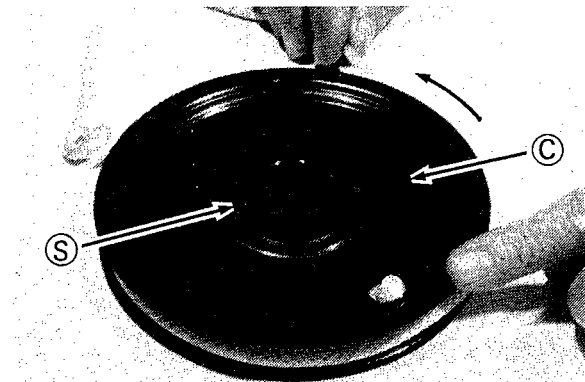
### REASSEMBLY

**WARNING:** Wear gloves during recoil spring (M) installation to avoid injury. The recoil spring must be assembled with great pressure.

1. Lightly grease recoil spring.
2. Set recoil spring in spring cassette (N) and install cassette so that hook (P) of spring catches tab (R) on case.
3. If rope is unwound from reel (C), wind rope in reel counterclockwise facing pawl groove (S).



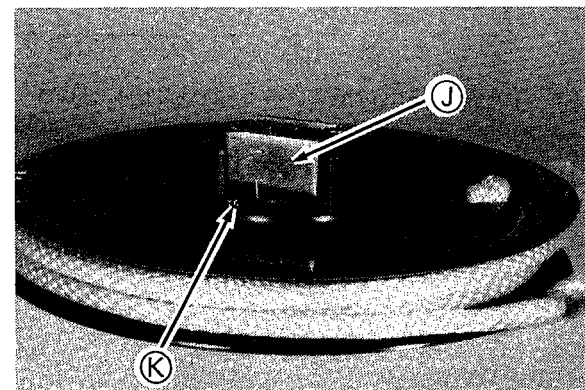
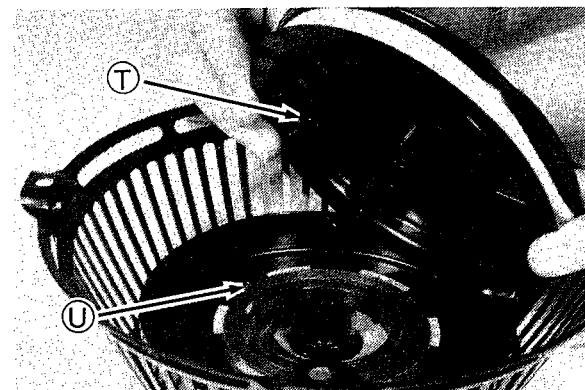
4. Aligning guide pin (T) on reel with recoil spring hook (U) on cassette, install reel into case.



5. Install pawl springs (K), pawls (J), center spring and retainer, then tighten bolt.

**NOTE:** Pawl springs (K) and pawls (J) are assembled into reel as shown.

6. Rotate reel two turns counterclockwise to preload recoil spring.
7. Pull rope out of case through rope hole and install handle.



E27FC04W4

# ELECTRIC STARTER & CHARGING

## TROUBLE SHOOTING

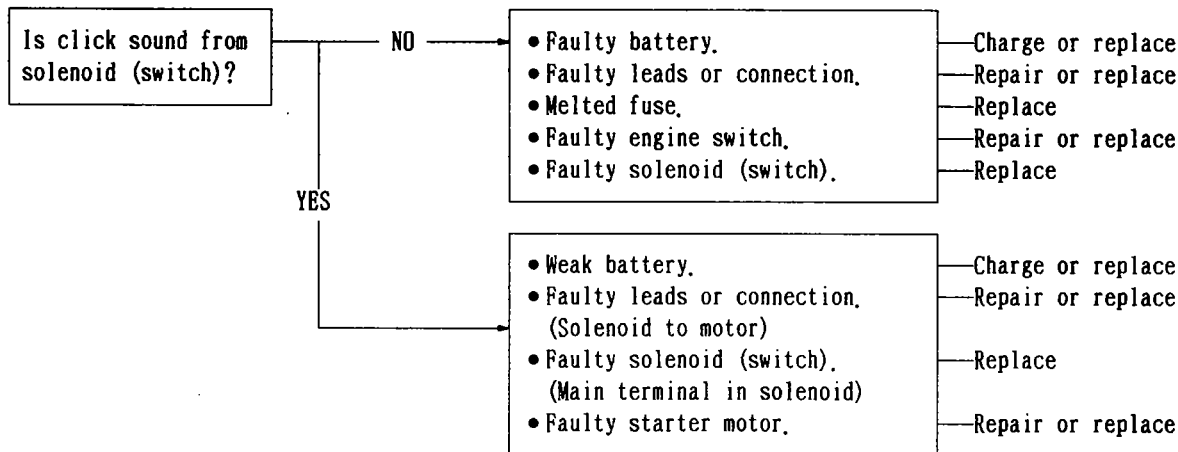
1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn engine switch to "START" position and check condition.



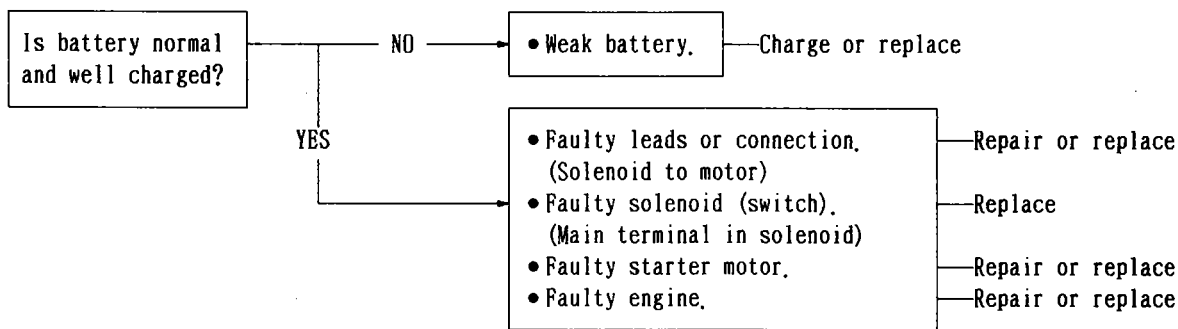
**WARNING:** Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

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

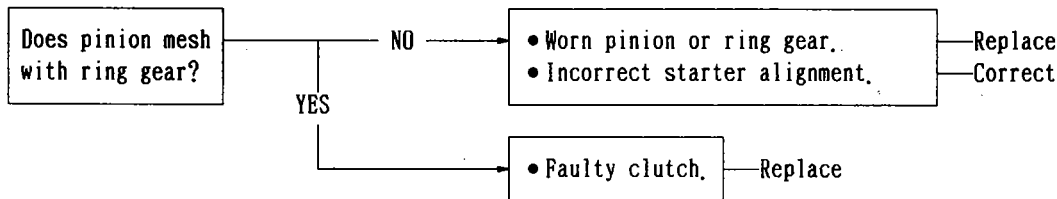
### (STARTER DOES NOT ROTATE)



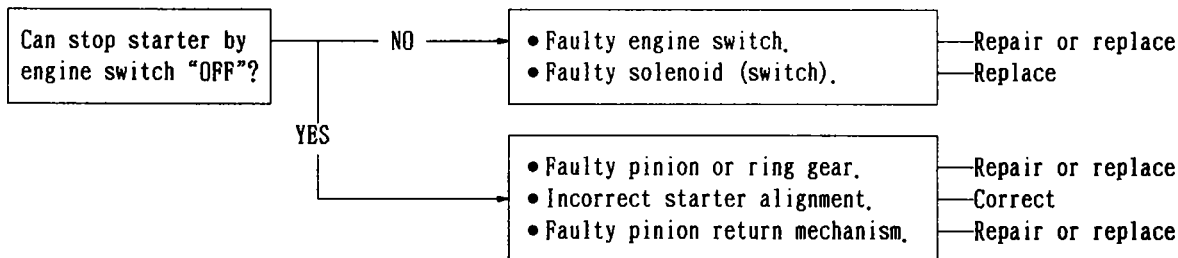
### (STARTER ROTATES BUT SLOW)



### (STARTER ROTATES BUT CAN NOT CRANK ENGINE)



### (STARTER DOES NOT STOP IN ENGINE SWITCH "RUN")



E28FC01W4

## ELECTRIC STARTER &amp; CHARGING

**SOLENOID AND CIRCUIT CHECK**

This procedure is for shift type starter, but can be used for Bendix type by replacing word "SOLENOID" to "SOLENOID SWITCH."

**NOTE :** Before this test, make sure battery is fully charged.

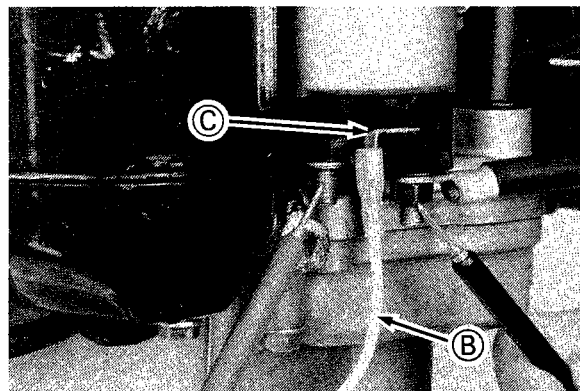
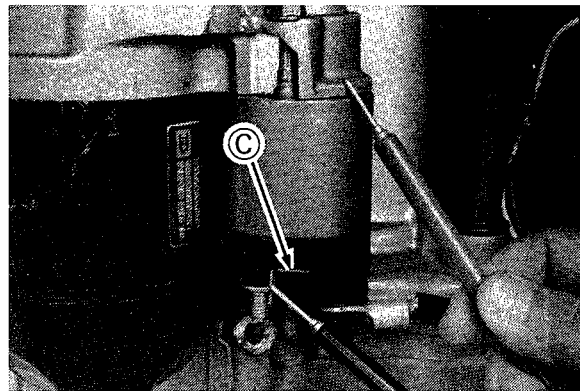
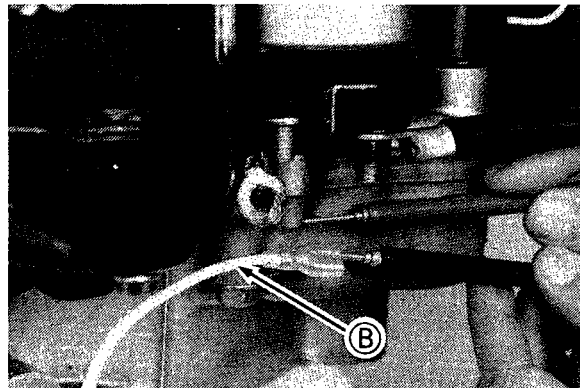
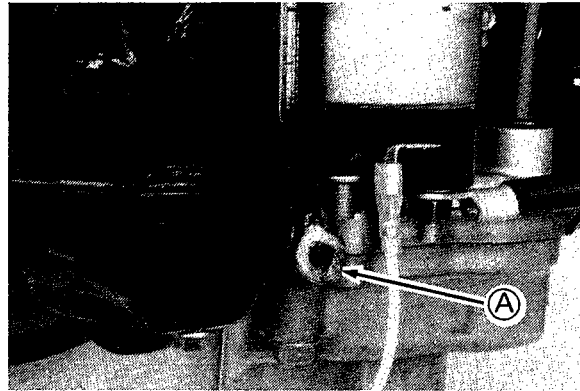
1. Disconnect lead (A) between starter motor and solenoid, and keep the lead away from terminal of solenoid to avoid accidental cranking in test.

**NOTE :** Painted part is not grounded.

2. Disconnect lead (B) between solenoid and engine switch. Set multimeter selector switch to 25V DC position and connect it with lead (B) and grounded part. Turn engine switch to "START" and check voltage.
  - If voltage is 0 or much less than battery voltage, check engine switch and/or circuit.
  - If voltage is same as battery voltage, go to next step.

3. Set multimeter selector switch to  $R \times 1\Omega$  position and check resistance between terminal (C) and grounded part.
  - If resistance is not nearly  $0\Omega$ , replace solenoid.
  - If continuity is observed, go to next step.

4. Connect lead (B) to terminal (C). Set multimeter selector switch to  $R \times 1\Omega$  position and connect it with two terminals on solenoid as shown. Turn engine switch to "START" and check resistance.
  - If resistance is not nearly  $0\Omega$  or solenoid does not click, replace solenoid.
  - If solenoid is normal, go to next step.



E28FC02W4

## ELECTRIC STARTER & CHARGING

### STARTER MOTOR CHECK

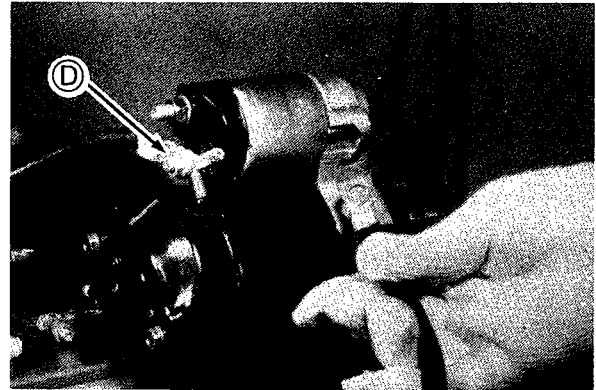
**WARNING:** Disconnect negative (-) lead first and then positive (+) lead to prevent spark at terminal.

1. Disconnect battery before removing electric starter from engine to avoid accidental running of starter in handling.
2. Remove electric starter from engine.

**WARNING:** The test room must be free from any flammable object. Keep away your body from pinion.

**CAUTION:** Be careful not to deform electric starter body by holding.

3. Hold electric starter with vice.
  4. Connect first jumper cable with positive (+) battery terminal and starter motor terminal (D) on solenoid.
  5. Connect second jumper cable with negative (-) battery terminal.
  6. Touch starter body (not painted part) with the other end of second jumper cable intermittently (within one second).
- If pinion does not turn, repair or replace starter motor.



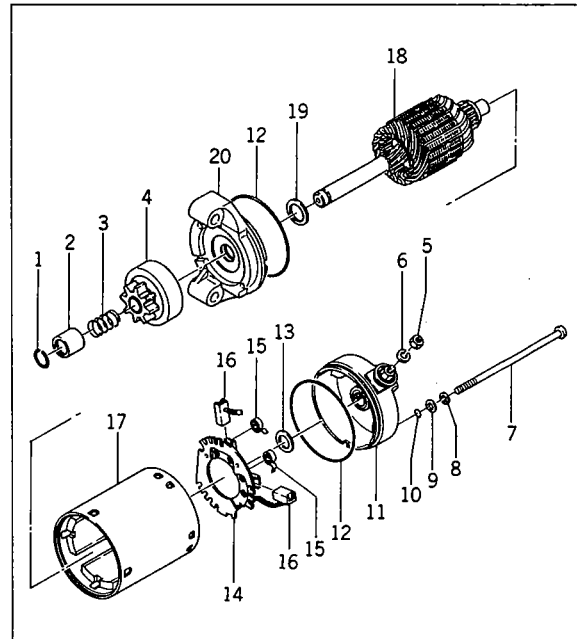
E28FC03W3



# ELECTRIC STARTER & CHARGING

## COMPONENTS - FC290 (Bendix Type)

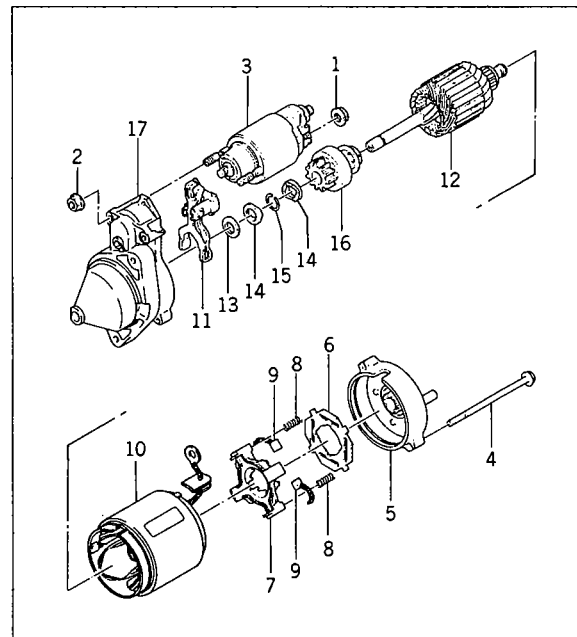
Ref. No.	Part Name	Ref. No.	Part Name
1	Snap ring	11	Rear cover
2	Collar	12	O-ring
3	Spring	13	Washer
4	Pinion assy	14	Brush holder assy
5	Nut	15	Brush spring
6	Spring washer	16	Brush
7	Through bolt	17	Yoke assy
8	Spring washer	18	Armature
9	Washer	19	Washer
10	O-ring	20	Front cover



E28FC05W2

## COMPONENTS - FC400-FC420 (Shift Type)

Ref. No.	Part Name	Ref. No.	Part Name
1	Nut	10	Yoke assy
2	Nut	11	Shift lever
3	Solenoid	12	Armature
4	Bolt	13	Washer
5	Rear cover	14	Stopper
6	Insulator	15	Snap ring
7	Brush holder	16	Pinion assy
8	Brush spring	17	Front cover
9	Brush		

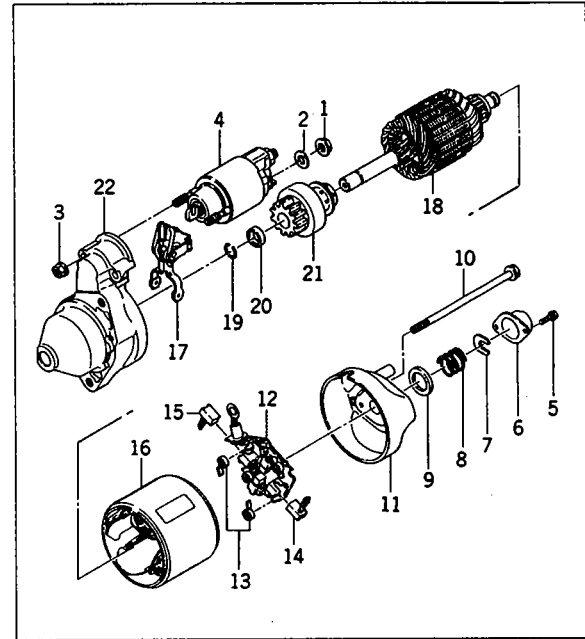


E28FC06W2

# ELECTRIC STARTER & CHARGING

## COMPONENTS-FC540 (Shift Type)

Ref. No.	Part Name	Ref. No.	Part Name
1	Nut	12	Brush holder assy
2	Washer	13	Brush spring
3	Nut	14	Brush
4	Solenoid assy	15	Brush
5	Screw	16	Yoke assy
6	Cover	17	Shift lever
7	Stopper	18	Armature
8	Spring	19	Snap ring
9	Seal	20	Pinion stopper
10	Through bolt	21	Pinion assy
11	Rear cover assy	22	Front cover assy



E28FC07W2

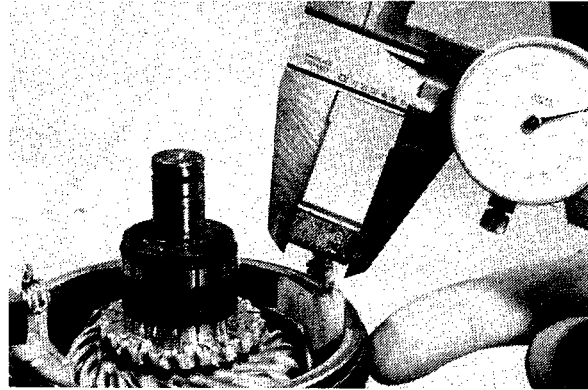
## ELECTRIC STARTER & CHARGING

### BRUSH SERVICE LIMIT

1. Check overall length of each brush with vernier calipers.
  - If length is less than MIN, replace brush.

### BRUSH LENGTH MIN

FC290	8.5 mm (0.34 in.)
FC400-FC420	6.0 mm (0.24 in.)
FC540	10.5 mm (0.41 in.)



E28FC08W1

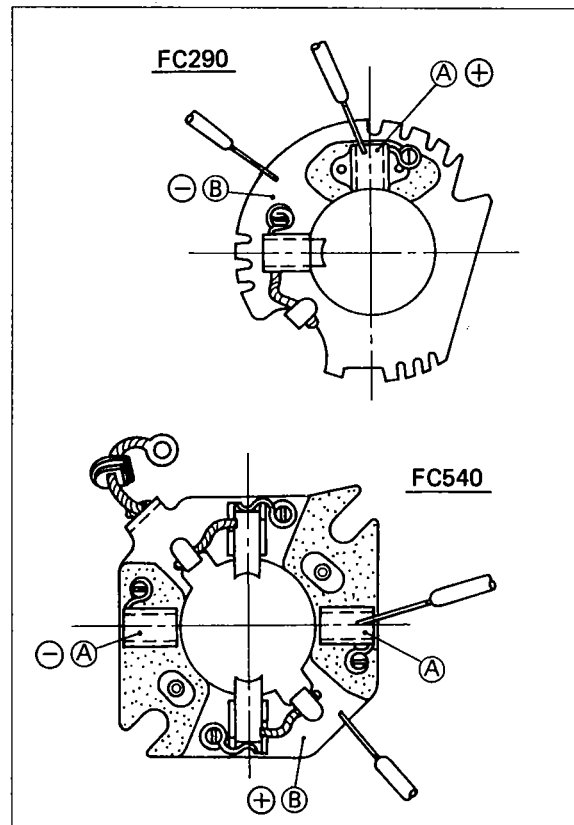
### BRUSH SPRING CHECK

1. Check each brush spring for breakage or distortion.
  - If brush spring does not snap brush firmly into place, replace it.

E28FC09W1

### BRUSH HOLDER CHECK

1. Set multimeter selector switch to  $R \times 1k\Omega$  position and check resistance between brush holder (A) and its base (B).
  - If resistance is not infinite ( $\infty$ ), replace brush holder.

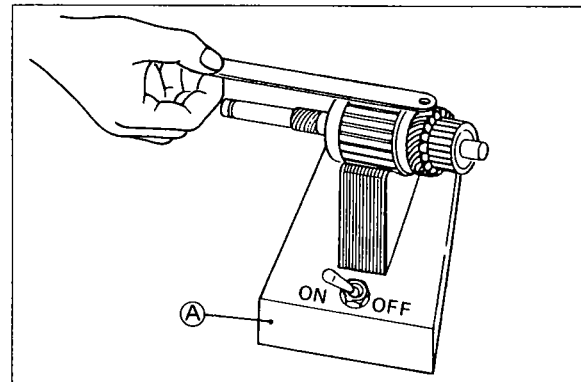
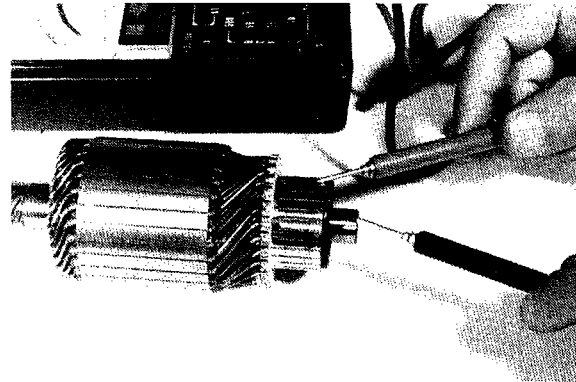
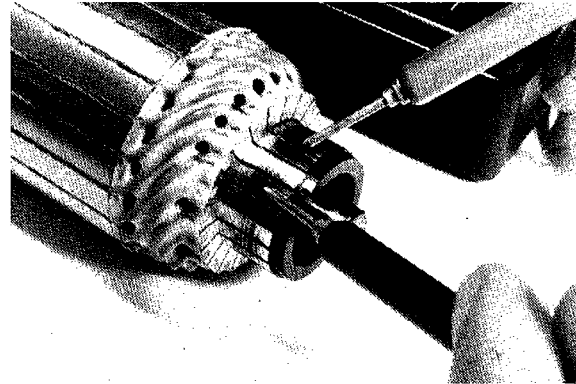
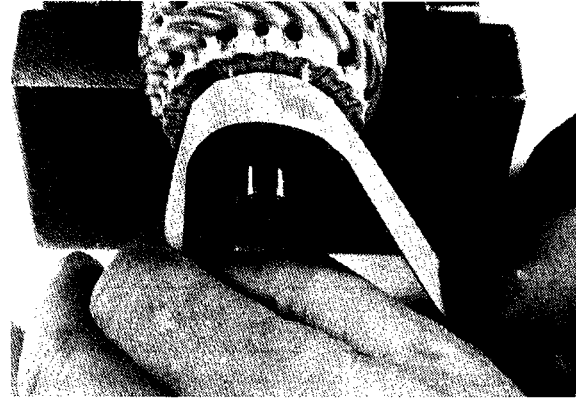


E28FC10W2

## ELECTRIC STARTER & CHARGING

### ARMATURE CHECK

1. Check surface of commutator and grooves.
  - If it has scratch or is dirty, polish it with very fine emery paper (No. 5000 - No. 6000) and clean grooves.
  
2. Set multimeter selector switch to R x 1 $\Omega$  position and check resistance between segments.
  - If resistance is not nearly 0 $\Omega$ , replace armature. (open circuit)
  
3. Set multimeter selector switch to R x 1k $\Omega$  position and check resistance between commutator and armature shaft.
  - If resistance is not infinite ( $\infty$ ), replace armature. (short circuit)
  
4. Check armature windings for shorts.
  - (1) Place armature on growler (A).
  - (2) Hold thin metal strip (e.g., hack saw blade) on top of armature.
  - (3) Turn on growler and rotate armature one complete turn.
  - If metal strip vibrates at any position, replace armature. (short circuit)

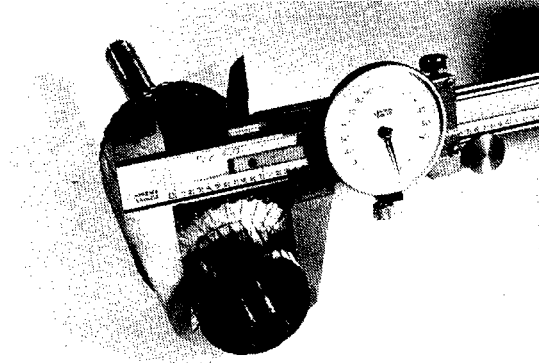


E28FC11W4

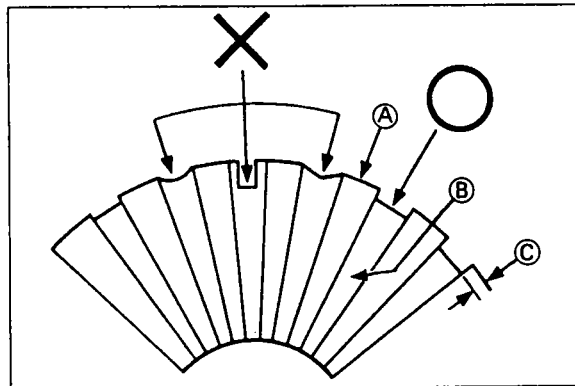
## ELECTRIC STARTER & CHARGING

### ARMATURE SERVICE LIMIT

1. Check commutator outside diameter at several points with vernier calipers.
  - If diameter is less than 27 mm (1.06 in.), replace armature.



2. Check groove depths between commutator segments.
  - If depths are less than 0.2 mm (0.01 in.), cut insulating material to STD depth with thin file and clean grooves.

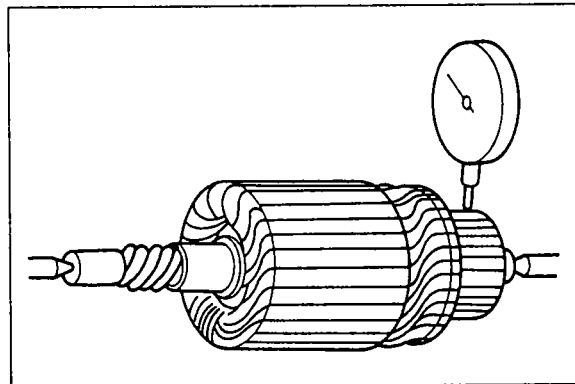


### STD GROOVE DEPTH

0.5 - 0.8 mm (0.02 - 0.03 in.)
--------------------------------

- A : Segment
- B : Insulating material
- C : Depth

3. Support armature in alignment jig at each ends of shaft as shown. Position dial indicator perpendicular to commutator. Rotate armature slowly and check run-out.
  - If run-out is more than MAX, turn down commutator or replace armature.



### COMMUTATOR RUN-OUT MAX

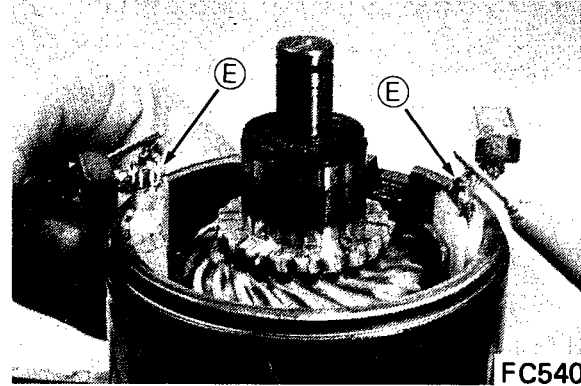
FC290•FC400•FC420	0.4 mm (0.016 in.)
FC540	0.5 mm (0.019 in.)

## ELECTRIC STARTER & CHARGING

### YOKE CHECK

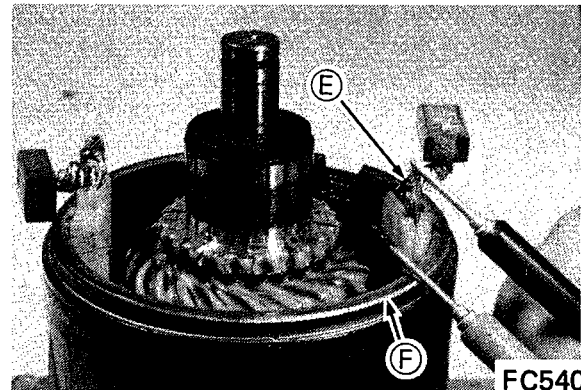
1. Set multimeter selector switch to R x  $1\Omega$  position and check resistance between negative terminals (E). (FC400· FC420· FC540)

- If resistance is not nearly  $0\Omega$ , replace yoke assembly.



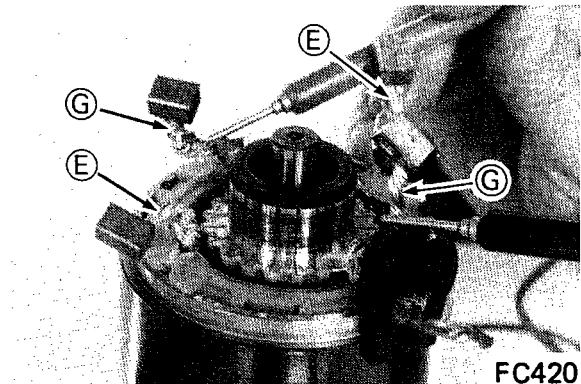
2. Set multimeter selector switch to R x  $1\Omega$  position and check resistance between negative terminals (E) and yoke case (F). (FC400· FC420· FC540)

- If resistance is not nearly  $0\Omega$ , replace yoke assembly.



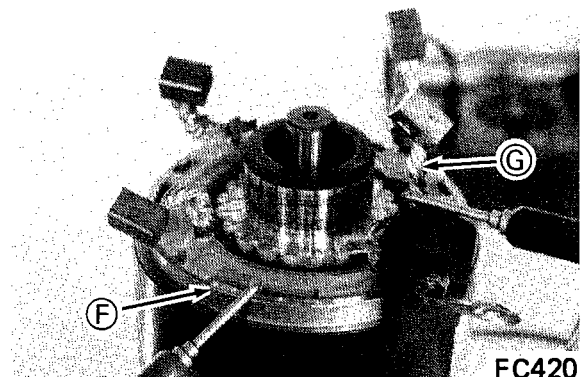
3. Set multimeter selector switch to R x  $1\Omega$  position and check resistance between positive terminals (G). (FC400· FC420)

- If resistance is not nearly  $0\Omega$ , replace yoke assembly.



4. Set multimeter selector switch to R x  $1k\Omega$  position and check resistance between positive terminal (G) and yoke case (F). (FC290· FC400· FC420)

- If resistance is not infinite ( $\infty$ ), replace armature.

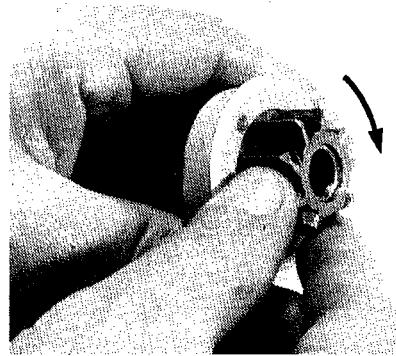


E28FC13W4

## ELECTRIC STARTER & CHARGING

### PINION CLUTCH CHECK

1. Check pinion to rotate with armature shaft when turned clockwise (→).
  2. Check pinion to rotate freely when turned counterclockwise.
- If pinion does not move normally, replace pinion assembly.



E28FC14W1

### STARTER MOTOR REASSEMBLY

1. Coat multi purpose grease to following parts.
  - \* Sliding surface or pinion and spline shaft
  - \* Bearings
  - \* Dust seal lip
  - \* Contact surface of shift lever
2. Do not use removed snap ring again.

E28FC17W1

### REGULATOR CHECK

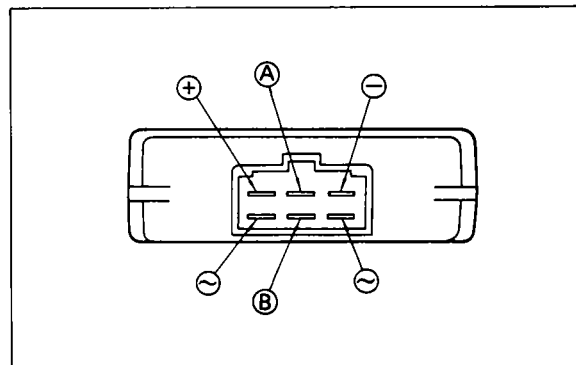
1. Remove all leads from regulator.
  2. Set multimeter selector switch to R x 1kΩ position.
  3. Check resistance between terminals as shown on table.
- A : Key switch  
B : Charging monitor  
C : Multimeter terminal

⊕ ⊖	+	(A)	-	~	~	(B)
+		∞	∞	∞	∞	∞
(A)	4kΩ ~ 20kΩ		200Ω ~ 1kΩ	1kΩ ~ 5kΩ	1kΩ ~ 5kΩ	200kΩ ~ ∞
-	3kΩ ~ 15kΩ	200Ω ~ 1kΩ		1kΩ ~ 5kΩ	1kΩ ~ 5kΩ	200kΩ ~ ∞
~	1kΩ ~ 5kΩ	∞	∞		∞	∞
~	1kΩ ~ 5kΩ	∞	∞	∞		∞
(B)	10kΩ ~ 50kΩ	1kΩ ~ 5kΩ	1.5kΩ ~ 7.5kΩ	4kΩ ~ 20kΩ	4kΩ ~ 20kΩ	

- If resistance is not as specified, replace regulator.

**NOTE :** Resistance value may vary with individual meters.

**CAUTION :** Do not use Megger.

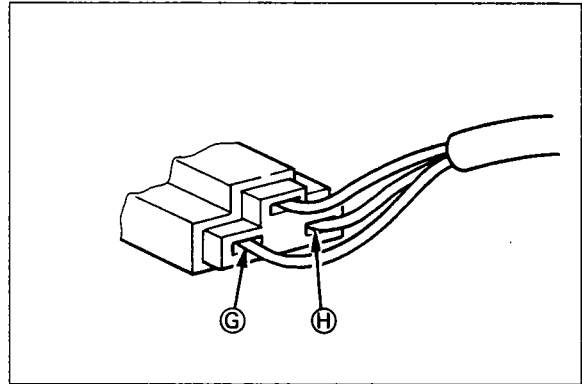


E28FC18W2

## ELECTRIC STARTER & CHARGING

### UNREGULATED STATOR OUTPUT (13-15A TYPE)

1. Disconnect regulator.
  2. Start and warm up engine.
  3. Set multimeter selector switch to 250V AC position.
  4. Connect meter with stator lead terminals (G, H) in 3P coupler.
  5. Run engine at 3,350 rpm and check voltage.
- If voltage is less than MIN, replace stator.

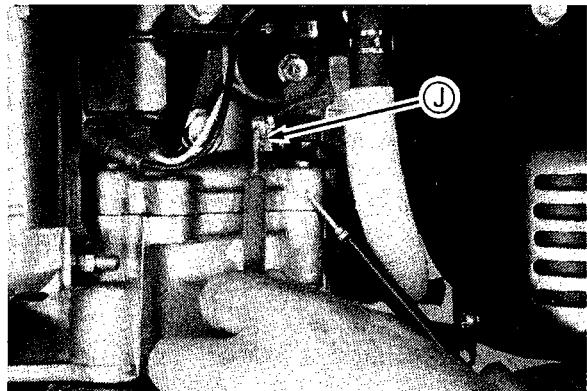


### UNREGULATED STATOR OUTPUT MIN

FC290•FC400•FC420	30 V
FC540	27 V

### STATOR OUTPUT (3A TYPE)

1. Disconnect lead from rectifier (to engine).
  2. Start and warm up engine.
  3. Set multimeter selector switch to 250V AC position.
  4. Connect meter with stator lead (J) and engine body.
  5. Run engine at 3,350 rpm and check voltage.
- If voltage is less than MIN, replace stator.



E28FC19W2

### STATOR OUTPUT MIN

FC290•FC400•FC420	26 V
FC540	24 V

E28FC20W2



## IGNITION SYSTEM

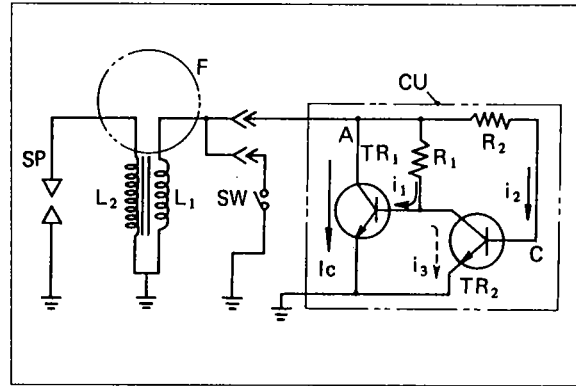
### TYPE OF IGNITION SYSTEM

Transistor controlled ignition system is used for these engines and this system consists of following components.

1. Ignition coil
2. Control unit
3. Flywheel (with permanent magnet)

These components do not mechanically contact and periodic maintenance is not required.

$L_1$ : Primary coil	$TR_1$ : Transistor
$L_2$ : Secondary coil	$TR_2$ : Transistor
CU: Control unit	F : Flywheel
$R_1$ : Control resistor	SP : Spark plug
$R_2$ : Control resistor	SW : Engine switch



### SPARK CHECK

To check ignition system, check spark as follows;

1. Remove spark plug and connect plug cap with the removed spark plug.
2. Install spare plug to plug hole to avoid fuel spitting from hole.

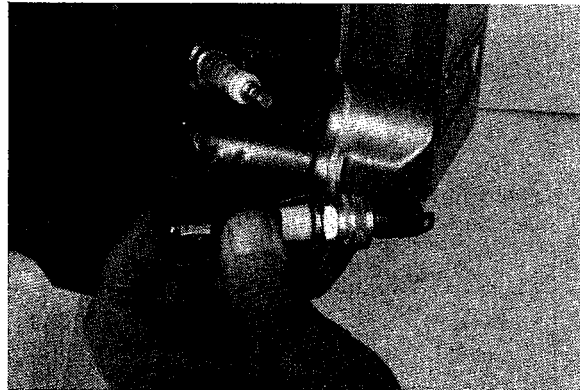
**WARNING :** To avoid electric shock, hold plug cap, but not spark plug.

3. Keeping contact with spark plug metal part (not center electrode) and engine block, crank engine.

**CAUTION :** Do not clean spark plug with bead or sand cleaner.

- If no or very weak spark is observed, clean spark plug and regap it to 0.7-0.8 mm (0.028-0.031 in.) and try engine cranking again.
- If spark is not improved by cleaning, try checking again with new spark plug.
- If spark is not improved yet, check ignition system.

E30FC01W2



E30FC02W2

## IGNITION SYSTEM

### CONTROL UNIT CHECK

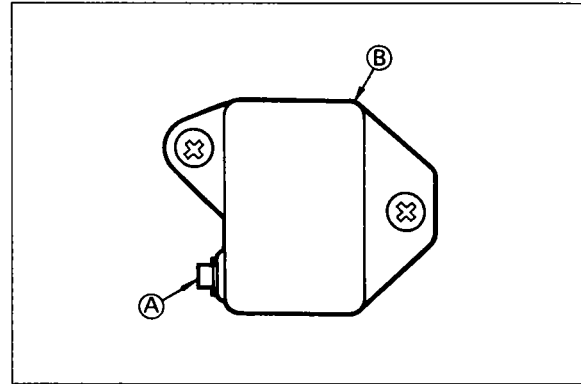
1. Set multimeter selector switch to  $R \times 10\Omega$  position.
  2. Check resistance between terminal (A) and case (B).
- If resistance is out of specified value, replace control unit.

**CAUTION :** Do not use Megger.

### CONTROL UNIT RESISTANCE ( $\Omega$ )

Meter $\ominus$	Terminal (A)	Case (B)
Meter $\oplus$	/	
Terminal (A)	60-100	
Case (B)	400-600	/

**NOTE :** This check may not cover every defect.



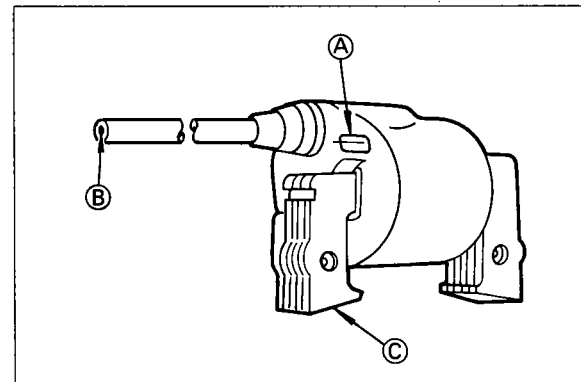
E30FC03W2

### IGNITION COIL CHECK

1. Check resistance between the points as specified.
2. If resistance is out of specified value, replace ignition coil.

### IGNITION COIL RESISTANCE

	Connection	Resistance
Primary coil	Primary terminal (A) and Core (C)	$0.48 - 0.72\Omega$ ( $R \times 1\Omega$ Range)
Secondary coil	Plug lead (B) and Core (C)	$10.9 - 16.3k\Omega$ ( $R \times 1k\Omega$ Range)



E30FC04W2

## IGNITION SYSTEM

### FLYWHEEL REMOVAL

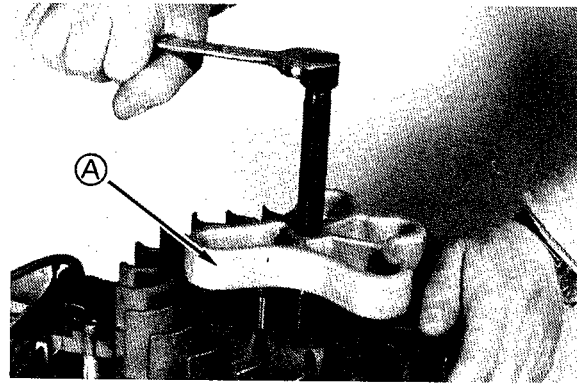
**WARNING:** Remove plug cap from spark plug to avoid engine starting.

**CAUTION:** Do not insert any tool in flywheel fins or ring gear to avoid rotation. The tool will damage flywheel.

1. Loosen nut by turning it counterclockwise. Use 1/2" air impact wrench or strap wrench to avoid flywheel rotation.

**CAUTION:** Keep shoulder of nut flush with end of crankshaft until taper engagement is released.

2. Use flywheel puller (A) to remove flywheel.



E30FC05W2

### FLYWHEEL INSTALLATION

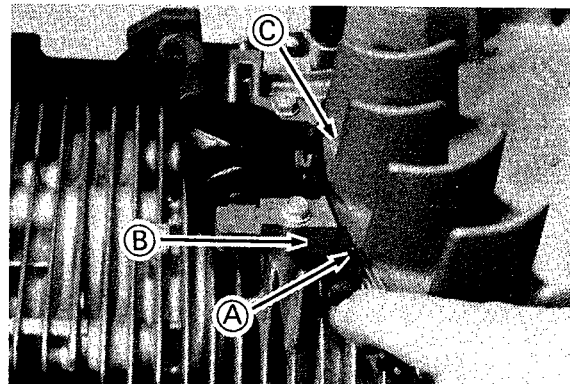
1. Before installing flywheel, remove grease and oil from taper part of crankshaft and taper hole of flywheel.
2. Make sure key is in place when installing flywheel.
3. Torque nut as specified in TORQUE SPECIFICATIONS.

E30FC06W1

### IGNITION COIL AIR-GAP ADJUSTMENT

If ignition coil is removed or replaced, adjust AIR-GAP in installing coil.

1. Insert 0.3 mm (0.012 in.) feeler gauge or solid sheet (A) between coil legs (B) and flywheel rim (C).
2. Pushing coil to flywheel, tighten coil mounting screws firmly.



E30FC07W1

## FUEL PUMP

### REMOVAL AND DISASSEMBLY

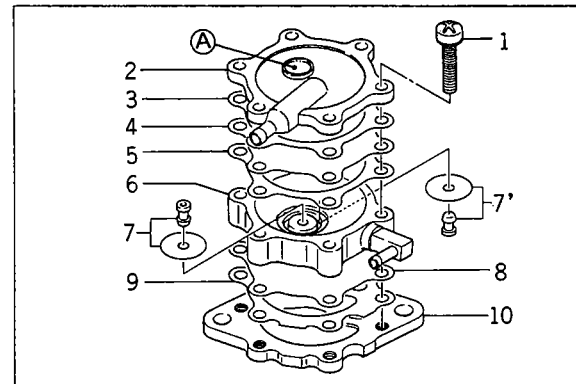
**WARNING :** Gasoline is extremely flammable.  
Avoid fires due to smoking or careless practices.

**WARNING :** Avoid spilling of gasoline in removing  
and disassembling fuel pump. Plug fuel line discon-  
nected from pump intake joint, immediately.

E31FC01W1

### COMPONENTS

Ref. No.	Part Name	Ref. No.	Part Name
1	Screw	7	Valve assy (in)
2	Cover	7'	Valve assy (out)
3	Gasket	8	Diaphragm (rubber)
4	Diaphragm	9	Gasket
5	Gasket (rubber)	10	Base
6	Body		



E31FC02W1

A : Vent hole & screen

### CHECK

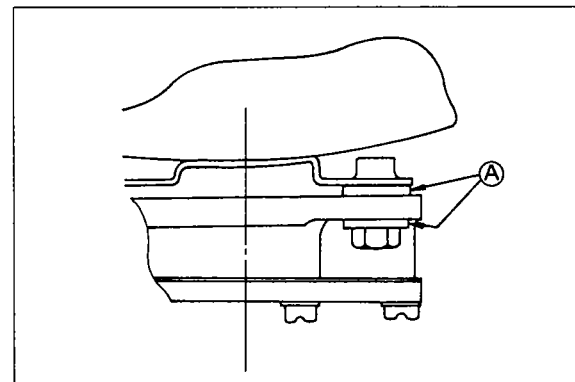
- Check vent hole and screen for plugging or clogging.
  - If vent hole and screen are plugged or clogged, remove dirt from them.
- Check diaphragms for crack, tear or hole.
  - If defect is found, replace it.
- Check valves for crack, tear or wear.
  - If defect is found, replace them.

**CAUTION :** Make sure rubber gasket and rubber dia-  
phragm are placed as shown in COMPONENTS.

E31FC03W1

### INSTALLATION

- Make sure to use heat shield washers (A) as shown, on FC400-FC420 and FC540.
- Make sure to fasten fuel and pulse lines at pump with clamps.



E31FC04W1

## CYLINDER HEAD

### COMPRESSION CHECK

1. Remove spark plug and set compression gauge to plug hole.
  2. Crank engine with recoil or electric starter several times and check highest reading.
- If highest reading is less than 483 kPa (71 psi), check engine in accordance with TROUBLE SHOOTING.

**NOTE :** Battery should be fully charged for this test.

E32FC01W1

### REMOVAL

1. Disconnect plug cap from spark plug.
2. Remove rocker cover.

**NOTE :** Always note position of each cyl. head screws so they are properly re-installed.

3. Remove cyl. head.
4. If push rods are removed, mark push rods so they are placed in their original positions in re-installing.

E32FC02W1

### MAINTENANCE

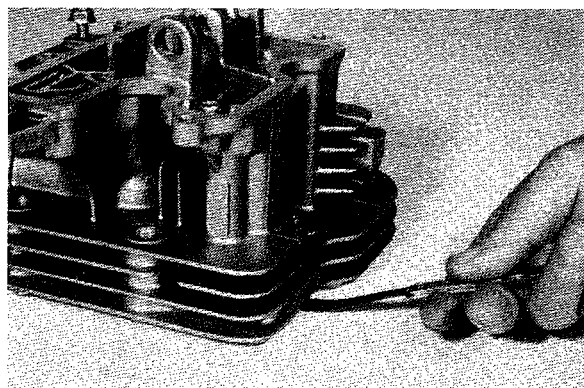
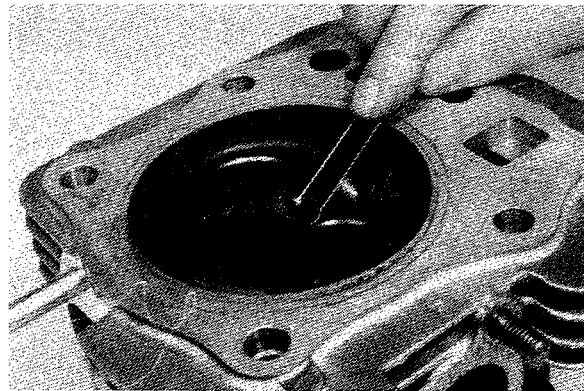
**WARNING :** If chemical cleaner is used, always follow the manufacturer's safety instructions carefully.

1. Remove coating material stuck on surfaces, with oil stone.

**CAUTION :** If deposit on combustion chamber is removed, remove valve system from cyl. head.  
(See VALVE AND RELATED PARTS REMOVAL.)

Do not damage valve seat and gasket surface of cyl. head in deposit cleaning.

2. Remove deposit from cyl. head.
  3. Check flatness of head gasket surface on surface plate with feeler gauge.
- If cyl. head is warped more than 0.05 mm (0.003 in.), replace it.



E32FC03W2

## CYLINDER HEAD

### INSTALLATION

**CAUTION:** Gasket is coated with special sealant. Do not damage surface of gasket during installation. If surface coating is damaged, replace gasket.

1. Rotate crankshaft until piston comes up at highest position in compression stroke.
2. Install push rods in their respective position in cylinder.
3. Place head gasket and cyl. head assy on cyl. block.
4. Align push rod ends with recess of rocker arms adjust screws.
5. Put screws and related parts as follows;

FC290 : Five (all) bolts

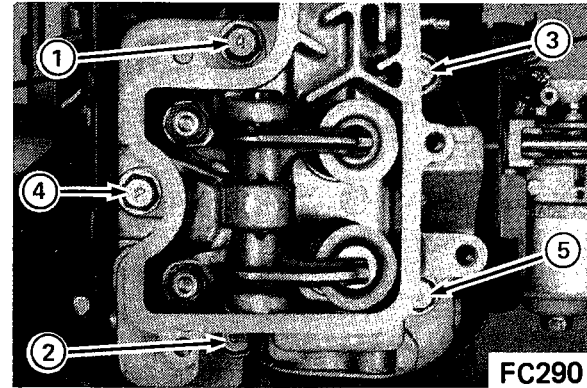
FC400 : Sequence 1, 3 & 4 - bolts  
Sequence 2 - long nut & spacer

FC420 : Sequence 1, 3 & 4 - bolts  
Sequence 2 - long nut & spacer  
Sequence 5 - long nut & washer

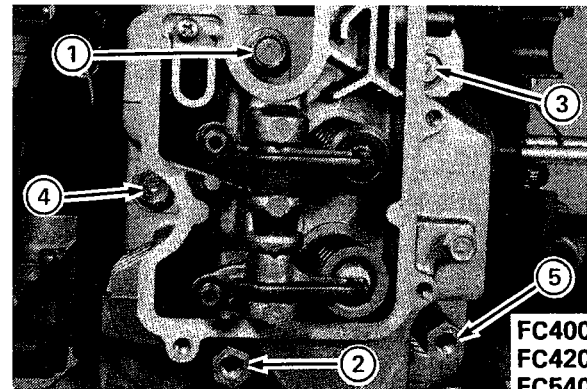
FC540 : Sequence 1, 3 & 4 - bolts  
Sequence 2 & 5 - long nuts, spacers & washers

**CAUTION:** Do not tighten one screw completely while others are loose. It may cause warped cyl. head.

6. Tighten screws down evenly by hand and then torque them in sequence as specified.  
(See TORQUE SPECIFICATIONS.)



FC290



FC400  
FC420  
FC540

E32FC04W3

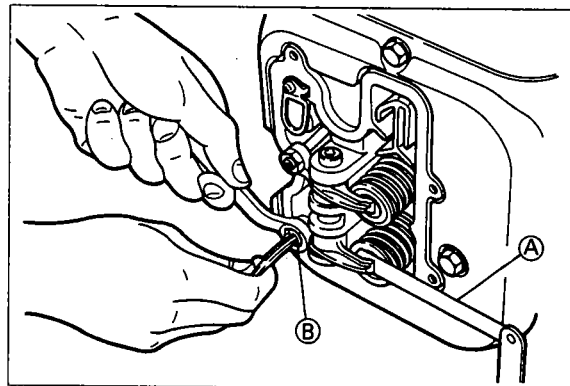
## VALVE

### VALVE CLEARANCE ADJUSTMENT

When any part related to valve clearance is changed or modified for defect correction, or after engine has been used for long period, adjust valve clearance.

**NOTE :** Do adjustment while engine is cold.

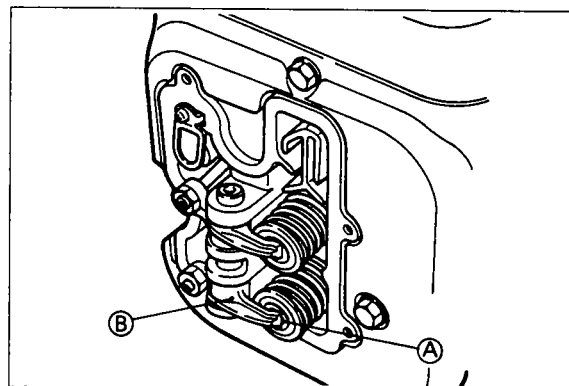
1. Turn crankshaft until piston comes up at highest position in compression stroke.
  2. Check clearance between valve stem and rocker arm with 0.15 mm (0.006 in.) feeler gauge (A). - for both valves
- If clearance is out of specified value, adjust it turning adjuster (B), and then lock adjuster by nut with torque specified in TORQUE SPECIFICATION.



### AUTOMATIC COMPRESSION RELEASE (ACR) CHECK

ACR is device to release compression during engine start, for easy cranking.

1. Remove rocker cover.
  2. Remove spark plug to ease hand cranking.
  3. Make sure valve clearance is as specified. (See VALVE CLEARANCE ADJUSTMENT.)
  4. Rotate crankshaft slowly in usual direction observing movement of exhaust valve (A) and rocker arm (B).
- If exhaust valve does not open more than 0.6 mm (0.024 in) briefly just after intake valve closes, ACR mechanism on camshaft is faulty. (See CAMSHAFT VISUAL CHECK.)



E33FC01W2

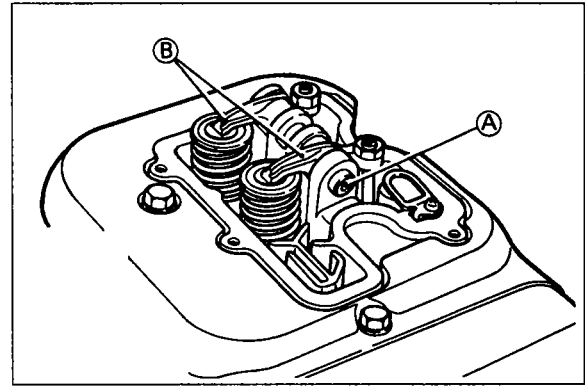
E33FC02W2

# VALVE

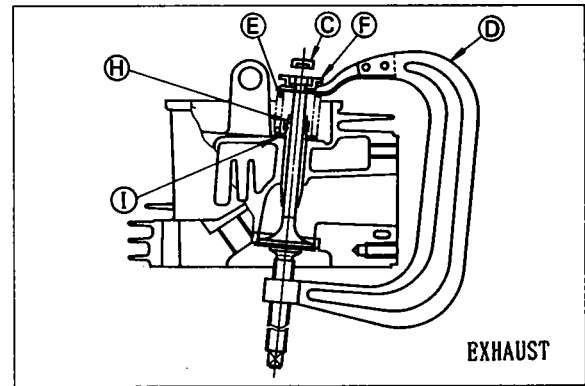
## VALVE AND RELATED PARTS REMOVAL

**NOTE :** Mark push rods so they are placed in their original positions in re-installing.

1. Remove push rods.
2. Pull out rocker shaft (A) with pliers and remove rocker arms (B).

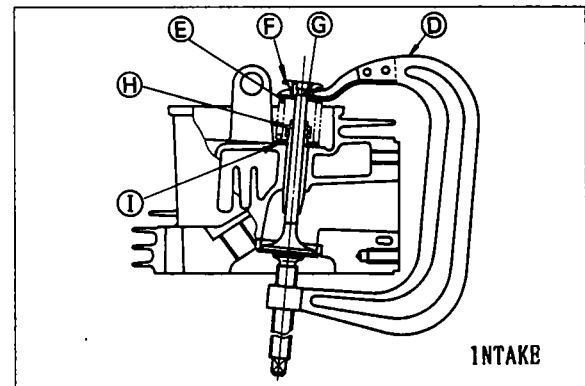


3. Remove valve rotator cap (C) on exhaust valve stem end.
4. Place screw head of valve spring compressor (D) on the valve head and slip jaw of compressor between spring (E) and retainer (F).
5. Compress spring and remove retainer (F) and collets (G) - for intake valve - with needle nose pliers.
6. Remove compressor and valve spring.



**NOTE :** Before pulling valve out of guide, remove all burrs from valve stem, and oil to stem to avoid damaging valve stem seal (H). If stem seal is not damaged, do not remove seal and bottom spring retainer (I).

7. If stem seal (H) must be replaced, remove it with screw driver.



E33FC03W3



## VALVE

### CHECK AND MAINTENANCE

1. Check valve head for excessive deposit and gas leakage.
2. Remove carbon from valve head with wire brush.
3. Check valve head for warped face (A), dent on face and margin (B) of less than 0.6 mm (0.024 in.).

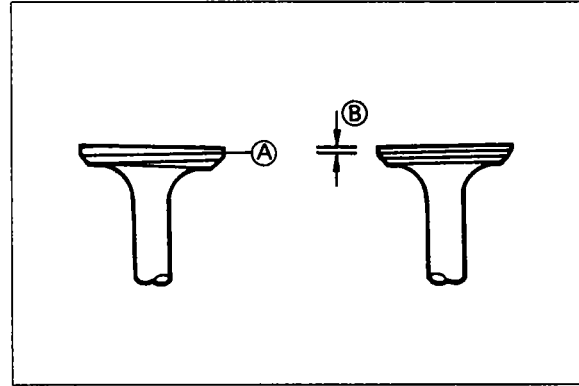
- If valve head has above defect, replace valve.

**NOTE :** Excessive deposit is caused by leaded gasoline, and deposit triggers gas leakage causing valve defects. Therefore unleaded gasoline is recommended.

4. Check valve stem for sticking, gummy deposit, discoloration at area covered by valve guide, and excessive corrosion.
5. Remove carbon from valve stem as well as head.

- If valve stem is worn excessively or does not move smoothly in guide, replace valve.

**NOTE :** Sticking and discoloration are caused by over heating of engine, or gas leakage from valve face. Therefore such causes must be corrected as well as valve maintenance. Gummy deposit is caused by old or stale gasoline. Clean fuel system and use fresh gasoline. Remove gasoline from fuel system before long storage.



E33FC04W3

## VALVE

### SERVICE LIMIT

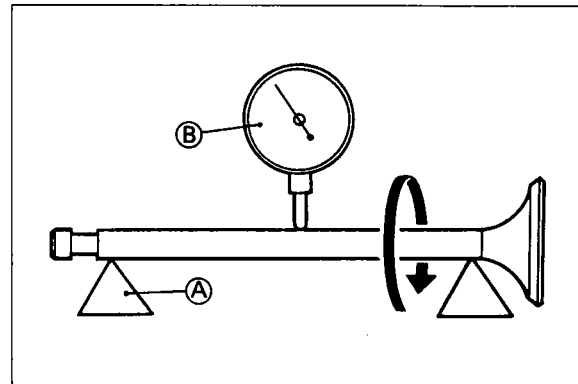
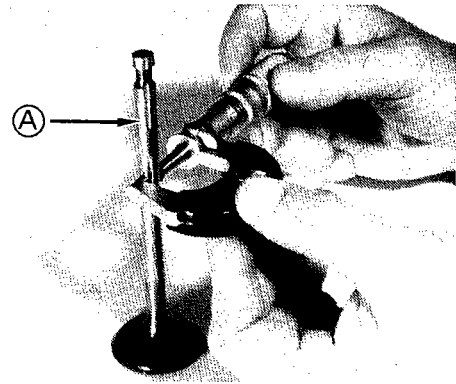
1. Check diameter of valve stem in area covered by valve guide at several points with micrometer.
  - If diameter is less than MIN, replace valve.

### VALVE STEM DIA. MIN

Intake	6.930 mm (0.2728 in.)
Exhaust	6.915 mm (0.2722 in.)

2. Check bend of valve stem at center part with V blocks (A) and dial indicator (B).
  - If bend (dial gauge reading) of valve stem is more than 0.03 mm (0.0012 in.), replace valve.

**CAUTION:** Do not try to grind or recondition valve face. If valve face is worn or damaged, replace it.



E33FC05W2

### VALVE SPRING SERVICE LIMIT

1. Check valve spring for any damage and replace it if necessary.
2. Check free length of valve spring with vernier calipers.
  - If length is less than MIN, replace spring.

### FREE LENGTH MIN (Intake & Exhaust)

FC290	31.0 mm (1.22 in.)
FC400•FC420•FC540	37.5 mm (1.47 in.)

E33FC06W2

## VALVE

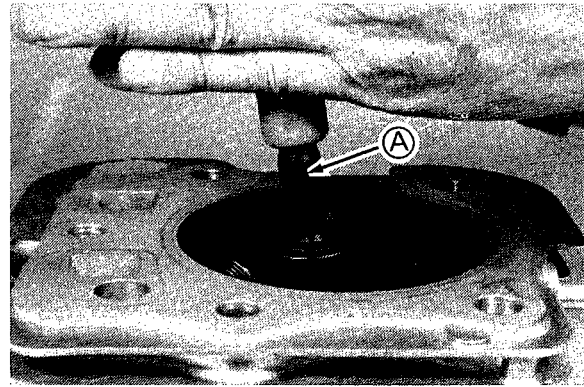
### LAPPING

If valve does not contact all way around with seat, lap valve into seat.

1. Coat fine lapping compound sparingly on valve face.
2. Rotate valve in circular motion with valve lapper (A).

**NOTE :** Lapping mark should appear on or near center of valve face.

3. Check valve every 8 to 10 strokes and continue lapping until uniform ring appears on valve seat all way around.
4. After lapping, wash parts in solvent to remove compound. Dry parts thoroughly.



### VALVE SEAT RECONDITIONING

Pitted or worn valve seat can be refaced.

1. Reface valve seat with 45° cutter, removing only enough material to make smooth and concentric seat.
2. Use 30° cutter to narrow seat to STD width as specified below.

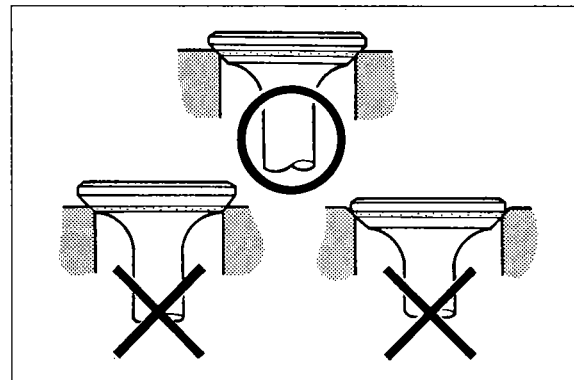
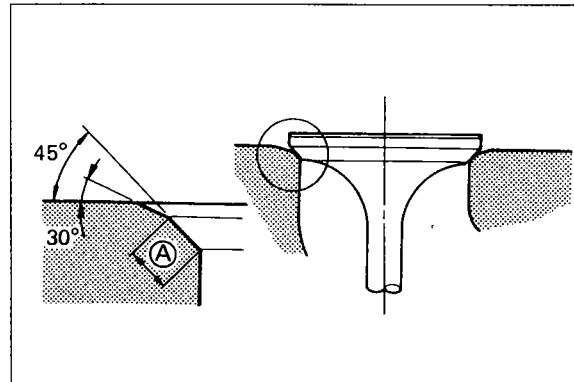
A : Seat width

### STD VALVE SEAT WIDTH (Intake & Exhaust)

FC290	0.5 - 1.10 mm (0.020 - 0.043 in.)
FC400•FC420•FC540	1.1 - 1.46 mm (0.043 - 0.057 in.)

3. Make a light pass with 45° cutter to remove any burr at edge of seat.
4. Coat marker and check contact of valve face and seat. Contact should be at center part of valve face as shown and all way around.
5. Lap valve into seat. (See LAPPING.)

E33FC07W2

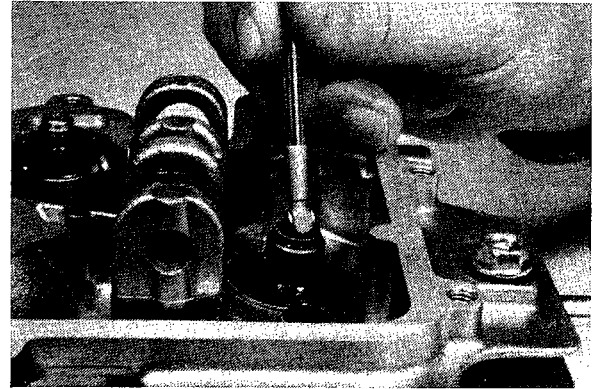


E33FC08W2

## VALVE

### VALVE GUIDE SERVICE LIMIT

1. Use valve guide cleaner to clean inside of valve guides.
  2. Check inside diameter of valve guide at several points with inside micrometer.
- If diameter is more than 7.065 mm (0.2781 in.), replace valve guide.



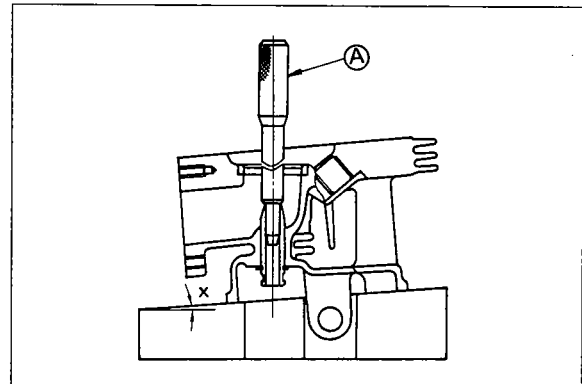
E33FC09W1

### VALVE GUIDE REPLACEMENT

#### REMOVAL

1. Place cyl. head on support plate with combustion chamber upward.
2. Remove valve guide with driver (A).

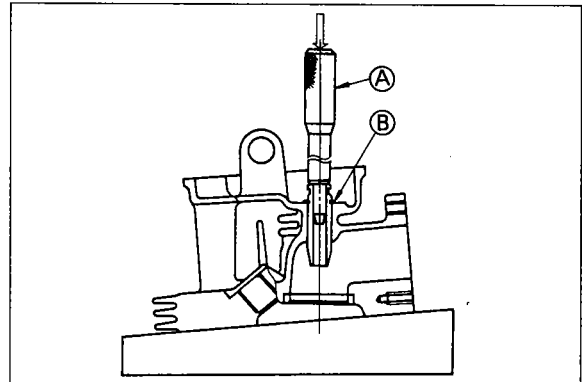
X = 5°



#### INSTALLATION

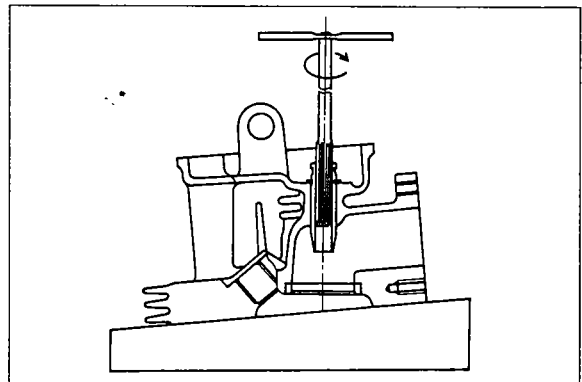
1. Place cyl. head on support plate with combustion chamber downward.
2. Install snap ring (B) on valve guide.
3. Coat a film of oil on outer surface of valve guide.
4. Install valve guide with driver (A) until snap ring (B) just seats on head.

**CAUTION:** Be careful not to damage head gasket surface while installing valve guide.



#### FINISH

1. Finish valve guide to 7.00 - 7.015 mm (0.2756 - 0.2762 in.) - for all valves - with valve guide reamer.
2. Lubricate reamer with kerosene or proper lubricant and turn reamer clockwise.
3. Clean parts thoroughly before assembly.
4. Check valve seating and reface valve seat, if necessary.

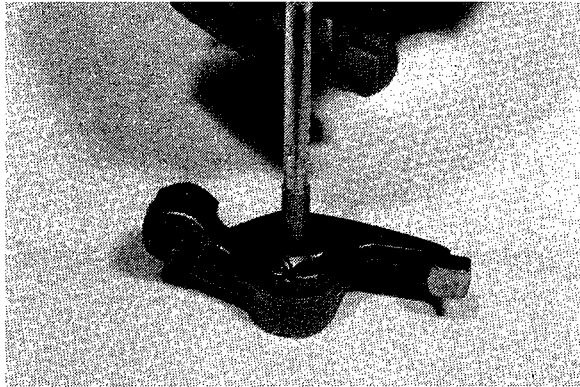


E33FC10W3

## VALVE

### ROCKER ARM SERVICE LIMIT

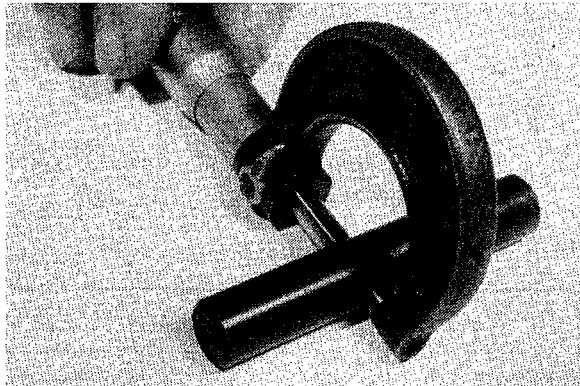
1. Check rocker arm for pitted or worn contact surface with valve stem.
  - If necessary, replace rocker arm.
2. Check inside diameter of rocker arm at several points with inside micrometer.
  - If diameter is more than 13.068 mm (0.5145 in.), replace rocker arm.



E33FC11W1

### ROCKER SHAFT SERVICE LIMIT

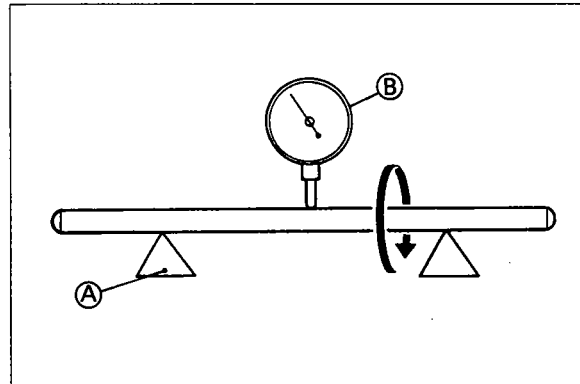
1. Check outside diameter of rocker shaft at several points with micrometer.
  - If diameter is less than 12.936 mm (0.5093 in.), replace rocker shaft.



E33FC12W1

### PUSH ROD SERVICE LIMIT

1. Check bend of push rod at center part with V blocks (A) and dial indicator (B).
  - If bend (dial gauge reading) is more than 0.3 mm (0.012 in.), replace push rod.



E33FC13W1

## CRANKCASE COVER

### REMOVAL

**WARNING:** Be careful not to burn yourself by hot oil.

1. Drain engine oil to suitable container.
2. Remove rust and burr from edge of PTO shaft step.
3. Loosen screws, and tap parts near dowel alternately with soft mallet.

### SERVICE LIMIT

1. Check inside diameter of PTO bearing (A) at several points with inside micrometer.
  - If diameter is more than MAX, replace crankcase cover (FC400•FC420•FC540) or bushing (FC290).

#### PTO BEARING INSIDE DIA. MAX

FC290	30.125 mm (1.1860 in.)
FC400•FC420	35.069 mm (1.3807 in.)
FC540	38.056 mm (1.4983 in.)

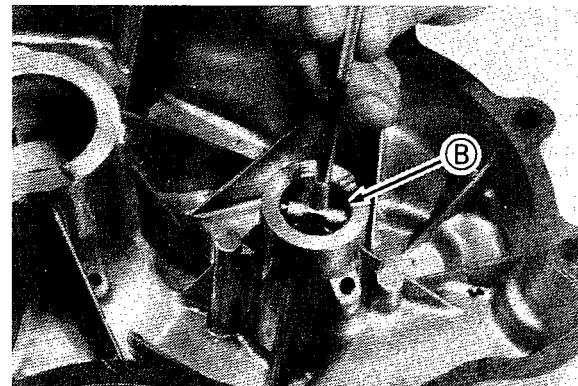
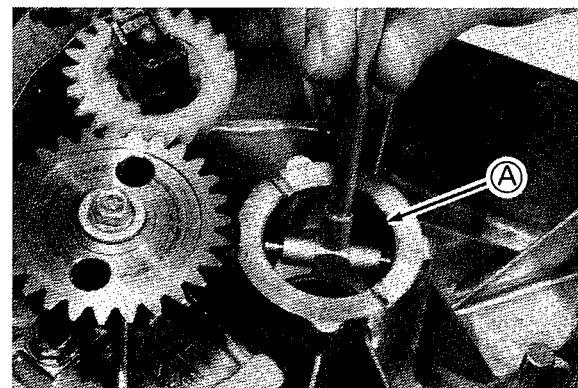
2. Check inside diameter of camshaft bearing (B) at several points with inside micrometer.

- If diameter is more than MAX, replace crankcase cover.

#### CAMSHAFT BEARING INSIDE DIA. MAX

FC290	14.054 mm (0.5533 in.)
FC400•FC420•FC540	21.076 mm (0.8298 in.)

E34FC01W1



E34FC02W3

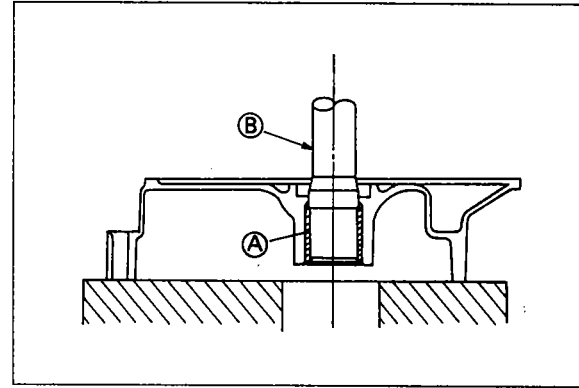
## CRANKCASE COVER

### BUSHING REPLACEMENT — FC290

1. Remove oil seal from crankcase cover.

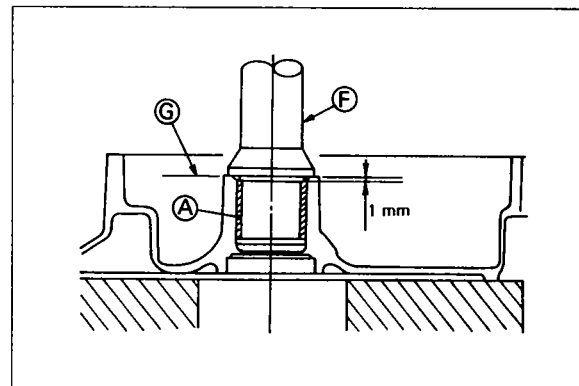
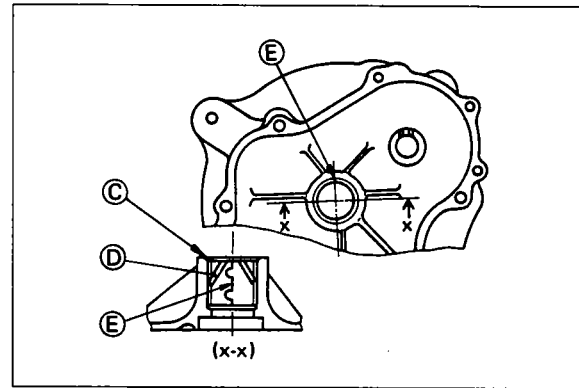
**NOTE :** Do not re-use oil seal.

2. Place crankcase cover on bench with oil seal side up.
3. Push out bushing (A) with bushing tool (B).



4. Place crankcase cover on bench with gasket surface side up.
5. Coat a light film of oil on outside of bushing (A) and entrance of bushing housing (C).
6. Aligning oil grooves (D) and seam (E) as shown, install new bushing (A) into crankcase cover with bushing tool (F) until bushing end goes 1 mm (0.039 in.) below housing end (G).

**NOTE :** Finishing of bushing inside dia. is not required.



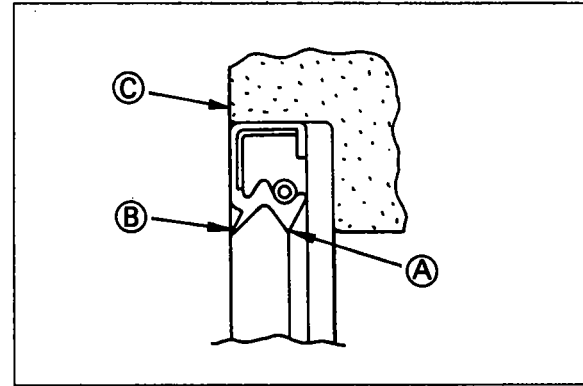
E34FC03W3

## CRANKCASE COVER

### OIL SEAL REPLACEMENT

If oil leakage through oil seal is observed or seal lip is damaged, replace oil seal.

1. Remove oil seal by tapping it out with screw driver or punch.
2. Placing spring held seal lip (A) inside, push oil seal into housing until seal outside surface becomes flush with housing end (C).
3. Before final assembly, pack some amount of grease for high temperature application into space between seal lip (A) and dust lip (B).



E34FC04W2



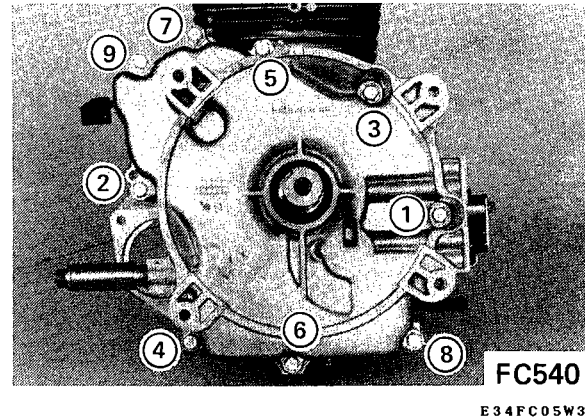
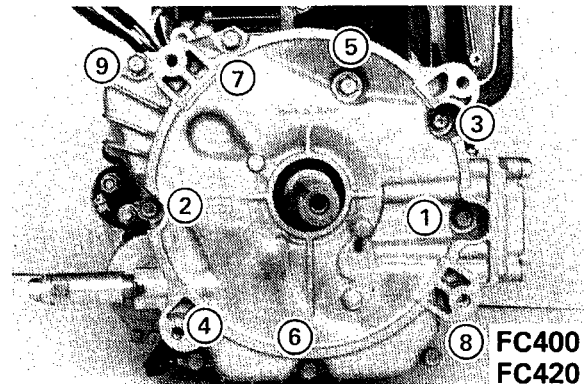
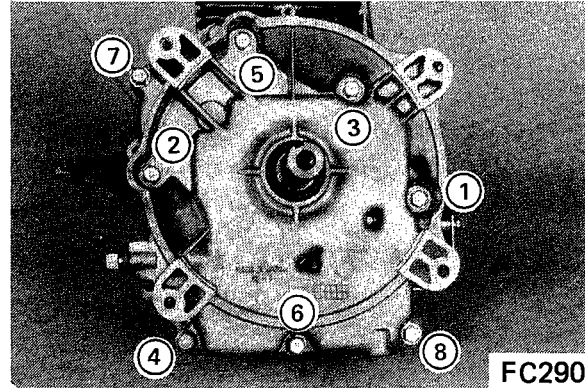
## CRANKCASE COVER

### INSTALLATION

1. Clean gasket surface and place new gasket on crankcase cover.
2. Pack grease into oil seal. (See OIL SEAL REPLACEMENT.)
3. Coat a light film of oil on bearings.
4. Make sure governor weights are closed.

**NOTE :** Make sure to place shim on crankshaft.

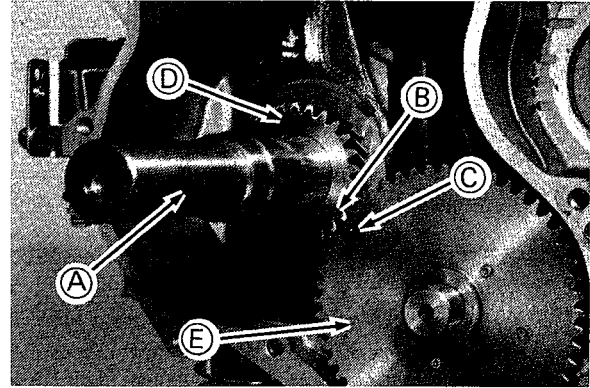
5. Make sure governor gear and oil pump gear are properly aligned to mesh with their respective drive gears when installing crankcase cover. Do not force cover into position.
6. Install crankcase cover and tighten bolts down evenly by hand. Tighten bolts in the sequence as shown and to the specified torque. (See TORQUE SPECIFICATIONS.) Do not tighten one bolt completely before the others. It may cause warped crankcase cover.



## CAMSHAFT

### REMOVAL

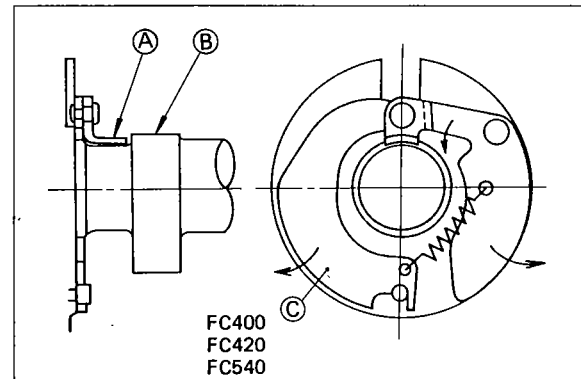
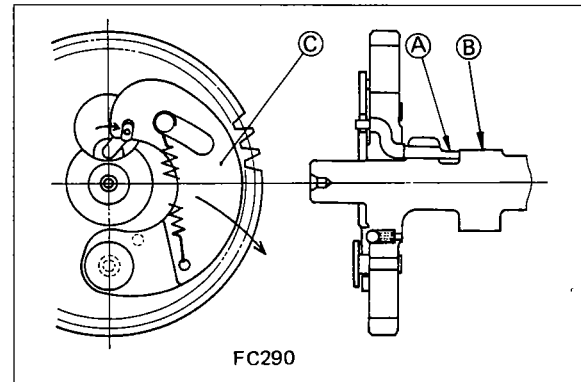
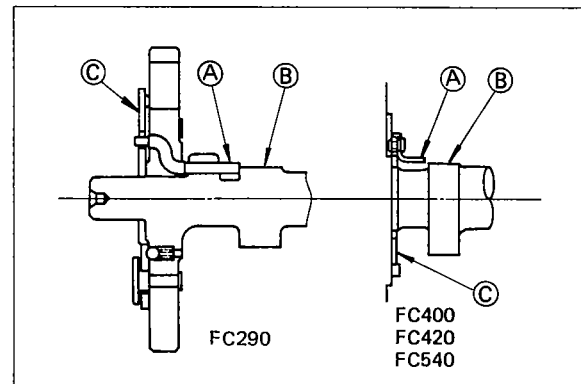
1. Place cyl. block upside down on bench.
2. Rotate crankshaft (A) until timing marks (B,C) on crankshaft gear (D) and camshaft gear (E) align, to avoid interference between tappets and camshaft in removal.
3. Remove tappets, and mark them so they can be placed in their original position in re-installing.



E35FC01W1

### VISUAL CHECK

1. Check cam gear for worn or broken teeth.
  - If excessively worn or broken teeth are observed, replace camshaft.
2. Check movement and damage of ACR mechanism on camshaft.
  - If outer surface of tab or arm (A) is not placed above cam heel (B) when weight (C) is closed, replace ACR mechanism.
  - If outer surface of tab or arm (A) does not lower below cam heel (B) when weight (C) is pulled toward outside by finger, replace ACR mechanism.
  - If parts of mechanism are worn, replace ACR mechanism.



E35FC02W3

## CAMSHAFT

### SERVICE LIMIT

1. Check bearing journal diameter with micrometer.
  - If diameter is less than MIN, replace camshaft.

#### BEARING JOURNAL DIA. MIN FC290

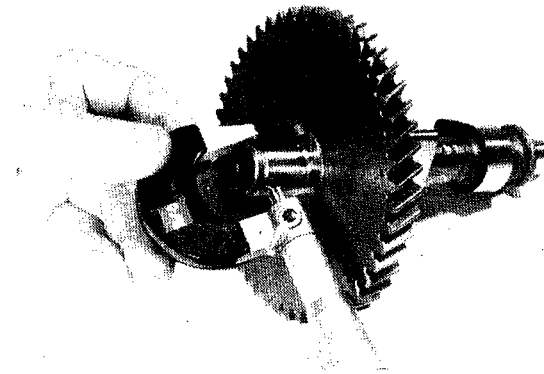
Gear side	13.922 mm (0.5481 in.)
Cam side	15.921 mm (0.6268 in.)

#### FC400 • FC420

Gear side	20.912 mm (0.8233 in.)
Cam side	19.912 mm (0.7839 in.)

#### FC540

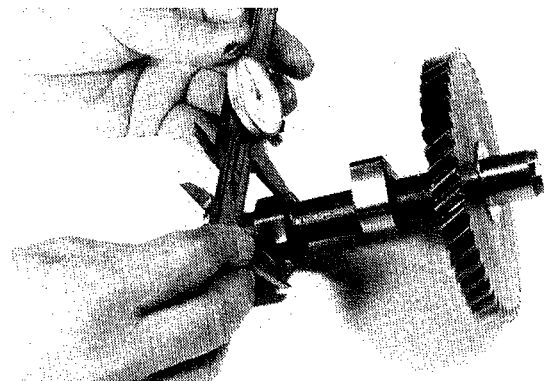
Gear side	20.912 mm (0.8233 in.)
Cam side	



2. Check cam lobe height with vernier calipers.
  - If lobe height is less than MIN, replace camshaft.

#### LOBE HEIGHT MIN (Intake and Exhaust)

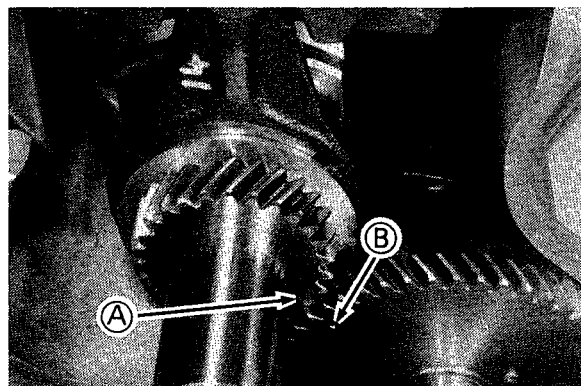
FC290	27.08 mm (1.066 in.)
FC400 • FC420	36.75 mm (1.447 in.)
FC540	37.10 mm (1.461 in.)



E35FC03W3

### INSTALLATION

1. Place cyl. block upside down on bench.
2. Install tappets in their respective positions and push them all the way into guide to avoid interference with camshaft in assembling.
3. Rotate crankshaft until piston is at highest position.
4. Aligning timing marks (A) and (B), install camshaft into crankcase.



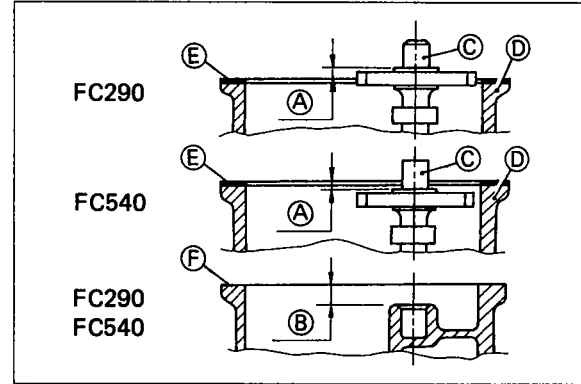
E35FC04W1

# CAMSHAFT

## AXIAL PLAY ADJUSTMENT

When any part related to axial play is changed, adjust axial play as follows;

1. Measure distance (A), installing camshaft (C) into crankcase (D) and placing gasket (E) on crankcase,
2. Measure depth (B) of crankcase cover (F).
3. Select appropriate shim with each chart.
4. Chamfered side of shim should be placed toward cam gear.



### FC 290

T (mm)	P/N
1.60	92025-2162
1.65	92025-2163
1.70	92025-2164
1.75	92025-2165
1.80	92025-2166
1.85	92025-2167
1.90	92025-2208
1.95	92025-2209

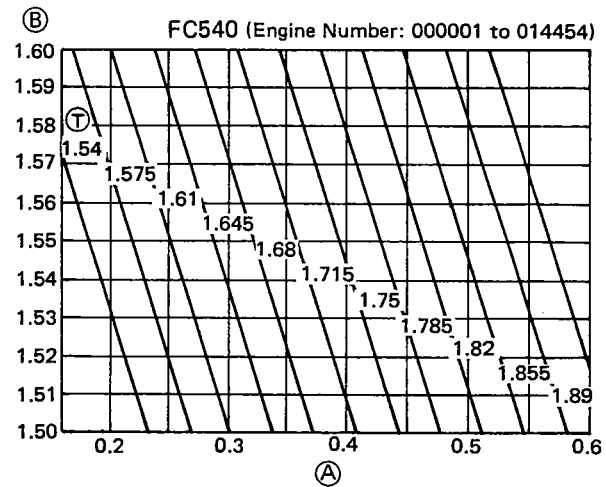
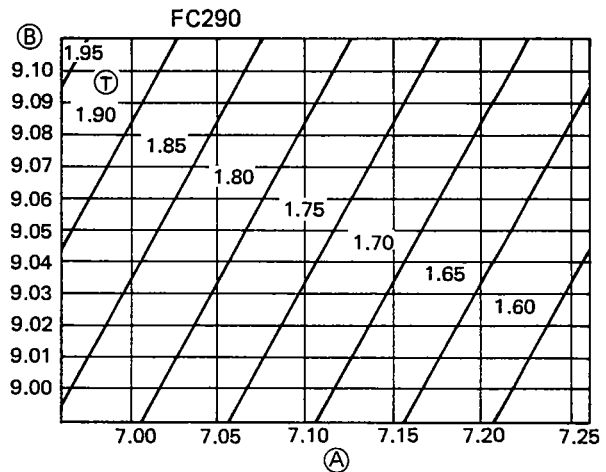
### FC 540

T (mm)	P/N
1.54	92025-2177
1.575	92025-2192
1.61	92025-2178
1.645	92025-2193
1.68	92025-2179
1.715	92025-2194
1.75	92025-2180
1.785	92025-2195
1.82	92025-2181
1.855	92025-2196
1.89	92025-2182

T : Thickness of shim P/N : Part Number

Play after adjustment is 0.07-0.19 mm (0.0028-0.0075 in.) for FC290 and FC540.

**NOTE** : FC420 and FC540 with serial number higher than 014455 do not require camshaft axial play adjustment. The camshaft is pressurized to avoid out of adjustment.

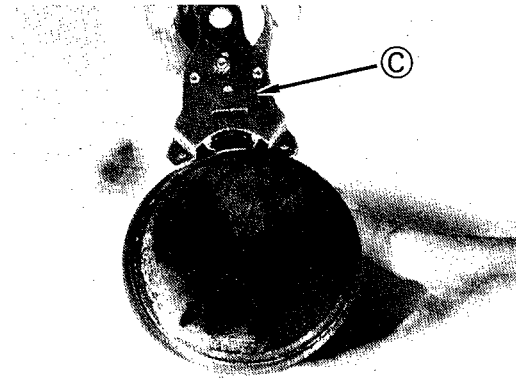
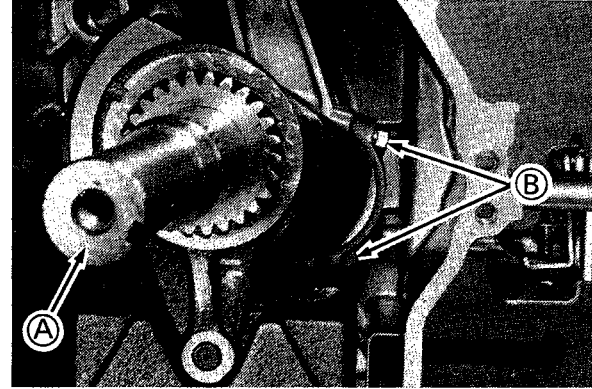


## PISTON & CON-ROD

### REMOVAL

**CAUTION:** Remove any carbon or ridge at top of cyl. bore to avoid piston ring breakage in removing.

1. Rotate crankshaft (A) to expose con-rod bolts (B).
2. Loosen con-rod bolts and remove con-rod cap.
3. Push piston and con-rod out through top of cylinder.
4. Remove piston from con-rod.
5. Remove piston rings from piston with ring expander (C).



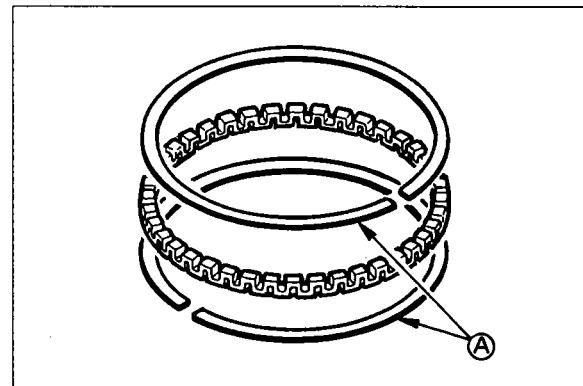
E36FC01W2

## PISTON & CON-ROD

### PISTON AND PISTON RING VISUAL CHECK

Appearance of piston and piston rings shows condition of engine in running. If excessive damage is observed, replace piston and/or piston rings and remove cause of such damage.

1. Rings of wrong size or rings having improper end gap will not fit to shape of cylinder. This causes high oil consumption and excessive blowby.
  - Check ring end gap and arrange end gap as shown in PISTON RING INSTALLATION.
2. Scuffing or scoring of both rings and piston occurs when friction and/or combustion temperature are unusually high.
  - Check and clean cooling system.
  - Check and correct quality and level of oil.
  - Check and adjust fuel and combustion systems.
3. Engine running at abnormally high temperature may cause varnish, lacquer, or carbon deposit formed in piston ring grooves making rings stick.
  - Apply same treatment as above 2.
4. Vertical scratches across piston rings are due to abrasive in engine. Abrasive may be airborne, may have been left in engine during overhaul, or may be loose lead and carbon deposit.
  - Check air cleaner and clean or replace damaged one.
  - Check any air intake through abnormal route.
  - Clean engine inside and change oil.
5. Scratches across oil side rails (A) are due to abrasive in engine oil, and other rings will also be worn in this condition causing high oil consumption, increased deposit in combustion chamber, and ring sticking.
  - Clean engine inside and change oil.



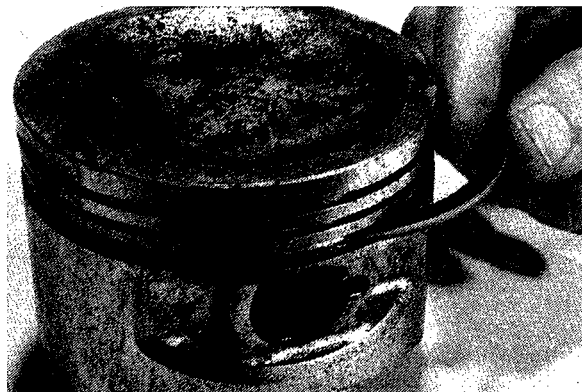
E36FC02W4

## PISTON & CON-ROD

### PISTON CLEANING

**CAUTION:** Do not use caustic cleaning solution or wire brush to clean piston.

1. Remove all deposits from piston.
2. Clean carbon from piston ring grooves with ring groove cleaner. If cleaning tool is not available, use old piston ring breaking into suitable size.
3. Make sure oil return passages in ring groove are open.



E36FC03W1

### PISTON SERVICE LIMIT

1. Check clearance between ring groove and ring using new ring and feeler gauge.
  - If clearance is more than MAX, replace piston.



### RING GROOVE CLEARANCE MAX FC290

Top ring	0.16 mm (0.0062 in.)
Second ring	0.14 mm (0.0055 in.)
Oil ring	0.19 mm (0.0075 in.)

### FC400 • FC420 • FC540

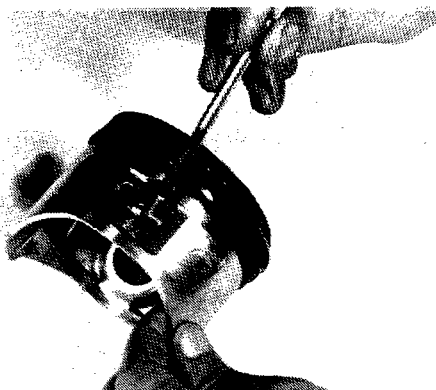
Top ring	0.17 mm (0.0067 in.)
Second ring	0.15 mm (0.0059 in.)
Oil ring	0.20 mm (0.0079 in.)

2. Check inside diameter of piston pin hole at several points with inside micrometer.

- If diameter is more than MAX, replace piston.

### PISTON PIN HOLE DIA. MAX

FC290	19.031 mm (0.7493 in.)
FC400 • FC420 • FC540	22.037 mm (0.8676 in.)



E36FC04W3

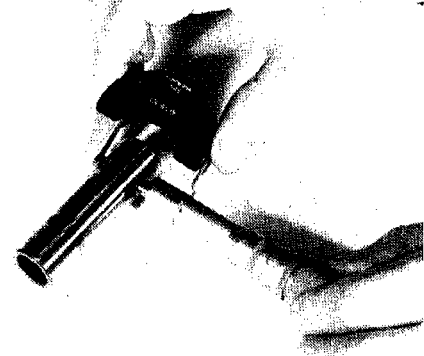
## PISTON & CON-ROD

### PISTON PIN SERVICE LIMIT

1. Check outside diameter of piston pin at several points with micrometer.
  - If piston pin diameter is less than MIN, replace piston pin.

### PISTON PIN DIA. MIN

FC290	18,981 mm (0.7473 in.)
FC400-FC420-FC540	21,977 mm (0.8652 in.)



E36FC05W1

### PISTON RING SERVICE LIMIT

1. Check thickness of piston ring at several points with micrometer.
  - If thickness is less than MIN, replace piston ring.

### PISTON RING THICKNESS MIN (Top and Second)

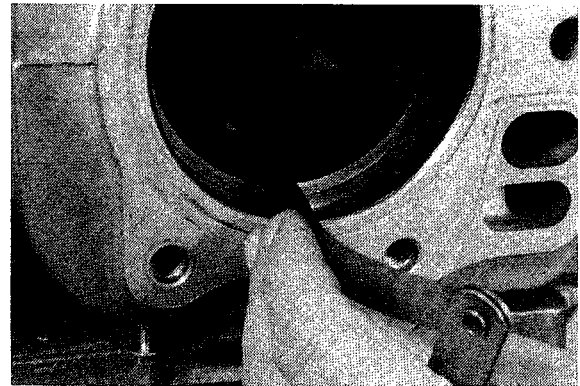
FC290-FC400	1.44 mm (0.056 in.)
FC420-FC540	1.94 mm (0.076 in.)



2. Check piston ring end gap with feeler gauge, installing each ring squarely in cylinder at approx. 25 mm (1 in.) from top.
  - If gap is more than MAX, replace piston ring.

### PISTON RING END GAP MAX (Top and Second)

FC290	0.7 mm (0.028 in.)
FC400-FC420-FC540	0.9 mm (0.035 in.)



E36FC06W2

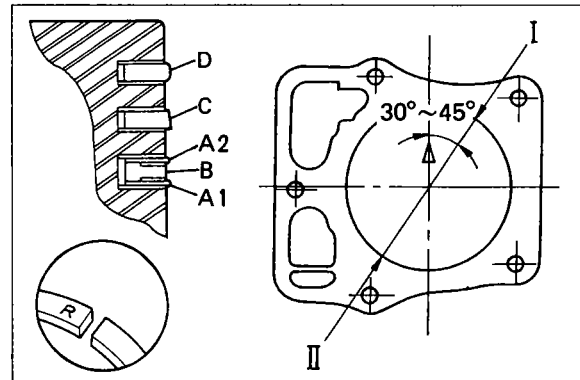
**NOTE :** Replace oil ring together with compression rings.

### PISTON RING INSTALLATION

1. Use ring expander.

**NOTE :** Face up "R" mark on top and second rings.

2. Install rings in following sequence;  
Lower side rail (A1) - Spacer (B) - Upper side rail (A2) - Second ring (C) - Top ring (D).
3. Place end gaps as follows;
  - I : C, A1
  - II : D, A2



E36FC07W1



## PISTON & CON-ROD

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### CON-ROD VISUAL CHECK

Check con-rod especially big end for wearing, scratching, scoring, and/or discoloring.

1. Abnormal wearing and scratching are caused by foreign particle(s) in oil.
  - Clean engine inside and change oil.
  - Check oil filter and air cleaner and clean or replace damaged one.
  - If con-rod and/or crankshaft are used again, remove ridges on their surface carefully.
  
2. Scoring and discoloring are symptom of poor lubricating and/or over heating.
  - If crankpin surface is damaged by melted con-rod metal, replace con-rod and crankshaft.
  - Check lubricating system including oil pump, oil filter, and oil passages and repair or replace damaged part.
  - Check and clean cooling system.
  - Check quality of oil and maintenance method with user.

**CAUTION :** Check re-used components carefully when re-assembling engine which had con-rod big end seizure.  
Never start engine without oil even for short test run.

E36FC08W3

## PISTON & CON-ROD

### CON-ROD SERVICE LIMIT

1. Check inner diameter of small end at several points with inside micrometer.

- If inside diameter is more than MAX, replace con-rod.

### SMALL END INSIDE DIA. MAX

FC290	19.059 mm (0.7540 in.)
FC400•FC420•FC540	22.059 mm (0.8685 in.)

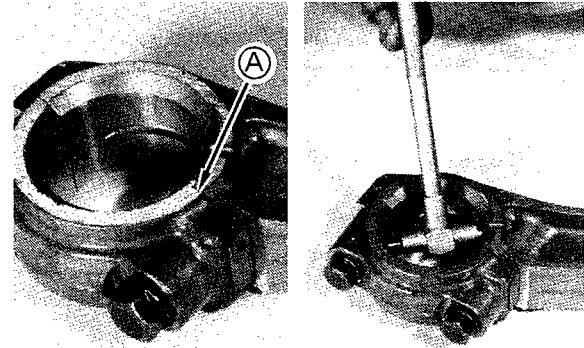
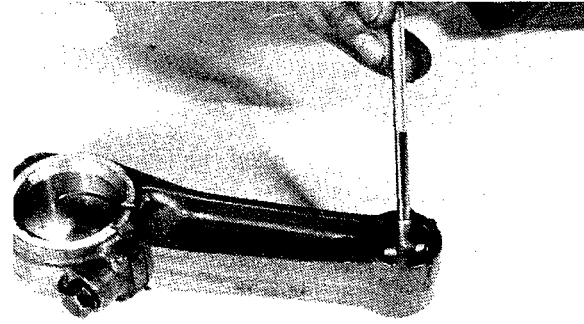
2. Assemble con-rod big end aligning pilot grooves (A), and tighten con-rod bolts as specified in TORQUE SPECIFICATIONS.

3. Check inner diameter of big end at several points with inside micrometer.

- If inside diameter is more than MAX, replace con-rod.

### BIG END INSIDE DIA. MAX

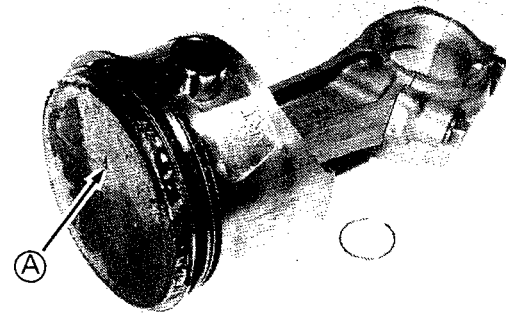
FC290	35.567 mm (1.4003 in.)
FC400•FC420•FC540	41.068 mm (1.6169 in.)



### PISTON AND CON-ROD ASSEMBLY

1. Aligning mark "Δ" (A) on piston head with "MADE IN JAPAN" on con-rod, assemble piston over con-rod.
2. Coat a light film of oil on piston pin and insert pin through piston and con-rod.
3. Install retaining rings in each grooves firmly.

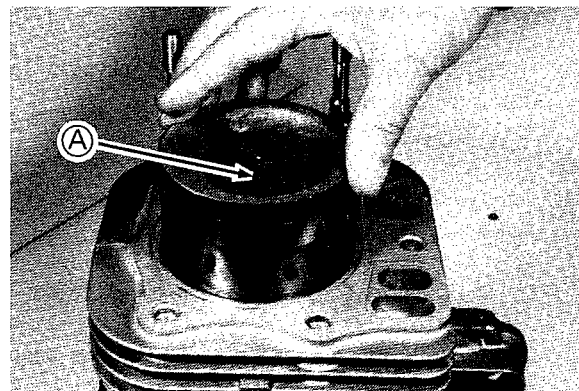
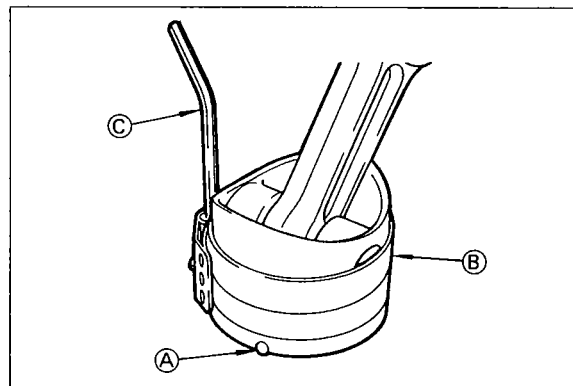
**CAUTION:** Do not re-use retaining ring removed. Removal may deform or weaken the ring allowing it to come out during operation causing damage to cly. wall.



## PISTON & CON-ROD

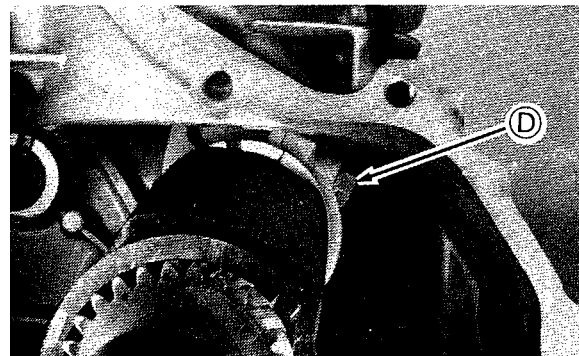
### PISTON/CON-ROD ASSY INSTALLATION

1. Set ring compressor (B) over piston, flushing with piston top, with projection (A) on compressor toward top of piston.
  2. Tighten compressor with wrench (C), then loosen it slightly.
  3. Coat a light film of oil on cyl. bore.
  4. Rotate crankshaft with crank pin in lowest position.
- 
5. Aligning mark "Δ" (A) on piston head toward flywheel side, install piston/conrod assy into cylinder.
  6. Leading big end of con-rod to crank pin, push piston down further.
  7. Coat a light film of oil on crank pin, con-rod big end, cap, and con-rod bolts.



8. Aligning pilot groove, install cap to big end and tighten cap bolts (D) as specified in TORQUE SPECIFICATIONS.
9. Make sure con-rod moves sideways lightly on crank pin.

**CAUTION:** Con-rod bolt tightening is one of the most important items in assembling. Always use torque wrench.

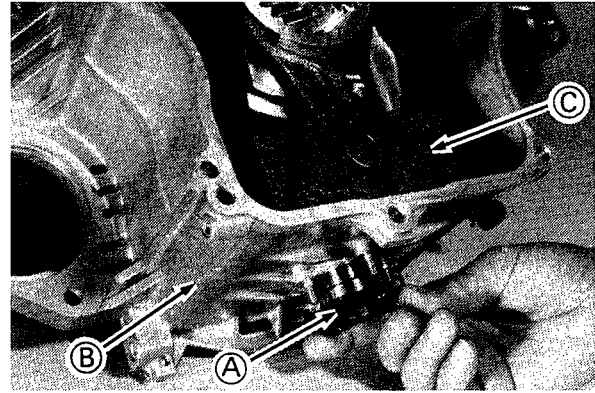


E36FC11W3

## CRANKSHAFT

### REMOVAL

1. Remove balancer support shaft (A) from crankcase (B).
2. Pull crankshaft and balancer Assy (C) out of crankcase (B).
3. Remove crank gear and balancer link rods from crankshaft.



E37FC01W1

### VISUAL CHECK

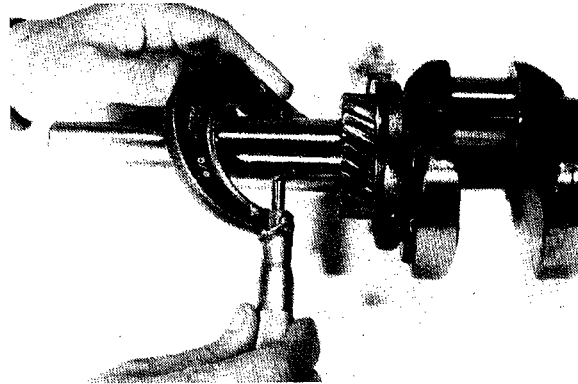
1. Check crank pin part and bearing journals for score, wear, or corrosion.
  - If crank pin part shows any damage, carefully check con-rod big end and repair or replace con-rod and/or crankshaft. (See CON-ROD VISUAL CHECK.)
2. Check crank gear for worn or broken teeth.
  - If excessively worn or broken teeth are observed, replace crank gear.

E37FC02W2

## CRANKSHAFT

### SERVICE LIMIT

1. Check outside diameter of both main bearing journals at several points with micrometer.
- If outside diameter is less than MIN, replace crankshaft.



### JOURNAL OUTSIDE DIA. MIN FC290

PTO side	29.922 mm (1.1780 in.)
Magneto side	29.940 mm (1.1784 in.)

### FC400 · FC420

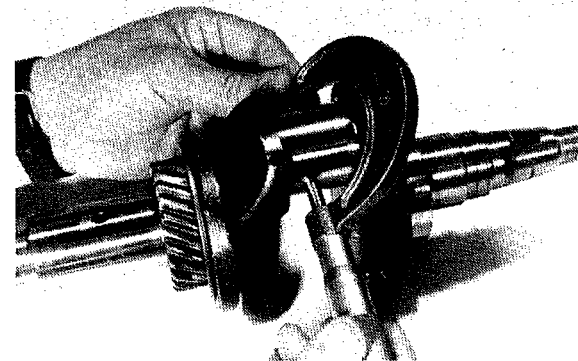
PTO side	34.919 mm (1.3747 in.)
Magneto side	34.945 mm (1.3757 in.)

### FC540

PTO side	37.904 mm (1.4923 in.)
Magneto side	34.945 mm (1.3757 in.)

2. Check outside diameter of crank pin at several points with micrometer.

- If outside diameter is less than MIN, repair or replace crankshaft.  
For repair, see RE-GRINDING OF CRANK PIN.



### CRANKPIN OUTSIDE DIA. MIN

FC290	35.428 mm (1.3948 in.)
FC400·FC420·FC540	40.928 mm (1.6113 in.)

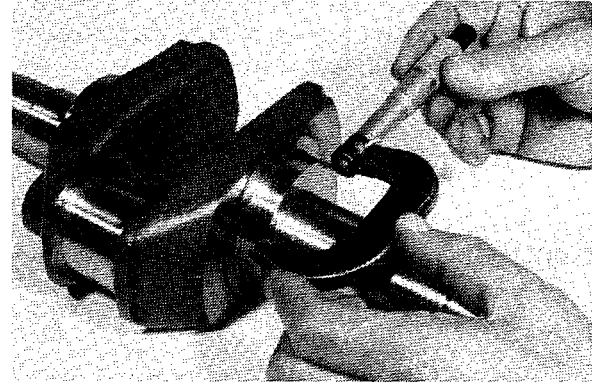
## CRANKSHAFT

3. Check outside diameter of balancer link rod journal at several points with micrometer.

- If outside diameter is less than MIN, replace crankshaft.

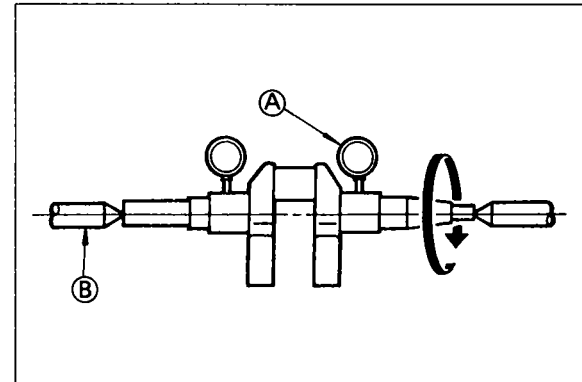
### BALANCER LINK ROD JOURNAL OUTSIDE DIA. MIN

FC290	46.953 mm (1.8453 in.)
FC400-FC420	53.950 mm (2.1240 in.)
FC540	57.941 mm (2.2811 in.)



4. Check run out of crankshaft at both bearing journals with dial indicator (A), setting crankshaft to alignment jig (B).

- If total reading of run out is more than 0.05 mm (0.002 in.), replace crankshaft.



E37FC03W7

# CRANKSHAFT

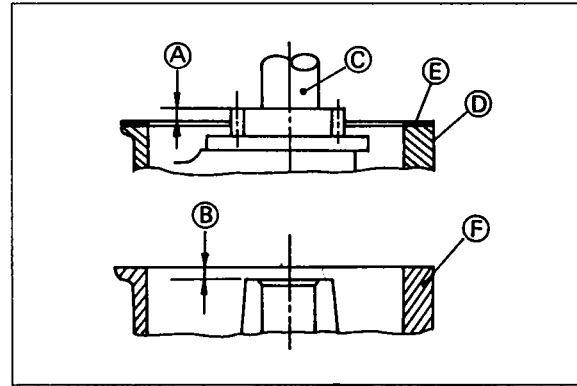
## AXIAL PLAY ADJUSTMENT

When any part related to axial play is changed, adjust axial play as follows;

1. Measure distance (A), installing crankshaft (C) into crankcase (D) and placing gasket (E) on crankcase.
2. Measure depth (B) of crankcase cover (F).
3. Select appropriate shim with each chart.

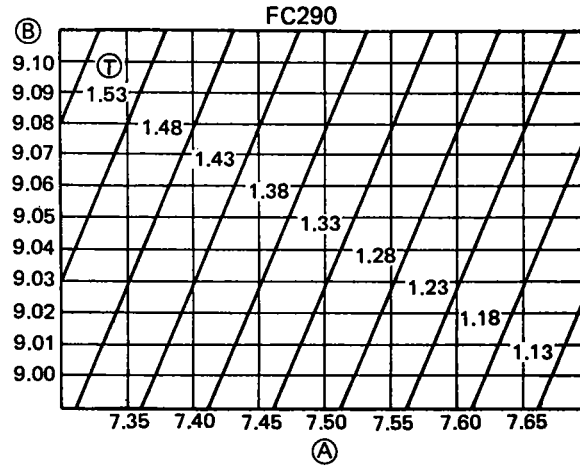
T: Thickness of shim P/N: Part Number

**NOTE:** Axial play after adjustment is 0.09-0.22 mm (0.0035-0.0087 in.).



### FC290

T (mm)	P/N
1.13	92025-2168
1.18	92025-2169
1.23	92025-2170
1.28	92025-2171
1.33	92025-2172
1.38	92025-2173
1.43	92025-2174
1.48	92025-2175
1.53	92025-2207



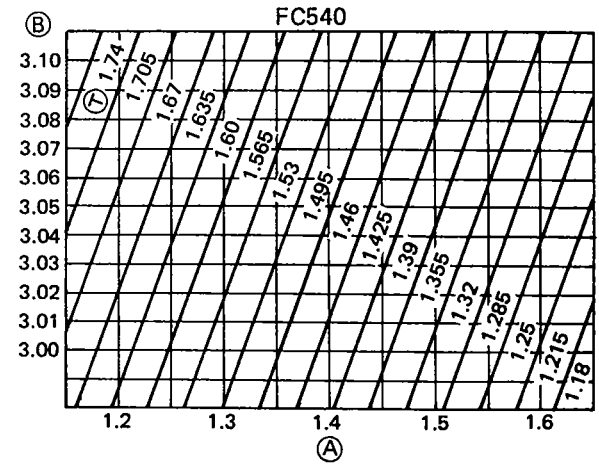
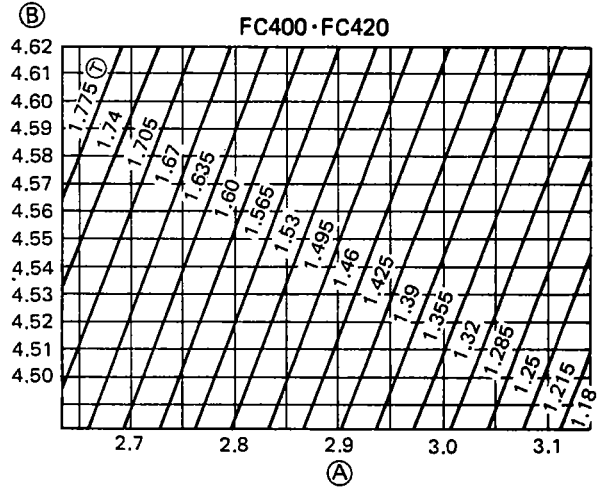
# CRANKSHAFT

## FC400 · FC420

T (mm)	P/N
1.180	92025-2210
1.215	92025-2211
1.250	92025-2212
1.285	92025-2213
1.320	92025-2214
1.355	92025-2215
1.390	92025-2216
1.425	92025-2217
1.460	92025-2218
1.495	92025-2219
1.530	92025-2220
1.565	92025-2221
1.600	92025-2222
1.635	92025-2223
1.670	92025-2224
1.705	92025-2225
1.740	92025-2226
1.775	92025-2227

## FC540

T (mm)	P/N
1.180	92025-2191
1.215	92025-2183
1.250	92025-2197
1.285	92025-2184
1.320	92025-2198
1.355	92025-2185
1.390	92025-2199
1.425	92025-2186
1.460	92025-2200
1.495	92025-2187
1.530	92025-2201
1.565	92025-2188
1.600	92025-2202
1.635	92025-2189
1.670	92025-2203
1.705	92025-2190
1.740	92025-2204





## CRANKSHAFT

### INSTALLATION

1. Coat a film of oil on bearing surfaces of parts assembled.
2. Assemble balance weight (A), balancer link rods (B), collar (C), spacer or governor drive gear for FC290 (D), and crank gear (E) to crankshaft.

**NOTE:** Place following parts in correct direction as shown below ;

Balance weight (A).....: Oil hole (F) to flywheel side

Link rods (B) of FC400•FC420

and FC540.....: Side oil grooves to collar (C) and spacer (D) side

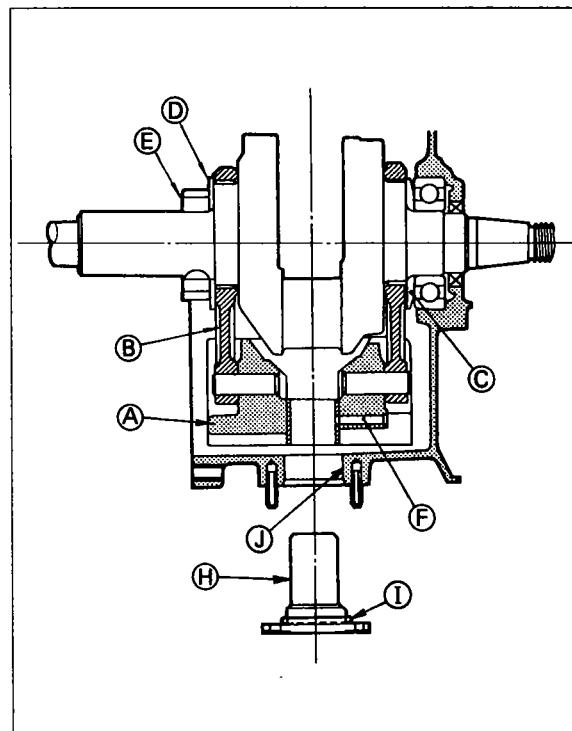
Collar (C).....: Conic face to ball bearing side

Governor drive gear

of FC290 and spacer

of FC400•FC420 and FC540 (D): Chamfered face to link rod (B) side

3. Tape key way at taper of crankshaft to avoid cutting of oil seal lips.
4. Pack some amount of grease for high temperature application into oil seal.
5. Placing crank pin for crankcase bottom, install crankshaft and assembled parts into crankcase.
6. Install balancer support shaft (H) with o-ring (I) through hole (J) of crankcase.



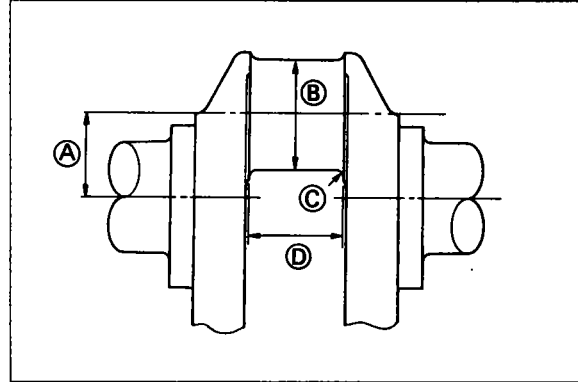
E37FC05W3

# CRANKSHAFT

## CRANK PIN RE-GRINDING

1. Re-grind crank pin to specified under size.  
**FC 2 9 0**

A	29.950 - 30.000 mm (1.1791 - 1.1811 in.)
B	34.980 - 34.990 mm (1.3772 - 1.3776 in.)
C	2.80 - 3.20 mm (0.110 - 0.126 in.)
D	28.4 mm (1.12 in.) MAX



**FC 4 0 0 - FC 4 2 0**

A	33.950 - 34.000 mm (1.3366 - 1.3386 in.)
B	40.467 - 40.480 mm (1.5932 - 1.5937 in.)
C	3.30 - 3.70 mm (0.130 - 0.146 in.)
D	32.5 mm (1.28 in.) MAX

**FC 5 4 0**

A	42.950 - 43.000 mm (1.6909 - 1.6929 in.)
B	40.467 - 40.480 mm (1.5932 - 1.5937 in.)
C	3.30 - 3.70 mm (0.130 - 0.146 in.)
D	32.5 mm (1.28 in.) MAX

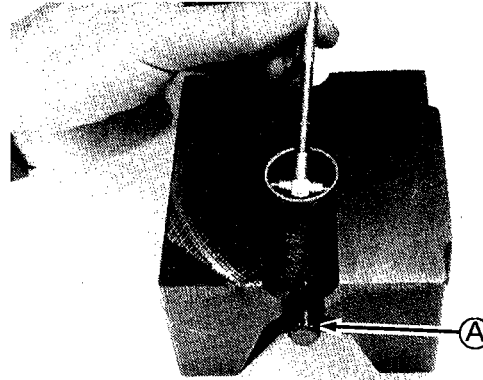
**NOTE :** Crank pin must be concentric and parallel within 0.005 mm (0.0002 in.) full indicator reading, and surface must be finished very smooth with super finishing stone.

**CAUTION :** If crank pin is re-ground, under-size con-rod must be used to keep specified clearance.

## BALANCER

### BALANCE WEIGHT SERVICE LIMIT

1. Check bearing inside diameter at several points with inside micrometer.
  - If inside diameter is more than 26.097 mm (1.0274 in.), replace balance weight.
2. Wrist pins (A) require no maintenance but if they are severely damaged, replace balance weight.



E38FC01W1

### BALANCER SUPPORT SHAFT SERVICE LIMIT

1. Check outside diameter of shaft at several points with micrometer.
  - If outside diameter is less than 25.927 mm (1.0208 in.), replace balancer support shaft.

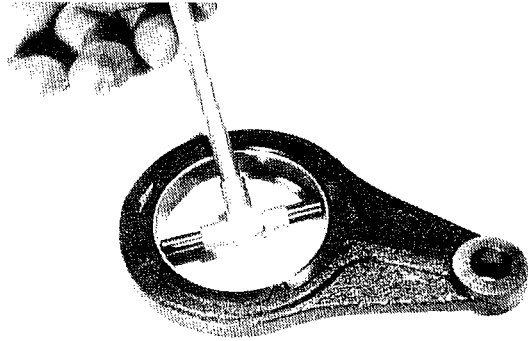


E38FC03W1

# BALANCER

## BALANCER LINK ROD SERVICE LIMIT

1. Check inside diameter of small end bearing at several points with inside micrometer.
  - If inside diameter is more than 12.60 mm (0.4748 in.), replace balancer link rod.
2. Check inside diameter of big end bearing at several points with inside micrometer.
  - If inside diameter is more than MAX, replace bushing.



## BIG END INSIDE DIA. MAX

FC290	47.121 mm (1.8552 in.)
FC400-FC420	54.121 mm (2.1307 in.)
FC540	58.153 mm (2.2895 in.)

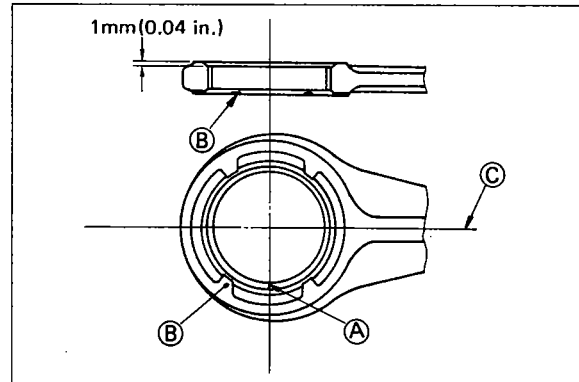
E38FC04W2

## LINK ROD BUSHING ASSEMBLY

**CAUTION:** Place seam (A) of bushing to right angle with lengthwise center (C).

1. Push bushing into link rod as shown.

**NOTE:** Bushing must be pushed from opposite side of oil grooves (B) for FC400-FC420 and FC540. FC290 does not need such attention because link rod is symmetric.



E38FC05W1

## GOVERNOR

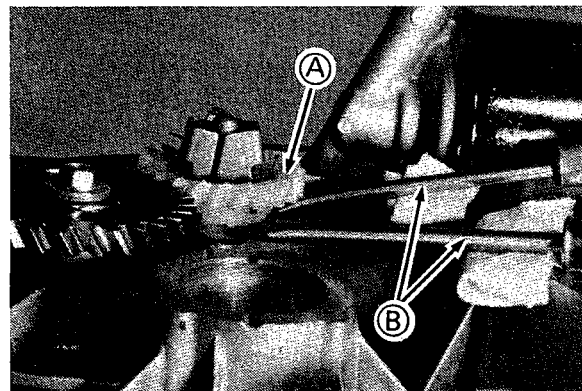
### GOVERNOR GEAR CHECK AND REMOVAL

1. Check governor gear assy for wear and damage, as installed in crankcase cover.

**CAUTION:** Do not remove governor gear assy from crankcase cover except to replace. If once removed, it cannot be re-used.

2. If governor gear assy (A) must be replaced, remove it with proper size screw drivers (B).

**CAUTION:** Do not damage gasket surface by screw drivers.

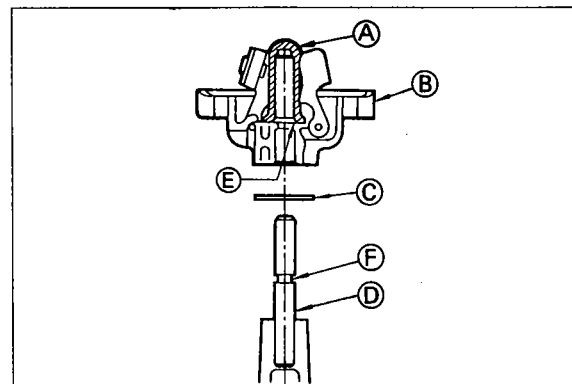


### GOVERNOR GEAR INSTALLATION

1. Place sleeve (A) into governor gear assy (B).

**CAUTION:** Sleeve can not be assembled after governor gear assy installed in crankcase cover.

2. Place thrust washer (C) on boss of shaft (D) and then install governor gear assy (B) with sleeve (A) to shaft until step (E) fits into groove (F).
3. Check free rotation of governor assy after installation.



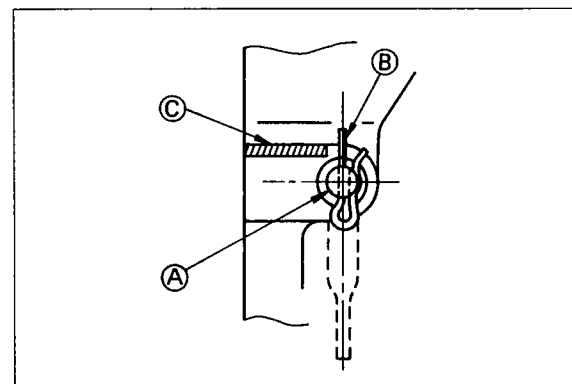
E39FC01W2

E39FC02W1

### GOVERNOR SHAFT INSTALLATION

1. Install governor shaft (A) into crankcase and set locking pin (B) to governor shaft positioning as shown.

**NOTE:** Be careful for position of locking pin end and projection (C) which is stopper of governor shaft (A).



E39FC03W1

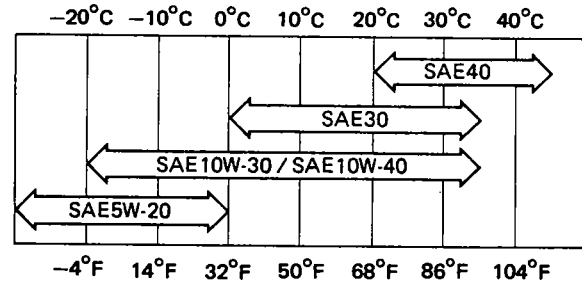
## LUBRICATING SYSTEM

### ENGINE OIL

1. Use high quality detergent engine oil classified "API Service SF, SE, or SD" or equivalent.

**NOTE:** Detergent engine oil delays formation of gum and varnish. Do not add any additives to detergent oil.

2. Select oil viscosity depending on expected environmental temperature as shown.



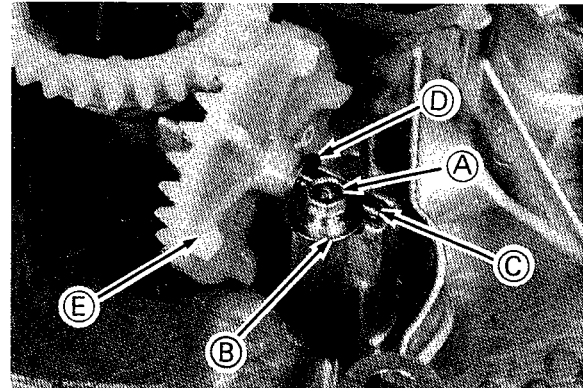
E40FC01W1

### OIL SLINGER CHECK - FC290

Lubricating system of FC290 is oil splash type in which oil slinger with paddles is driven by governor gear.

1. Remove bolt (A) and washer (B).
2. Remove shaft (C), washer (D) and slinger (E).
3. Check slinger for worn or broken teeth and paddles.

- If slinger is damaged, replace it.



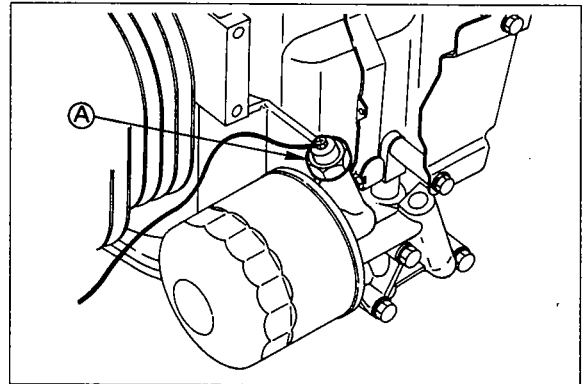
E40FC02W1

### OIL WARNING SYSTEM - FC400, FC420 & FC540

Oil pressure switch (A) is available for FC400, FC420 and FC540. It turns on warning light on dash if oil pressure falls below 29.4 kPa (4.2 psi).

This pressure switch is installed on oil filter adapter (with oil filter) or oil passage cover (without oil filter).

**CAUTION:** Whenever you start engine, make sure warning light is not on in started engine. If warning light comes on, stop engine immediately and check oil level.



Check oil warning system as follows;

When you start engine, observe warning light on dash carefully.

- If light is on in started engine in spite of adequate oil, check lead from pressure switch to warning light for short circuit and/or check pressure switch and replace damaged part.
- If light is not on at the moment of starter switch operation, check all leads of warning light circuit or bulb and replace damaged parts.

E40FC04W2

## LUBRICATING SYSTEM

### FULL FLOW OIL FILTER — FC400, FC420 & FC540

Cartridge type full-flow oil filter is available and it extends oil change interval to as much as 100 hours, (without oil filter: 50 hours)

Oil flows through inlet (A), element (B), and outlet (C). If element is clogged, oil flows through bypass (D) to avoid oil shortage.

Change oil filter as follows;



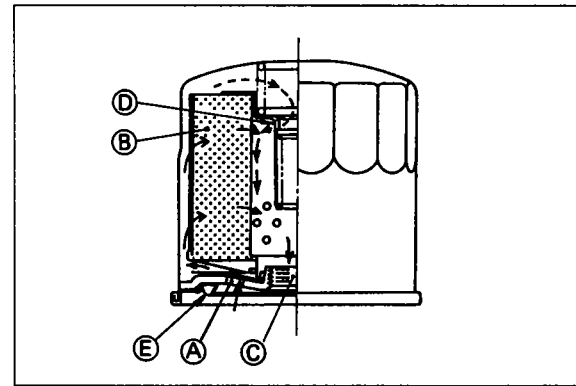
**WARNING :** Be careful not to burn yourself by hot oil.

**CAUTION :** Use only KAWASAKI genuine replacement filter. Others may fit but may be inferior in quality.

1. Drain engine oil to suitable container.

**CAUTION :** Before removing oil filter, place suitable pan under filter connection.

2. Turn filter counterclockwise to remove it.
3. Coat a film of engine oil on seal (E) of new filter.
4. Install new filter turning it clockwise until seal contacts mounting surface. Then turn filter 3/4 turn more by hand.
5. Supply engine oil as specified.
6. Run engine for about 3 minutes, stop engine, and check oil leakage around filter.
7. Add oil to compensate oil level down due to oil filter capacity.



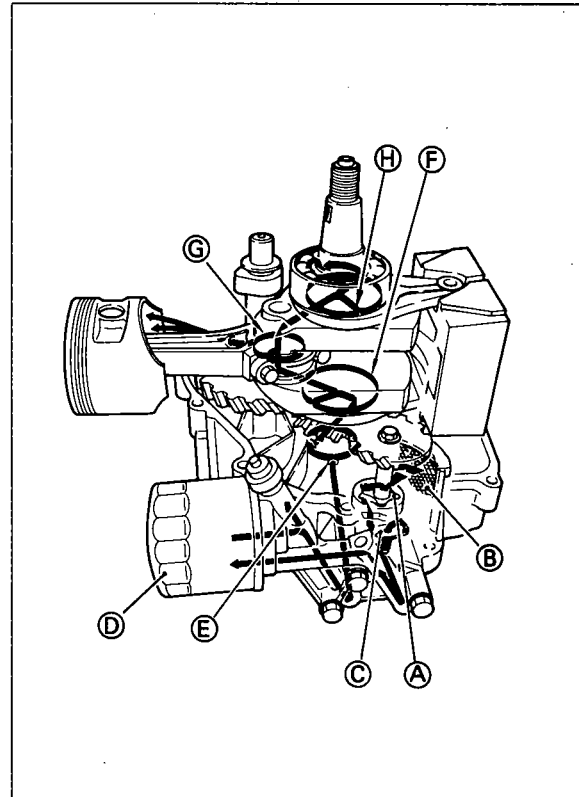
E40FC03W3

## LUBRICATING SYSTEM

### OIL PASSAGE CHECK - FC400, FC420 & FC540

FC400, FC420 and FC540 are equipped with crank gear driven trochoid pump to pressurize lubricating oil. Oil is drawn into pump chamber (A) through oil screen (B) and pressurized by pump. Oil pressure is controlled by relief valve (C) to 294 kPa (42.7 psi). Then oil flows through oil filter (D-if used), PTO side main journal (E), and crankshaft lubricating lower balancer link rod (F), crank pin (G), and upper balancer link rod (H). A portion of oil at crank pin passes through orifice in conrod and spreads on piston and cylinder. Another portion of oil at upper balancer link rod spreads on magneto side ball bearing.

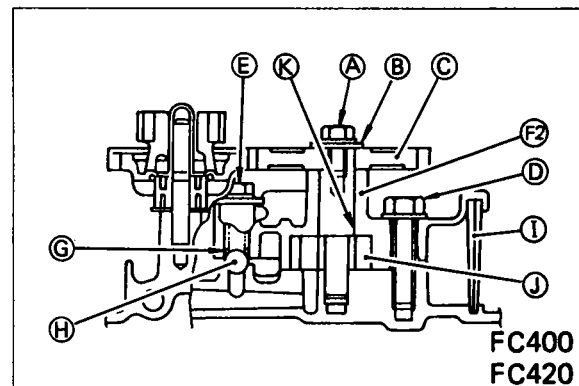
- If insufficient lubrication is observed inspite of adequate oil in oil pan, check oil passages shown above.



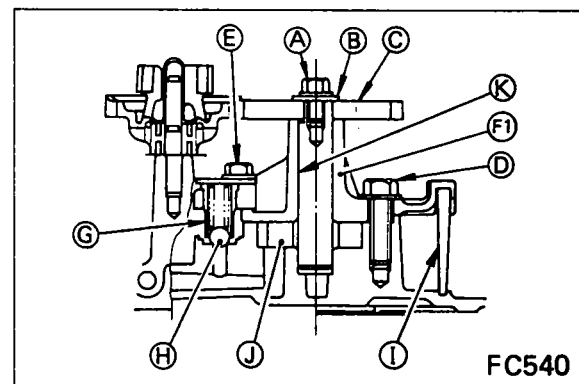
E40FC05W2

### OIL PUMP COMPONENTS - FC400, FC420 & FC540

- |                         |                              |
|-------------------------|------------------------------|
| A : Bolt                | H : Check ball               |
| B : Washer              | I : Oil screen               |
| C : Pump gear           | J : Rotors (inner and outer) |
| D : Bolt                | K : Pump shaft bearing       |
| E : Relief valve bolt   |                              |
| F1 : Pump cover         |                              |
| F2 : Pump housing       |                              |
| G : Relief valve spring |                              |



FC400  
FC420



FC540

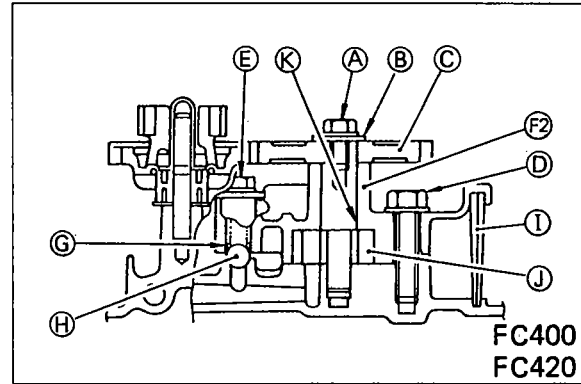
E40FC06W2



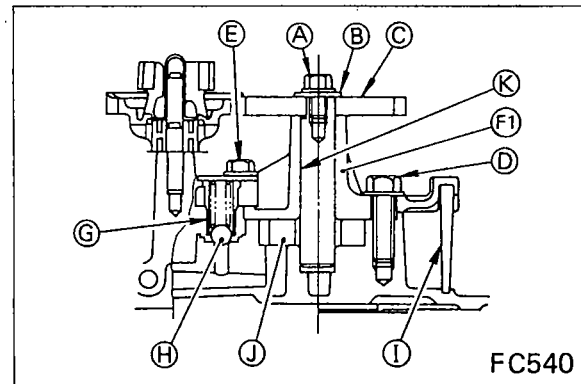
## LUBRICATING SYSTEM

### OIL PUMP CHECK — FC400·FC420 & FC540

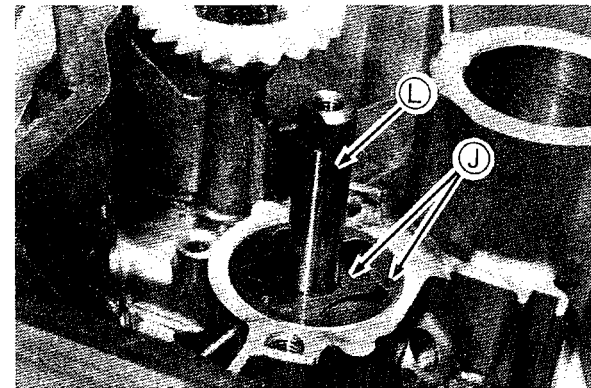
1. Check oil screen (I) for clogging and clean or replace it if necessary.
2. Check components such as relief valve seat in crankcase cover, rotors (J), and pump gear for any damage, and repair or replace faulty part.



3. Check free length of relief valve spring (G) with vernier calipers.
  - If free length is less than 19.0 mm (0.75 in.), replace valve spring.



4. Check outside diameter of pump shaft (L) at several points with micrometer.
  - If outside diameter is less than 12.627 mm (0.4971 in.), replace pump shaft including rotors (J).



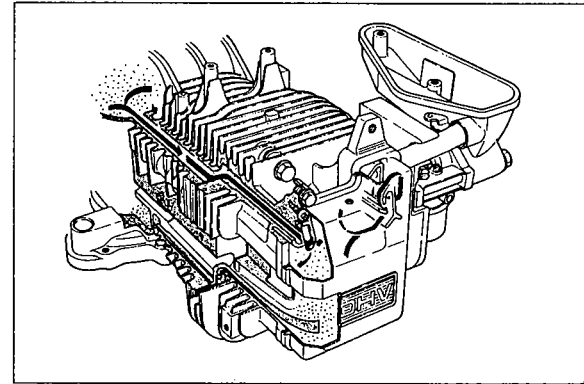
5. Check inside diameter of pump shaft bearing (K) at several points with inside micrometer.
  - If inside diameter is more than 12.760 mm (0.5024 in.), replace pump housing (FC400·FC420) or pump cover (FC540).

## LUBRICATING SYSTEM

### BREATHER SYSTEM

Function of breather is to keep vacuum in crankcase avoiding oil being forced out of engine.

Reed valve controls direction of air flow caused by piston movement so that air flow from inside of crankcase to outside can pass reed valve but not from outside to crankcase. Rocker chamber works as oil separator of oil laden air with space for expansion and maze. Finally, air from crankcase flows to air cleaner and is mixed with intake air.



**NOTE :** Reed valve is installed on cyl. top surface in FC290 and on rocker chamber in FC400•FC420 and FC540.

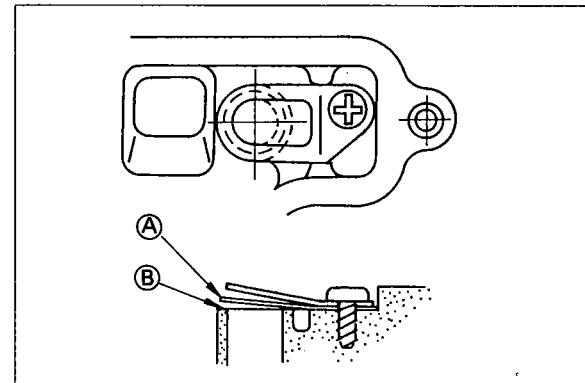
E40FC08W2

### BREATHER REED VALVE CHECK

1. Check valve and valve seat for any damage such as crack or wear.
  2. Check gap between reed valve (A) and seat (B) with feeler gauge.
- If gap is more than MAX, turn over valve or replace valve.

### REED VALVE GAP MAX

FC290	0.2 mm (0.008 in.)
FC400•FC420•FC540	1 - 2 mm (0.04 - 0.08 in.)

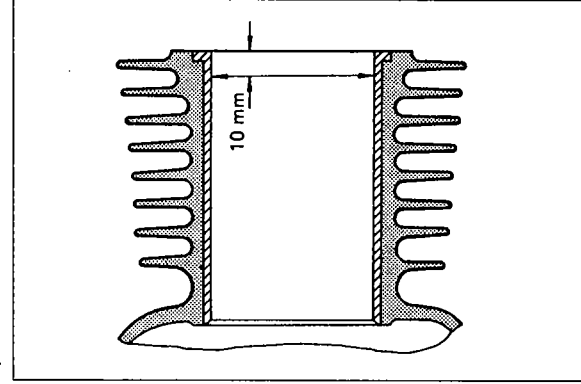


E40FC09W1

## CYLINDER/CRANKCASE

### CYLINDER SERVICE LIMIT

1. Visually check cyl. block for scored bore, broken fin, or other damages.
  - If unrepairable damage is observed, replace cyl. block.
2. Check inside diameter at 10 mm (0.4 in.) from top in directions of parallel and right angle to crankshaft, with inside micrometer.
  - If inside diameter and/or out of round are more than MAX., resize cyl. bore or replace cyl. block.



### CYL. BORE INSIDE DIA. MAX

FC290	78.067 mm (3.0735 in.)
FC400•FC420•FC540	89.076 mm (3.5069 in.)

### CYL. BORE OUT OF ROUND MAX

FC290	0.056 mm (0.0022 in.)
FC400•FC420•FC540	0.063 mm (0.0025 in.)

E41FC01W3

## CYLINDER/CRANKCASE

### CYLINDER BORE RE-SIZING

Oversize piston and piston rings for standard plus 0.25 mm (0.01 in.), 0.50 mm (0.02 in.), and 0.75 mm (0.03 in.) are available. Select suitable size depending on condition of cyl. bore to be re-sized.

1. Bore cylinder finely to size as shown on right table before honing.

O.S. : Over Size  
 B.S. : Boring Size

#### FC 2 9 0

O. S.	B. S.
0.25 mm	78.230 - 78.210 mm (3.0799 - 3.0791 in.)
0.50 mm	78.480 - 78.460 mm (3.0898 - 3.0890 in.)
0.75 mm	78.730 - 78.710 mm (3.0996 - 3.0988 in.)

#### FC 4 0 0

O. S.	B. S.
0.25 mm	87.230 - 87.210 mm (3.4343 - 3.4335 in.)
0.50 mm	87.480 - 87.460 mm (3.4441 - 3.4433 in.)
0.75 mm	87.730 - 87.710 mm (3.4540 - 3.4531 in.)

#### FC 4 2 0 · FC 5 4 0

O. S.	B. S.
0.25 mm	89.230 - 89.210 mm (3.5130 - 3.5122 in.)
0.50 mm	89.480 - 89.460 mm (3.5228 - 3.5220 in.)
0.75 mm	89.730 - 89.710 mm (3.5327 - 3.5319 in.)

## CYLINDER/CRANKCASE

2.hone cylinder to final size as shown on right table following procedure shown below.

**CAUTION:** Consider shrinkage of cyl. bore for 0.006-0.008 mm (0.0002-0.0003 in.) after cooling down from honing heat.

F.S. : Final Size

**NOTE:** Use honing stone recommended by hone manufacturer.

- (1) Align centers of cyl. bore and drill press carefully and set cyl. block on drill press table.
- (2) Install hone to drive shaft and set stopper of drill press so that hone can only extend 20-25 mm (3/4-1 in.) from top to bottom of cyl. bore.
- (3) Adjust honing stone to contact snugly against cyl. wall at narrowest point.  
DO NOT FORCE.
- (4) Rotate hone by hand. If it cannot be rotated, adjust hone until it can be rotated by hand.
- (5) Set drill press rpm to 200 - 250.
- (6) Coat honing oil on cyl. bore.

**CAUTION:** Do not use solvent or gasoline.

- (7) Drive drill press and move hone up and down in cyl. bore about 20 cycles/minute.

**WARNING:** Stop drill press when checking or measuring cyl. bore.

- (8) Measure inside diameter in suitable periods with inside micrometer, and check finishing pattern which should be 40 to 60 degrees crosshatch.
- (9) Clean cyl. block thoroughly with soap and warm water for "white glove inspection".

**CAUTION:** Thoroughly wash honing grit from cylinder. Grit is extremely abrasive to engine components.

- (10) Dry cyl. block and coat engine oil to cyl. bore.

### FC290

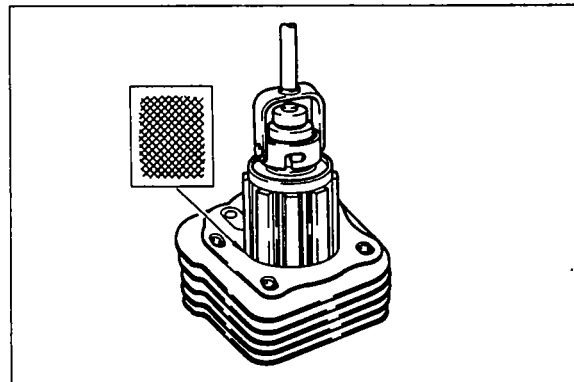
O. S.	F. S.
0.25 mm	78.250 - 78.230 mm (3.0807 - 3.0799 in.)
0.50 mm	78.500 - 78.480 mm (3.0906 - 3.0898 in.)
0.75 mm	78.750 - 78.730 mm (3.1004 - 3.0996 in.)

### FC400

O. S.	F. S.
0.25 mm	87.250 - 87.230 mm (3.4350 - 3.4343 in.)
0.50 mm	87.500 - 87.480 mm (3.4449 - 3.4440 in.)
0.75 mm	87.750 - 87.730 mm (3.4547 - 3.4539 in.)

### FC420 · FC540

O. S.	F. S.
0.25 mm	89.250 - 89.230 mm (3.5138 - 3.5130 in.)
0.50 mm	89.500 - 89.480 mm (3.5236 - 3.5228 in.)
0.75 mm	89.750 - 89.730 mm (3.5335 - 3.5327 in.)



## CYLINDER/CRANKCASE

### BALL BEARING CHECK

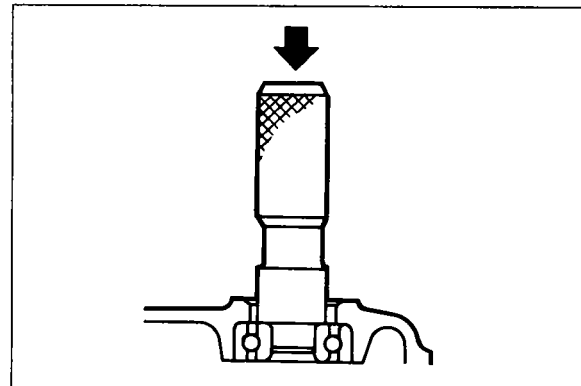
**CAUTION:** Do not remove ball bearing from housing except replacing.

1. Clean ball bearing with high flash point solvent.
  2. Pour engine oil to bearing.
  3. Rotate bearing inner race slowly by hand.
- If any roughness is felt and it can not be removed by re-cleaning, replace ball bearing.

E41FC03W1

### BALL BEARING REPLACEMENT

1. Remove oil seal preceding ball bearing replacement. Do not re-use removed oil seal.
2. Push out ball bearing with bearing driver.
3. Clean bearing housing with high flash point solvent and dry it.
4. Coat a light film of oil on bearing.
5. Push new ball bearing into housing to end.

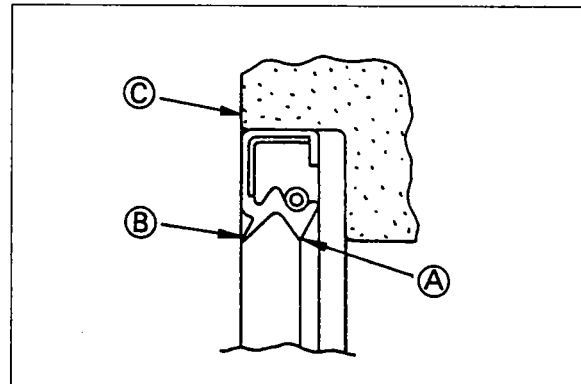


E41FC04W1

### OIL SEAL REPLACEMENT

If oil leakage through oil seal is observed or seal lip is damaged, replace oil seal.

1. Remove oil seal by tapping it out with screw driver or punch.
2. Placing spring held seal lip (A) inside, push oil seal into housing until seal outside surface becomes flush with housing end (C).
3. Before final assembly, pack some amount of grease for high temperature application into space between seal lip (A) and dust lip (B).

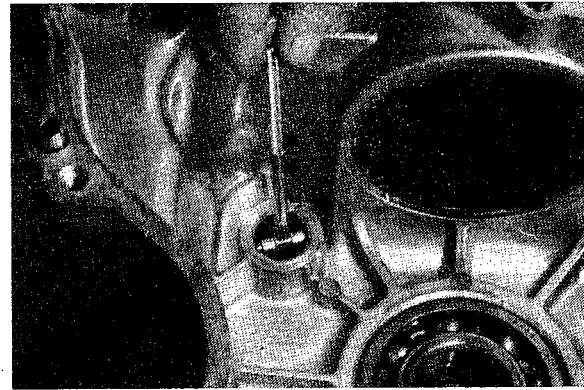


E41FA04W2

## CYLINDER/CRANKCASE

### CAMSHAFT BEARING SERVICE LIMIT

1. Check inside diameter of camshaft bearing in crankcase at several points with inside micrometer.
- If inside diameter is more than MAX, replace cylinder/crankcase.



### CAMSHAFT BEARING INSIDE DIA. MAX

FC290	16.055 mm (0.6321 in.)
FC400-FC420	20.076 mm (0.7904 in.)
FC540	21.076 mm (0.8298 in.)

E41FC05W2

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