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Kawasaki

FC150V

OHV

4-stroke air-cooled gasoline engine


WORKSHOP MANUAL

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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E00FC01W3


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

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

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.

GENERAL INFORMATION

ELECTRICAL SYSTEM

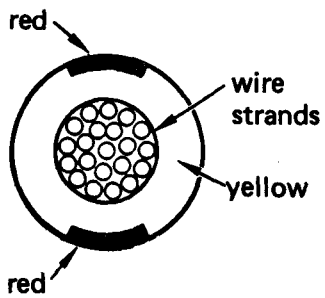
No Shock

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.

TWO-COLOR LEAD

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

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.

GENERAL SPECIFICATIONS

I T E M	F C 1 5 0 V
Engine Type	Forced Air-cooled, Vertical Shaft, OHV, 4-Stroke Gasoline Engine
Number of Cylinder	1
Piston Displacement	153 cc (9.3 cub-in.)
Bore x Stroke	65 x 46 mm (2.56 x 1.81 in.)
Direction of Rotation	Counterclockwise facing the PTO Shaft
Fast Idle Speed	3050 ~ 3200 rpm cf. Note 4
Slow Idle Speed	1400 ~ 1600 rpm
ACR	Mechanical Flyweight Type
Lubricating Method	Splash
Oil Pan Capacity	0.55 L (1.16 US pt)
Fuel Tank Capacity	1.3 L (1.37 US qt.)
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 - 0.5 A with Diode
Spark Plug	BP6ES
RFI Suppressor *	Per Canada and USA Requirement
Electric Starter *	12 V - 0.2 kW Bendix Type
Cooling Air Inlet	Recoil Starter and Rotating Screen
Governor	Mechanical Flyweight
Brake *	Band Brake on Flywheel
Recommended Battery	12 V - 4 Ah

- Note :
1. Specifications are subject to change without notice.
 2. ACR = Automatic Compression Release.
 3. Parts with * are option.
 4. Fast idle speed may vary depending on each equipment on which engine is used. Refer to the equipment specification.

WIRING DIAGRAM

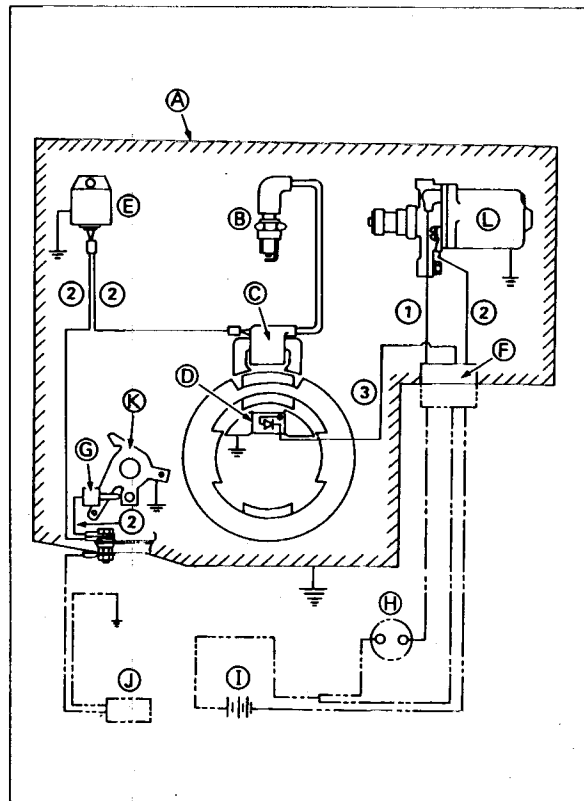
ELECTRIC STARTER MODEL

1. Portion surrounded by hatching shows KAWASAKI procurement parts.

- A: Engine
- B: Spark plug
- C: Ignition coil
- D: Charging coil
- E: Control unit
- F: Connector (3P)
- G: Stop switch
- H: Key switch
- I: Battery
- J: Discharge chute interlock switch
- K: Control lever
- L: Starter

Lead Color

- 1: Red
- 2: Black
- 3: Yellow



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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 (○).

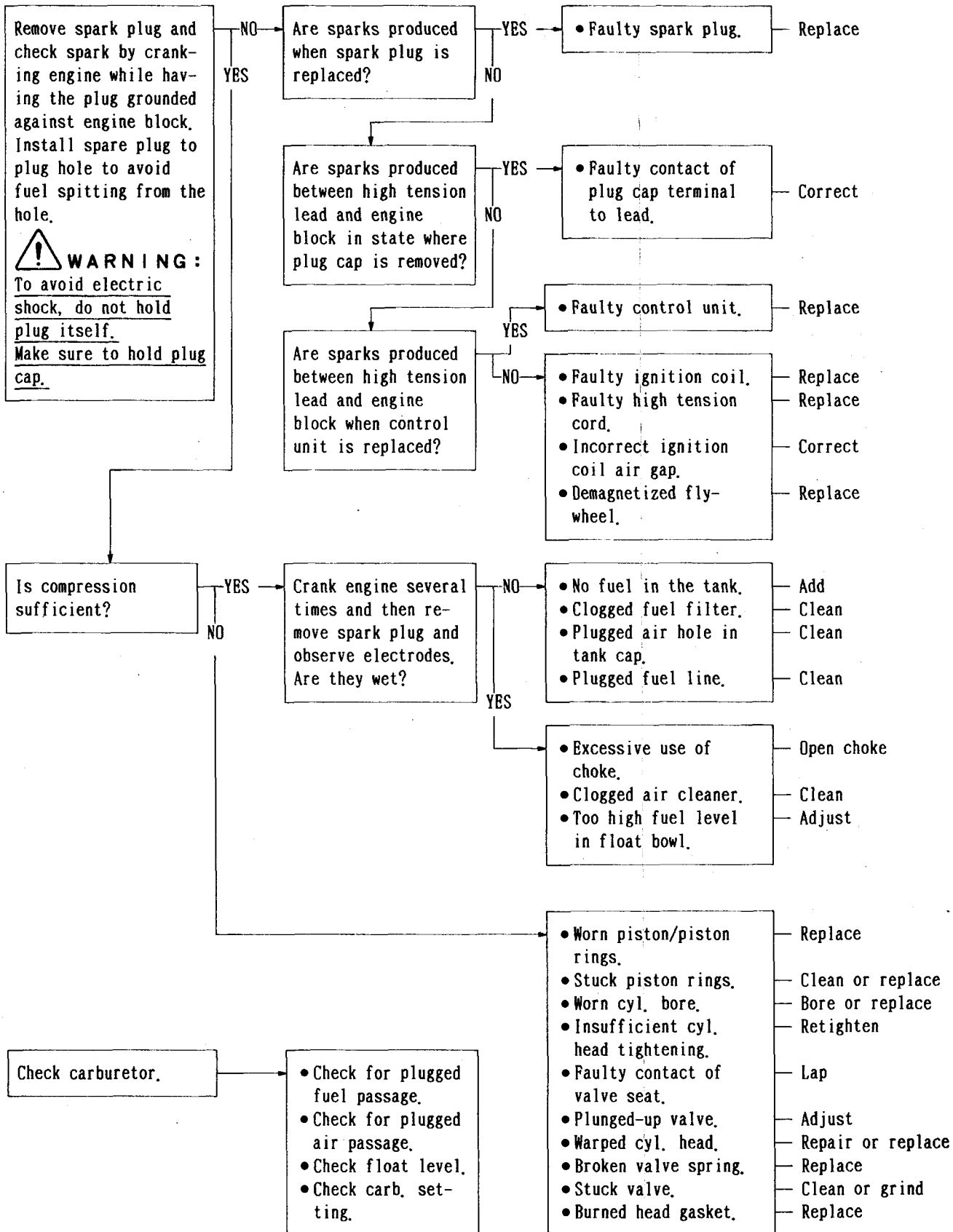
MAINTENANCE	INTERVAL				
	Daily	Every 25 hr	Every 50 hr	Every 100 hr	Every 300 hr
Check and add engine oil.	○				
Check for loose or lost nuts and screws.	○				
Check for fuel and oil leakage.	○				
Check battery electrolyte level.	○				
Check and clean air intake screen.	○				
Clean engine switch and control panel on engine.	○				
★★ Clean air cleaner foam element.		○			
Tighten nuts and screws.		○ (first)		○	
Clean fuel filter.			○		
★ Change engine oil.			○		
Check band brake system on engine.			○		
Check and adjust band brake cable.			○		
★★ Clean air cleaner paper element.				○	
Clean and regap spark plug.				○	
Clean combustion chamber.				○	
Check and adjust valve clearance.				○	
Clean and lap valve seating surface.				○	
★★ Replace air cleaner paper element.					○
★★ Clean cylinder and cylinder head fins of dust and dirt.					○

★ Perform these maintenances after first 5 hours of use, then at recommended intervals.

★★ Service more frequently under dusty conditions.

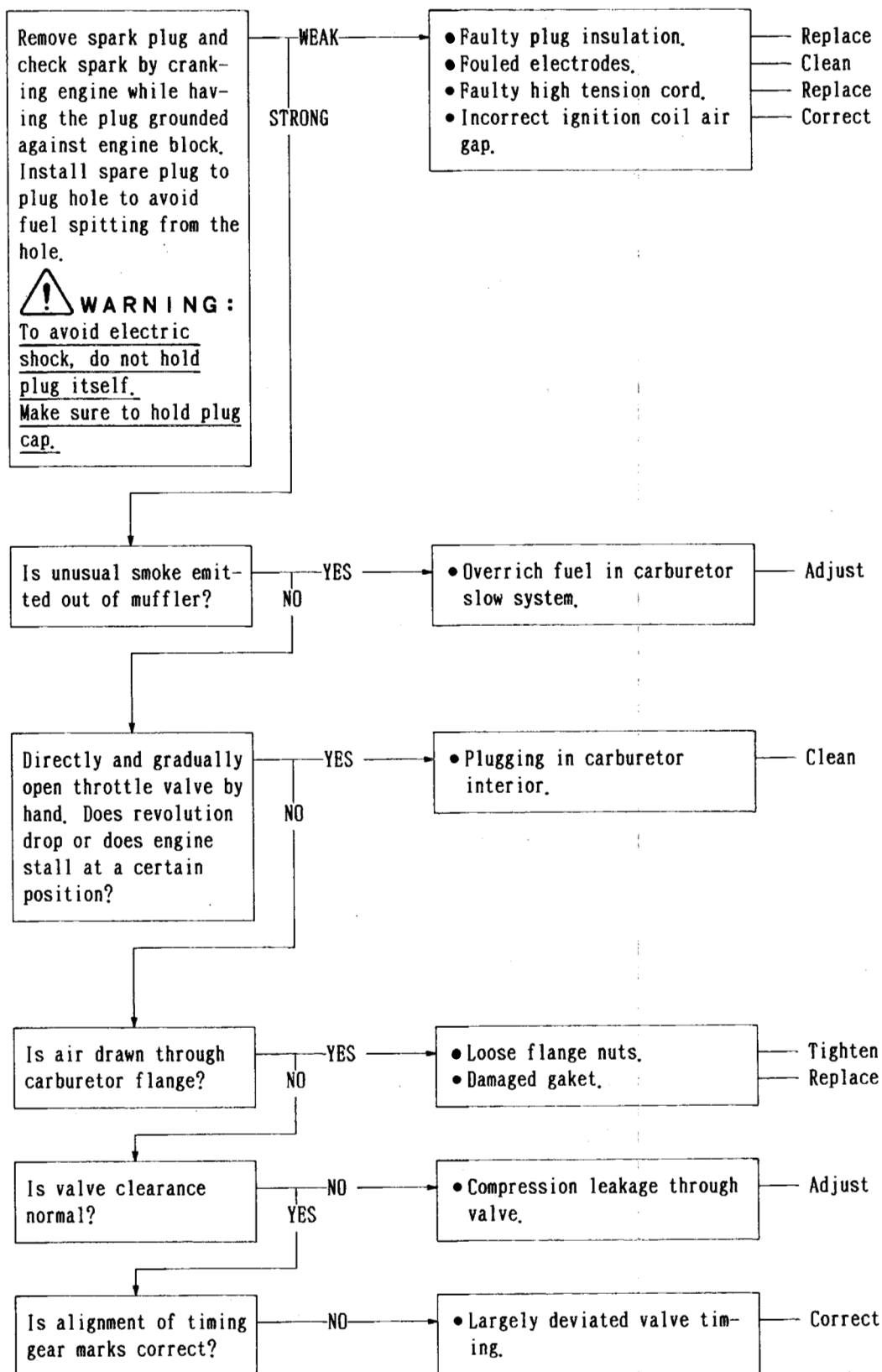
TROUBLE SHOOTING

ENGINE — HARD STARTING



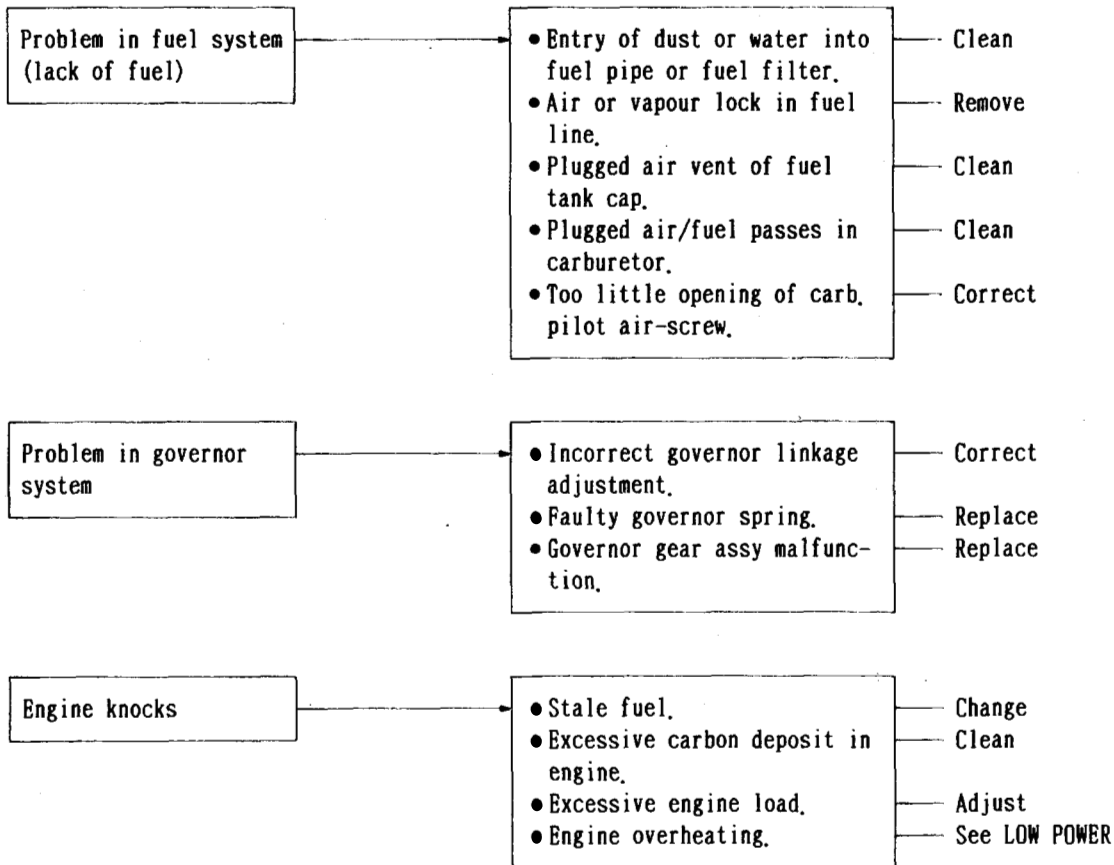
TROUBLE SHOOTING

ENGINE - MALFUNCTIONS AT LOW SPEED



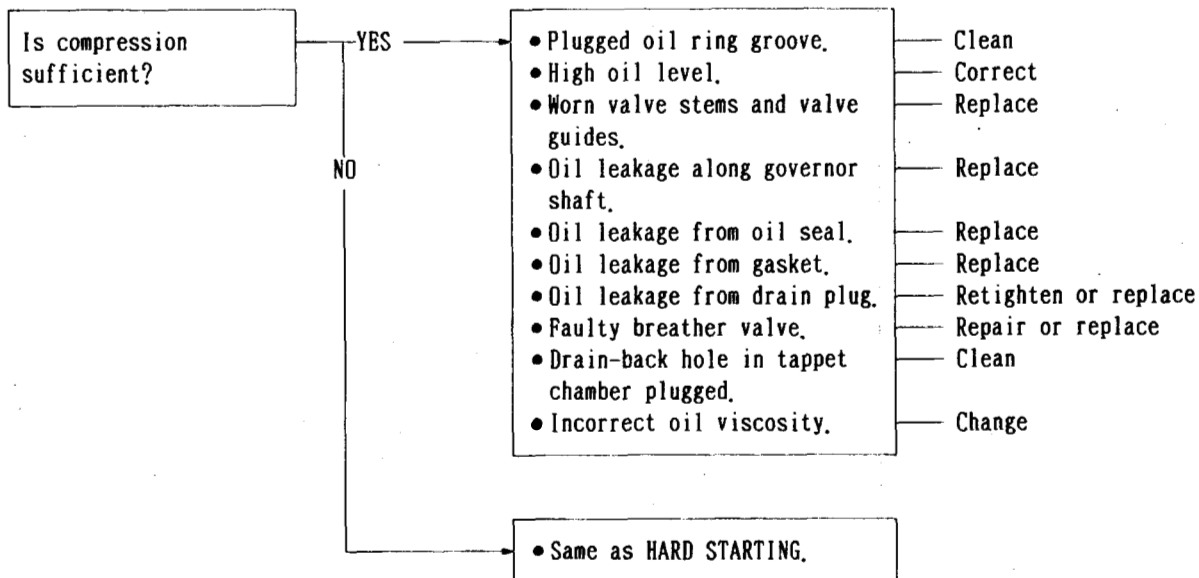
TROUBLE SHOOTING

ENGINE - ERRATIC RUN



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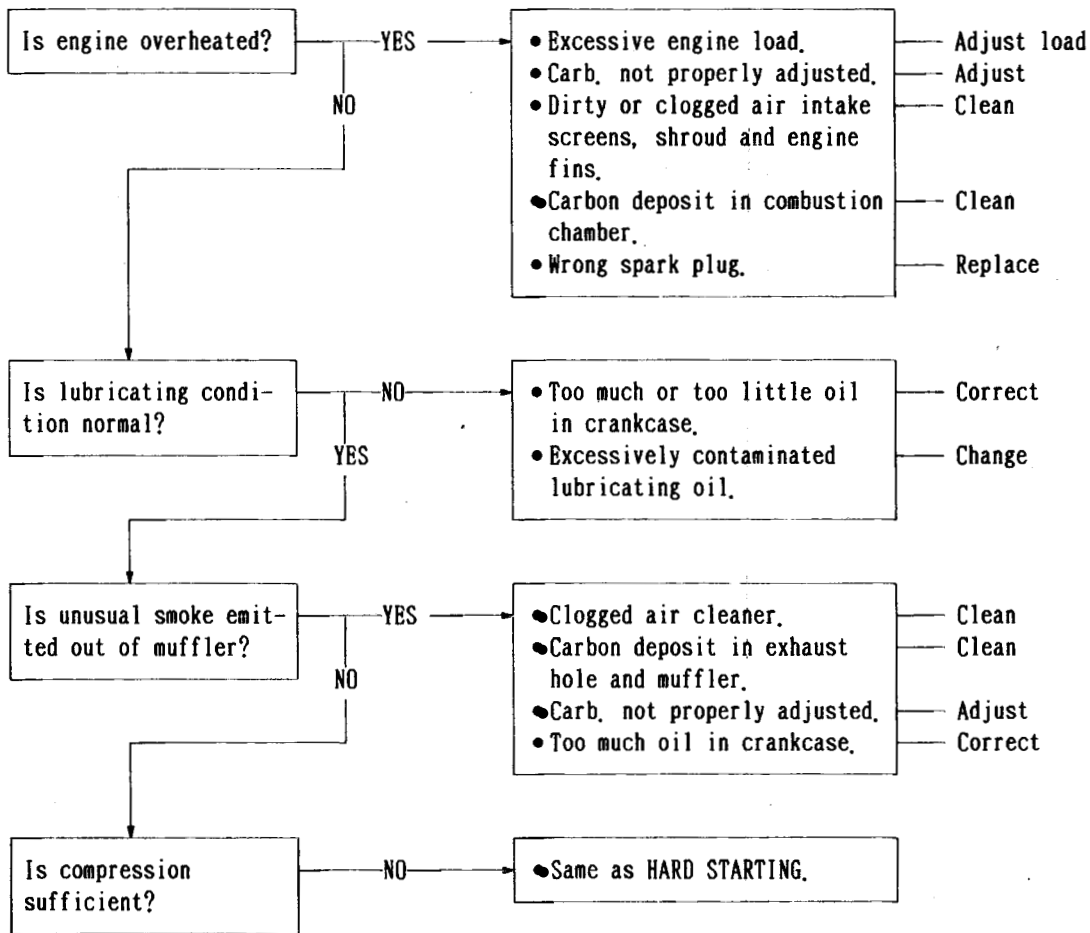
ENGINE - EXCESSIVE OIL CONSUMPTION



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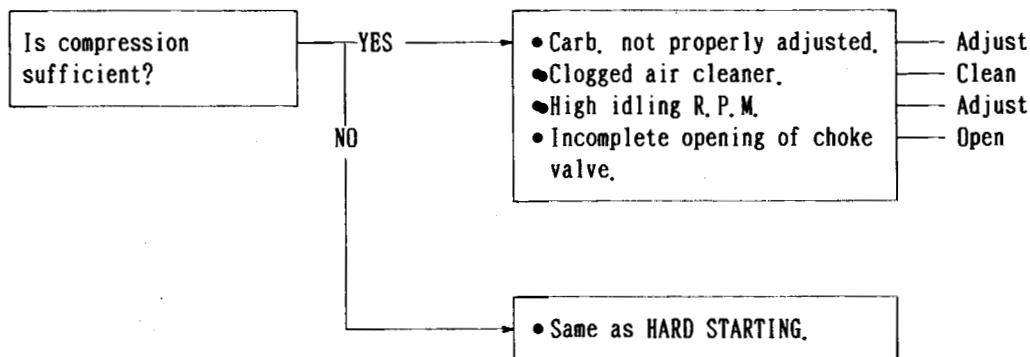
TROUBLE SHOOTING

ENGINE - LOW POWER



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ENGINE - EXCESSIVE FUEL CONSUMPTION

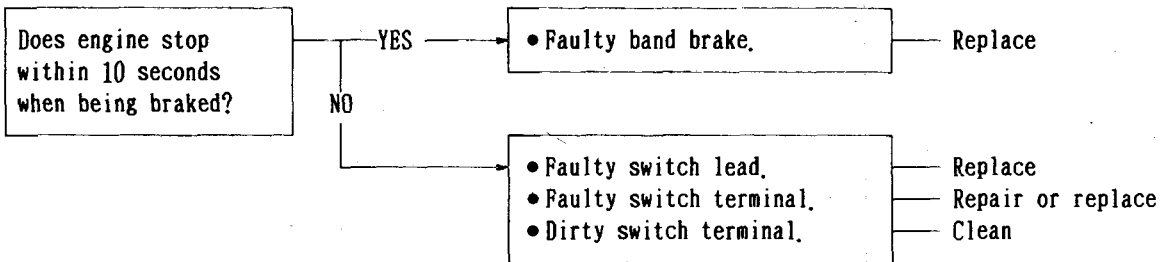
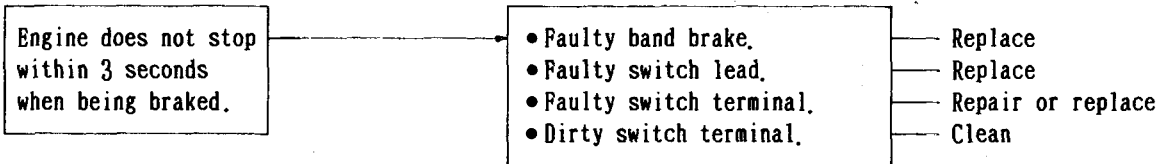


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TROUBLE SHOOTING

ENGINE - MALFUNCTIONS OF STOPPING

(BAND BRAKE MODEL)



TORQUE SPECIFICATIONS

ITEM	FC150
Con-rod bolt	12 N·m (105 lbf·in)
Crankcase cover bolt	7 N·m (60 lbf·in)
Valve clearance adjust nut (lock nut)	7 N·m (60 lbf·in)
Cylinder head bolt	23 N·m (205 lbf·in)
Flywheel nut	45 N·m (33 lbf·ft)
Ignition coil bolt	6 N·m (50 lbf·in)
Rocker arm stud and nut	7 N·m (60 lbf·in)
Recoil starter center screw	3.5 N·m (30 lbf·in)
Recoil starter stud	7 N·m (60 lbf·in)
Recoil starter nut ★	7 N·m (60 lbf·in)
Governor arm nut	7 N·m (60 lbf·in)
Muffler nut	7 N·m (60 lbf·in)
Carburetor and intake pipe bolt ★	7 N·m (60 lbf·in)
Fuel tank cover bolt ★	3.5 N·m (30 lbf·in)
Electric starter to block bolt and nut	9.5 N·m (85 lbf·in)
Engine switch screw	3 N·m (26 lbf·in)
Side drain plug ★★	20-22 N·m (180-190 lbf·in)
Bottom drain plug	21 N·m (185 lbf·in)
PTO side crankshaft end bolt (with plane washer)	38 N·m (340 lbf·in)
Engine mounting flange bolt (M10)	28 N·m (250 lbf·in)
BBC mounting bolt (M8) ★★★	18 N·m (160 lbf·in)
General bolt ④	
M 5	3.5 N·m (30 lbf·in)
M 6	6 N·m (50 lbf·in)
M 8	15 N·m (130 lbf·in)

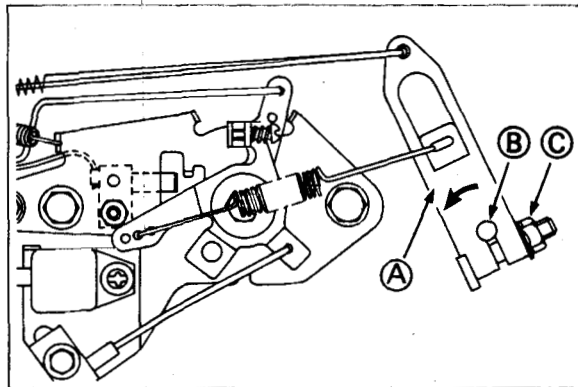
- ★ All bolts and screws especially for plastic part tightening -- Do not tighten completely at a time.
- ★★ When new crankcase cover is used, tighten plug to minimum specified torque and loosen it a little at first, then tighten it to specified torque to get good sealing face.
Do not over-tighten it. Crankcase cover may be damaged.
- ★★★ BBC = Blade Brake Clutch

CONTROL SYSTEM

GOVERNOR LEVER SETTING

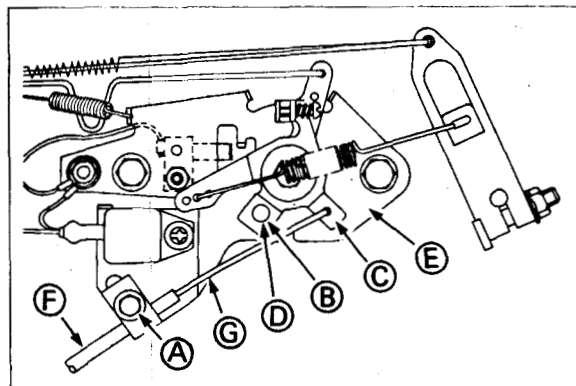
Whenever carburetor or governor lever is removed from engine and then installed again, adjust governor lever position.

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) counterclockwise or place throttle lever on dash in "FAST" position to open carb. throttle valve fully.
3. Turn governor shaft (B) counterclockwise to end of travel.
4. Keeping governor lever position of throttle fully open, tighten nut (C).



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)



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CONTROL SYSTEM

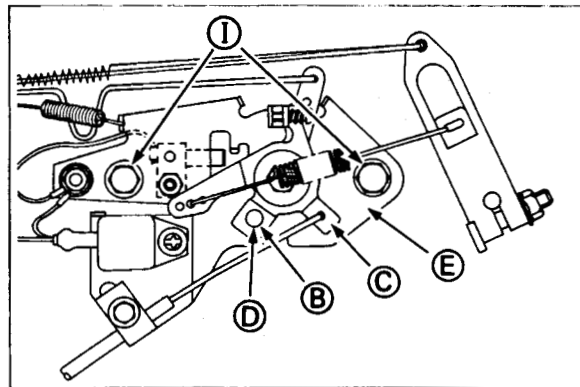
FAST IDLE SPEED ADJUSTMENT

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.

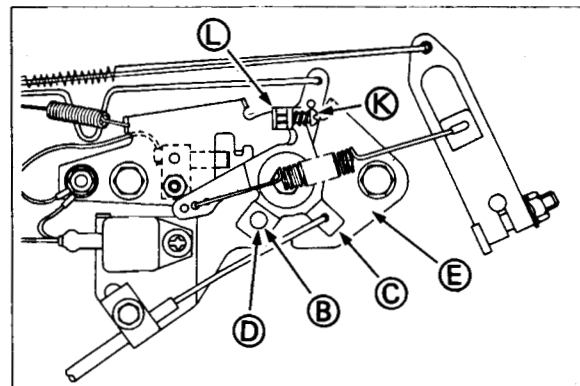
NOTE : Make sure choke valve is fully opened.

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. Remove 6 mm pin, stop engine, and set throttle lever on dash in "CHOKE" position. Make sure carb. choke valve is closed completely.



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.



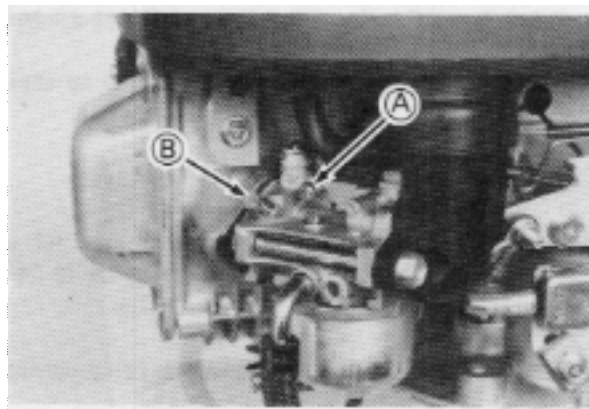
E16FC08W2

E16FC09W2

CONTROL SYSTEM

SLOW IDLE SPEED ADJUSTMENT

1. Turn carb. pilot screw (B) in until it just seats and then back out 1 turn.
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.



E16FC10W2

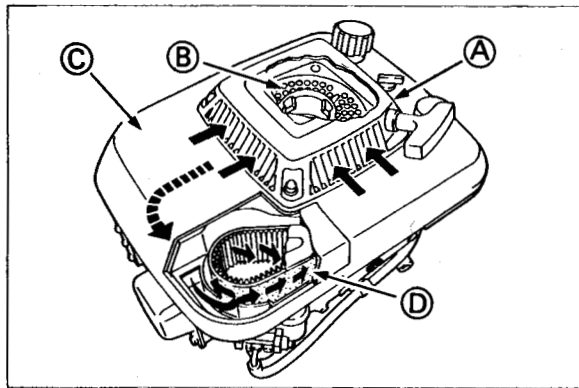
AIR CLEANER

"K" KLEEN SYSTEM

Intake air is inducted through grille of recoil starter (A), rotary screen (B), fan housing (C), and air cleaner (D) 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. Do not remove any parts constructing air passages when running engine.
3. Keep air passages free from grass and rubbish.

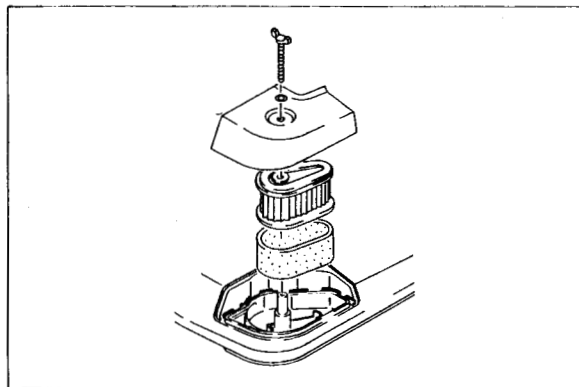


MAINTENANCE

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.



E22FC03W2

E22FC04W2

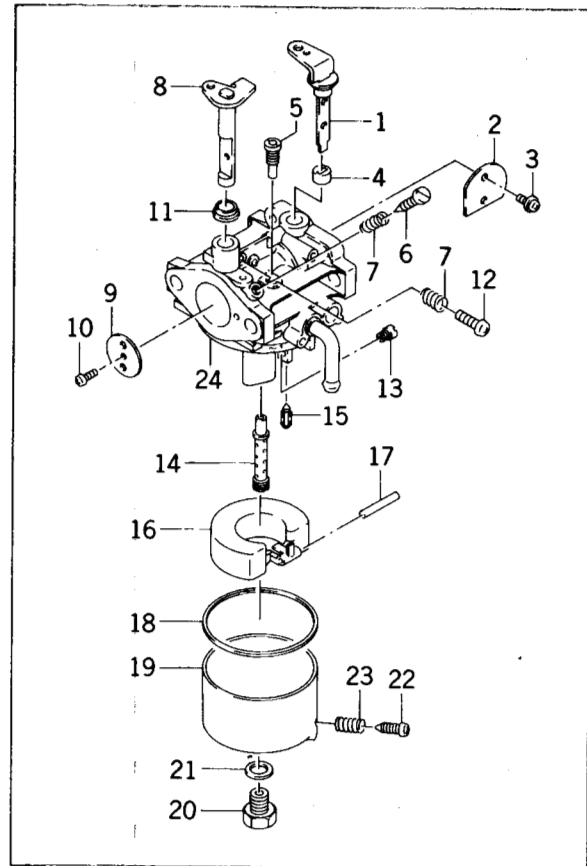
CARBURETOR

COMPONENTS

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

NOTE : Refer to each parts catalog for detailed parts configuration.

Ref. No.	Part Name	Ref. No.	Part Name
1	Choke shaft	13	Main jet
2	Choke valve	14	Main nozzle
3	Screw	15	Needle valve
4	Ring	16	Float
5	Pilot jet	17	Float pin
6	Pilot screw	18	Gasket
7	Spring	19	Float chamber
8	Throttle shaft	20	Bolt
9	Throttle valve	21	Gasket
10	Screw	22	Drain screw
11	Collar	23	Spring
12	Screw	24	Carb. body



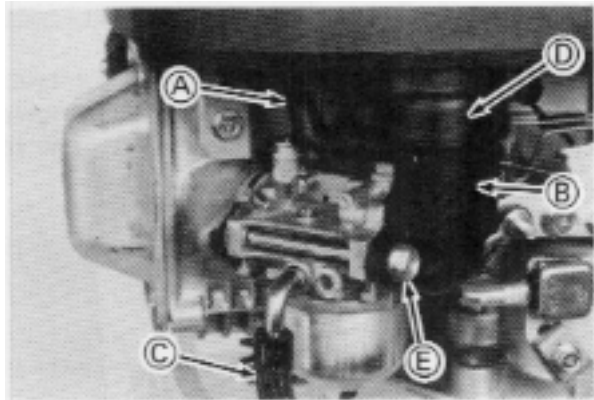
CARBURETOR

REMOVAL

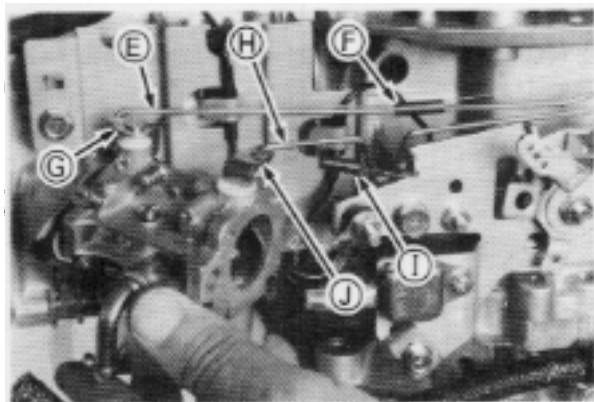
WARNING: Gasoline is extremely flammable.
Avoid fires due to smoking or careless practices.

1. Shut fuel valve.
2. Drain fuel from float chamber.
3. Disconnect fuel line (C) from carburetor. Plug the fuel line opening immediately or drain fuel in the line into suitable container.
4. Disconnect breather tube (A) from intake pipe (B).
5. Disconnect adaptor (D) from intake pipe (B).
6. Remove bolts (E).

CAUTION: Do not lose collars in intake pipe bolt holes.



7. Unhook throttle rod (E) and rod spring (F) from throttle lever (G).
8. Unhook choke rod (H) and choke rod spring (I) from choke lever (J).

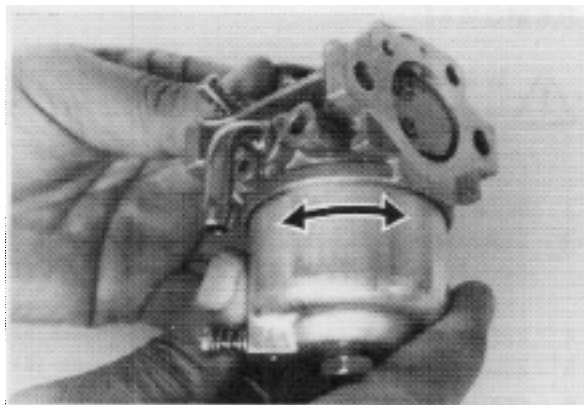


E24FC09W3

CARBURETOR

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.



E24FC10W1

CLEANING

CAUTION : Remove main jet before removing main nozzle. Main jet will interfere with main nozzle.

CAUTION : Do not clean jet orifices and float valve seat 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.

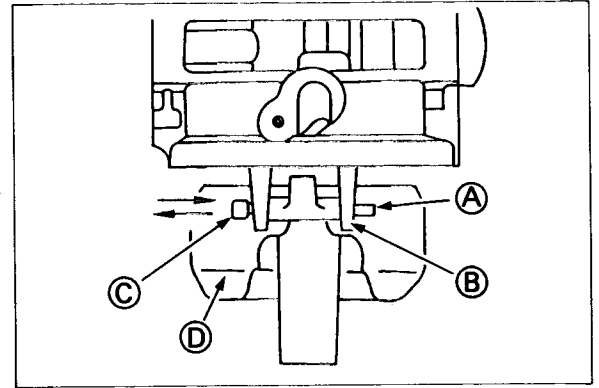
E24FC11W3

CARBURETOR

FLOAT ADJUSTMENT

CAUTION: Do not strike float pin (A) to remove or install it, to avoid breakage of pin holder (B). To remove float pin, pull the transformed end (C) with pliers. To install float pin, push float pin transformed end until both coming off pin ends are at same length.

NOTE: Float (D) does not require check and adjustment.

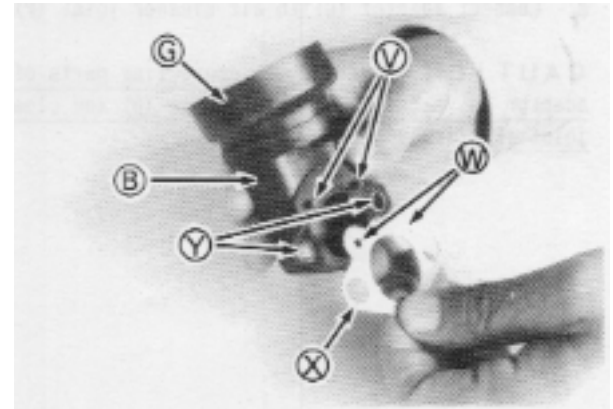


E24FC12W1

ASSEMBLY AND INSTALLATION

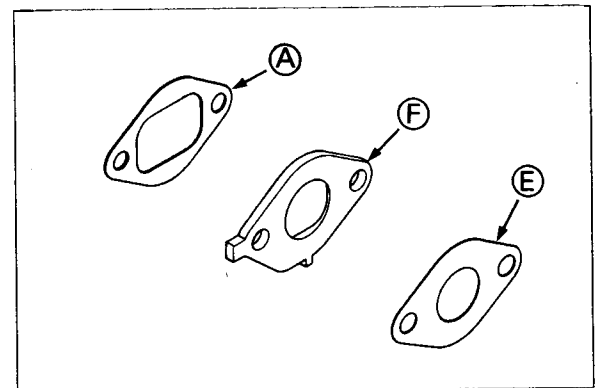
CAUTIONS:

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.
-
1. Install adaptor (G) to intake pipe (B).
 2. Fit holes (W) in gasket (X) on projections (V) of intake pipe flange.
 3. Put collars (Y) in place.



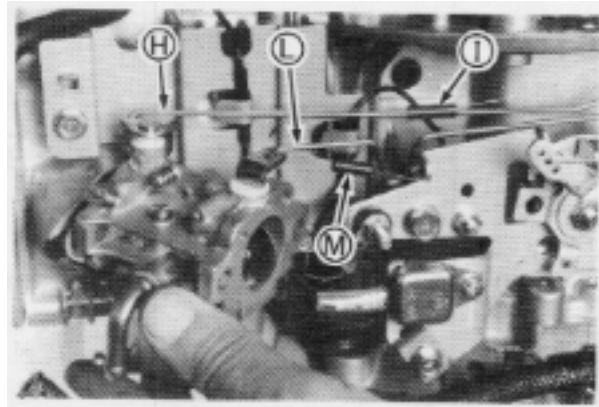
4. Arrange gasket (A), insulator (F), and gasket (E) as shown.

Gasket (A): Cylinder side
Gasket (E): Carburetor side



CARBURETOR

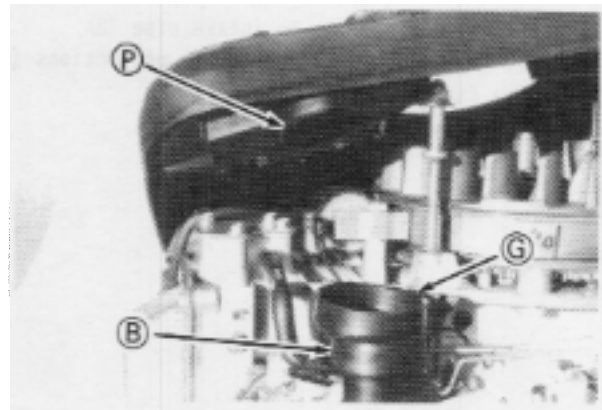
5. Hook throttle rod (H), rod spring (I), choke rod (L), and choke rod spring (M) to carburetor levers.



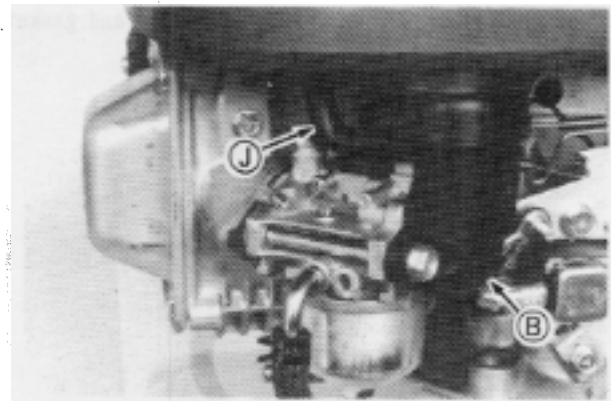
6. Set related parts through the bolts in following sequence:
 Intake pipe
 Gasket - for intake pipe
 Carburetor
 Gasket - with round hole
 Insulator
 Gasket - with square hole
7. Install the related parts on cylinder flange and tighten bolts to specified torque.
 (See TORQUE SPECIFICATIONS.)

8. Connect adaptor (G) to air cleaner joint (P).

CAUTION: Confirm both connecting parts of adaptor (G) fit in with intake pipe (B) and cleaner joint (P) firmly.



9. Connect breather tube (J) to intake pipe (B).
10. Connect fuel line to carburetor and fasten the line with clamp.



CARBURETOR

CARBURETOR IDENTIFICATION

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

Example:

<u>Part Number</u>	<u>Stamp</u>
31 <u>5510</u> - 6100 <u>C</u>	5510C
1500 <u>1</u> - <u>2541</u>	12541

E24FA07W1

COOLING SYSTEM

ENGINE COVER REMOVAL

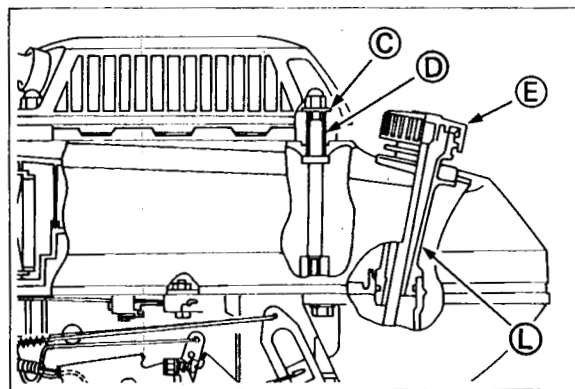
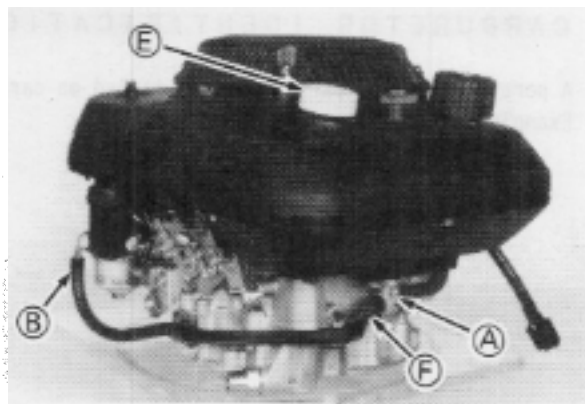
WARNING: Gasoline is extremely flammable. Avoid fires due to smoking or careless practices.

Engine cover is removed together with fuel tank, tank cap, fuel valve, and fuel tank cover.

1. Shut fuel valve (A) and disconnect fuel line (B) from carburetor inlet.
2. Open fuel valve and drain fuel into suitable container.
3. Remove recoil starter.

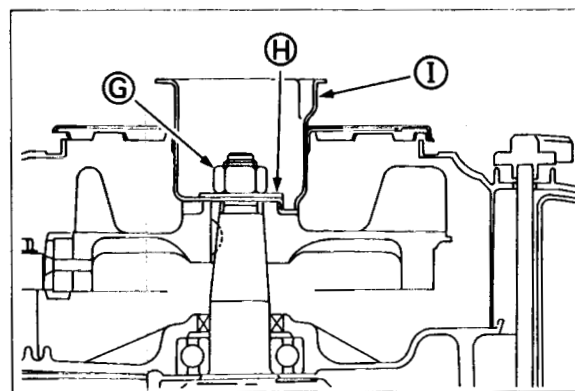
CAUTION: Do not lose washers (C) and collars (D).

4. Remove oil filler cap (E).
5. Disconnect fuel line (F) from fuel valve (A).

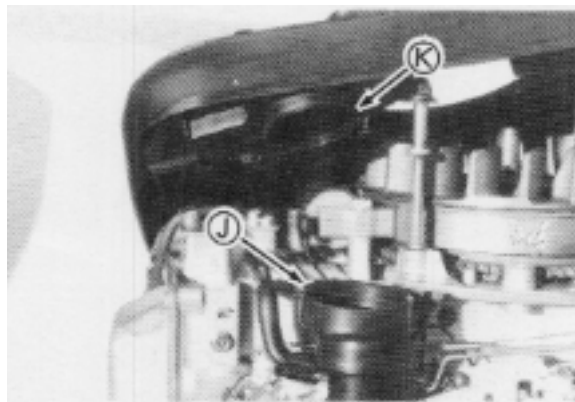


WARNING: Remove plug cap from spark plug to avoid engine starting.

6. Loosen flywheel nut (G) by turning it counterclockwise. Use air impact wrench to avoid flywheel rotation.
7. Remove flywheel nut (G), washer (H), and starting pulley (I).



8. Slightly lifting up engine cover, disconnect intake pipe adaptor (J) from air cleaner outlet (K).
9. Remove engine cover assy.
10. Remove oil filler (L).



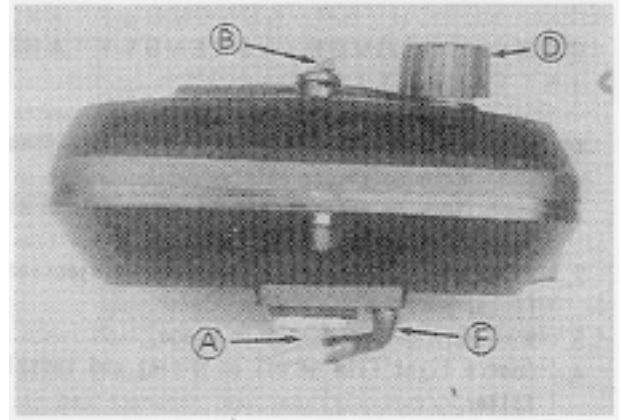
E26FC02W4

COOLING SYSTEM

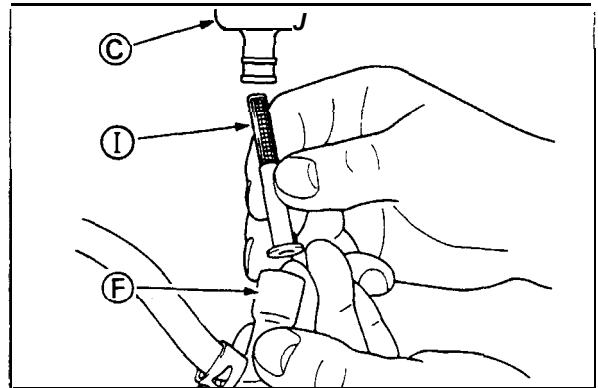
ENGINE COVER DISASSEMBLY

1. Remove fuel tank *cap* (D).
2. Pull fuel valve knob (B) off from valve shaft (E)

N O T E : Knob (B) is installed on valve shaft (E) with snap fit.



3. Disconnect fuel line (F) from fuel tank (C).
4. Remove fuel strainer (I) from fuel tank (C).

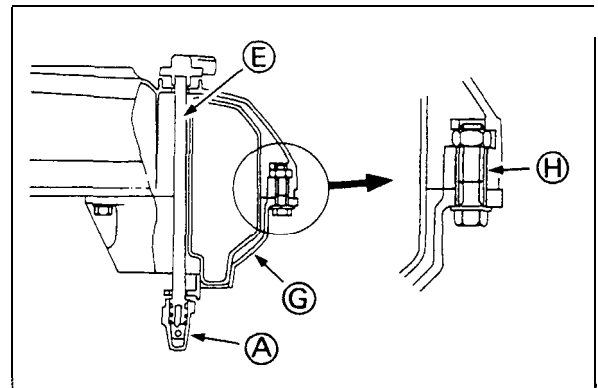


5. Remove fuel tank cover (G).

C A U T I O N : Do not lose collars (H).

6. Remove fuel valve (A).

C A U T I O N : Do not disassemble fuel valve (A).



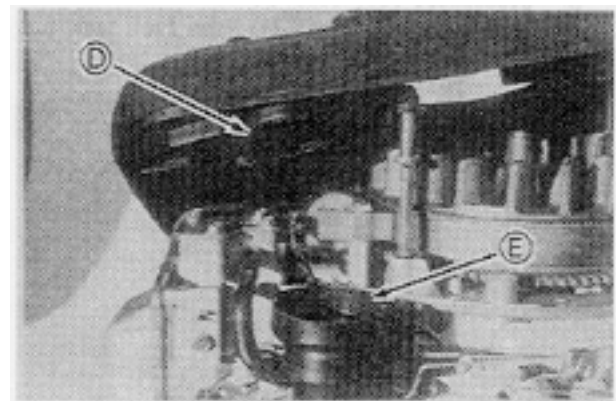
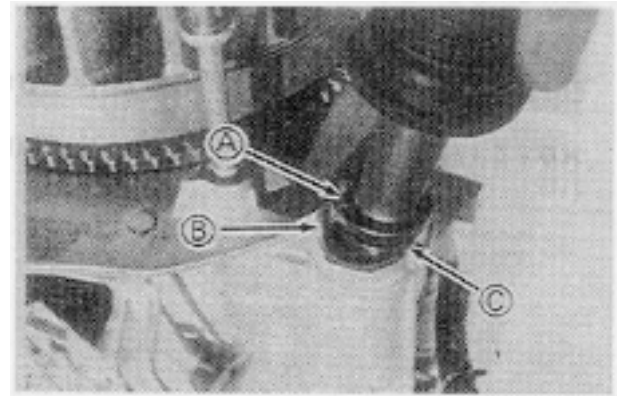
E26FC03W3

COOLING SYSTEM

ENGINE COVER ASSEMBLY AND INSTALLATION

Assembly and installation are reverse of disassembly and removal. Note following points.

1. Apply locking agent on thread when replace stud for engine cover mounting.
2. Align notch (A) of oil filler with projection (B) of filler port.
3. Make sure O-ring (C) is in place.
4. Coat a light film of oil on O-ring and install oil filler.
5. Tighten screws in crisscross sequence and evenly to specified torque.
Do not tighten screw completely at a time.
6. Holding pulley, torque flywheel nut as specified in TORQUE SPECIFICATIONS.
7. Connect air cleaner outlet (D) and intake pipe adaptor (E) firmly.



E26FC04W2

RECOIL STARTER

DISASSEMBLY

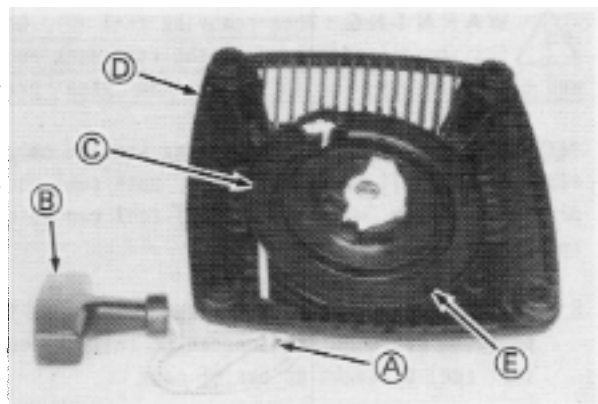
CAUTION: Do not wedge rope between reel and case.

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.

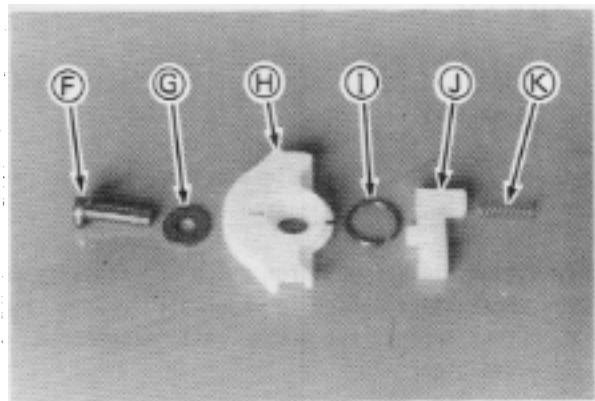
WARNING: Wear gloves during disassembling to avoid injury.

3. While carefully holding reel (C) and case (D), remove locking pliers or untie knot.
4. Unwind spring tension slowly.

NOTE: As for recoil starter with extended rope, steps 1 through 4 are not necessary except when rope and/or handle are changed. Instead of the steps, unwind spring tension keeping rope in notch (E) of reel.



5. Remove screw (F) and washer (G).
6. Remove retainer (H) with circlip (I) carefully.
7. Before removing pawl (J), make sure position of the pawl, then remove pawl and spring (K).



RECOIL STARTER

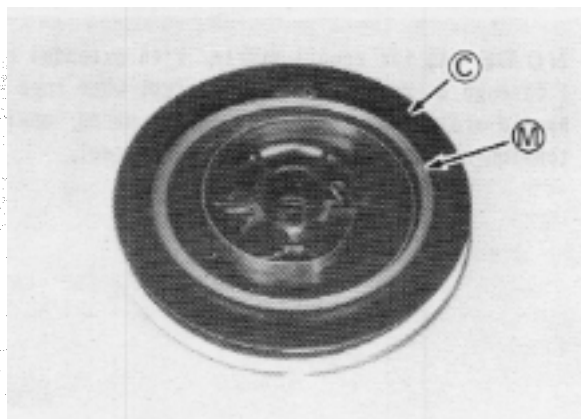
WARNING: When removing reel (C), be careful that recoil spring under the reel does not fly loose and causes injury. The spring is under great pressure.

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.

8. 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.

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

9. If recoil spring (M) must be removed from reel (C), hold the reel with spring side downward in suitable container and tap reel to remove recoil spring.



E27FC05W6

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 pawl 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 reel. Recoil spring may fly loose from reel and cause injury.

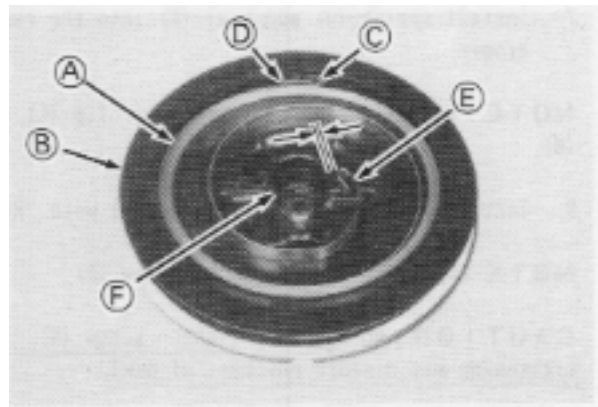
E27FA02W2

RECOIL STARTER

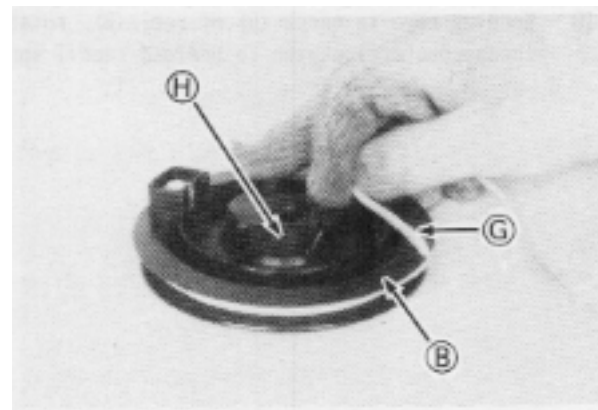
REASSEMBLY

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

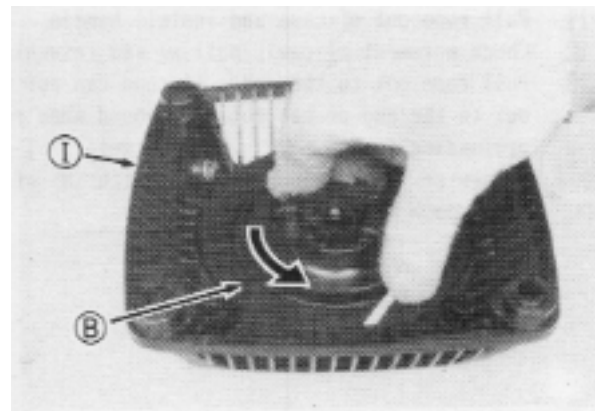
1. Coat grease for high temperature application on recoil spring (A) and sliding surfaces.
2. Set recoil spring (A) in reel (B) so that spring end (C) catches hook (D) in reel.
3. Wind recoil spring (A) into reel (B) counterclockwise.
4. Make sure that gap between spring hook (E) and outside of reel boss (F) is 2 - 4 mm (0.08 - 0.16 in.).
If not, make the gap by bending spring end with long nose plier.



5. If rope (G) is unwound from reel (B), wind rope in reel 3.5 turns counterclockwise facing pawl groove (H).



6. Install reel (B) into case (I) and turn the reel counterclockwise until spring tension is felt.



RECOIL STARTER

7. Install spring (J) and pawl (K) into the respective groove.

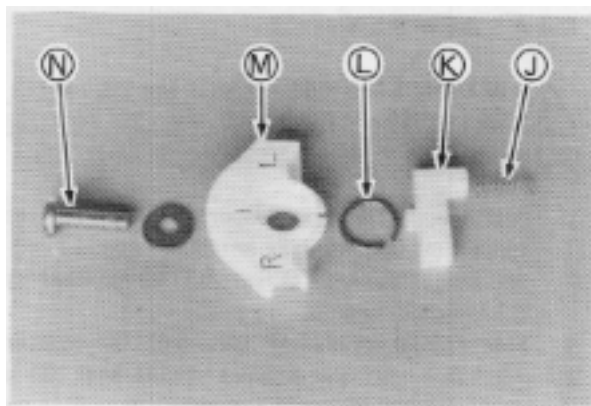
NOTE: Do not forget to install circlip (L) to retainer (M).

8. Install retainer (M), covering pawl with "R" side groove.

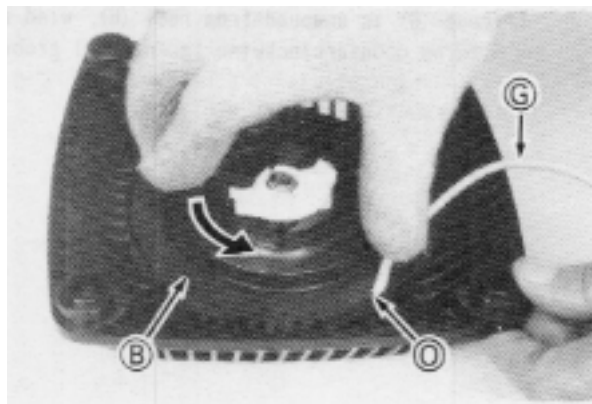
NOTE: Apply locking agent on screw (N).

CAUTION: Do not over tighten screw (N). Over tightening may disturb movement of pawl.

9. Tighten screw (N) to specified torque. (See TORQUE SPECIFICATIONS.)



10. Keeping rope in notch (O) of reel (B), rotate reel 3 turns counterclockwise to preload recoil spring.



11. Pull rope out of case and install handle.
 12. Check movement of pawl, pulling and returning rope.
 13. Pull rope out to the end. If rope can not be pulled out to the end or can not be rewound when released, preloading is too much. Rotate reel (B) 1 turn clockwise, keeping rope (G) in notch (O) of reel, and then check the condition again.

ELECTRIC STARTER & CHARGING

TROUBLE SHOOTING

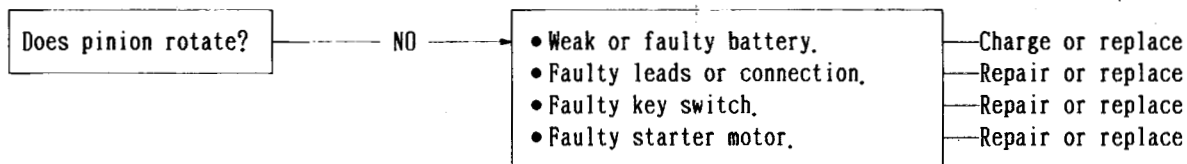
1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn key switch to "ON" position and check condition.



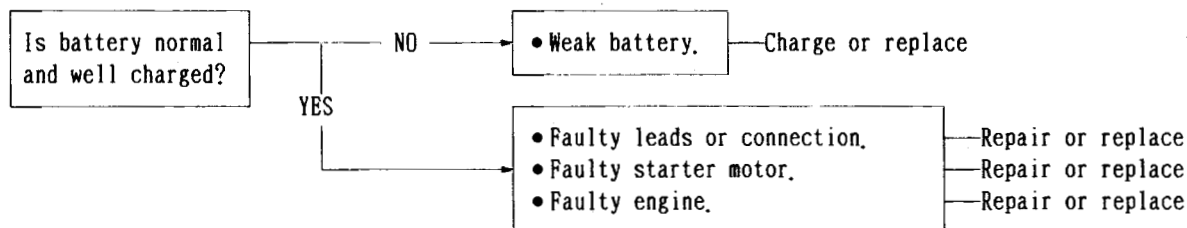
WARNING: Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

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

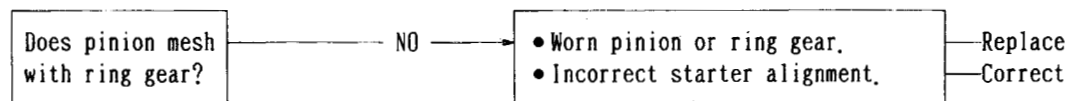
(STARTER DOES NOT ROTATE)



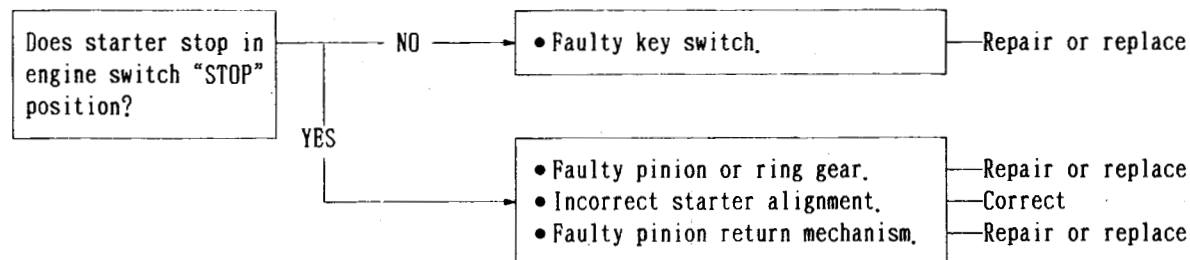
(STARTER ROTATES BUT SLOW)



(STARTER ROTATES BUT CAN NOT CRANK ENGINE)



(STARTER DOES NOT STOP IN KEY SWITCH "OFF")



ELECTRIC STARTER & CHARGING

STARTER MOTOR CHECK

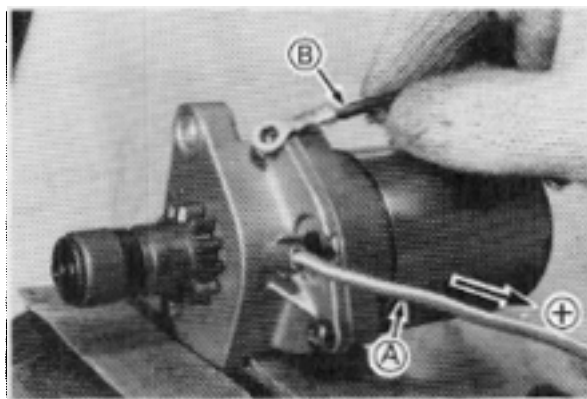
WARNING: Disconnect negative (-) lead first and then positive (+) lead to prevent spark at terminal.

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 cable (A) with positive (+) battery terminal.
 5. Connect jumper cable (B) with negative (-) battery terminal.
 6. Touch starter body with the other end of jumper cable (B) intermittently (within one second).
- If pinion does not turn, repair or replace starter motor.

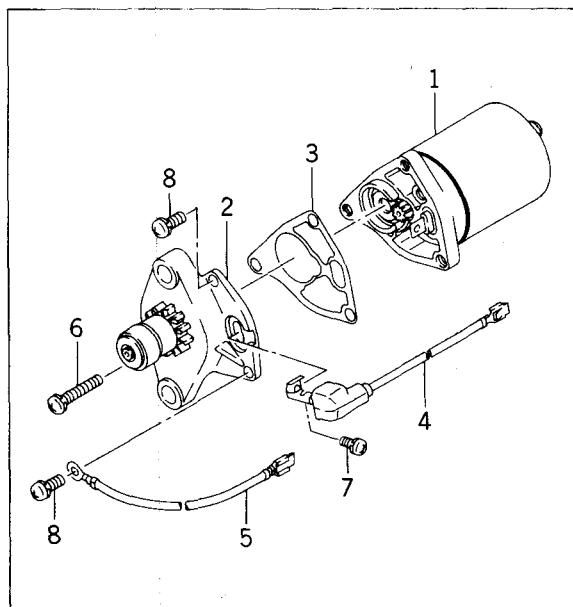


E28FC22W2

COMPONENTS

Ref. No.	Part Name	Ref. No.	Part Name
1	Motor	5	Lead wire
2	Cover assy	6	Screw
3	Gasket	7	Screw
4	Lead wire	8	Screw

CAUTION: Because of difficulty in reassembling, further disassembling is not recommended.



E28FC23W2

ELECTRIC STARTER & CHARGING

RING GEAR CHECK

1. Check ring gear for worn or damaged teeth.
 - If teeth are extremely worn or damaged, replace flywheel by one with new ring gear.

E28FC15W1

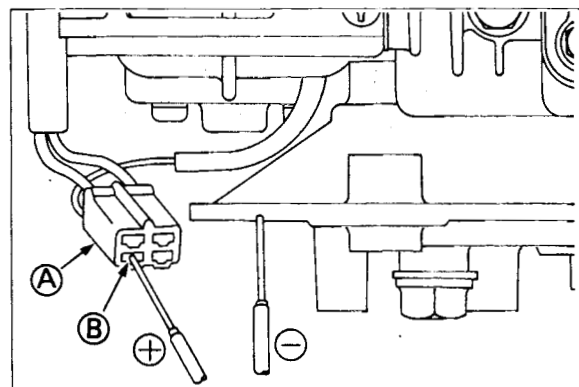
STARTER MOTOR REASSEMBLY

1. Coat multi purpose grease on reduction gears.
2. Do not miss putting shim on shaft in cover assy.

STATOR OUTPUT

1. Disconnect connector (A).
2. Start and warm up engine.
3. Set multimeter selector switch to 25V DC position.
4. Connect tester positive probe with stator terminal (B) and negative probe with crankcase.
5. Run engine at 3,000 rpm and check voltage.
 - If voltage is less than 8V, replace stator.

E28FC24W1



E28FC25W1

IGNITION SYSTEM

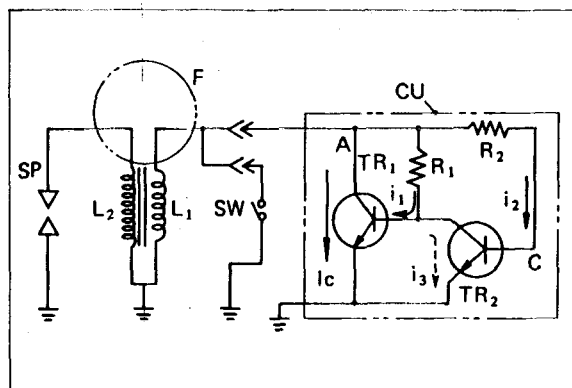
TYPE OF IGNITION SYSTEM

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



E30FC01W2

SPARK CHECK

To check ignition system, check spark as follows;

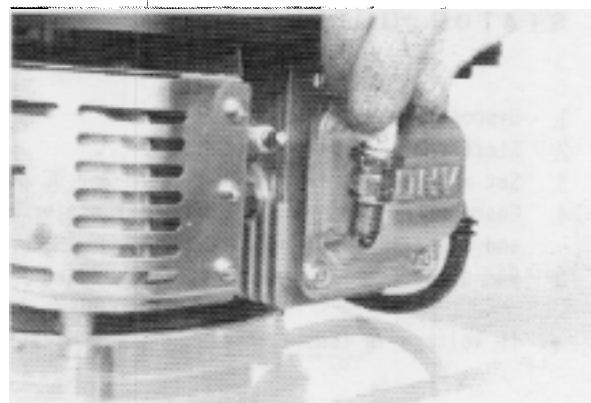
1. Remove spark plug and connect plug cap with the removed spark plug.
2. Install spare plug to plug hole to avoid fuel spitting from hole.

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.



E30FC08W2

IGNITION SYSTEM

CONTROL UNIT CHECK

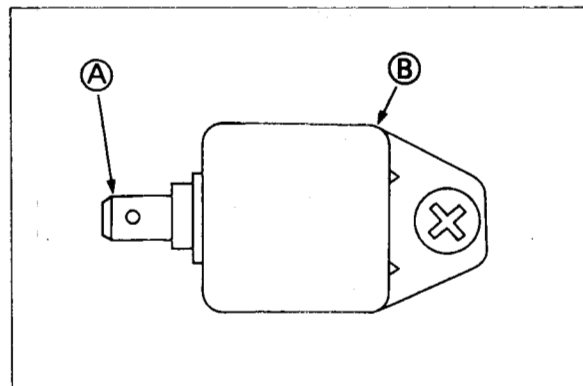
1. Set multimeter selector switch to $R \times 1k\Omega$ position.
 2. Check resistance between terminal (A) and case (B).
- If resistance is out of specified value, replace control unit.

CAUTION: Do not use Megger.

CONTROL UNIT RESISTANCE ($k\Omega$)

Meter \ominus	Terminal (A)	Case (B)
Meter \oplus		
Terminal (A)		0.2 - 0.7
Case (B)	1 - 5	

NOTE: This check may not cover every defect.

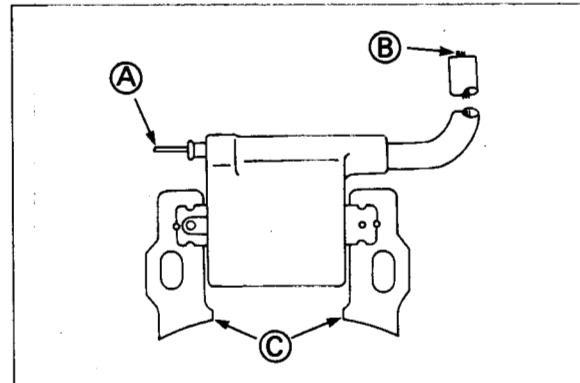


IGNITION COIL CHECK

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)	0.67 - 1.10 Ω ($R \times 1\Omega$ Range)
Secondary coil	Plug lead (B) and Core (C)	6.0 - 10.0 $k\Omega$ ($R \times 1k\Omega$ Range)



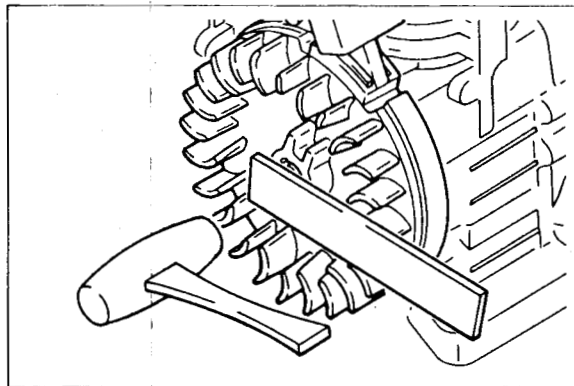
E30FC09W2

E30FC10W2

IGNITION SYSTEM

FLYWHEEL REMOVAL

1. Remove starting pulley and engine cover assy. (See ENGINE COVER REMOVAL.)
2. Avoiding flow-out of engine oil, place engine on bench so that flywheel faces sideward.
3. Put soft metal piece on shaft end to avoid damage and strike metal piece sharply until flywheel comes loose.



E30FC11W1

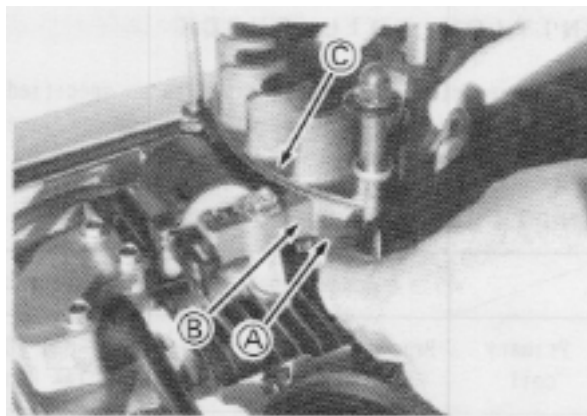
FLYWHEEL INSTALLATION

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. (See ENGINE COVER ASSEMBLY AND INSTALLATION.)

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.



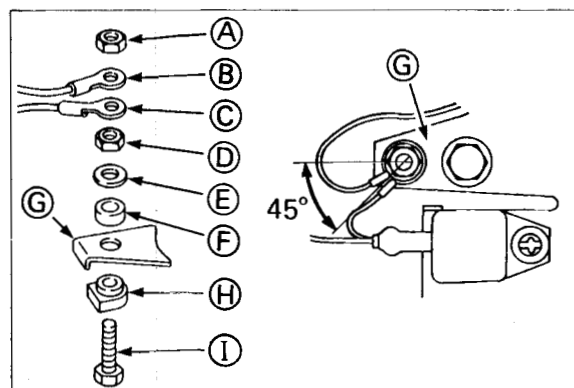
E30FC12W1

E30FC13W1

INTERMEDIATE CONNECTOR INSTALLATION

Intermediate connector installation is as shown. Be careful of terminal direction.

- | | |
|--------------------------|------------------|
| A: Nut | F: Insulator |
| B: Control unit terminal | G: Control plate |
| C: Stop switch terminal | H: Insulator |
| D: Nut | I: Bolt |
| E: Washer | |



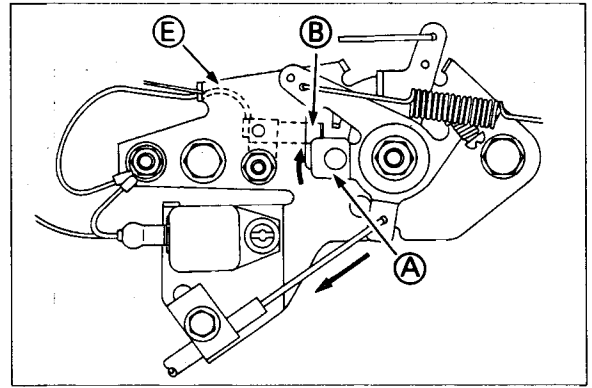
E30FC14W1

IGNITION SYSTEM

THROTTLE-LEVER-LINKED ENGINE SWITCH

Engine switch linked with throttle lever is equipped on control pannel of engine and operated as follows:

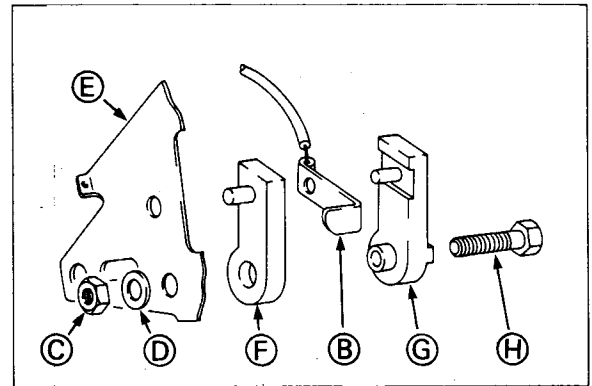
1. When control lever (A) is positioned at slow idle, fast idle, or choke, control lever is far from engine switch tang (B).
2. When control lever (A) is pulled beyond slow idle position, the lever contacts with engine switch tang (B) and grounds ignition circuit.



CAUTION: Check and clean engine switch tang area to keep good contact.

3. Engine switch installation is as shown.

- A: Control lever
- B: Switch tang
- C: Nut
- D: Washer
- E: Control plate
- F: Insulator
- G: Insulator
- H: Bolt

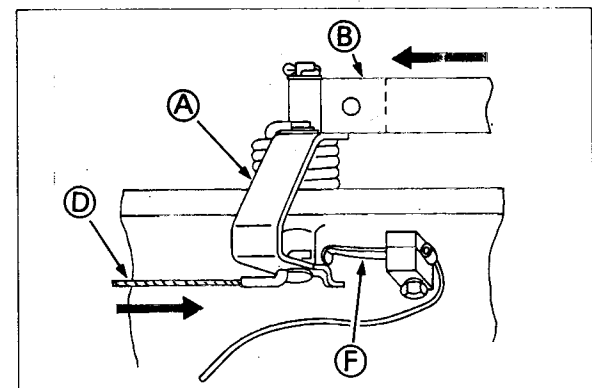
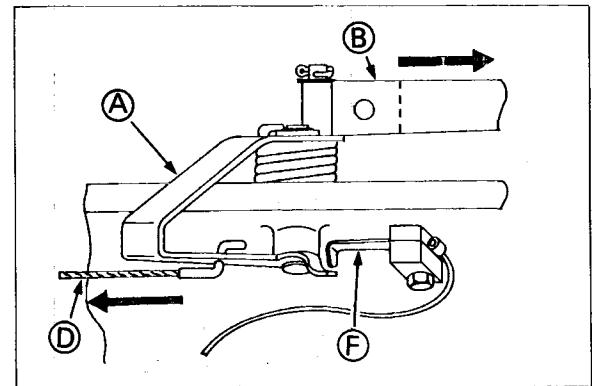


E30FC15W2

BAND-BRAKE-LINKED ENGINE SWITCH

Engine switch linked with band brake is equipped on crank-case side and operated as follows:

1. When brake control lever on equipment is moved to start position, control cable (D) pulls lever (A) to release shoe (B) from flywheel and to release engine switch tang (F) from lever (A).
2. When brake control lever on equipment is moved to stop position, control cable (D) releases lever (A) to force shoe (B) to contact flywheel and to make engine switch tang (F) contact with lever (A).



CAUTION: Check and clean engine switch tang area to keep good contact.

NOTE: Switch configuration is the same as that of throttle-lever-linked engine switch.

E30FC16W2

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 343 kPa (50 psi), check engine in accordance with TROUBLE SHOOTING.

NOTE : Battery should be fully charged for this test.

E32FC05W1

REMOVAL

1. Disconnect plug cap from spark plug.
2. Remove rocker cover.
3. Remove cyl. head.
4. If push rods are removed, mark push rods so they are placed in their original positions in re-installing.

E32FC06W1

MAINTENANCE



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

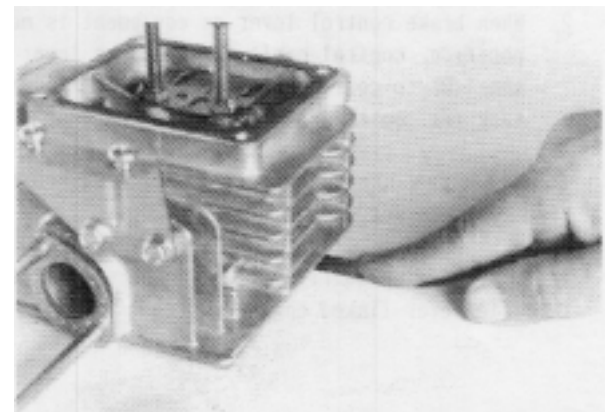
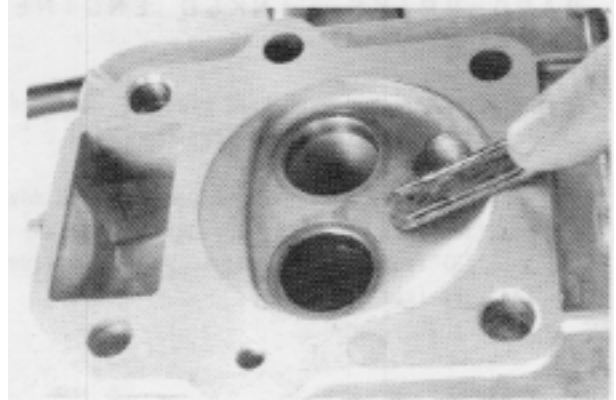
1. Remove coating material stuck on surfaces, with oil stone.

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 0.07 mm (0.003 in.), replace it.



E32FC07W2

CYLINDER HEAD

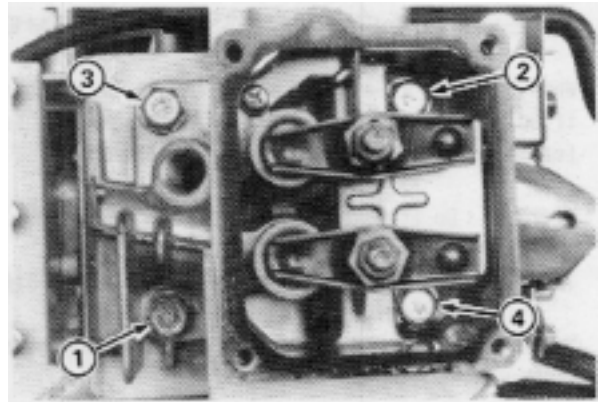
INSTALLATION

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. Make sure both spherical ends of push rods are in place on rocker arms and tappets.

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

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



E32FC08W2

VALVE

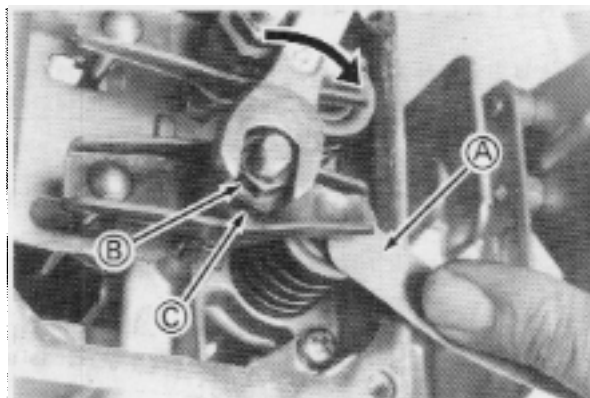
VALVE CLEARANCE ADJUSTMENT

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 feeler gauge (A).
- If clearance is out of value specified below, adjust clearance as follows:
 - (1) Make sure both spherical ends of push rod are in place on rocker arm and tappet.
 - (2) Loosen lock nut (B) and turn rocker arm pivot (C) in or out until valve clearance becomes 0.3 mm (0.01 in.), and then tighten lock nut to specified torque. (See TORQUE SPECIFICATIONS.)
 - (3) Turn lock nut (B) clockwise until valve clearance becomes 0.12 mm (0.005 in.), - for both valves

CAUTION : Do not turn lock nut (B) counterclockwise to enlarge valve clearance. If necessary to do so, follow step (2) and (3).

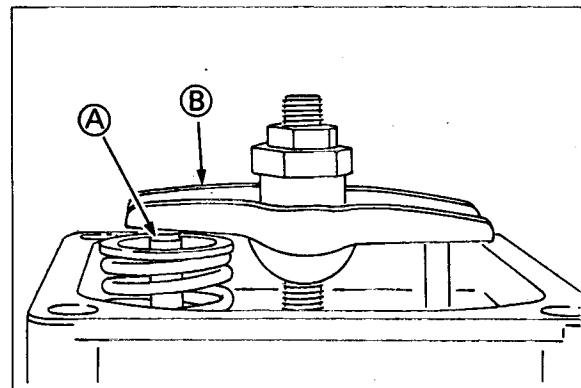


VALVE

**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 0.50 mm (0.02 in.) briefly just after intake valve closes, ACR mechanism on camshaft is faulty.
(See CAMSHAFT VISUAL CHECK.)



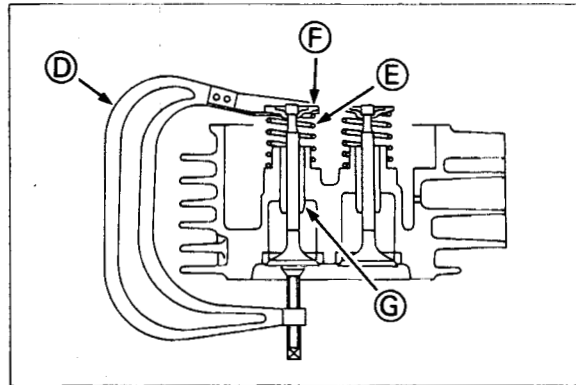
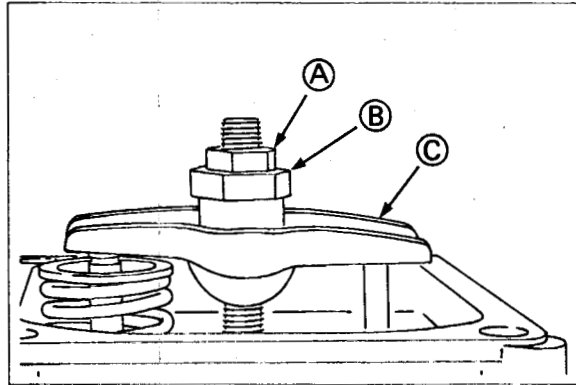
VALVE

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. Unscrew lock nuts (A) and pivots (B), and then remove rocker arms (C).
3. Place screw head of valve spring compressor (D) on the valve head and slip jaw of compressor between spring (E) and retainer (F).
4. Compress spring and remove retainer (F) with needle nose pliers.
5. Remove compressor and valve spring.

NOTE: Before pulling valve out of guide (G), remove all burrs from valve stem, and oil to stem to avoid damaging valve guide.



ROCKER ARM STUD INSTALLATION

When re-installing or replacing rocker arm stud, apply locking agent on thread and tighten to specified torque. (See TORQUE SPECIFICATIONS.)

E33FC16W3

E33FC25W1

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 0.5 mm (0.020 in.).

- If valve head has above defect, replace valve.

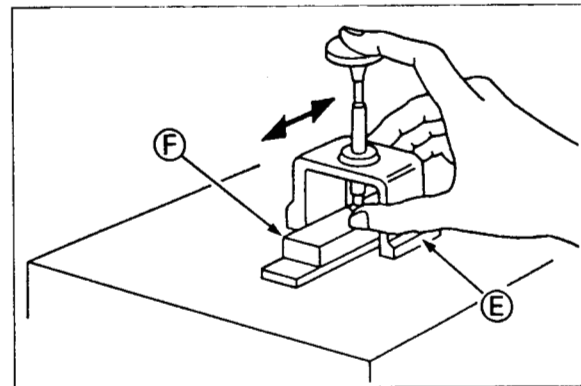
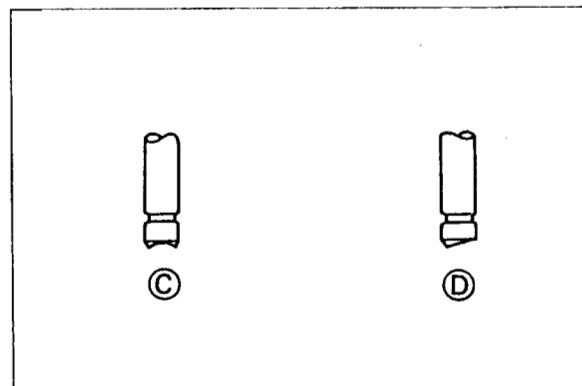
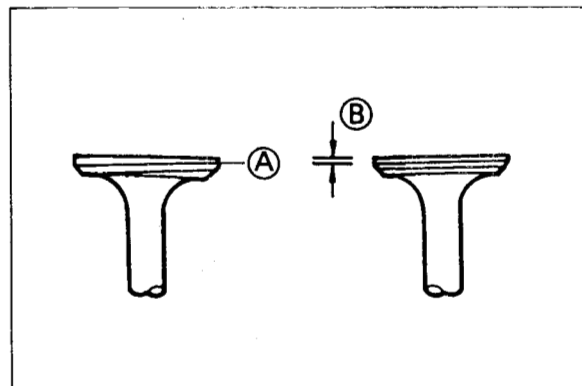
NOTE : Excessive deposit is caused by leaded gasoline, and deposit triggers gas leakage causing valve defects. Therefore unleaded gasoline is recommended.

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.

6. Check valve stem for worn stem end.
 7. Grind worn stem end (C, D) squarely to stem shaft with valve lapping guide (E) and oil stone (F).
- If length from stem end to groove is less than 3.8 mm (0.15 in.) after grinding, replace valve.



VALVE

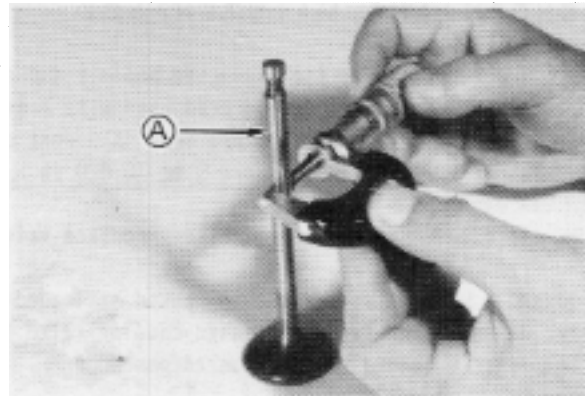
SERVICE LIMIT

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

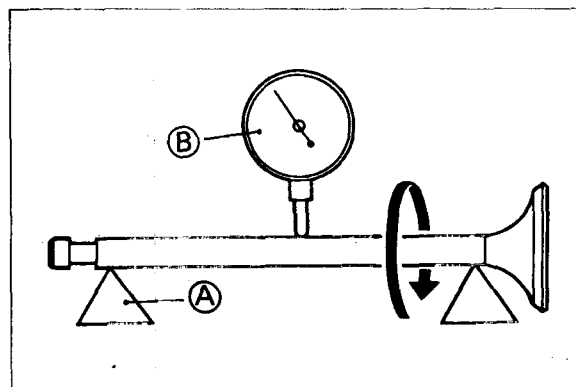
Intake	5.435 mm (0.2139 in.)
Exhaust	5.420 mm (0.2133 in.)



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.



E33FC18W2

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 31.5 mm (1.240 in.), replace spring. - for both springs

E33FC19W1

VALVE

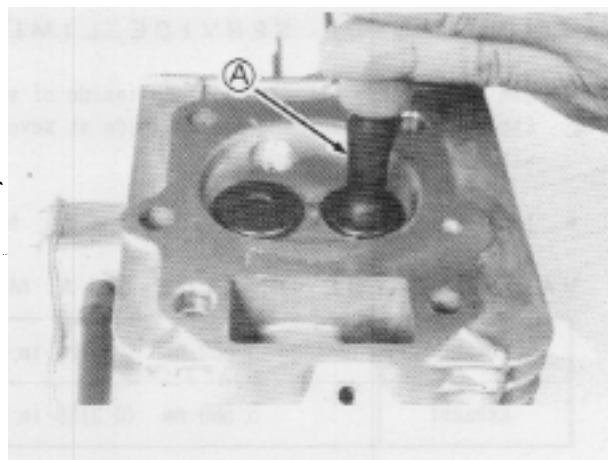
LAPPING

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.



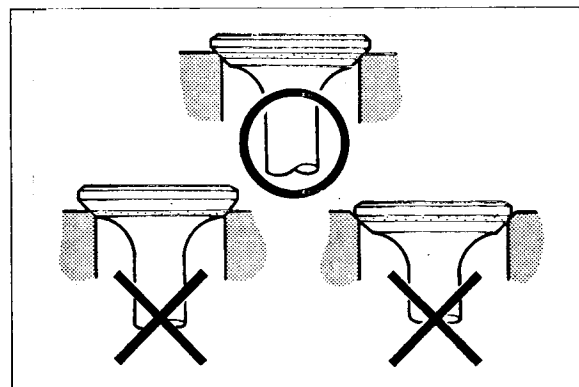
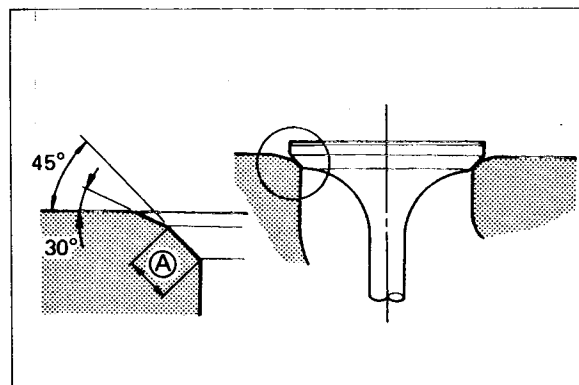
VALVE SEAT RECONDITIONING

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 width to 0.53 - 1.16 mm (0.021 - 0.046 in.).

A : Seat width

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.)



E33FC20W2

E33FC21W2

VALVE

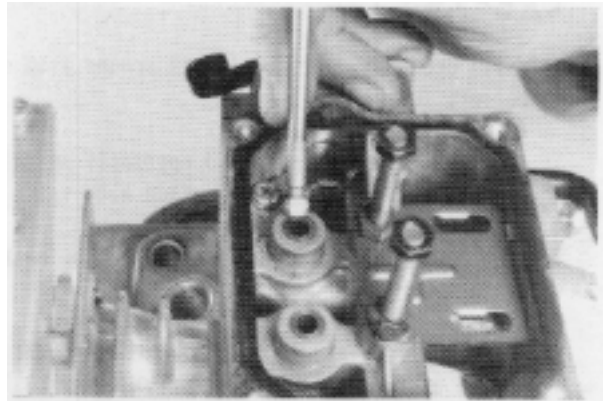
VALVE GUIDE SERVICE LIMIT

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 MAX, replace cyl. head.

VALVE GUIDE INSIDE DIA. MAX

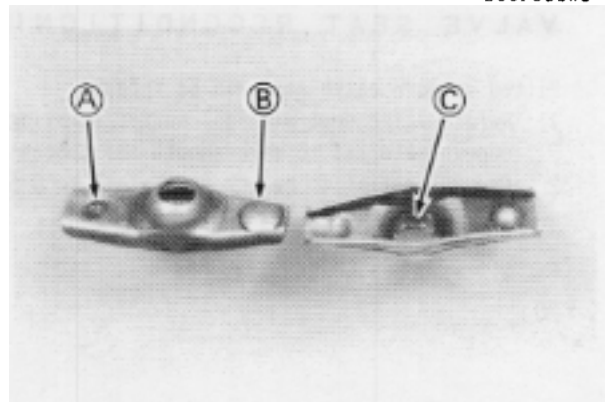
Intake	5.550 mm (0.2185 in.)
Exhaust	5.560 mm (0.2189 in.)



ROCKER ARM SERVICE LIMIT

1. Check rocker arm for pitted or worn contact surfaces (A - with push rod), (B - with valve stem), and (C - with pivot).

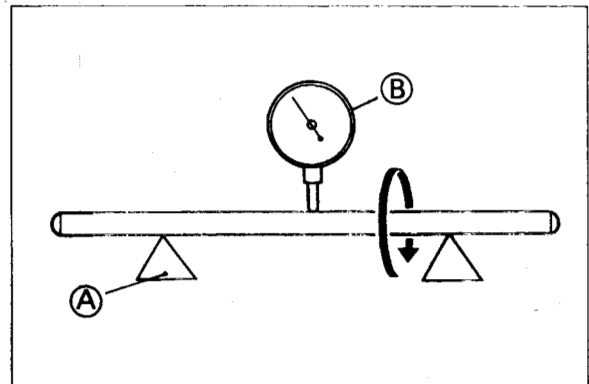
- If necessary, replace rocker arm.



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 0.6 mm (0.024 in.), replace push rod.



E33FC24W1

CRANKCASE COVER

REMOVAL

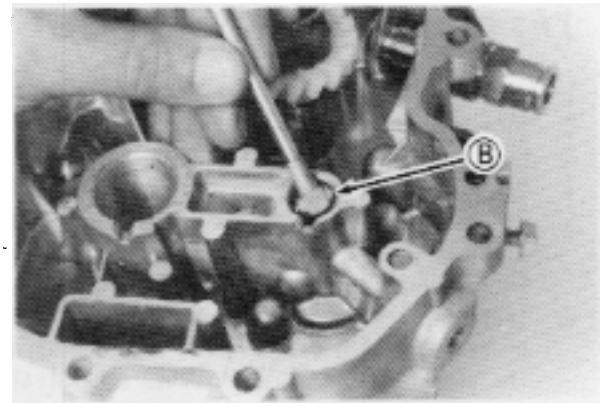
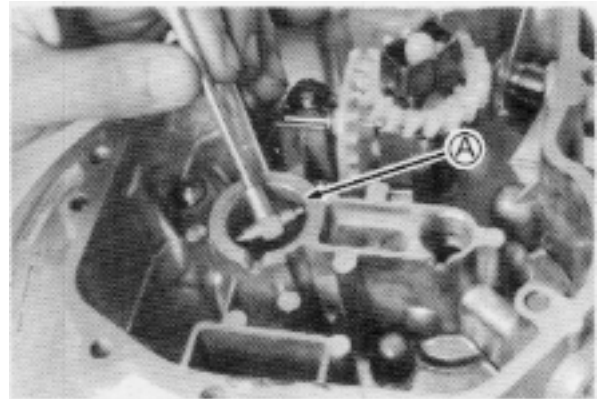
 **WARNING:** Be careful not to burn yourself by hot oil.

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 25.100 mm (0.9882 in.), replace crankcase cover.
2. Check inside diameter of camshaft bearing (B) at several points with inside micrometer.
 - If diameter is more than 14.070 mm (0.5539 in.), replace crankcase cover.

E34FC01W1



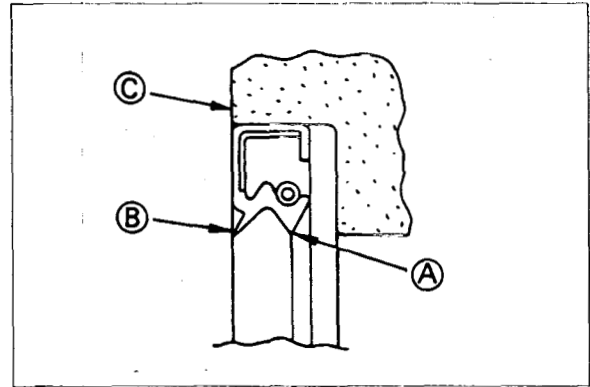
E34FC06W2

CRANKCASE COVER

OIL SEAL REPLACEMENT

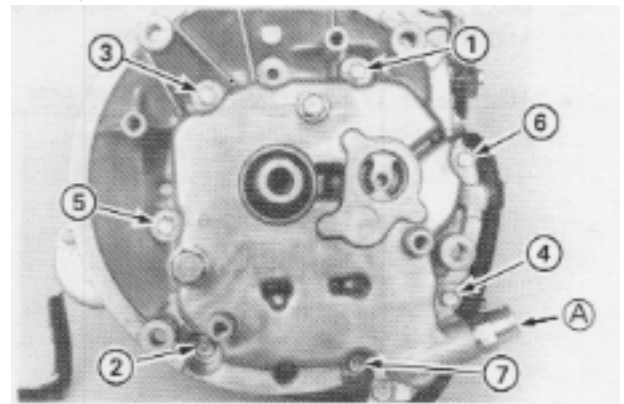
If oil leakage through oil seal is observed or seal lip is damaged, replace oil seal.

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).



INSTALLATION

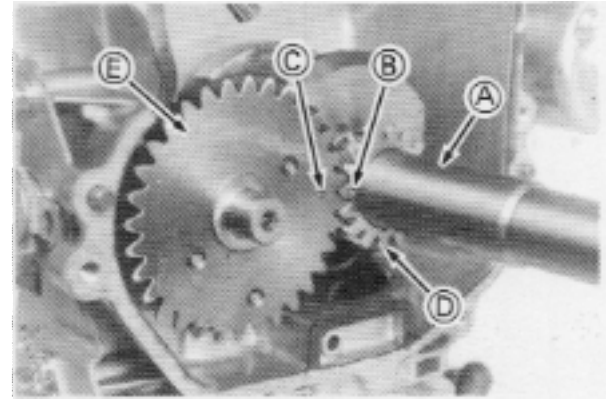
1. Clean gasket surface and place new gasket on crankcase.
2. Pack grease into oil seal. (See OIL SEAL REPLACEMENT.)
3. Coat a light film of oil on bearings.
4. Make sure governor weights are closed.
5. Make sure governor gear is properly aligned to mesh with cam gear when installing crankcase cover. 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.
7. When new crankcase cover is used, tightening of side drain plug (A) must be performed carefully. (See NOTE in TORQUE SPECIFICATIONS.)



CAMSHAFT

REMOVAL

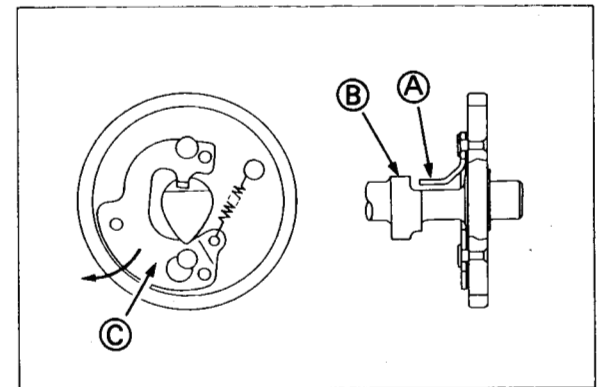
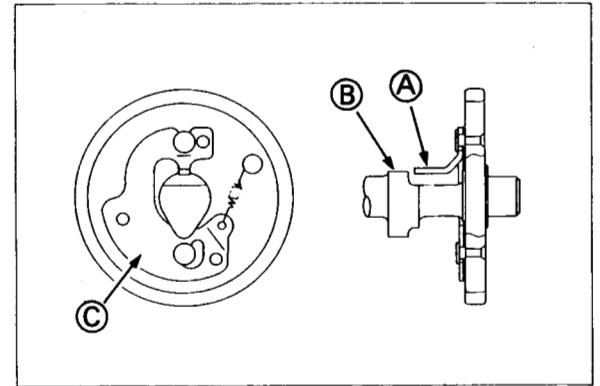
1. Place cyl. block upside down on bench.
2. Rotate crankshaft (A) until timing marks (B, C) on crankshaft gear (D) and camshaft gear (E) align, to avoid interference between tappets and camshaft in removal.
3. Remove tappets, and mark them so they can be placed in their original position in re-installing.



E35FC06W1

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 (A) is not placed above cam heel (B) when weight (C) is closed, replace ACR mechanism.
 - If outer surface of tab (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.



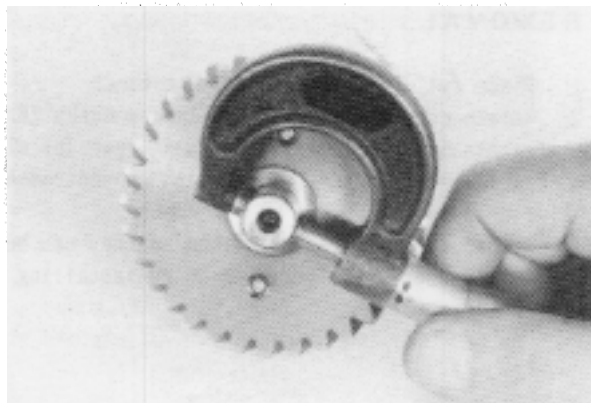
E35FC07W2

CAMSHAFT

SERVICE LIMIT

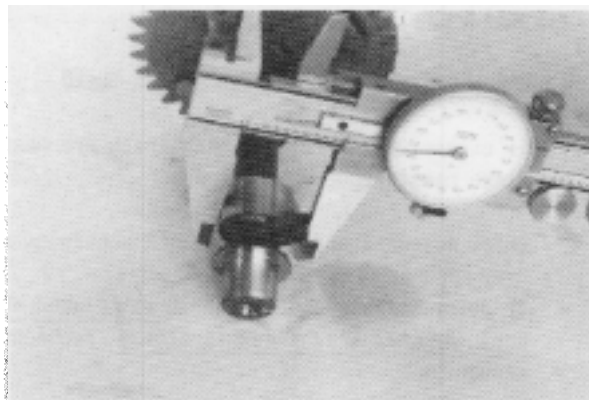
1. Check bearing journal diameter with micrometer.

- If diameter is less than 13.920 mm (0.5480 in.), replace camshaft. - for both side



2. Check cam lobe height with vernier calipers.

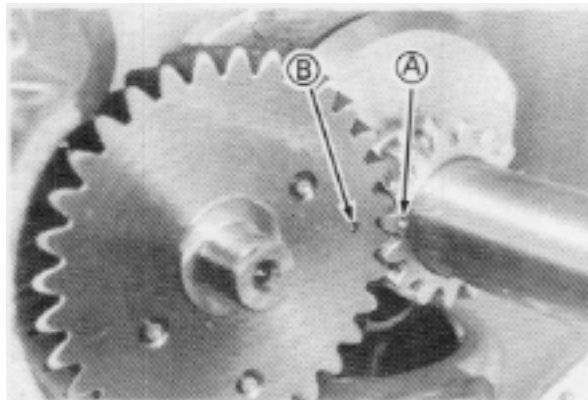
- If lobe height is less than 22.80 mm (0.898 in.), replace camshaft.



E35FC08W2

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.



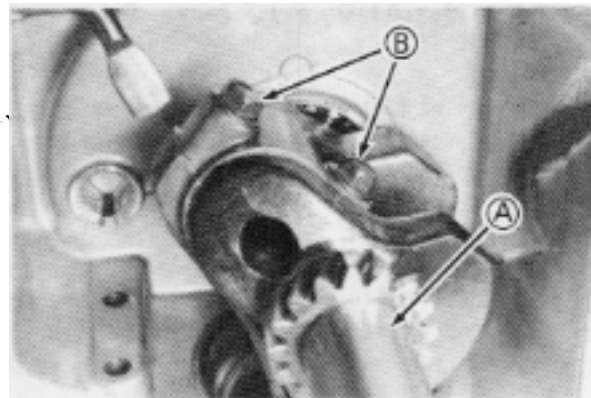
E35FC09W1

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).



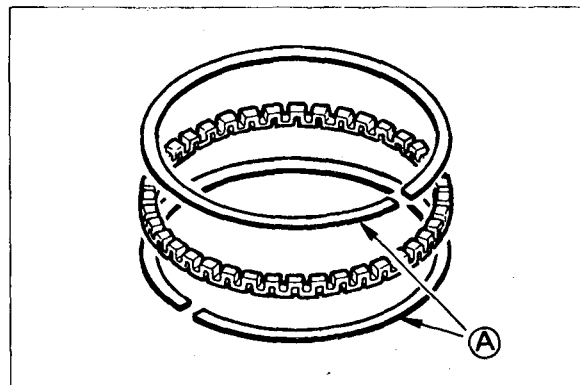
E36FC12W2

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.

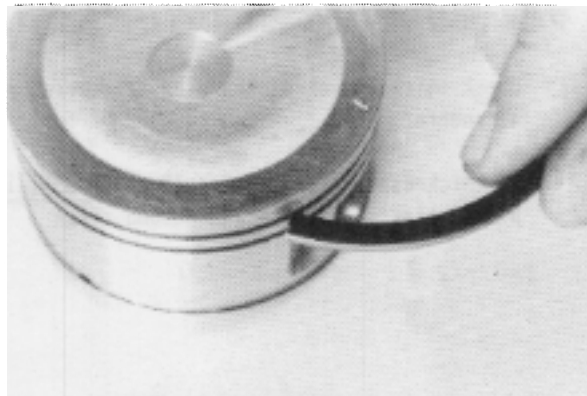


PISTON & CON-ROD

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.

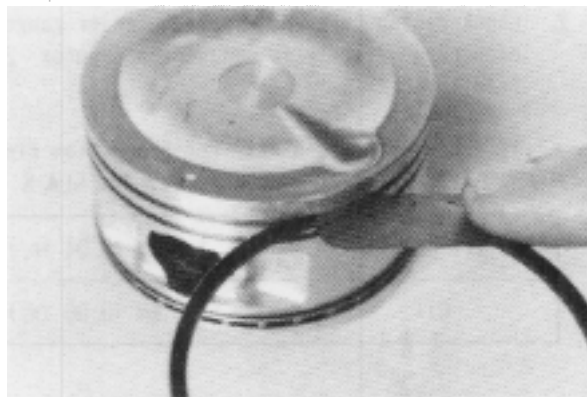


E36FC13W1

PISTON SERVICE LIMIT

1. Check clearance between ring groove and ring using new ring and feeler gauge.
 - If clearance is more than 0.10 mm (0.004 in.), replace piston, - for top and second rings

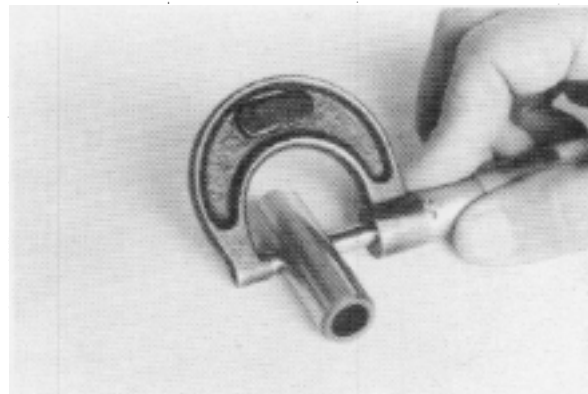
2. Check inside diameter of piston pin hole at several points with inside micrometer.
 - If diameter is more than 15.050 mm (0.5925 in.), replace piston.



E36FC14W2

PISTON PIN SERVICE LIMIT

1. Check outside diameter of piston pin at several points with micrometer.
 - If piston pin diameter is less than 14.975 mm (0.5896 in.), replace piston pin.



E36FC15W1

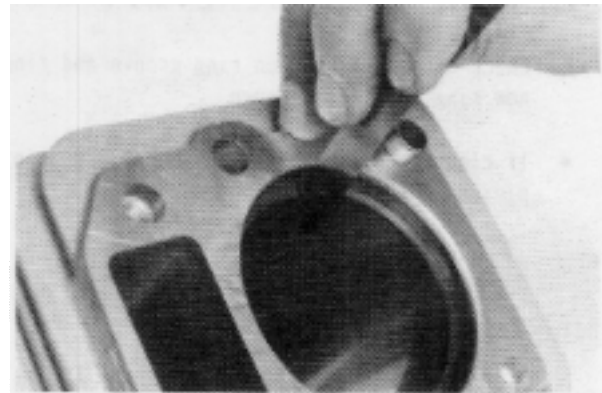
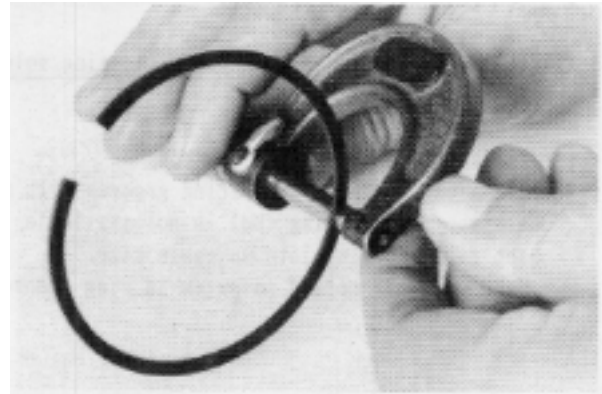
PISTON & CON-ROD

PISTON RING SERVICE LIMIT

1. Check thickness of piston ring at several points with micrometer.
 - If thickness is less than 1.40 mm (0.0551 in.), replace piston ring. - for top and second rings
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 • Second	1.0 mm (0.04 in.)
Oil	1.5 mm (0.06 in.)



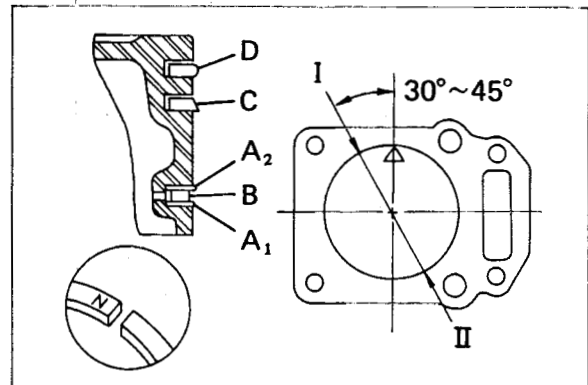
E36FC16W2

PISTON RING INSTALLATION

1. Use ring expander.

NOTE : Face up "N" 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



E36FC17W1

PISTON & CON-ROD

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 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 and clean cooling system.
 - Check quality of oil and maintenance method with user.

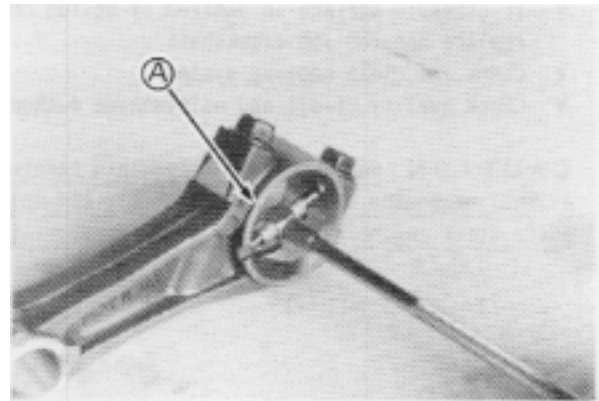
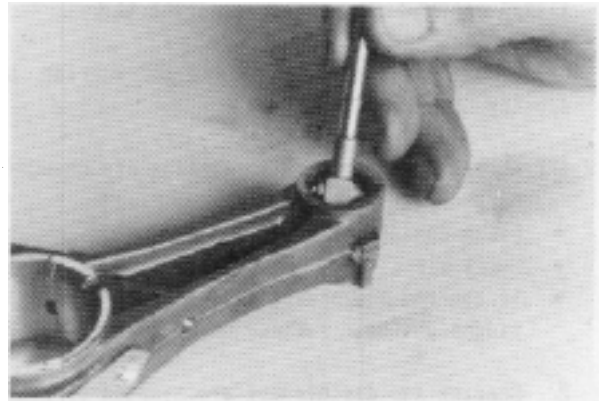
CAUTION: Check re-used components carefully when re-assembling engine which had con-rod big end seizure.
Never start engine without oil even for short test run.

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 15.050 mm (0.5925 in.), replace con-rod.

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 28.070 mm (1.1051 in.), replace con-rod.



E36FC19W2

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.

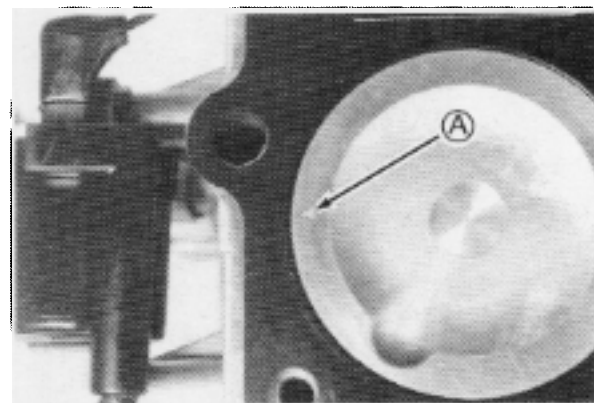
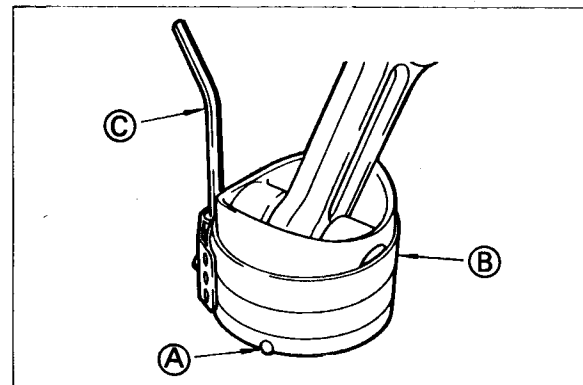


E36FC20W2

PISTON & CON-ROD

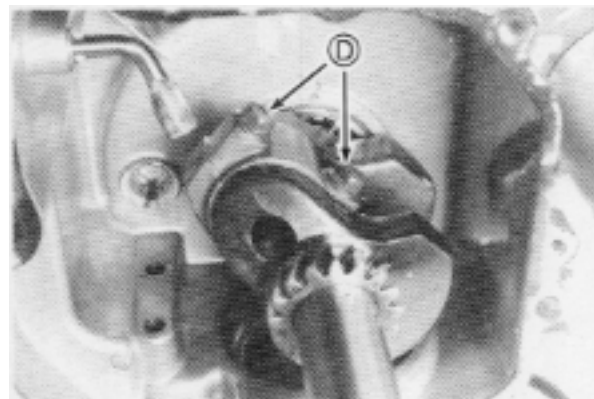
PISTON/CON-ROD ASSY INSTALLATION

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.



E36FC21W3

CRANKSHAFT

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.

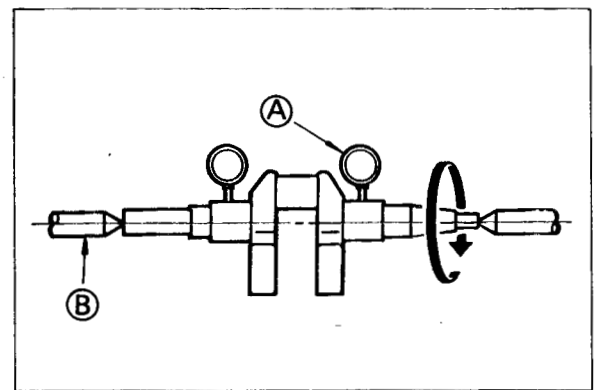
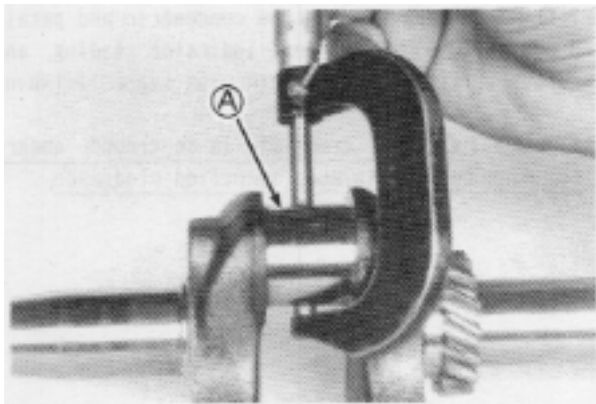
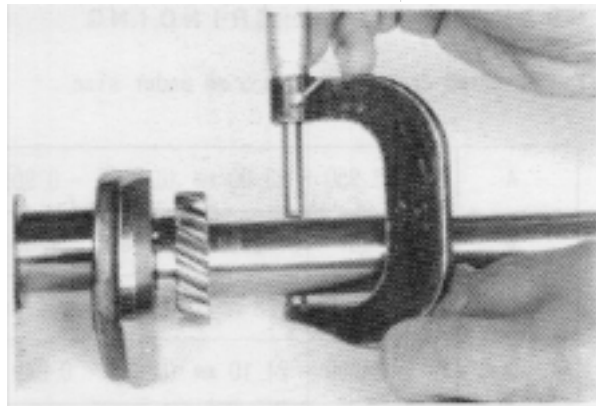
E37FC02W2

SERVICE LIMIT

1. Check outside diameter of both main bearing journals at several points with micrometer.
 - If outside diameter is less than 24.920 mm (0.9811 in.), replace crankshaft. - for both journals

2. Check outside diameter of crank pin (A) at several points with micrometer.
 - If outside diameter is less than 27.920 mm (1.0992 in.), replace crankshaft.

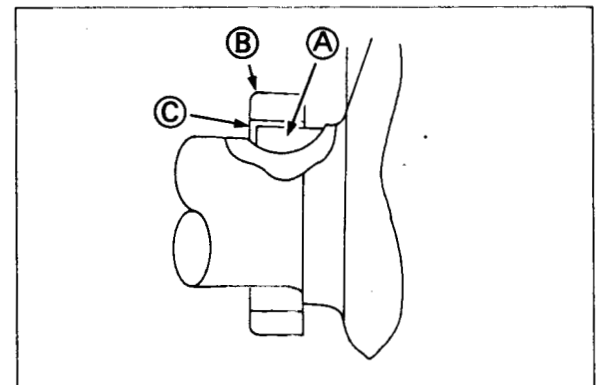
3. Check run out of crankshaft at both bearing journals with dial indicator (A), setting crankshaft to alignment jig (B).
 - If total reading of run out is more than 0.20 mm (0.008 in.), replace crankshaft.



E37FC07W3

INSTALLATION

1. Install key (A) as shown.
2. Install crank gear (B) as timing mark facing outside.
3. Make sure end of key is not projecting from crank gear surface (C).
4. Coat a film of oil on bearing surfaces of crankshaft.
5. Tape key way at taper of crankshaft to avoid cutting of oil seal lips.
6. Pack some amount of grease for high temperature application into oil seal.



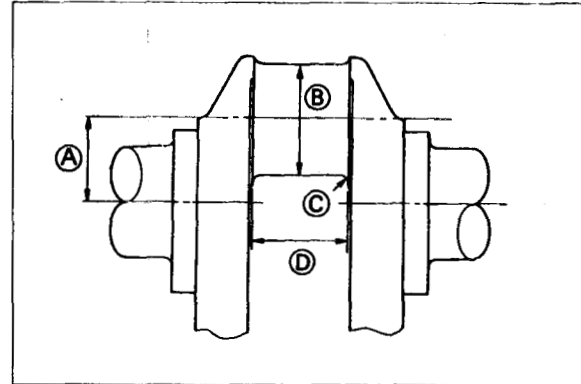
E37FC08W1

CRANKSHAFT

CRANK PIN RE-GRINDING

1. Re-grind crank pin to 0.5 mm under size.

A	22.950 - 23.00 mm (0.9035 - 0.9055 in.)
B	27.467 - 27.480 mm (1.0814 - 1.0819 in.)
C	1.5 - 1.8 mm (0.059 - 0.071 in.)
D	24.00 - 24.10 mm (0.945 - 0.949 in.)



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.

GOVERNOR

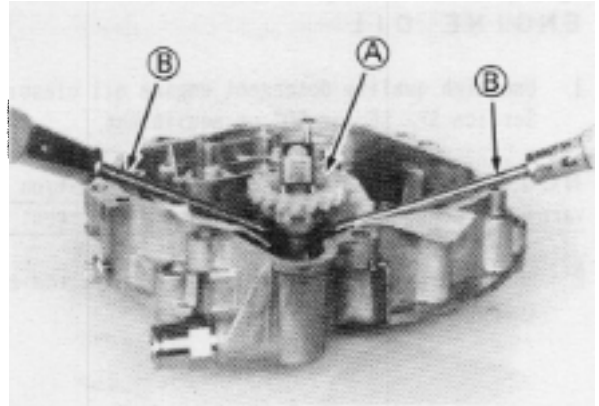
GOVERNOR GEAR CHECK AND REMOVAL

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.

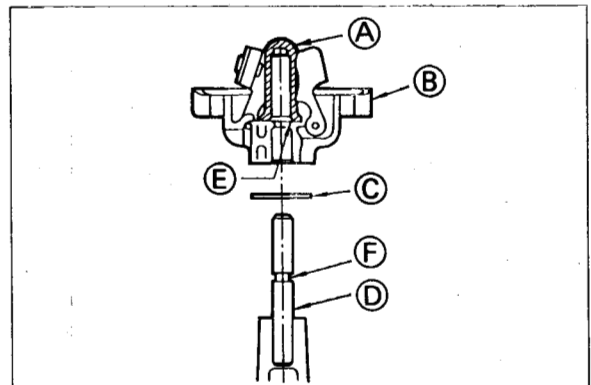


GOVERNOR GEAR INSTALLATION

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.



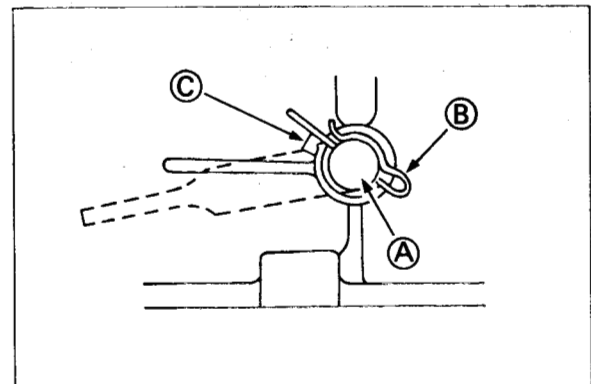
E39FC04W2

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).



E39FC05W1

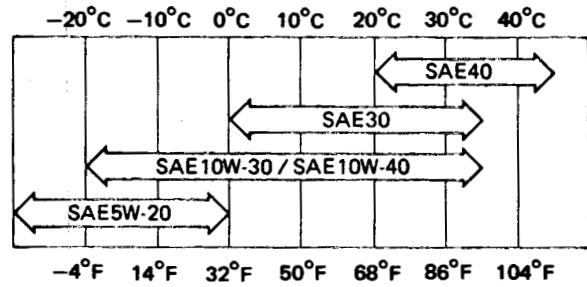
LUBRICATING SYSTEM

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.



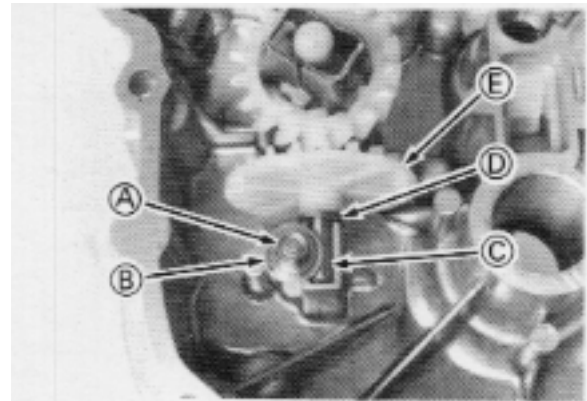
E40FC01W1

OIL SLINGER CHECK

Lubricating system is oil splash type in which oil slinger 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.

- If slinger is damaged, replace it.



E40FC10W1

BREATHER SYSTEM

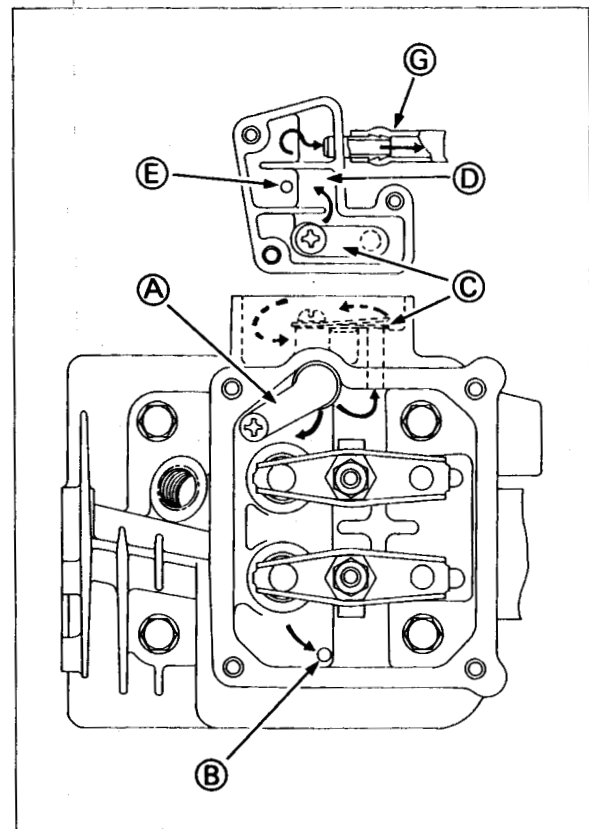
Function of breather is to keep vacuum in crankcase avoiding oil being forced out of engine.

Reed valve controls direction of air flow caused by piston movement so that air flow from inside to outside can pass reed valve but not from outside to inside.

Oil laden air in crankcase passes through first reed valve (A) and expands in valve chamber, where some portion of oil is separated from air and returns to crankcase through hole (B).

The air passes through second reed valve (C) and expands in breather chamber (D), where remained oil is separated from air and drain to valve chamber through hole (E).

Then air passes through maze in breather chamber (D) and is vented to intake pipe through tube (G).

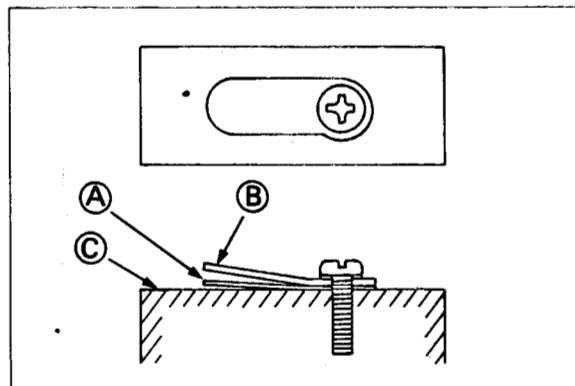


E40FC11W2

LUBRICATING SYSTEM

BREATHER REED VALVE CHECK

1. Check valve and valve seat for any damage such as crack or wear.
 2. Install reed valve (A) and back plate (B) on inspection tool (C), and check gap between reed valve (A) and tool surface (C) with feeler gauge.
- If gap is more than 0.2 mm (0.008 in.), turn over valve or replace valve.

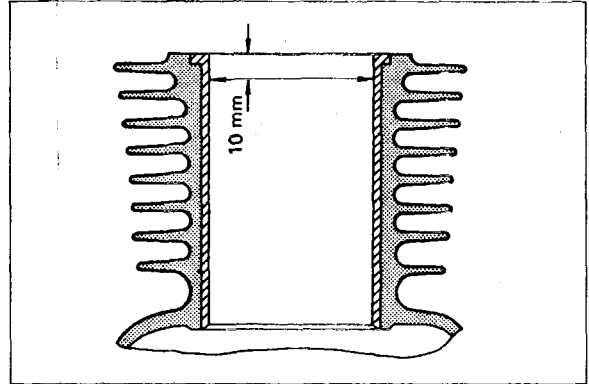


E40FC12W1

CYLINDER/CRANKCASE

CYLINDER SERVICE LIMIT

1. Visually check cyl. block for scored bore, broken fin, or other damages.
 - If unreparable 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

65.060 mm (2.5614 in.)

CYL. BORE OUT OF ROUND MAX

0.060 mm (0.0024 in.)

E41FC06W2

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

O. S.	B. S.
0.25 mm	65.210 - 65.230 mm (2.5673 - 2.5681 in.)
0.50 mm	65.460 - 65.480 mm (2.5772 - 2.5779 in.)
0.75 mm	65.710 - 65.730 mm (2.5870 - 2.5878 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.

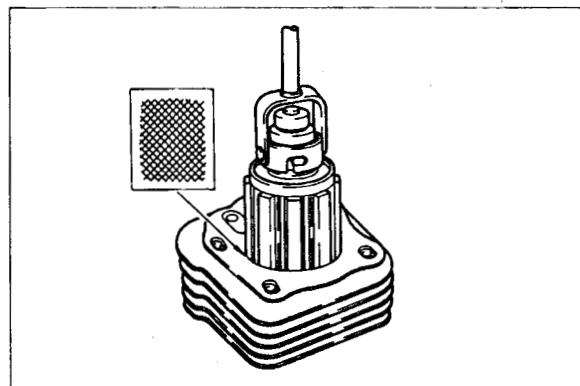
WARNING: Stop drill press when checking or measuring cyl. bore.

- (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.

O. S.	F. S.
0.25 mm	65.230 - 65.250 mm (2.5681 - 2.5689 in.)
0.50 mm	65.480 - 65.500 mm (2.5779 - 2.5787 in.)
0.75 mm	65.730 - 65.750 mm (2.5878 - 2.5886 in.)



CYLINDER/CRANKCASE

BALL BEARING CHECK

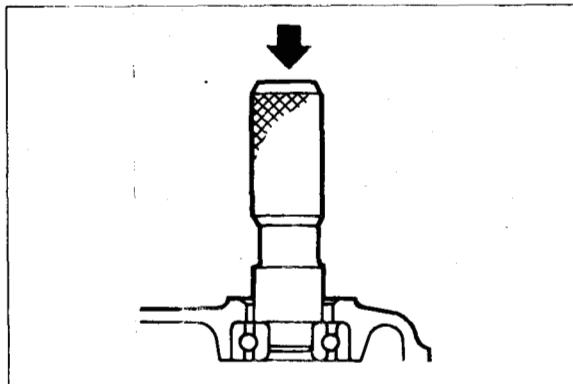
CAUTION: Do not remove ball bearing from housing except replacing.

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.

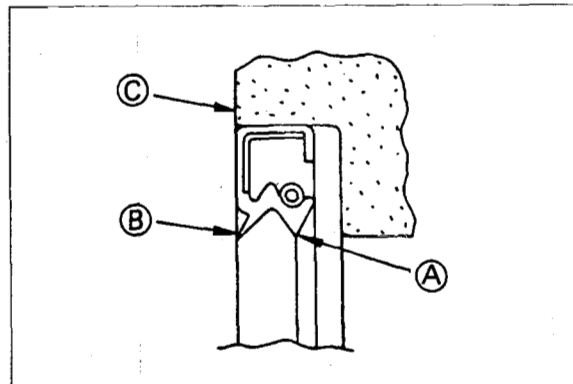


E41FC04W1

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).

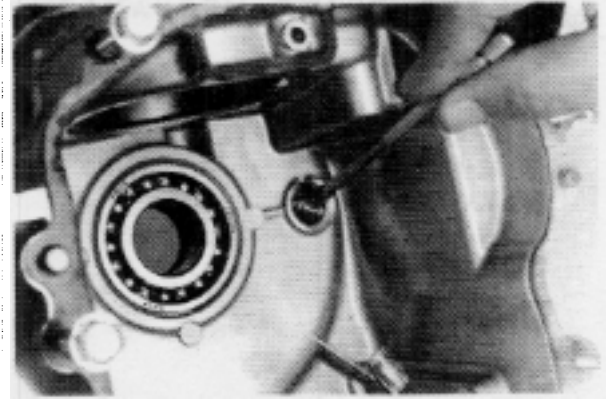


E41FA04W2

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 14.070 mm (0.5539 in.), replace cylinder/crankcase.



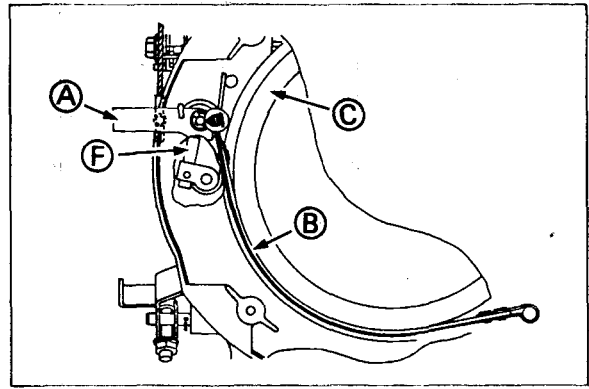
E41FC08W1

BAND BRAKE

BAND BRAKE MECHANISM

In the brake system, shoe (B) operated by lever (A) brakes flywheel (C) to stop engine quickly when brake control lever on equipment is moved to stop position. At the same time, engine switch tang (F) contacts with lever (A) to ground ignition circuit.

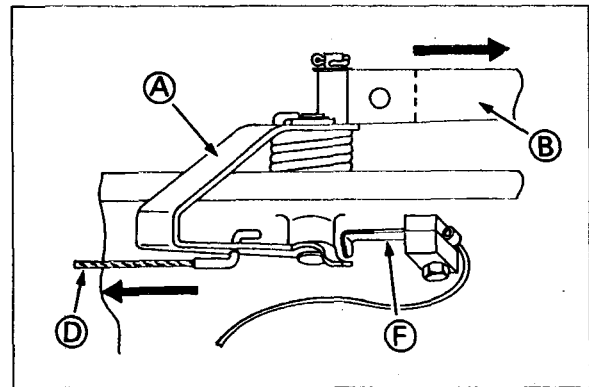
The operations are as follows:



1. Starting

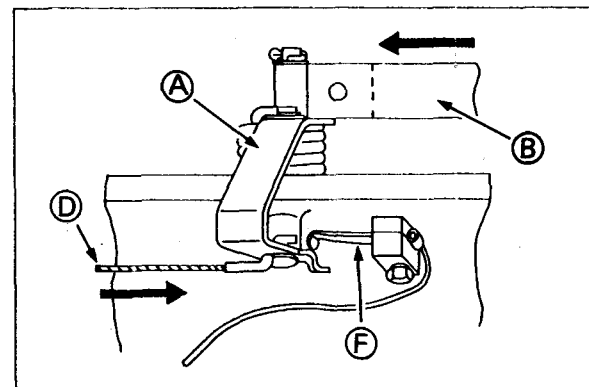
When brake control lever on equipment is moved to start position, control cable (D) pulls lever (A) to release shoe (B) from flywheel (C) and to release engine switch tang (F) from lever (A).

CAUTION: Do not try to start engine when band brake is ON. Starter and band brake will be damaged.



2. Stopping

When brake control lever on equipment is moved to stop position, control cable (D) releases lever (A) to force shoe (B) to contact flywheel (C) and to make engine switch tang (F) contact lever (A).



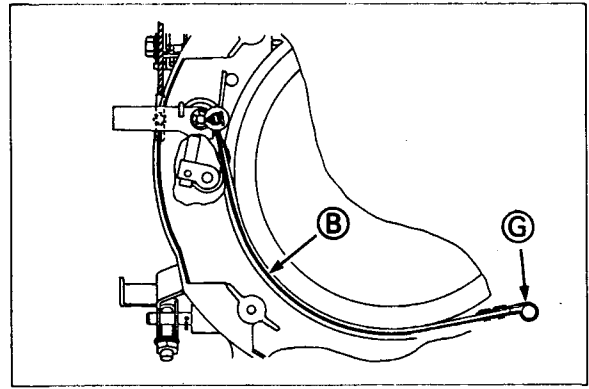
CAUTION: Check and clean engine switch tang area to keep good contact.

Make sure that band brake always stop engine within 3 seconds when band brake is ON. If not, check brake shoe and/or related parts for wear and damage. Replace parts if necessary.

BAND BRAKE

BRAKE SHOE REPLACEMENT

1. Do not remove brake shoe (B) from stud (G) except when replacing the shoe.
2. If stud (G) is removed to replace shoe (B), apply locking agent on the thread when reinstalling the stud.
3. Shoe (B) does not require adjustment in installation.

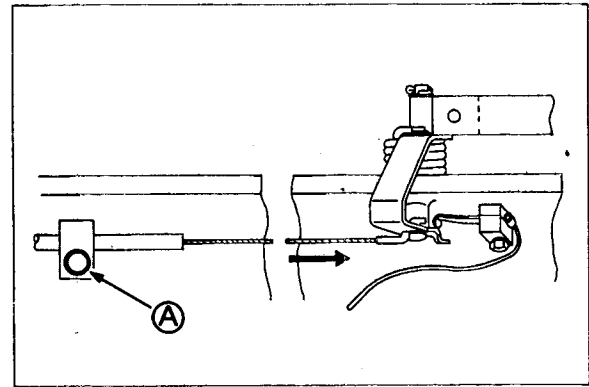


E43FC02W1

BRAKE CABLE ADJUSTMENT

Operate brake control lever on equipment and check brake cable for any slack. If necessary, adjust brake cable connection.

1. Release brake control lever on equipment.
2. Loosen outer cable clamp bolt (A) and pull outer cable to remove any slack.
3. Then tighten clamp bolt (A).



E43FC03W1



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