

OHV GTS 140 ENGINE SERVICE MANUAL

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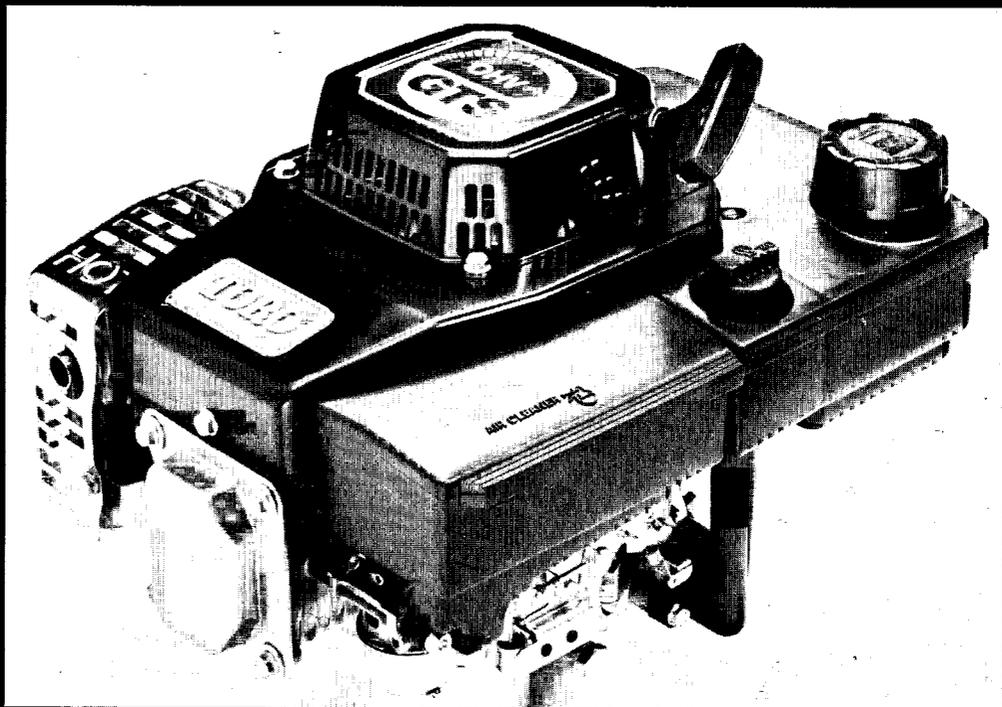
FUEL TANK

RECOIL STARTER



over head
valve engine

SERVICE MANUAL



PREFACE

This Service and Overhaul Manual was written expressly for the TORO model VMF5 and VMG6 Overhead Valve Engine.

The Toro Company has made every effort to make this service manual a useful and lasting addition to every service facility. To assure proper and effective service, and to provide optimum performance for the life of the engine, you are urged to read this manual carefully.

It is not the purpose of this manual to teach component theory, but rather to provide the mechanic with a working guideline of maintenance, troubleshooting, test, repair and overhaul procedures.

The Toro Company reserves the right to change product specifications or this manual without notice.

The Toro Company gratefully acknowledges the assistance of the Suzuki Motor Company in the production of this manual.

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1. GENERAL INFORMATION

SAFETY INSTRUCTIONS



This safety symbol means **WARNING** or **CAUTION-PERSONAL SAFETY INSTRUCTION**. Read the instruction because it has to do with safety. Failure to comply with the instruction may result in personal injury.

This manual is intended to be a service and repair manual only. The safety instructions provided in this manual are for the troubleshooting and service of the product only. Individual owners manuals will contain safety information for the operation of products that are fitted with the engine described in this manual.

Operators manuals with complete operational safety instructions are available through:

The Toro Company
Publications Department
8111 Lyndale Avenue South
Minneapolis, MN 55420 U.S.A.

Be sure to include the model and serial number of your machine.

If you have any questions concerning this Repair Manual, please contact:

The Toro Company
Service Department
8111 Lyndale Avenue South
Minneapolis, MN 55420 U.S.A.

GENERAL SERVICE SAFETY INSTRUCTIONS

1. Use extreme care when handling any gasoline and oil that may be in the engine. Gasoline and oil are flammable and should not be exposed to flame or spark. Do not smoke while handling any fuel or oil.
2. Drain and/or store gasoline and oil only in approved containers.
3. Wipe up any spilled gasoline or oil.
4. Do not run an engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
5. Disconnect and ground the spark plug high tension wire before performing any engine service. This will prevent accidental starting of the engine.
6. If the engine must be kept running to perform maintenance or making adjust-

ments, keep clear of the PTO shaft, cutting blades and other moving parts.

7. Do not overspeed the engine by changing the governor settings. Maximum engine speed with no load is listed in the engine specifications on page 2.
8. The engine must be stopped before checking the oil or adding oil to the crankcase.
9. Do not touch the engine muffler or guard while the engine is running or soon after it has stopped. These areas could be hot enough to cause a burn.

MODEL AND SERIAL NUMBERS

Each Toro OHV engine is equipped with two numbers; a four digit model number and a six digit serial number. The numbers are located on the muffler side of the blower housing. See Fig. 1-1. On units with the model number VMF5, the serial number 1 indicates zone start application, the number 2, BBC and number 3, key electric BBC.



Figure 1-1

On units with the model number VMG6 the serial numbers will start with 1, 2, 3, 4, 5 or 6. The number 1 indicates zone start, the number 2 indicates BBC, the number 3 indicates key electric BBC, the number 4 indicates international key electric, the number 5 indicates commercial application and the number 6 indicates zone start commercial.

The mower that these engines are mounted on also have model and serial numbers that are located on a decal on the back of the mower housing between the rear wheels.

In any correspondence concerning the mower or engine, supply the model and serial numbers to assure that the correct information and replacement parts are obtained. Genuine TORO replacement parts may be ordered through your local TORO Authorized Service Dealer.

SPECIFICATIONS

Engine type	Air cooled 4 cycle, gasoline, OHV
Bore and stroke	64 mm x 44 mm (2.52 in x 1.73 in)
Displacement	141 cc (8.7 cu. in)
Maximum output	4 HP/3600 rpm
Maximum torque	0.83 kg-m (6.00 ft-lb)/2700 rpm
Spark plug	NGK BPR6ES
Spark plug gap	0.7 mm — 0.8 mm (0.028 in — 0.032 in)
Ignition coil air gap	.38-.50 mm (.015-.020)
Fuel	Unleaded regular
Fuel tank capacity	1.2 L (.26 gallon)
Oil	30 weight or 10w-30 multi-viscosity
Oil capacity	550 ml (18.59 oz)
Ignition system	Electronic transistorized ignition
Ignition timing degree	25 BTDC \pm 2°/3000 rpm
Starting system	Recoil starter/Electric (12 volt)
Governor	Centrifugal mechanical
Pump system	Trochoid oil pump
Carburetor	Butterfly valve
Air cleaner	Polyurethane foam element
Dry weight	12.0 kg (26.5 lbs)

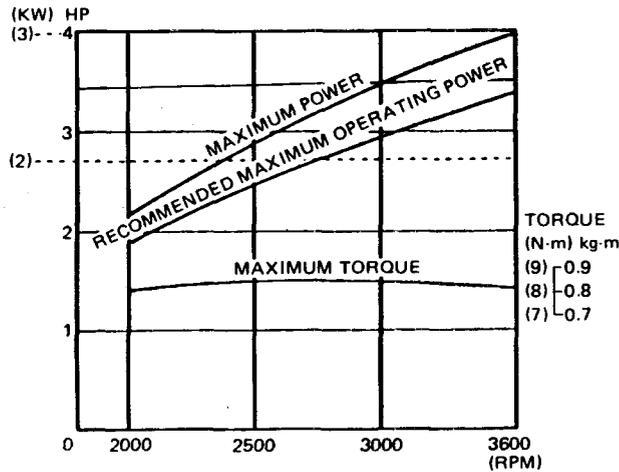


Figure 1-2

SERVICE DATA

ITEM		UNIT	DATA
Crankshaft diameter		mm (in)	Upper crankshaft: 21.960 — 21.980 (0.8646 — 0.8654)
			Lower crankshaft: 24.959 — 24.980 (0.9826 — 0.9835)
Crankshaft deflection	Limit	mm (in)	0.05 (0.0020)
Wear limit on cylinder bore		mm (in)	0.100 (0.0039)
Piston diameter	STD	mm (in)	63.960 — 63.975 (2.5181 — 2.5187)
	Limit	mm (in)	63.915 (2.5163)
Piston-to-cylinder clearance	STD	mm (in)	0.025 — 0.055 (0.0010 — 0.0022)
	Limit	mm (in)	0.120 (0.0047)
Piston pin hole diameter		mm (in)	15.006 — 15.014 (0.5904 — 0.5911)
Piston pin diameter		mm (in)	14.995 — 15.000 (0.5904 — 0.5906)
Piston pin clearance in connecting rod	STD	mm (in)	0.006 — 0.019 (0.0002 — 0.0007)
	Limit	mm (in)	0.05 (0.0020)
Piston ring groove width (Top and 2nd)		mm (in)	1.52 — 1.54 (0.0598 — 0.0606)
Piston ring thickness	(Top)	mm (in)	1.47 — 1.49 (0.0579 — 0.0587)
	(2nd)	mm (in)	1.47 — 1.49 (0.0579 — 0.0587)
Piston ring clearance in groove	(Top) STD	mm (in)	0.03 — 0.07 (0.0012 — 0.0028)
	(Top) Limit	mm (in)	0.10 (0.0039)
	(2nd) STD	mm (in)	0.03 — 0.07 (0.0012 — 0.0028)
	(2nd) Limit	mm (in)	0.10 (0.0039)
Piston ring end gap	(Top) STD	mm (in)	0.2 — 0.4 (0.0079 — 0.0158)
	(Top) Limit	mm (in)	0.70 (0.0276)
	(2nd) STD	mm (in)	0.2 — 0.4 (0.0079 — 0.0158)
	(2nd) Limit	mm (in)	0.70 (0.0276)
Connecting rod big end side clearance	STD	mm (in)	24.00 — 24.20 (0.945 — 0.953)
Crank pin diameter		mm (in)	25.99 — 26.00 (1.023 — 1.024)
Connecting rod big end inside diameter		mm (in)	26.015 — 26.025 (1.024 — 1.025)
Crankpin oil clearance in connecting rod	STD	mm (in)	0.015 — 0.035 (0.0006 — 0.0014)
	Limit	mm (in)	0.080 (0.0031)
Cylinder head distortion limit		mm (in)	0.03 (0.0012)
Cylinder distortion limit		mm (in)	0.03 (0.0012)
Valve head thickness	STD	mm (in)	0.03 — 0.07 (0.0012 — 0.0028)
	Limit	mm (in)	0.20 (0.0079)
Width of valve seat contact		mm (in)	0.900 — 1.100 (0.0354 — 0.0433)
Valve Lash		mm (in)	.13 (.001 — .005)
Valve stem diameter	Intake	mm (in)	5.460 — 5.475 (0.2150 — 0.2156)
	Exhaust	mm (in)	5.440 — 5.455 (0.2142 — 0.2148)
Valve guide inside diameter	Intake	mm (in)	5.500 — 5.512 (0.2165 — 0.2170)
	Exhaust	mm (in)	5.500 — 5.512 (0.2165 — 0.2170)

SERVICE DATA (Continued)

ITEM		UNIT	DATA
Valve guide to valve stem clearance	Intake (STD)	mm (in)	0.025 — 0.052 (0.0010 — 0.0020)
	Intake (Limit)	mm (in)	0.080 (0.0032)
	Exhaust (STD)	mm (in)	0.045 — 0.072 (0.0018 — 0.0028)
	Exhaust (Limit)	mm (in)	0.100 (0.0039)
Valve guide oversize		mm (in)	0.3 (0.0118)
Valve spring free length	STD	mm (in)	32.0 — 34.0 (1.2598 — 1.3386)
	Limit	mm (in)	31.0 (1.2205)
Cam height (Intake & Exhaust)	STD	mm (in)	30.517 — 30.577 (1.2015 — 1.2038)

CARBURETOR

ITEM	UNIT	DATA
Type		MIKUNI BV 18-13
Main jet (High altitude)	#	82.5 (80 part number 81-1040)
Main air jet	mm (in)	1.8 (0.0709)
Pilot jet	#	40
Pilot air jet	mm (in)	1.0 (0.0394)
Throttle valve	#	130
Pilot outlet	mm (in)	0.7 (0.0276)
Valve seat	mm (in)	1.5 (0.0591)
Air screw turns open	(rotation)	1.0

FASTENER TORQUE SPECIFICATION

ITEM	UNIT	DATA
Cylinder head bolt	kg-m (ft-lb)	1.8 — 2.8 (13.0 — 20.0)
Flywheel nut	kg-m (ft-lb)	5.6 — 6.4 (40.5 — 46.5)
Connecting rod nut	kg-m (ft-lb)	0.6 — 1.0 (4.5 — 7.0)
Conventional bolts		
5 mm	kg-m (ft-lb)	0.2 — 0.4 (1.5 — 3.0)
6 mm	kg-m (ft-lb)	0.4 — 0.7 (3.0 — 5.0)
8 mm	kg-m (ft-lb)	1.0 — 1.6 (7.0 — 11.5)
10 mm	kg-m (ft-lb)	2.2 — 3.5 (16.0 — 25.5)
"#7" marked bolts		
5 mm	kg-m (ft-lb)	0.3 — 0.6 (2.0 — 4.5)
6 mm	kg-m (ft-lb)	0.8 — 1.2 (6.0 — 8.5)
8 mm	kg-m (ft-lb)	1.8 — 2.8 (13.0 — 20.0)
10 mm	kg-m (ft-lb)	4.0 — 6.0 (29.0 — 43.5)

SPECIAL TOOLS

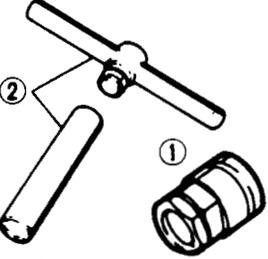
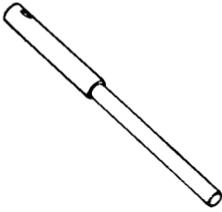
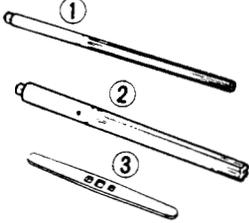
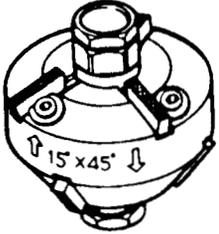
<p>① Adaptor ② T-handle wrench</p>  <p>① 50-9410* ② 50-9480*</p>	<p>Expandable pilot</p>  <p>50-9500*</p>	<p>① ② Valve guide reamer ③ Reamer handle</p>  <p>① 81-4840 ② 81-4850 ③ 81-4860</p>	<p>Cutter head 15°/45°</p>  <p>81-4870</p>
<p>Valve guide remover & installer</p>  <p>81-4880</p>	<p>Cutter head 60°</p>  <p>81-4830</p>	<p>Rotor remover</p>  <p>41-7650</p>	<p>*These tools are also used on the edger and generator engines.</p>

Figure 1-3

All fasteners on the OHV engine are metric. The standard set of tools will require the following:

- 3/8 in. drive ratchet with short extension
- 10 mm socket
- 12 mm socket
- 14 mm socket
- 19 mm socket
- 10 mm open end
- 14 mm open end

- Torque wrench
- Ring compressor
- Pliers
- Feeler gauge
- Compression tester
- Inside and outside micrometer measuring tools
- Screwdrivers, standard and phillips
- Tachometer

2. MAINTENANCE

AIR CLEANER

The consumer air cleaner should be serviced every 25 hours of engine use. The commercial air cleaner is of a two part design; the foam pre-cleaner should be serviced every 25 hours and the paper element every 50 hours. More frequent service for both air cleaners may be required in dusty or dirty conditions.

Consumer Air Cleaner Maintenance

1. Stop the engine and pull the high tension wire off the spark plug.
2. Clean loose debris from the air cleaner body.
3. Push in the locking tabs and lift off the air cleaner cover. See Fig. 2-1. Clean the cover.

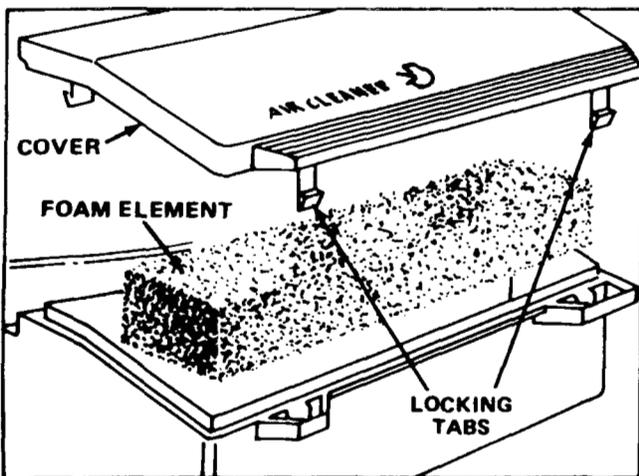


Figure 2-1

4. Remove the foam element. See Fig. 2-1.
5. Wash the element in soap and water. Squeeze to remove dirt, do not twist as the element may tear.
6. Dry the element and saturate it with 5 teaspoons of SAE 30 engine oil. Squeeze the element to remove excess oil.
7. Reinstall the air cleaner element and cover.

Commercial Air Cleaner Maintenance

1. Follow steps 1 and 2 in Consumer Air Cleaner Maintenance.
2. Loosen and remove the two cover knobs. See Fig. 2-2.
3. Lift the cover away from the body.
4. Remove the air cleaner elements (paper and foam). See Fig. 2-3.



Figure 2-2

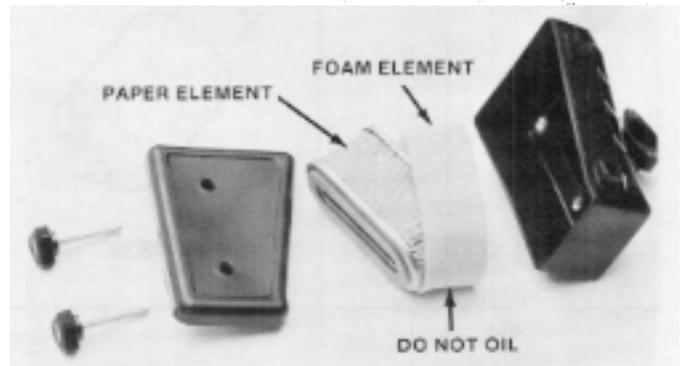


Figure 2-3

5. Clean the foam element with soap and water. **DO NOT OIL THIS ELEMENT.**
6. Clean the paper element with Air Filter Element Cleaner, Toro part number 27-7220. **CAUTION:** This compound contains sodium metasilicate which may cause burns and is harmful if swallowed. Keep this chemical out of the reach of children. Follow the manufacturers instructions.
7. Light accumulations of dust may be removed by blowing compressed air from the inside to the outside of the dry element. **CAUTION:** Always wear safety glasses when working with compressed air. This procedure should be used if the element must be immediately put back in service because a washed element must be dried before use.
8. Make sure the compressed air is at 280 kPa (40 psi) or less. Hold the air nozzle at least 1 inch away from the element.
9. After cleaning examine the paper element for holes or leaks by holding a light behind the element. Slowly turn the element and look through the paper for defects.

CHANGING OIL

Change oil after the first 2 hours of use and every 25 hours thereafter. Run the engine to warm the oil before draining.

1. Stop the engine and pull the high tension wire off the spark plug.
2. Drain gasoline from the fuel tank. Refer to Fuel System on page 8.
3. Raise the left side of the mower at least 12 inches and remove the drain plug. Use a 12 mm socket or wrench.
4. Insert an oil drain tube, part number 56-6680, over the drain opening and lower the mower. Raise the right side of the mower until all the oil has flowed into a drain pan. See Fig. 2-4.

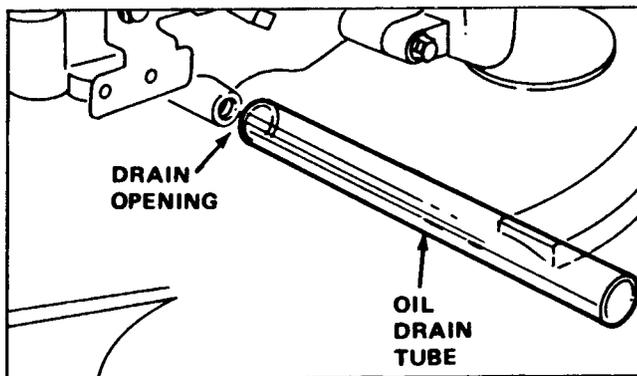


Figure 2-4

5. Install the drain plug and fill the crankcase with .53 liters (18 oz) of SAE 30 weight oil. SAE 10W30 is an acceptable substitute. Make sure the oil has a service classification of MS, SC, SD, SE or SF. Do not overfill the engine with oil.
6. Check the dipstick to make sure the oil level is between the full and add mark. See Fig. 2-5.

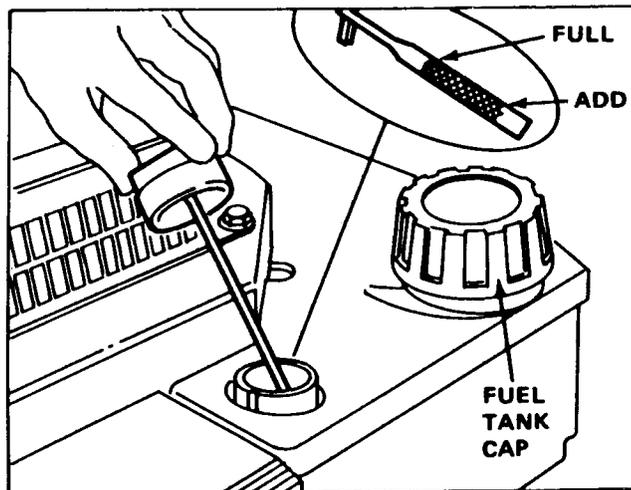


Figure 2-5

SPARK PLUG

Remove the spark plug after every 25 operating hours and check its condition. Use an NGK BPR6ES spark plug or its equivalent. The air gap is .813 mm (.032 in.).

1. Stop the engine and remove the spark plug wire.
2. Clean the area around the spark plug and remove the plug.
3. Replace a cracked, fouled or dirty spark plug. Do not sandblast, scrape or clean electrodes because engine damage could result from grit entering the cylinder.
4. Set the air gap to .813 mm (.032 in.). See Fig. 2-6. Install the plug and tighten it to 2 Kg-m (15 ft-lbs).

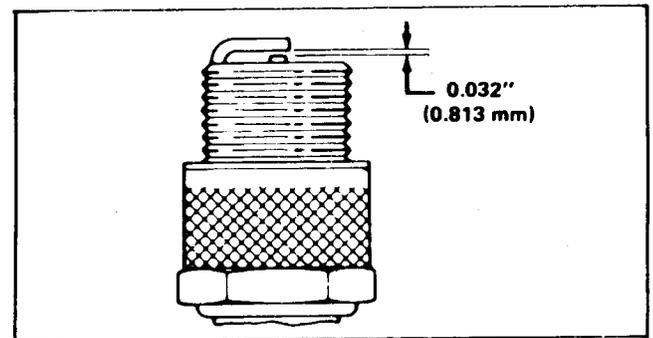


Figure 2-6

VALVE LASH

Valve lash is preset at the factory to .025 — .13 mm (.001 in. — .005 in.). There is no regular maintenance or adjustment of the valve lash required unless the head has been removed or other service in the valve train has been performed. See Valve Lash Adjustment on page 33 for complete valve setting instructions.

GOVERNOR AND THROTTLE LINKAGE

The governor is set to operate the engine at 3000 RPM. To adjust the governor:

1. Loosen the governor arm locknut.
2. Turn the governor shaft fully clockwise.
3. Move the governor arm fully to the right.
4. Tighten the governor arm locknut.

See Fig. 2-7. It is not necessary to remove the oil fill tube to make this adjustment.

The engine should operate at 3000 RPM when set on fast. To adjust the throttle:

1. Stop the engine and remove the spark plug wire.
2. Loosen throttle cable clamp.

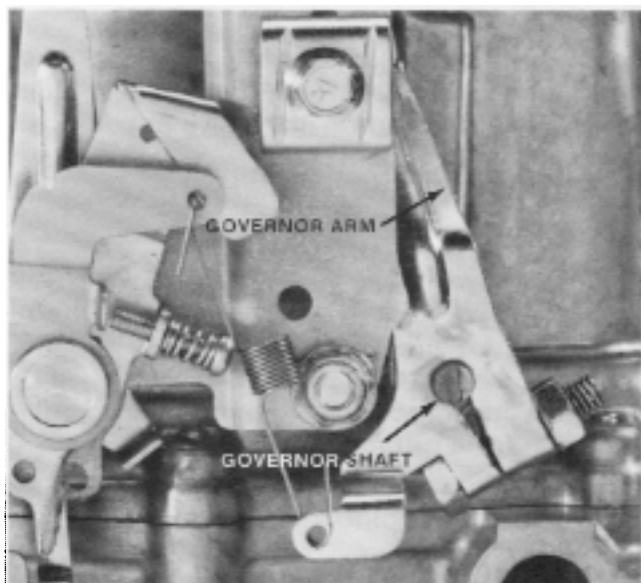


Figure 2-7

3. Align the holes in the throttle bracket and throttle lever.
4. Insert a tight fitting pin; e.g. 1/8 in. drill bit.
5. Move the throttle control on the handle to "fast" and tighten the cable clamp screw.
6. Back out the upper screw until only a few threads remain in the throttle lever.
7. Install the plug wire and start the engine.
8. *Using only the lower screw*, adjust the engine speed to 3000 RPM.
9. Now turn the upper screw until it just barely contacts the throttle lever tang (a maximum gap of .020 in. is acceptable).
10. Remove the alignment pin.
11. On BBC engines, set the throttle control on the handle in the "stop" position. Bend the grounding tang until it just contacts the throttle lever. See Fig. 2-8.

Governor and throttle adjustments should be made on an as needed basis only.

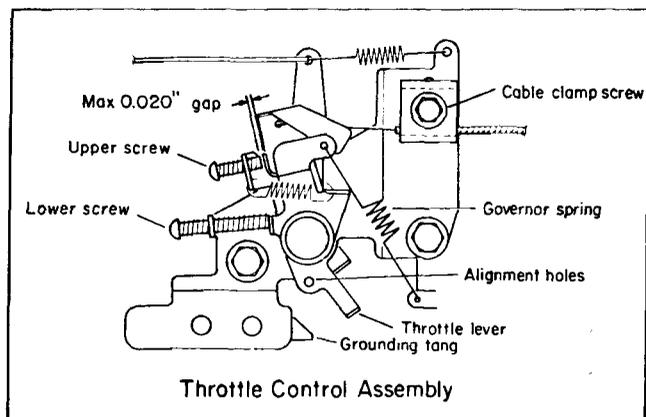


Figure 2-8

IGNITION

The OHV engine uses a solid state ignition system with timing fixed at 25 degrees BTDC \pm 2 degrees at 3000 RPM. Ignition timing is not adjustable. However, ignition timing may change if a blade impact has occurred and the flywheel key has sheared. The engine may continue to run with a degradation in performance. Under these conditions the timing will advance, making starting and running difficult. The coil to flywheel air gap is set at .38 mm (.015 in.).

FUEL SYSTEM

The fuel tank has a capacity of 1.21 L (44 oz) and should be drained of fuel before changing oil and at the end of each season. To drain the fuel:

1. Pull off the spark plug wire.
2. Use a pump or syphon to transfer the gasoline into a clean gasoline container.



CAUTION: Gasoline is highly flammable, handle it carefully. Do not smoke or allow any open flame or spark while handling gasoline.

CAUTION: Gasoline is highly flammable, handle it carefully. Do not smoke or allow any open flame or spark while handling gasoline.

The fuel system is equipped with an 84 micron inline fuel filter. See Fig. 2-9. If poor running occurs, this filter should be examined for contamination. There is no "in tank" filter on this engine.

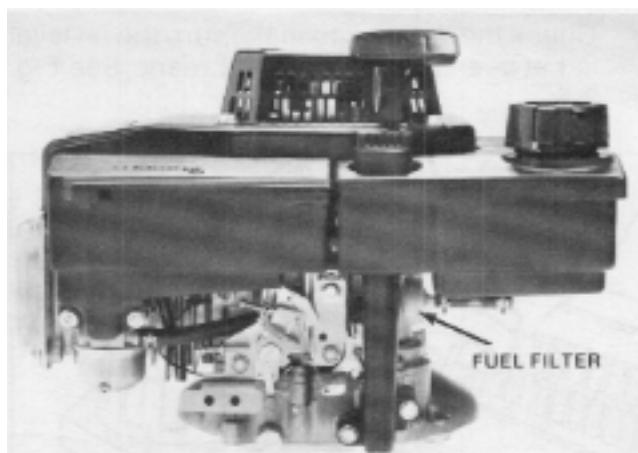


Figure 2-9

The fuel tank cap should be periodically examined for proper venting. The cap is fitted with a sealing disc but cannot be disassembled. See Fig 2-10.

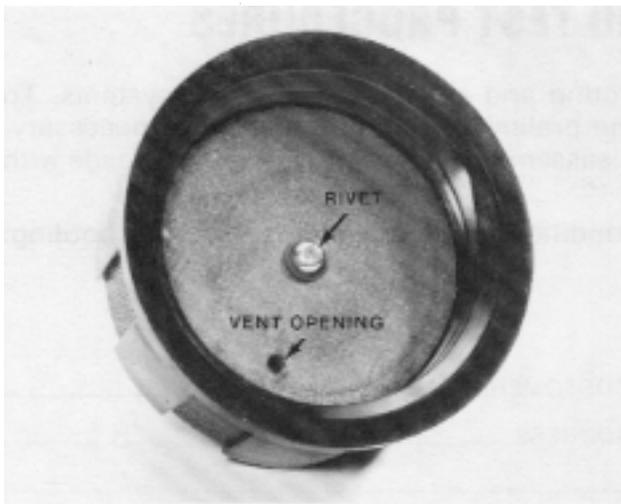


Figure 2-10

CARBURETOR

The OHV engine is equipped with a Mikuni BV 18-13 float bowl type carburetor. The standard main jet is a number 82.5. This number is stamped in the base of the jet. The only adjustment on the carburetor is the pilot system pilot screw. The pilot screw should be set one turn open. See Fig. 2-11. This will have the most effect at idle or low speed with no load on the engine.

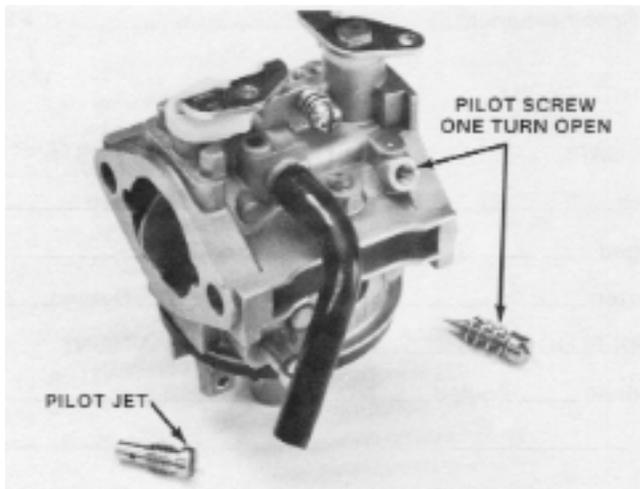


Figure 2-11

The carburetor on the VMF5 model uses a brass fuel inlet seat (not replaceable) and an inlet needle with a Viton tip. The needle is replaceable. The carburetor on the VMG6 model uses a Viton fuel inlet seat (not replaceable) and an

inlet needle with a stainless steel tip. The needle is replaceable.

The carburetor is also fitted with a bowl drain screw that can be used to drain fuel out of the bowl after the tank is drained. See Fig. 2-12. Open the screw and drain the fuel into a suitable container.

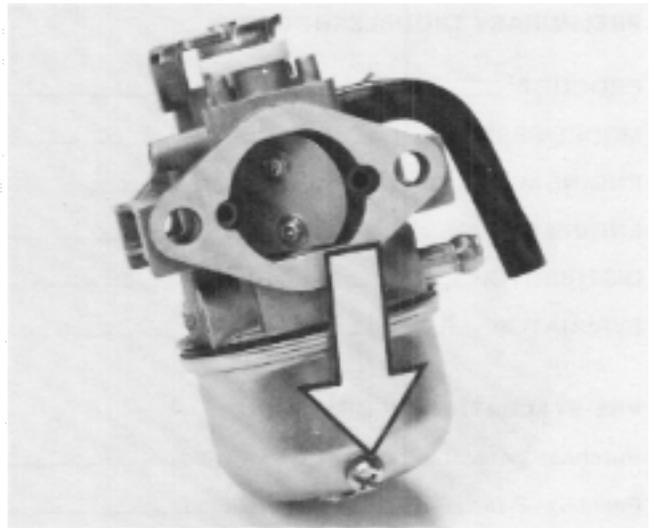


Figure 2-12

STORAGE

To insure long engine life and easy engine starting, it is important to follow these storage procedures at the end of each season:

1. Drain gasoline from the tank. Refer to Fuel System on page 8.
2. Drain gasoline from the carburetor bowl. Refer to Carburetor Maintenance above.
3. Drain the engine oil; refer to Changing Oil on page 7.
4. Remove the spark plug and pour 2 tablespoons of SAE 30 or 10W-30 oil into the cylinder. Pull the starter rope slowly to coat the inside of the cylinder. Install the spark plug and tighten it to 2.0 kg-m (15 ft-lbs).
5. Service the air cleaner; refer to Air Cleaner Maintenance on page 6.
6. Clean dirt from all areas of the engine.
7. Tighten all nuts, bolts and screws.
8. Refill the crankcase with oil; refer to Changing Oil on page 7.

3. TROUBLESHOOTING AND TEST PROCEDURES

This section has been divided into the troubleshooting and service of individual systems. To determine what system needs to be evaluated, some preliminary troubleshooting is necessary. These are checks that can be made with little or no disassembly and would normally be made with the customer or owner present.

The following form is useful in documenting engine conditions during preliminary troubleshooting:

PRELIMINARY TROUBLESHOOTING

PRODUCT _____ CUSTOMER NAME _____
 MODEL/SERIAL _____ ADDRESS _____
 ENGINE MODEL _____
 ENGINE SERIAL _____ PHONE _____
 DISTRIBUTOR _____ DEALER NAME _____
 EVALUATOR _____ DEALER CONTACT/PHONE _____

PRE-EVALUATION INFORMATION

Purchase Date _____ Date Failed _____ How Used? Residential _____ Commercial _____
 Fuel Mix: Ratio _____ Oil/Brand _____ Gasoline/Brand _____
 Symptoms Prior to Failure? _____

Engine Compressions? N/A _____ PSI _____ Compression Specification _____ PSI

VISUAL ANALYSIS

COOLING FINS:	CARBURETOR:	FUEL CAP:	MUFFLER/EXHAUST PORTS:
Clean _____	Clean _____	Vented _____	Clean _____ Carboned _____
Obstructed _____	Contaminated _____	Clogged _____	CRANKCASE: Clean _____
AIR CLEANER ASM:	Comments _____	Distorted _____	Contaminated _____ Burned _____
Clean _____	FUEL FILTER:	SPARK PLUG: Clean _____	METAL DISCOLORATION?
Dirty _____	Clean _____	Carboned _____ Fouled _____	NO _____
Damaged _____	Clogged _____	Type _____	Yes _____

TROUBLESHOOTING CHART

The information gathered in preliminary troubleshooting can now be used with the following troubleshooting chart to determine individual systems to be serviced.

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Engine does not start.	<ol style="list-style-type: none"> 1. Throttle not in CHOKE position. 2. Gas tank is empty. 3. Air cleaner element is dirty. 4. Spark plug is loose. 5. Spark plug wire is loose or disconnected from spark plug. 6. Spark plug gap is incorrect. 7. Spark plug is defective. 8. Carburetor is flooded with gasoline. 9. Valves not closing. 	<ol style="list-style-type: none"> 1. Move throttle to CHOKE. 2. Fill fuel tank with gasoline. 3. Clean air cleaner element. See page 6. 4. Tighten spark plug to proper specification. See page 7. 5. Install spark plug wire on spark plug. 6. Set air gap to proper specification. See page 7. 7. Install new, correctly gapped plug. See page 7. 8. Remove air cleaner element and pull starter rope continuously until carburetor clears itself and engine starts. When engine starts, stop it and install air cleaner element. See page 6. 9. Check valve lash. See page 33.
Engine starts hard or loses power.	<ol style="list-style-type: none"> 1. Dirt, water or stale gas in fuel tank. 2. Vent hole in fuel tank cap is plugged. 3. Air cleaner is dirty. 	<ol style="list-style-type: none"> 1. Drain gas and clean fuel tank. Fill tank with clean, fresh gasoline. See page 8. 2. Clean or replace fuel tank cap. See page 8-9. 3. Clean the air cleaner element. See page 6.
Engine operates erratically.	<ol style="list-style-type: none"> 1. Spark plug is defective. 2. Spark plug gapped incorrectly. 3. Air cleaner is dirty. 	<ol style="list-style-type: none"> 1. Install new, correctly gapped plug. See page 7. 2. Set air gap to proper specification. See page 7. 3. Clean the air cleaner element. See page 6.
Engine idles poorly.	<ol style="list-style-type: none"> 1. Air cleaner is dirty. 2. Oil level in crankcase is low. 3. Air slots in engine shroud are plugged. 4. Cooling fins and air passages under engine blower housing are plugged. 	<ol style="list-style-type: none"> 1. Clean the air cleaner element. See page 6. 2. Add oil to crankcase. See page 7. 3. Remove obstruction from slots. 4. Remove obstruction from cooling fins and air passages.
Engine skips at high speed.	<ol style="list-style-type: none"> 1. Air gap between electrodes of spark plug is too close. 	<ol style="list-style-type: none"> 1. Set air gap to proper specification. See page 7.
Engine overheats.	<ol style="list-style-type: none"> 1. Cooling air flow is restricted. 2. Oil level in crankcase is low. 3. Incorrect spark plug. 4. Low oil level. 	<ol style="list-style-type: none"> 1. Remove any obstruction from slots in shroud, blower housing, air passages, and cooling fins on engine. 2. Add oil to crankcase. See page 7. 3. Install new, correctly gapped plug. See page 7. 4. Change or add oil. Inspect for engine damage. See page 7.

CARBURETOR

Removal — Carburetor

1. Drain and remove the fuel tank; refer to Fuel System page 8. The fuel tank is held in place with two screws and is removed by pulling it straight up. Drain the carburetor fuel bowl and disconnect the fuel hose from the carburetor. See Fig. 3-1.

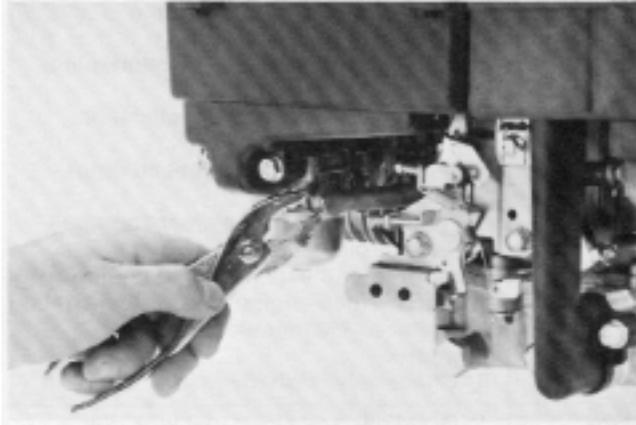


Figure 3-1

2. Remove the single screw retaining the air cleaner and dipstick tube and the two nuts retaining the air cleaner to the carburetor. See Fig. 3-2. Pull the air cleaner away from the carburetor. Remove the breather hose from the fitting on the air cleaner.

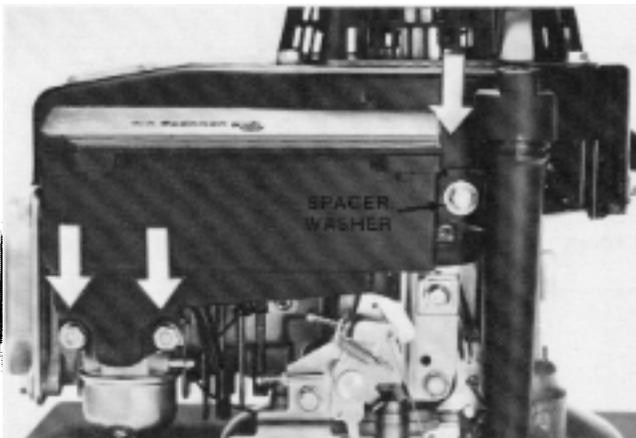


Figure 3-2

3. Lift the choke rod off the carburetor. The rod has a 90° bend as it is held in place by the body of the air cleaner. See Fig. 3-3. Please note the position of the gasket between the air cleaner and carburetor. The raised rib on the metal gasket should face the air cleaner.
4. The carburetor may be pulled off the studs. There is enough travel in the throttle control

rod to allow it to be unhooked after the carburetor has been removed.

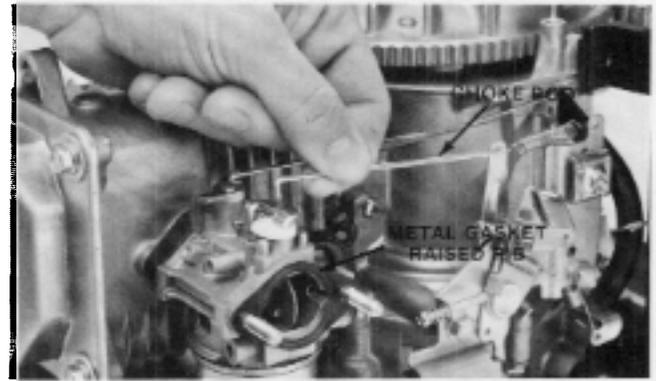


Figure 3-3

5. The bowl of the carburetor may be removed by unscrewing the retaining nut on the bottom of the bowl. See Fig. 3-4. The float and spacer (that limits float drop) are visible in this photograph.

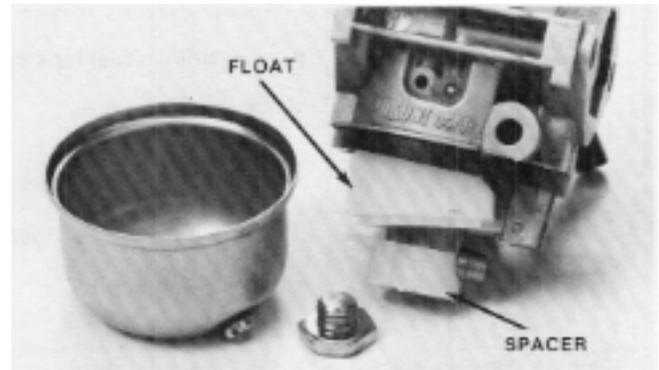


Figure 3-4

6. The standard main jet is a #82.5 and is equipped with a spacer/washer. The float and inlet needle may be removed by pulling out the float hinge pin. See Fig. 3-5. Please note: one end of the hinge pin is flattened slightly. The pin must be removed from this end.

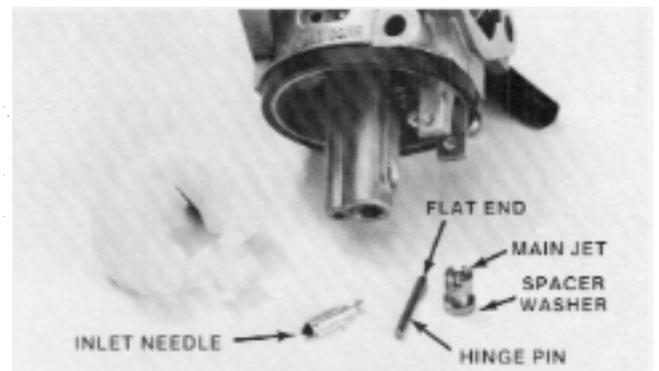


Figure 3-5

- The pilot jet may be removed next. The pilot jet is a #40 and can be cleaned or replaced. Fuel flows through the small opening in the end of the jet and air enters through the holes in the side. The opening on the top has no function as it is plugged.

The pilot screw controls air in the pilot circuit. It should be open one full turn. See Fig. 3-6.

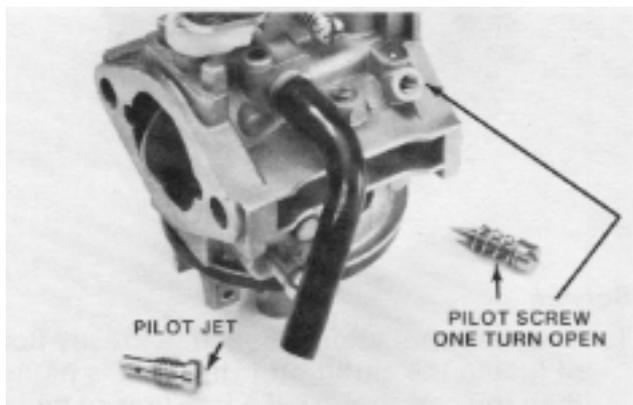


Figure 3-6

- Carburetor disassembly is completed by removing the choke and throttle shafts and the main nozzle. The bowl gasket is also replaceable and should be removed prior to service or cleaning of the carburetor. See Fig. 3-7. To withdraw the choke and throttle shaft, the choke and throttle plates must be removed. Each plate is retained with two screws.

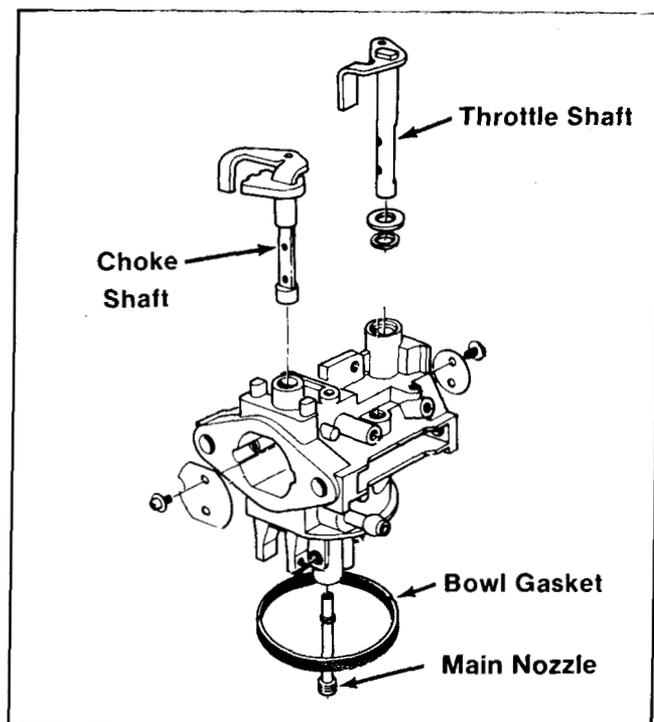


Figure 3-7

Service — Carburetor

The metallic body of the carburetor may be cleaned in carburetor cleaner. Plastic parts may be damaged by some carburetor cleaners. Carburetor passages may be cleaned out with compressed air.



CAUTION! Be sure to wear safety glasses when using compressed air.

Replace any components that show wear or damage. The inlet needle is replaceable but the seat is not.

If it is suspected that the seat is leaking, the carburetor can be pressure tested after it has been cleaned. Use Toro pressure tester, number 41-7910. If the seat is good, it will hold .5 kg/cm² (7 psi) for at least 10 seconds. This procedure should be completed with the carburetor turned upside down so the float holds the needle closed. See Fig. 3-8. If the pressure leaks down, replace the needle and try the test again. If the carburetor fails again, the seat is bad and the carburetor must be replaced.

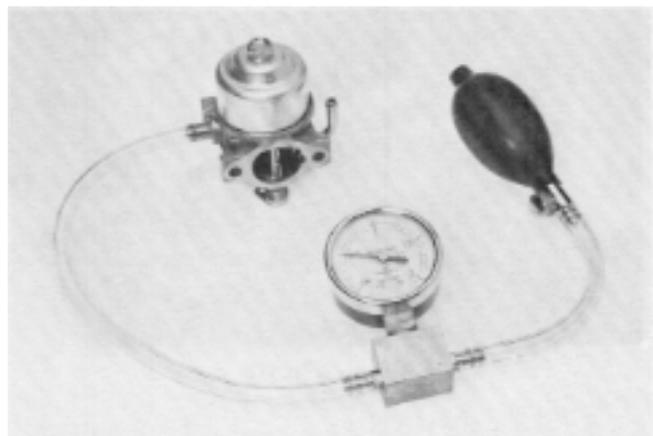


Figure 3-8

Reassembly — Carburetor

- Install the choke and throttle shafts. Check Fig. 3-3 and 3-7 for proper orientation of the shafts.
- Install the choke and throttle plates. Use a thread locking compound such as Loctite 271 on the screws.
- Replace the main nozzle and bowl gasket.
- Install the pilot jet and pilot screw. See Fig. 3-6. The pilot screw should be one turn open.
- Hook the inlet needle into the float and secure the float and needle in place with the hinge pin. See Fig. 3-9.

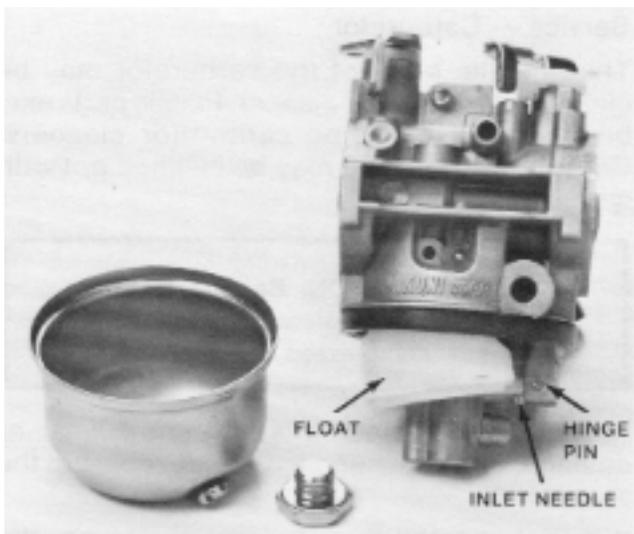


Figure 3-9

6. Remount the bowl and gasket.
7. Mount the gaskets and spacer on the studs. The correct sequence is described in Fig. 3-10.

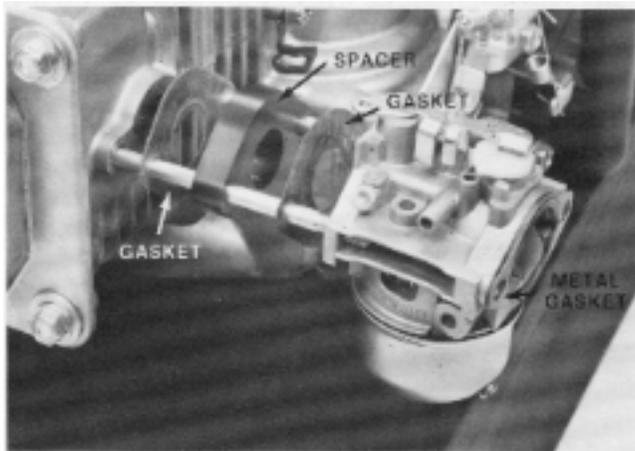


Figure 3-10

8. Hook the throttle control rod and spring into the governor arm and throttle, then mount the carburetor on the studs.
9. Remount the air cleaner. Make sure to install the spacer washer on the screw that retains the air cleaner and oil fill tube. Refer to Fig. 3-2.
10. Install the fuel tank and reconnect the fuel hose. Be sure to route the fuel hose behind the governor arm.

GAS CAP

Disassembly

1. The gas cap used on the OHV engine is a two piece design, however; no disassembly is recommended. The inner sealing disc is riveted into the plastic cap. See Fig. 3-11.

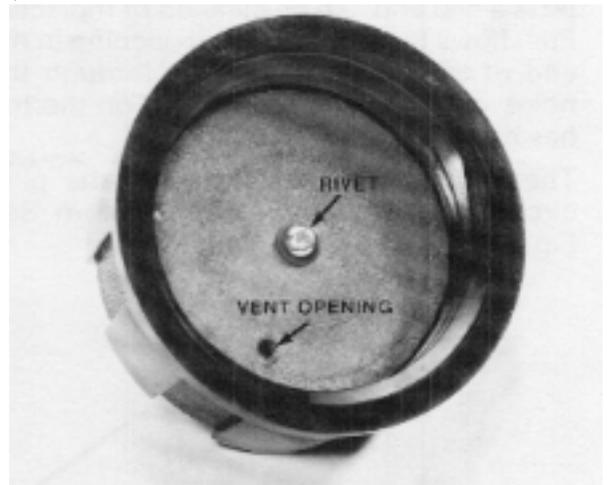


Figure 3-11

Service

1. The tank should provide a free gravity flow of fuel to the carburetor (the tank is higher than the carburetor). If a free flow of fuel is not evident (the engine is starving for fuel) loosen the cap and see if fuel flow is re-established.
2. If the fuel flow improves, the cap is not venting. Examine the vent hole in the sealing disc and the cap to make sure they are unobstructed.

Reassembly

1. Make sure the vent opening in the sealing disc is turned 90 degrees from the vent opening in the cap.
2. Remount the cap.

FUEL TANK AND FILTER

Disassembly

1. Drain the fuel tank with a siphon pump. Make sure you transfer the fuel to an approved container.
2. Disconnect the fuel hose at the carburetor. Refer to Fig. 3-1.
3. Wipe up any fuel that may have drained out of the hose when disconnected.

Service

1. If the fuel filter is plugged, clogged or dirty, replace it. See Fig. 2-9 on page 8.
2. This is the only fuel filter in the system and must be replaced with the same 84 micron filter. Part number 56-6360.
3. If the fuel tank is dirty or contaminated, wash the tank in parts cleaning solvent and dry completely.

Reassembly

1. Install a new filter, if necessary.
2. Mount the fuel tank using two spacers and two screws.
3. Route the fuel hose behind the governor arm.
4. Connect the hose to the carburetor.

IGNITION

Testing Spark Intensity

The ignition system can be checked for spark intensity using a spark tester, part number 41-7890.

1. Pull off the plug connector and remove the spark plug.
2. Inspect the plug for wear, carbon deposits and damage. Replace the plug if damaged, burnt or fouled.
3. Check for the correct plug gap and adjust, if necessary, to .7 — .8 mm (.028 in. — .032 in.).
4. Attach the spark tester and set the tester gap to 4.2 mm (.166 in). (4 turns counter-clockwise from the closed position.)
5. Pull the starter and observe for spark.
6. If the spark is evident, the ignition system is operating properly. If no spark is evident, proceed to testing kill switch operation.

Testing Kill Switch Operation

There are two ignition kill systems, one for zone start, and one for BBC and commercial applications. Both systems depend on a lever contacting a grounding tang to ground the ignition and stop the engine.

BBC and Commercial Kill Systems

1. Make sure the kill wire is properly connected to the grounding tang on the throttle control. See Fig. 3-12.

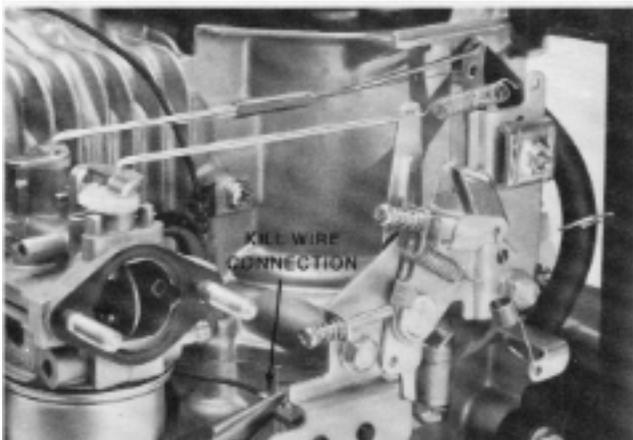


Figure 3-12

2. When the throttle control is in the "run" position, the throttle lever should move away from the ground tang. See Fig. 3-13.

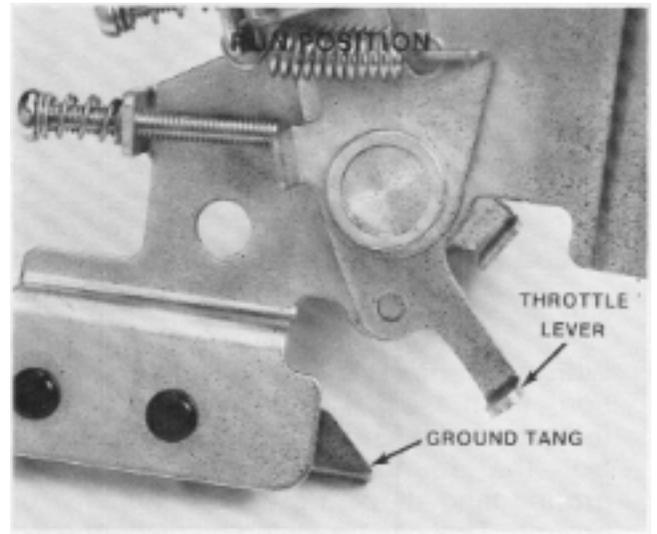


Figure 3-13

In this position, the ground tang should not have continuity to ground. This can be tested by disconnecting the kill wire and testing the tang with a volt-ohmmeter. Place the volt-ohmmeter on RX1 with one probe on the tang and one probe on ground. There should be a reading of infinity (no-continuity).

3. In the "off" position, the throttle lever should contact the ground tang. This will ground the ignition and stop the engine. See Fig. 3-14.

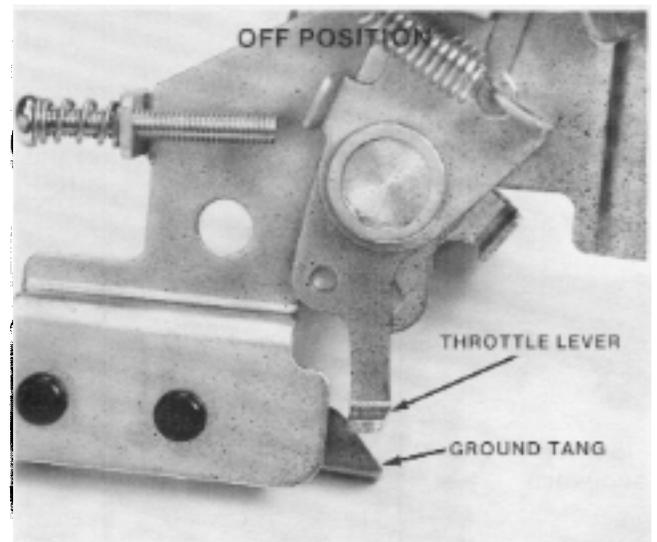


Figure 3-14

Zone Start Applications

1. Make sure the engine kill wire is connected to the ground tang. See Fig. 3-15.

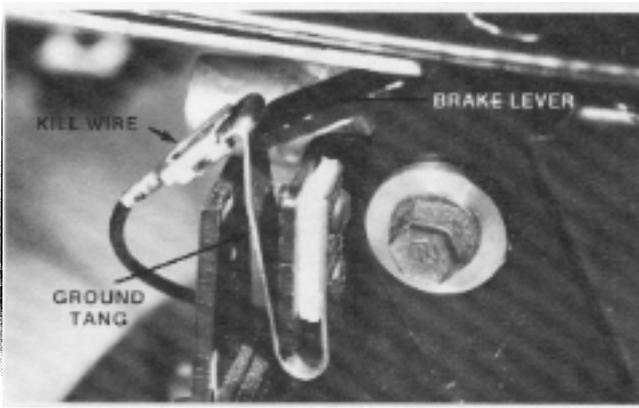


Figure 3-15

2. With the control bail tensioned (run position), the brake pad is pulled away from the flywheel and the brake lever is rotated away from the ground tang. See Fig. 3-16. The ground tang should not have continuity to ground. This can be tested by disconnecting the kill wire and testing the tang to ground continuity with a volt-ohmmeter.

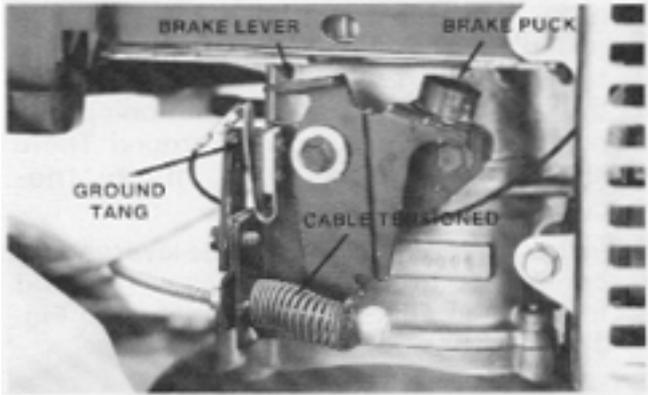


Figure 3-16

3. With the control bail in the "off" or "stop" position, the brake pad is against the flywheel and the brake lever is contacting the ground tang. This will ground the ignition and stop the engine. See Fig. 3-17.

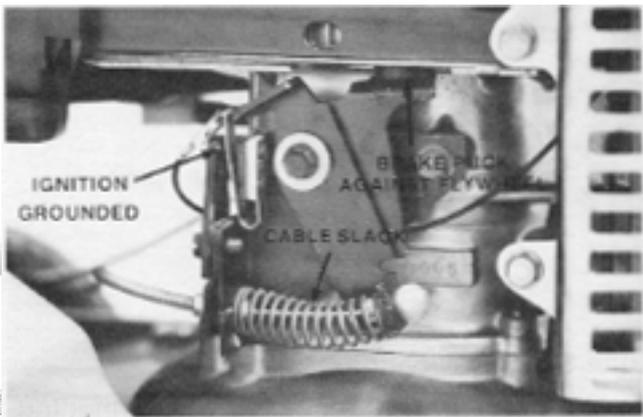


Figure 3-17

Removal — Ignition

1. Drain the fuel tank. Refer to Fuel System on page 8.
2. Remove the air cleaner assembly. Refer to Air Cleaner Removal on page 12.
3. Remove the shrouding, including one screw retaining the muffler guard. See Fig. 3-18. Note: It is not necessary to remove the recoil starter unless it is to be serviced.

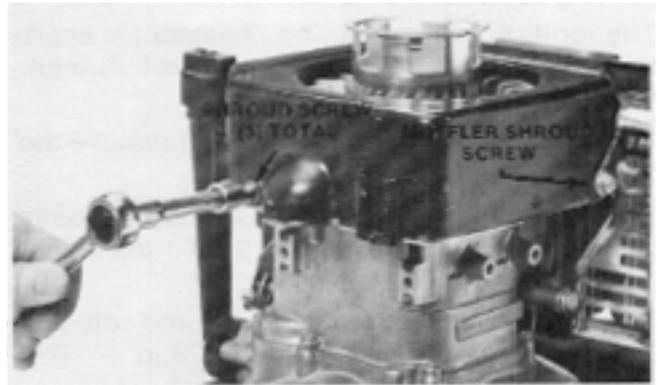


Figure 3-18

4. The ignition coil may now be removed from its mounting bosses. Be sure to unplug the kill wire. See Fig. 3-19.

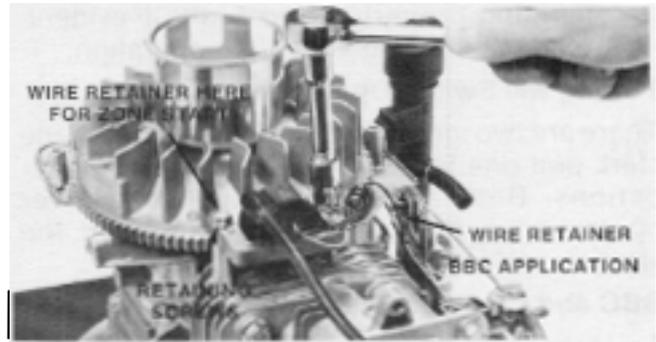


Figure 3-19

5. If removal of the throttle bracket is necessary, remove the two fasteners shown in Fig. 3-20.

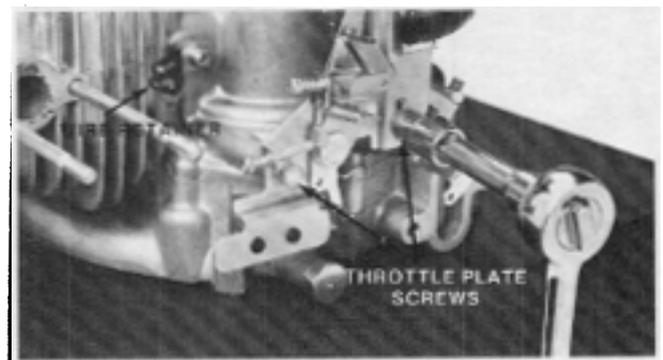


Figure 3-20

- If removal of the brake assembly and switch is necessary, remove the two retaining screws. See Fig. 3-21.

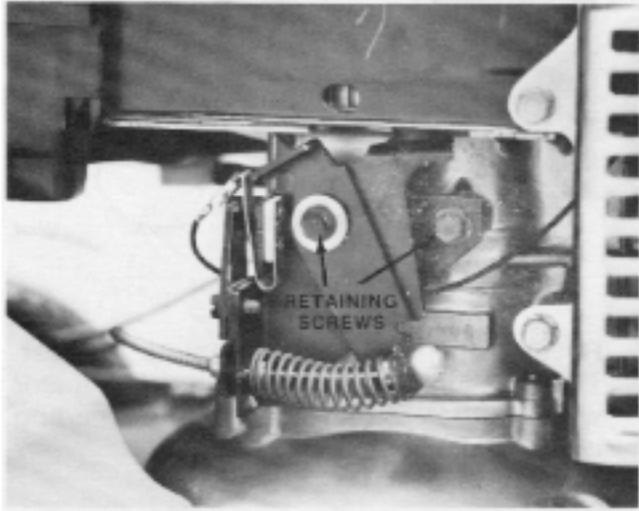


Figure 3-21

Installation — Ignition

- Mount the brake assembly or throttle assembly.
- Install the ignition coil. Mount a wire retainer on either the right or left side of the coil, depending on the brake system used. Refer to Fig. 3-19.
- Establish an air gap of .38 — .50 mm (.015 — .020) between the flywheel and ignition coil. Use a feeler gauge or spacer of appropriate thickness. Tighten the ignition coil fasteners.
- Reinstall all shrouding. Note: Do not install the screw for the oil fill tube at this time.
- Mount the air cleaner assembly. Install the long screw and spacer washers through the air cleaner and dip-stick tube at this time. Refer to Fig. 3-2.
- Mount the fuel tank. Route the fuel hose behind the governor arm.

ELECTRIC STARTER AND ALTERNATOR

The electric starter used on the OHV engine operates on 12 volts DC and is controlled by a start switch and ignition kill switch. The battery is under continuous charge with a 300 ma alternator. See Fig. 3-22 for the OHV electric start wiring schematic.

Testing — Electric Starter

The starter motor fails to turn:

- Check the battery, make sure it is connected and fully charged. If the motor still does not turn, go to step two.

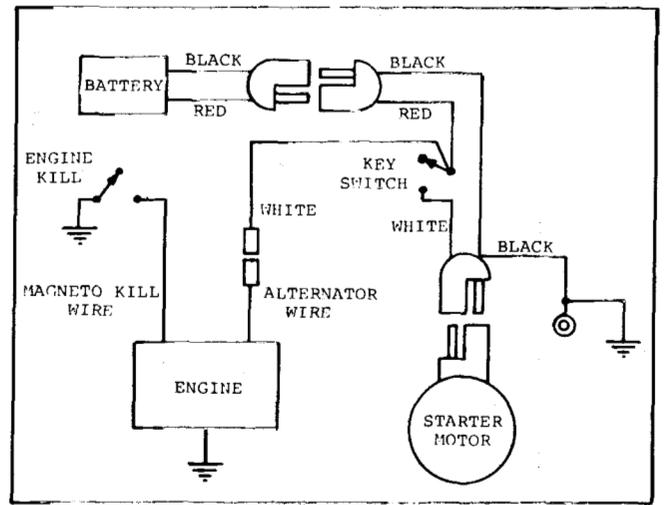


Figure 3-22

- Remove the spark plug wire and disconnect the starter motor plug.
- Apply 12 volts direct to the starter motor terminals. See Fig. 3-23.

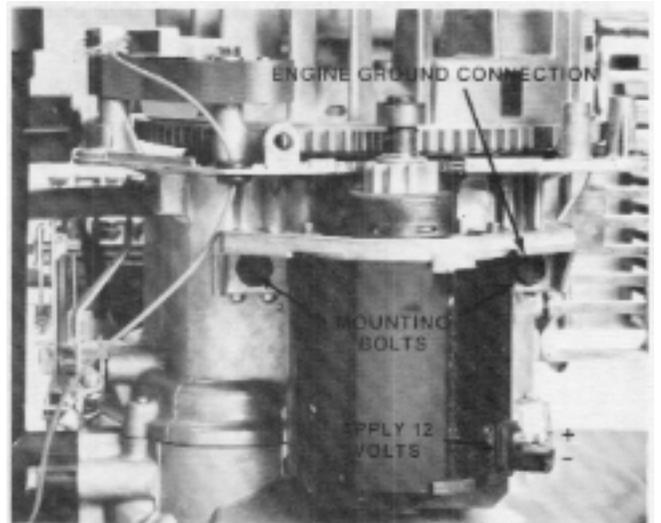


Figure 3-23

If the motor turns:

- Check the starter switch. Use a volt ohm-meter. There should be continuity through the switch in the "start" mode.
- Check the battery ground to the engine. There should be continuity between the negative battery terminal and the body of the engine.
- Check the wire connectors at the battery and starter motor.

If the motor does not turn:

- Verify that the engine is not seized. If the engine is free go to step "2".
- Replace the motor as the internal components are not replaceable.

Testing — Alternator

Battery does not charge during mower operation:

1. Check battery connections and alternator connections to make sure they are complete and secure. Check the connection points at the battery, alternator wire, key switch and all ground connections.
2. Measure the alternator output with the engine at 3000 RPM. With the battery connected, alternator output should be 13.2 volts DC. The voltage can be measured between the red wire on the key switch and the black ground wire.
3. If the measured voltage is 12 volts or less, it indicates the alternator may not be charging. Go to step four.
4. Complete a resistance test on the alternator coil. This test may be completed without removing the coil from the engine. All measurements are taken between the output wire and ground. Disconnect the wire for these tests. For clarity, the coil has been removed in the following figures.
5. The alternator coil is equipped with a diode assembly that will rectify the alternator output. See Fig. 3-24.

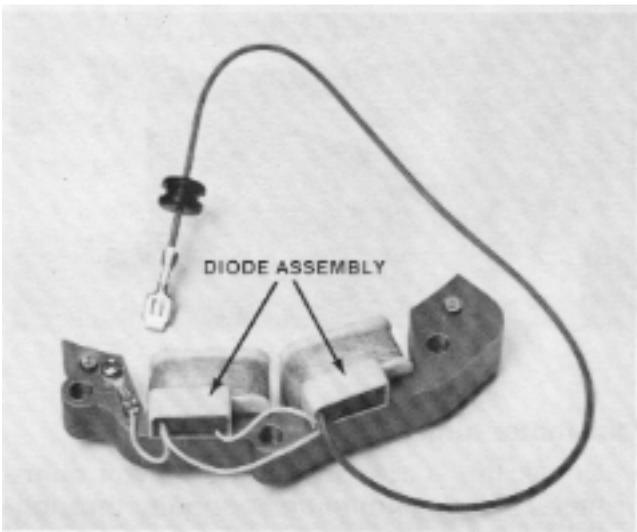


Figure 3-24

6. Check the diode and coil assembly with a volt-ohmmeter. The meter in Fig. 3-25 indicates a resistance of infinity when a numeral one appears to the left of the decimal point. The measurement should be infinity when the positive probe of the meter is placed on the output wire. See Fig. 3-25. The negative probe is connected to the ground terminal of the alternator coil.

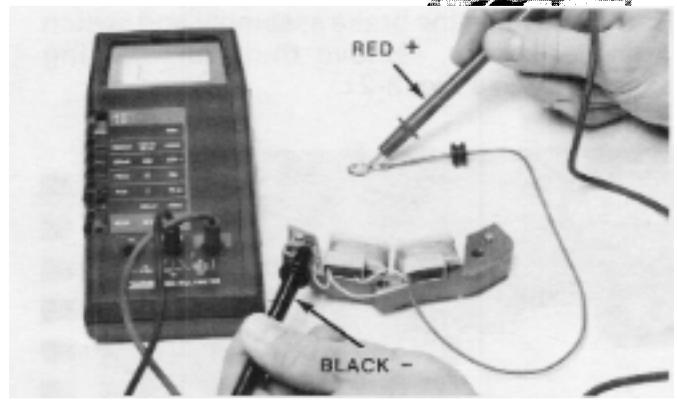


Figure 3-25

7. Reverse the leads and complete the test. The measurement is 707 ohms. The meter was on the 2000 ohm scale and the reading is .707 or 707 ohms. See Fig. 3-26.

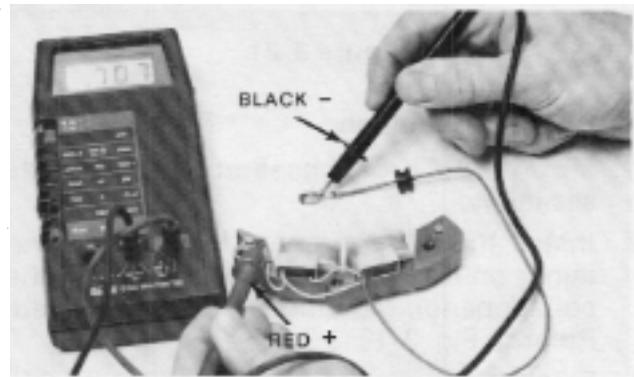


Figure 3-26

Removal — Electric Starter

1. Pull the spark plug wire off the spark plug.
2. Unplug the starter connector.
3. Unscrew the two mounting screws as shown in Fig. 3-32.
4. It is not necessary to take shrouding off the engine to remove the starter.
5. The serviceable components on the starter are shown in Fig. 3-27.
6. The pinion is serviceable by removing the retainer clip and then lifting the components off the starter motor shaft.

Installation — Electric Starter

1. Coat the starter motor worm shaft and pinion teeth with a light coat of molybdenum disulfide lubricant, Toro part number 505-37.
2. Assemble the starter motor components as shown in Fig. 3-27.
3. Install the starter motor and torque the fasteners to 2.2 — 3.5 kg-m (16-25 ft-lb). (Make sure you don't pinch the alternator wire under the starter motor.)

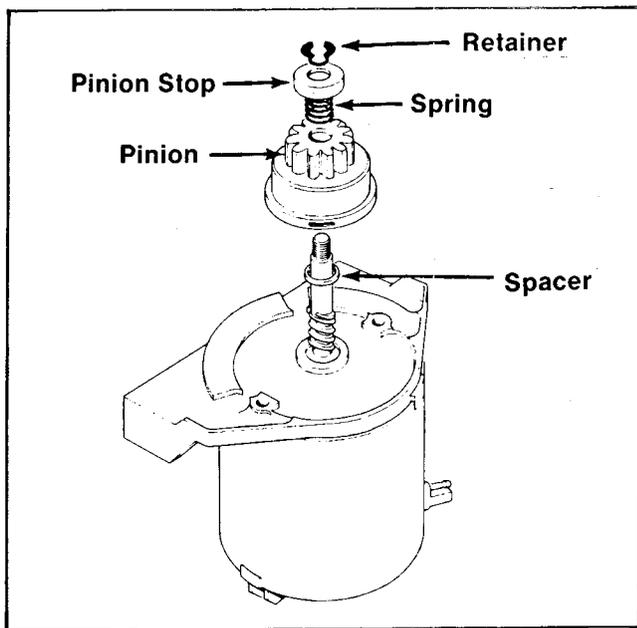


Figure 3-27

Removal — Alternator

1. Follow steps 1, 2, 3 under Removal — Ignition on page 16.
2. Remove the two screws retaining the alternator to the engine block.
3. Pull the alternator wire and rubber grommet out of the block.

Installation — Alternator

1. Install the alternator and secure with two fasteners. The screws should be tightened to 1.0 — 1.6 kg-m (7-11 ft-lbs). Route the wire and grommet through the opening in the engine block. See Fig. 3-28.

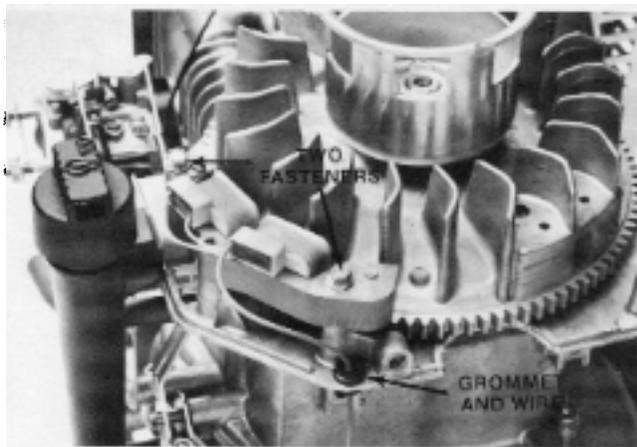


Figure 3-28

2. Take care that the alternator wire does not become pinched behind the starter motor.
3. Reinstall all shrouding, air cleaner and fuel tank. Follow steps 4, 5, 6 on page 17 on Installation — Ignition.

RECOIL STARTER

All OHV engines, including electric start, are equipped with recoil starters. Recoil starter service is performed as follows:

Removal and Disassembly — Recoil Starter

1. Remove the four screws retaining the starter to the blower housing. See Fig. 3-29. Note the orientation of the recoil rope for proper reassembly.



Figure 3-29

2. Turn the starter over and unwind the starter rope to release spring tension on the starter pulley. See step 1, 2, 3 on Rope Replacement, page 21. Carefully remove the recoil assembly retaining nut. The nut is under a slight amount of spring pressure. Slowly back off the nut until the spring pressure is released. See Fig. 3-30.

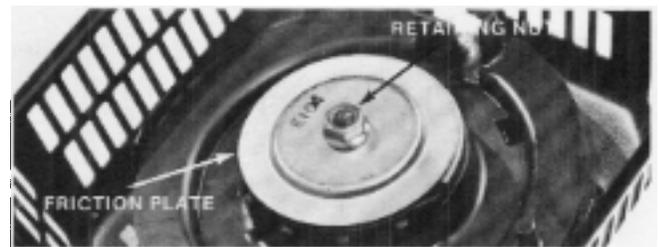


Figure 3-30

3. Lift off the friction plate and expose the starter pawl guide. See Fig. 3-31. Note how the guide is installed and remove it.

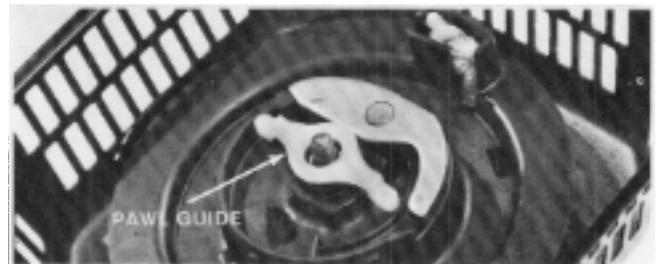


Figure 3-31

- The friction spring is directly underneath the starter pawl guide. The starter pawl is also visible. See Fig. 3-32. Remove the friction spring.

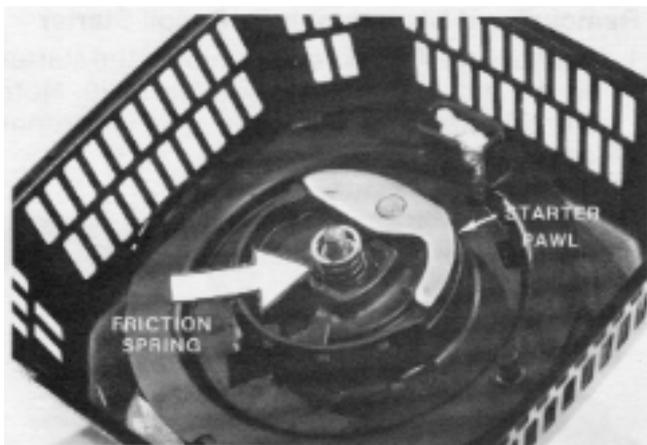


Figure 3-32

- Remove the shaft spacer. See. Fig. 3-33.

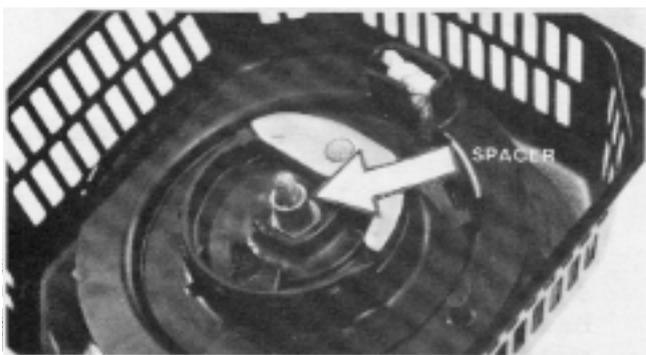


Figure 3-33

- Remove the nylon washer that is installed under the spacer and spring. See Fig. 3-34. Lift the starter pawl off at this time.

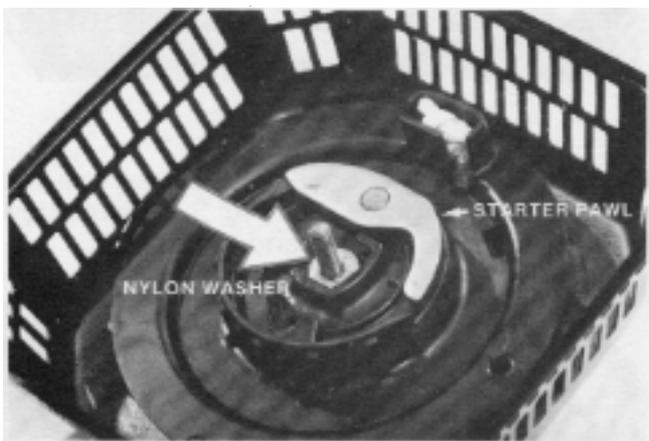


Figure 3-34

- The starter pawl pivots on the pin shown in Fig. 3-35. Remove the pin.

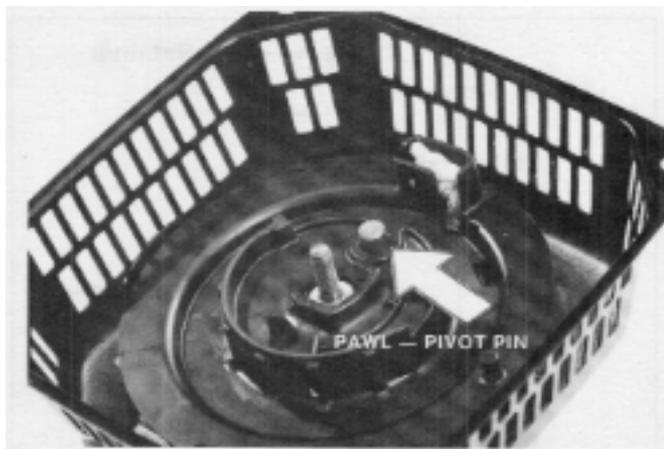


Figure 3-35

- The detensioned recoil spring will be captured in the bottom of the recoil pulley. Carefully lift the pulley and recoil spring free of the recoil housing. See Fig. 3-36.



Figure 3-36

- Turn the pulley over and examine the condition of the recoil spring. It should be retained in the pulley as seen in Fig. 3-37. On reassembly, the loop end of the spring must be caught on the lip of the hub in the recoil assembly.

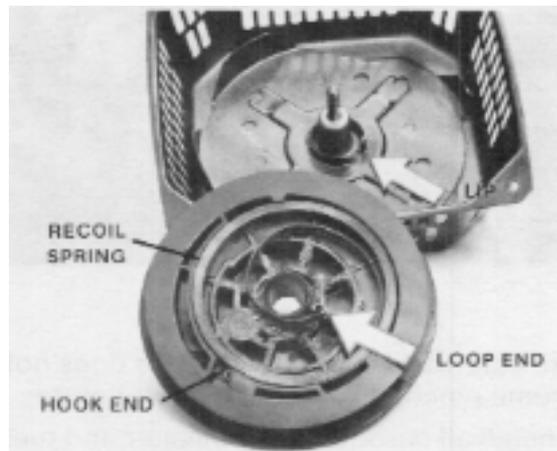


Figure 3-37

Repair — Recoil Starter

The most likely components on the recoil starter to require repair are the coil spring and starter rope.



CAUTION: Wear safety glasses and use extreme care when working with the recoil spring. If the spring is suddenly released, injury could result.

Rope Replacement

1. Rope replacement may be accomplished without disassembly of the starter. First take the starter off the engine.
2. If the pulley spring has not been detensioned, withdraw about one foot of rope and while holding the pulley in place, unwind the remaining rope on the pulley.
3. Slowly release the rope until the pulley spring fully relaxes. **IMPORTANT.** Do not turn the pulley any further in the clockwise direction or the spring will unhook from the center hub. If the spring un-hooks the pulley will turn freely in the counter-clockwise direction without an increase in spring tension. To correct, the pulley must be removed and the spring re-hooked.
4. Untie the knot in the rope and replace with new. The rope is 4mm (5/32 in.) in diameter and 175cm (70 in.) long.
5. Wrap the new rope around the pulley in a counter-clockwise direction. See Fig. 3-36.
6. When the rope is fully wound on the pulley, extend about two feet of rope, hold the pulley in place and take two additional wraps of rope around the pulley in a counter-clockwise direction. This will pre-load the spring.

7. Re-install the recoil starter.

Spring Replacement

1. Follow steps one through nine under "Recoil Starter Removal and Disassembly" on page 19.
2. Carefully remove the broken spring to prevent rapid expansion of the spring. **CAUTION: Wear safety glasses and use extreme care to prevent injury.**
3. The replacement spring is provided with a wire retainer to hold it together.
4. Place the spring in the pulley and release it from its retainer.
5. The spring should be installed in the pulley as shown in Fig. 3-37.
6. If the spring has expanded outside the pulley, it can be reinstalled by first placing the hook end into the pulley. See Fig. 3-37.
7. Wind the spring into the pulley in a counter-clockwise direction from the outside until the spring is fully retained.
8. Place the pulley in the recoil housing and turn it slowly in a counter-clockwise direction, with a slight down pressure, until the pulley drops down indicating the spring is hooked on the center hub.

Reassembly

1. Install the pawl-pivot pin. See Fig. 3-35.
2. Install the nylon washer, starter pawl and spacer. See Figs. 3-34, 3-33.
3. Install the friction spring and pawl guide. See Figs. 3-32, 3-31.
4. Install the friction disc and mounting nut. Use a thread locker on the nut: e.g. Loctite 242. See Fig. 3-30.
5. Install the recoil rope. Refer to steps 5 & 6 of Rope Replacement on page 21.

4. ENGINE DISASSEMBLY, INSPECTION AND REASSEMBLY

DISASSEMBLY

Recoil Starter

1. Remove the four screws retaining the starter.
2. If the recoil starter must be disassembled, refer to Recoil Starter Removal and Repair on page 19-20.

Fuel Tank

1. Drain the tank per instructions on page 8.
2. Drain the carburetor per instructions on page 9.
3. Disconnect the fuel hose.
4. Remove the two screws retaining the fuel tank.
5. Lift the fuel tank off the engine.

Air Cleaner

1. Remove the air cleaner assembly. Refer to steps one and two of Carburetor Service on page 12.

Cooling Shrouds

1. Remove the three screws retaining the engine top cover.
2. Remove the three screws retaining the muffler shroud. See Fig. 4-1.

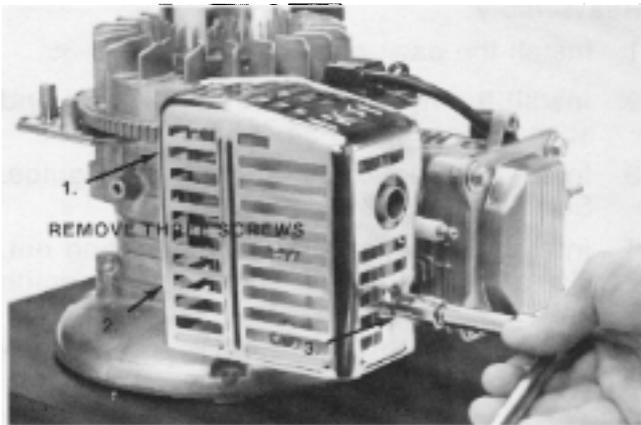


Figure 4-1

Muffler

1. Remove the two nuts retaining the muffler. These nuts may be loosened with a 12 mm wrench or socket. See Fig. 4-2.

Electric Starter

1. If the engine is an electric start model, the electric starter may be disconnected and removed.
2. Refer to Removal-Electric Starter on page 18.

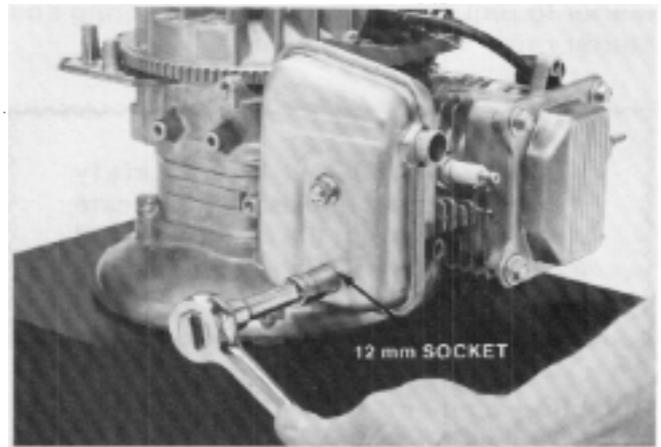


Figure 4-2

Alternator

1. If the engine is an electric start model, remove the alternator coil.
2. Refer to "Removal-Alternator" on page 19.

Ignition Coil

1. Remove the ignition coil.
2. Refer to "Removal-Ignition" on page 16.

Oil Fill Tube

1. Make sure the engine has been drained of oil. Refer to Changing Oil on page 7. Use a 12 mm wrench or socket on the drain plug.
2. Remove the two screws retaining the oil fill tube. Use a 10 mm socket. See Fig. 4-3.

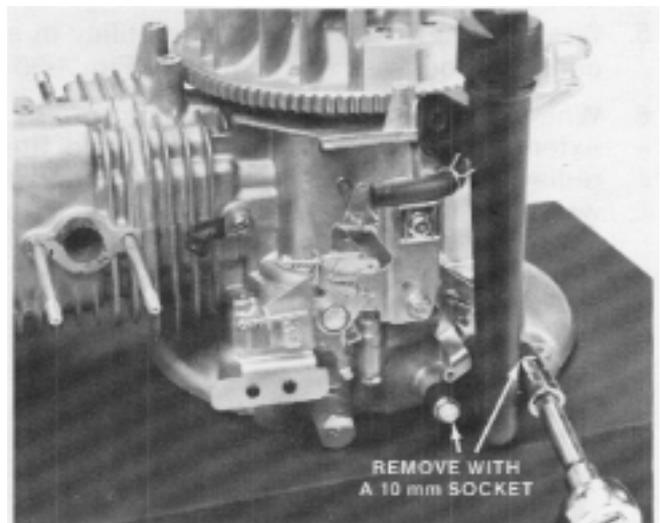


Figure 4-3

3. Note the position and condition of the "O" ring on the fill tube. If it is pinched or flattened, it should be replaced. See Fig. 4-4.

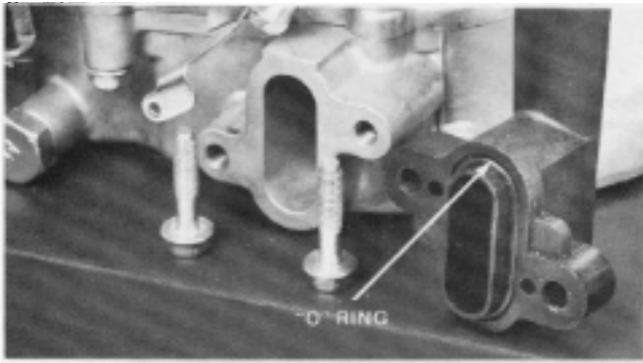


Figure 4-4

Throttle Control and Carburetor

1. Refer to "Removal-Carburetor" on page 12.
2. Refer to disassembly steps 5, 6, 7, 8 on page 12-13 if further carburetor service is necessary.

Flywheel

1. Use a screwdriver through the starter cup to hold the flywheel in place.
2. Use a 19 mm socket to remove the flywheel nut. See Fig. 4-5.

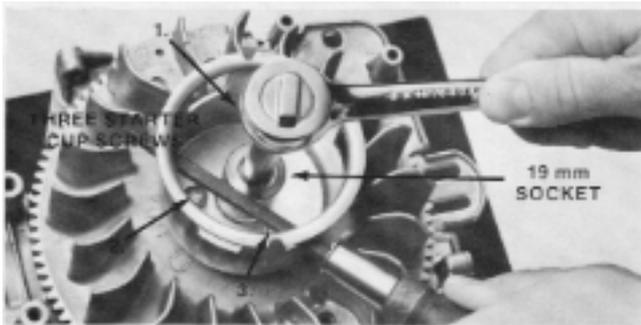


Figure 4-5

3. After the flywheel nut is removed, unscrew the three fasteners retaining the starter cup.
4. Mount flywheel puller #41-7650 and remove the flywheel. Insert the screws for the puller into the same holes used by the starter cup retaining screws. See Fig. 4-6.

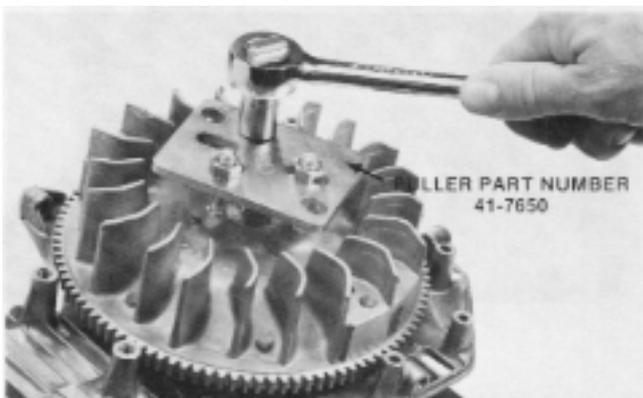


Figure 4-6

5. Examine the condition of the flywheel taper, keyway and crankshaft key and taper. See Fig. 4-7.

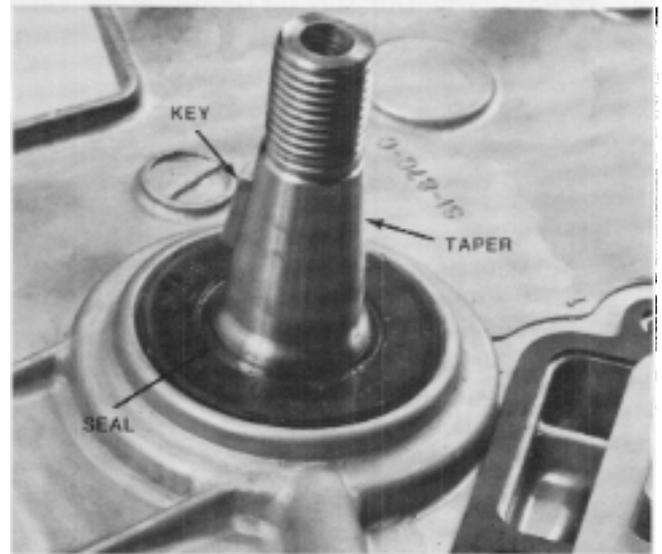


Figure 4-7

Breather

1. Remove the two screws retaining the breather assembly cover. Use a 10 mm socket or wrench. See Fig. 4-8.

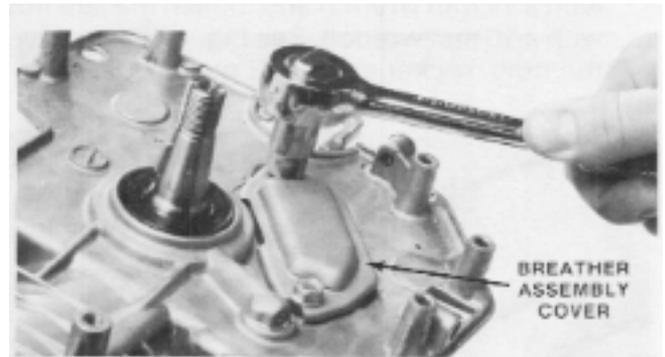


Figure 4-8

2. Under the cover will be a gasket, a reed plate and another gasket.

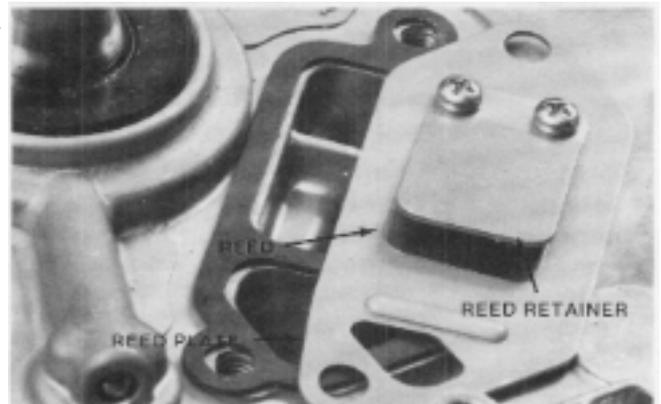


Figure 4-9

3. The reed retainer and reed must be mounted "up" as seen in Fig. 4-9.

Cylinder Head Assembly

1. Remove the four screws retaining the valve cover. See Fig. 4-10. Don't lose the washers under each screw.

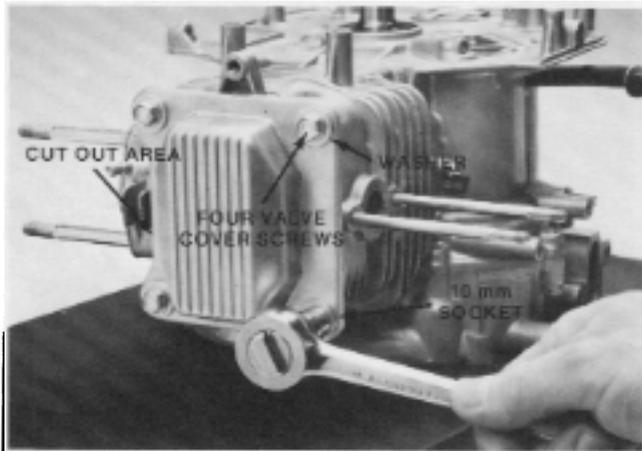


Figure 4-10

2. If the head assembly is to be completely torn down, remove each valve rocker arm. This step is not essential to the removal of the cylinder head. Hold the adjusting nut with a 14 mm wrench and loosen the jam nut with a 10 mm wrench. See Fig. 4-11. Remove the nuts, rocker arms and push rods.

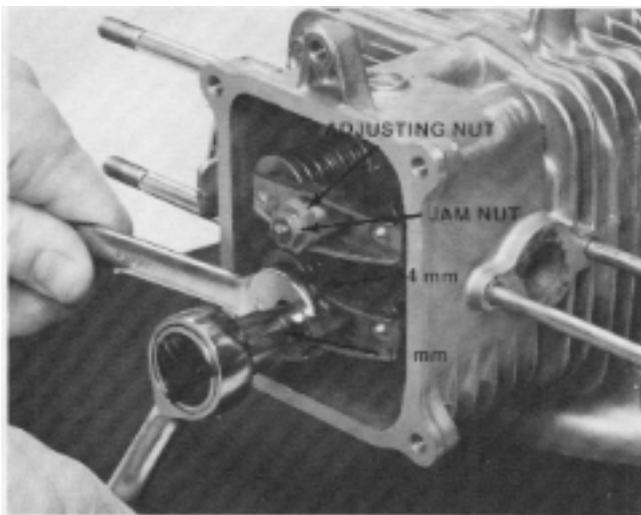


Figure 4-11

3. Remove the four head bolts. Use a 12 mm socket with a short extension. Two of the head bolts are under the valve cover. See Fig. 4-12.
4. Pull the head away from the engine block. Do not lose the two aligning pins. The head gasket will fit only one way over these pins. See Fig. 4-13.

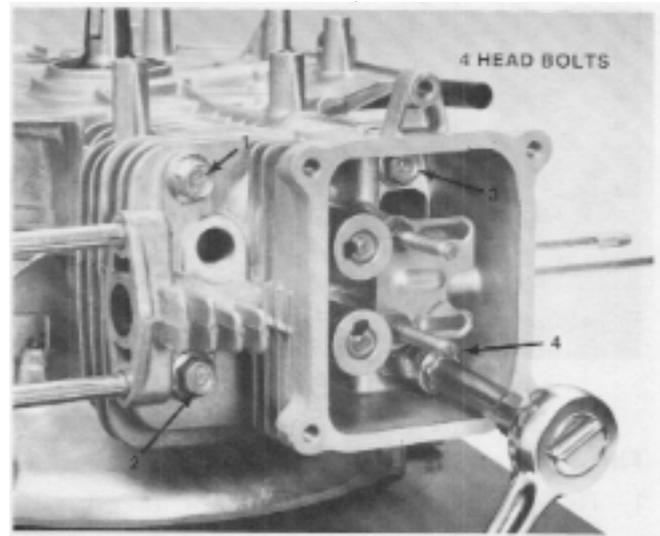


Figure 4-12

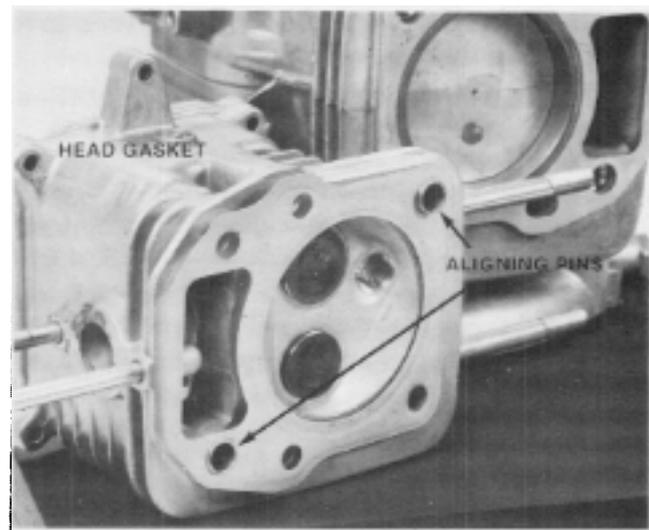


Figure 4-13

5. Lubricating oil flows into the head assembly through the passages shown in Fig. 4-14.

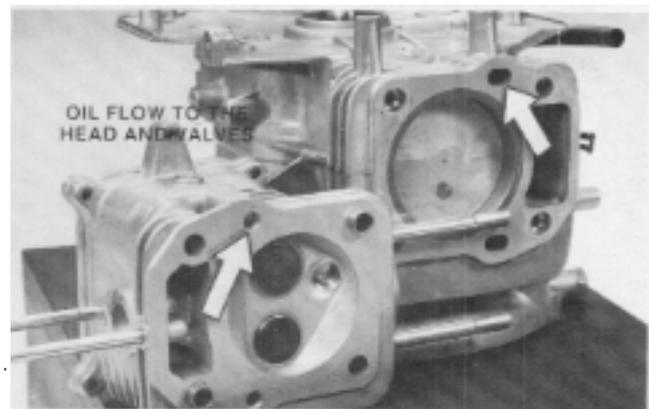


Figure 4-14

6. Lubricating oil flows back to the crankcase through the passages shown in Fig. 4-15.

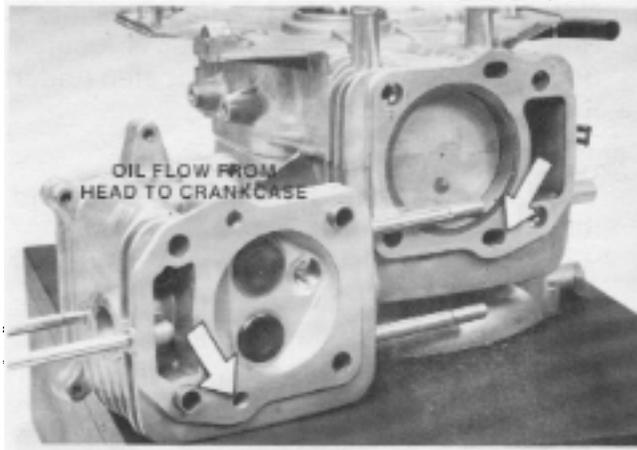


Figure 4-15

Valves

1. The valve keepers may be removed by hand. Support the bottom of the valve with your fingers and push down and back with your thumbs on the keeper. See Fig. 4-16.

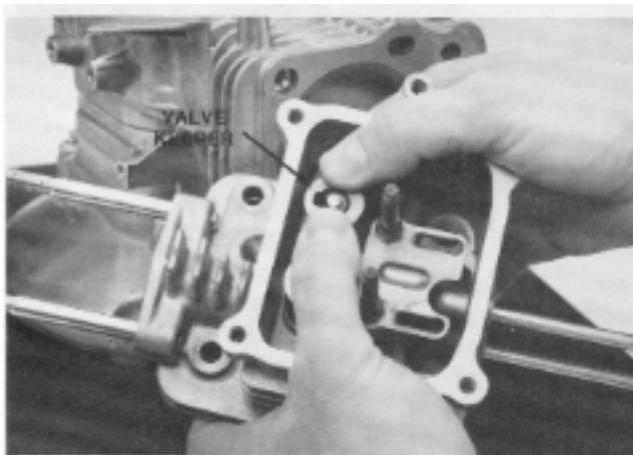


Figure 4-16

2. The valves may now be withdrawn from the head. The valve springs and keepers are identical and interchangeable. See Fig. 4-17.

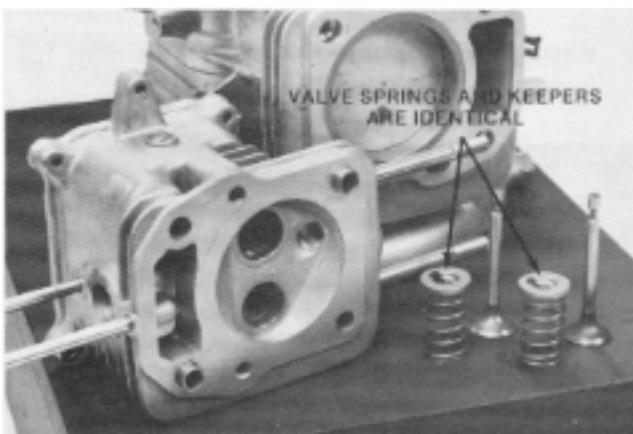


Figure 4-17

Oil Pump

1. Turn the engine upside down and remove the three screws retaining the oil pump cover. Use a 10 mm wrench or socket. See Fig. 4-18.

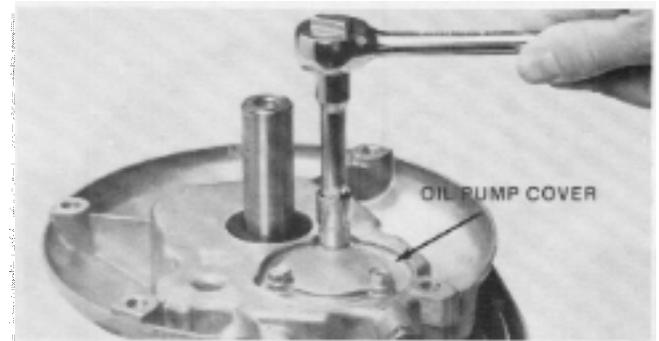


Figure 4-18

2. Remove the oil pump cover and examine the condition of the "O" ring. The oil pump is a two-piece gerotor type oil pump driven by the camshaft. See Fig. 4-19.

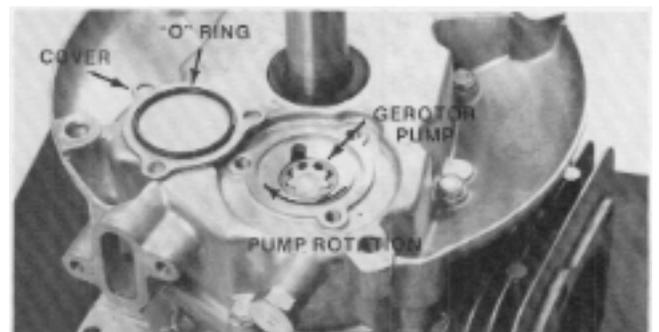


Figure 4-19

3. When removing the gerotor set, note the orientation of the parts so they may be reassembled in the same order.

Oil is drawn out of the crankcase through the opening toward the top in Fig. 4-20 and discharged through the opening in the bottom and up through the center of the camshaft.

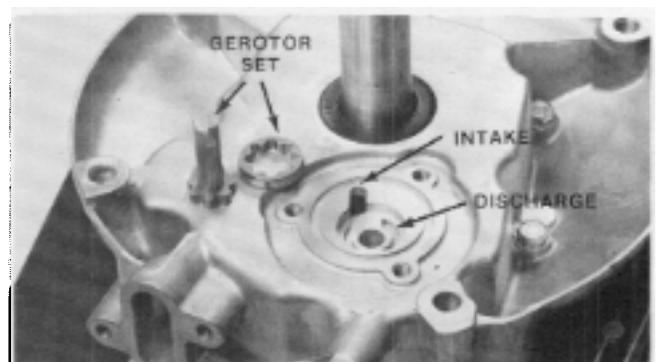


Figure 4-20

Crankcase

1. Remove the seven screws retaining the sump assembly to the block. When the sump is pulled off the crankshaft, take care not to cut the seal. See Fig. 4-21.

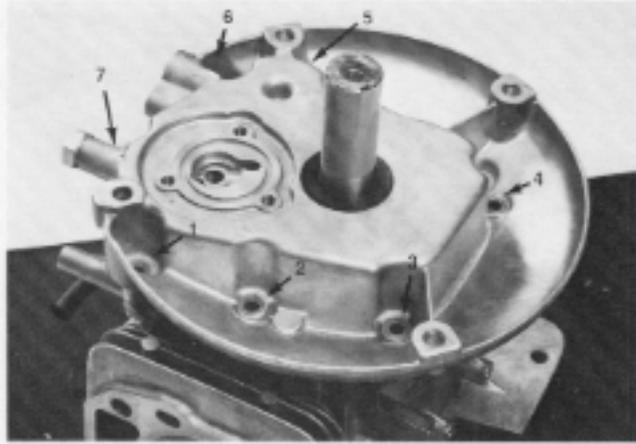


Figure 4-21

2. Turn the sump over and examine the governor assembly. Make sure the governor plunger has not dropped into the block of the engine as the plunger is loose on its shaft. See Fig. 4-22.



Figure 4-22

Governor Assembly

1. To disassemble the governor, pry up between the governor and the sump of the engine with a flat bladed screwdriver. See Fig. 4-23. The governor is held on its shaft with a nylon shoulder. There are no retaining rings.

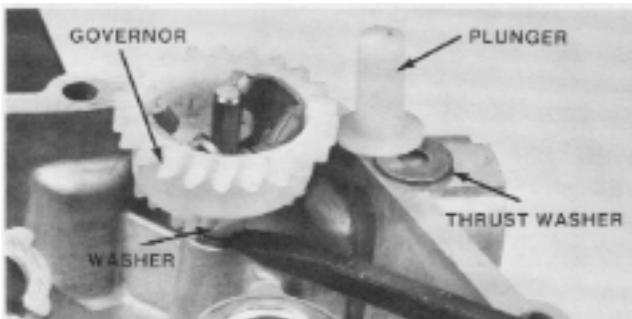


Figure 4-23

2. Note the position of the two thrust washers. Refer to Fig. 4-23. One washer is located under the plunger and one is located under the governor assembly.

Camshaft

1. The camshaft drives both the governor and the oil pump. Refer to Fig. 4-22.
2. The witness marks on the cam gear and crank gear can be seen in Fig. 4-24. These marks must be matched to establish correct valve timing.



Figure 4-24

3. The cam gear may now be removed from the crankcase. Note the oil pump drive pin in the end of the shaft. See Fig. 4-25.

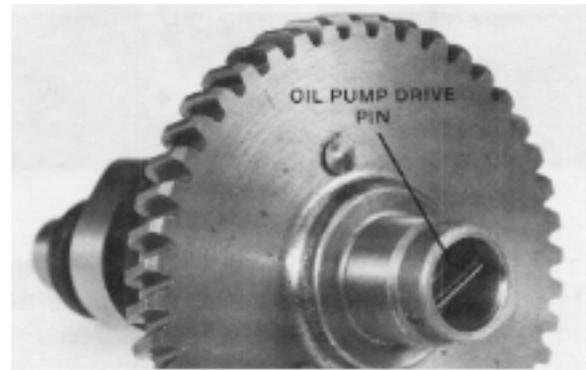


Figure 4-25

4. With the camshaft removed, the cam followers are exposed. See Fig. 4-26.

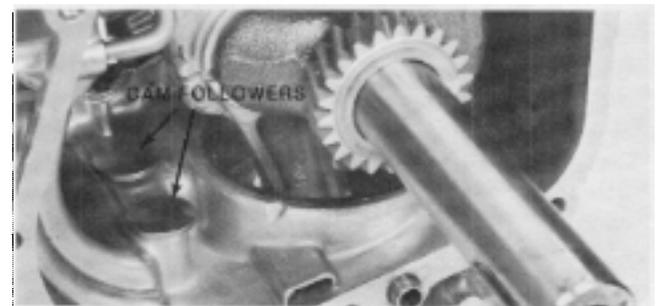


Figure 4-26

5. Pull the cam followers out of the engine. New parts are identical and may be placed in either opening. Used parts should be installed in the original holes to maintain wear patterns.

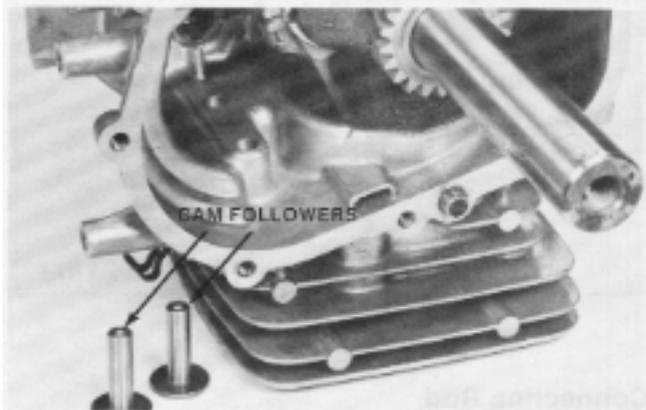


Figure 4-27

6. If necessary, the governor shaft may be removed by unseating the retaining ring and pulling the shaft out of the block. See Fig. 4-28. There are no seals or "O" rings in the block or on the shaft.

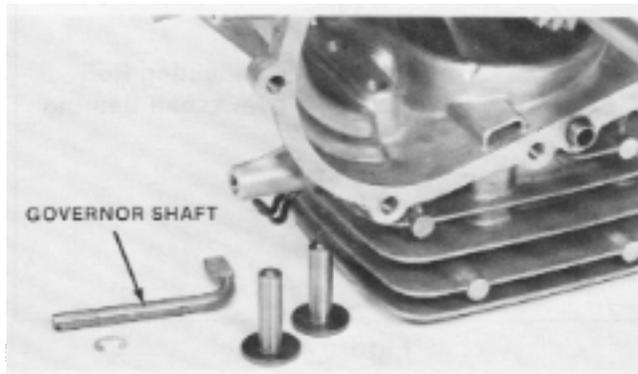


Figure 4-28

Compression Release

1. The compression release assembly is designed to hold the exhaust valve off its seat during start up. This is accomplished by an additional lobe on the back side of the exhaust cam that is activated by a flyweight assembly. The compression release is shown in Fig. 4-29 as it would be during cranking or starting.
2. When the engine speed increases, the flyweight will move in the direction of the arrow in Fig. 4-30. This will cause the lobe to rotate exposing its flat edge to the exhaust cam. This will allow the exhaust valve to fully close at operating speed. See Fig. 4-30.
3. The flyweight spring is the only replaceable part. Refer to Fig. 4-30.

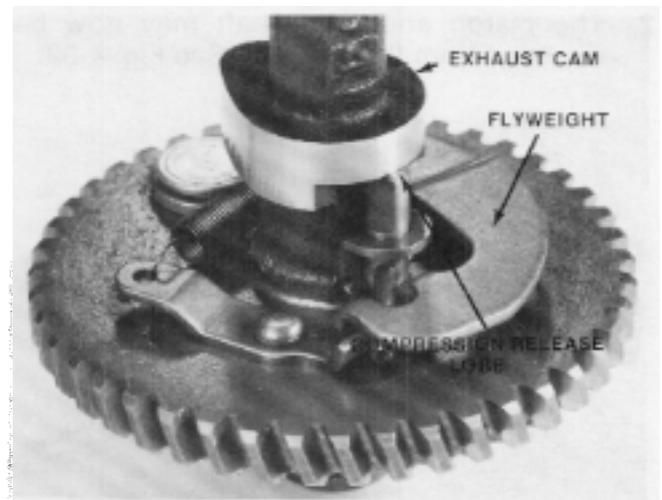


Figure 4-29

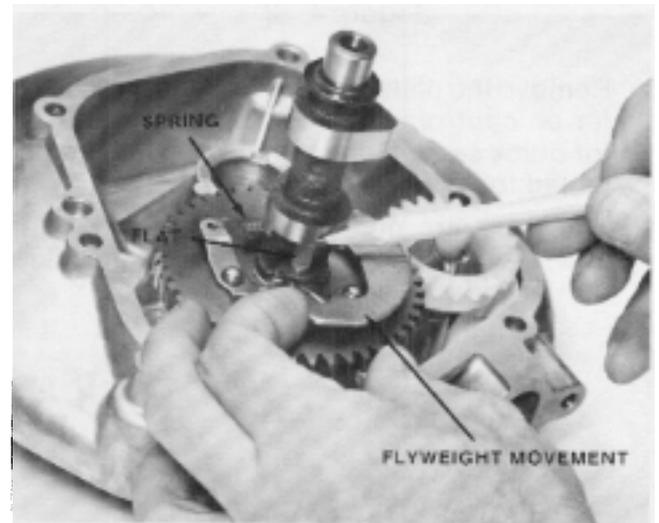


Figure 4-30

Piston and Connecting Rod

1. To remove the connecting rod, straighten the tabs on the locking plate and remove the rod cap nuts. See Fig. 4-31.

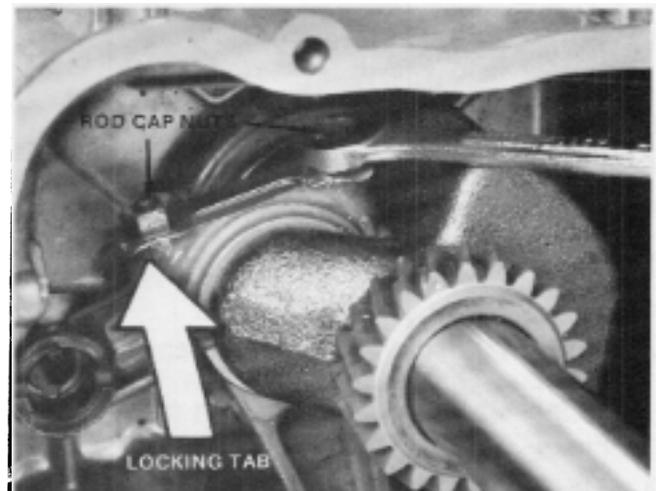


Figure 4-31

2. The piston and crankshaft may now be removed from the cylinder. See Fig. 4-32.

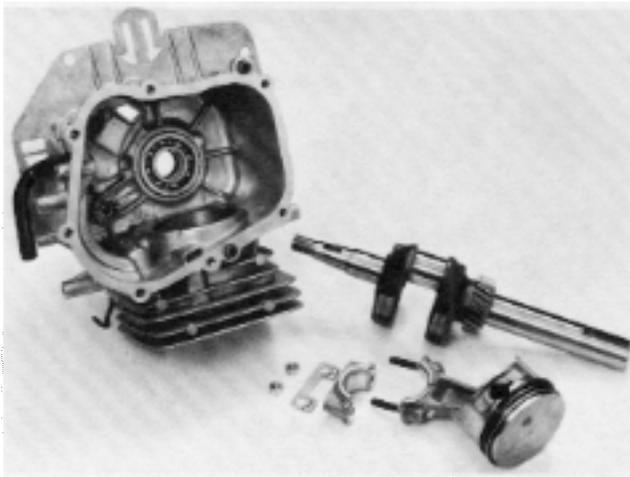


Figure 4-32

3. Remove the piston rings. The bottom ring is for oil control, the second ring is cast iron for quick seating and the top ring is chrome plated for long wear.
4. The rings are marked with the letter "N". The "N" should face up on correct installation. See Fig. 4-33.

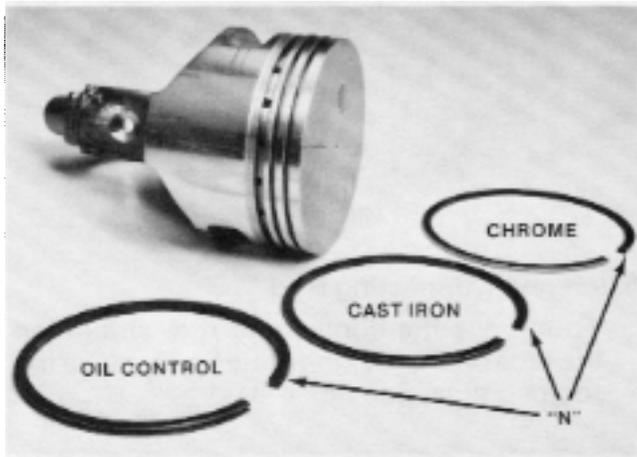


Figure 4-33

INSPECTION AND RECONDITIONING Crankshaft

1. Inspect for a bent crankshaft. The limit on crankshaft deflection (1/2 of a total indicated run-out on a dial indicator) is .05 mm (.002 in).
2. Measure the diameter of the crankshaft rod journal. The journal diameter should be 25.99 — 26.00 mm. (1.023 — 1.024 in.) See Fig. 4-34.
3. The upper diameter of the crankshaft is 21.960 — 21.980 mm (.8646 — .8654). The

lower diameter of the crankshaft is 24.959 — 24.980 (.9826 — .9835).

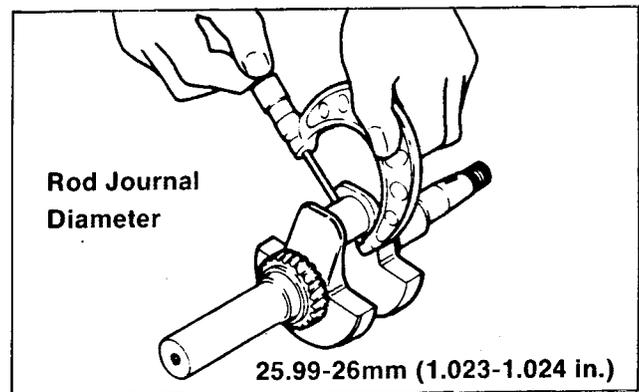


Figure 4-34

Connecting Rod

1. Measure the inside diameter of the connecting rod crankshaft bearing. The diameter should be 26.105 — 26.025 mm (1.024 — 1.025 in.) See Fig. 4-35.

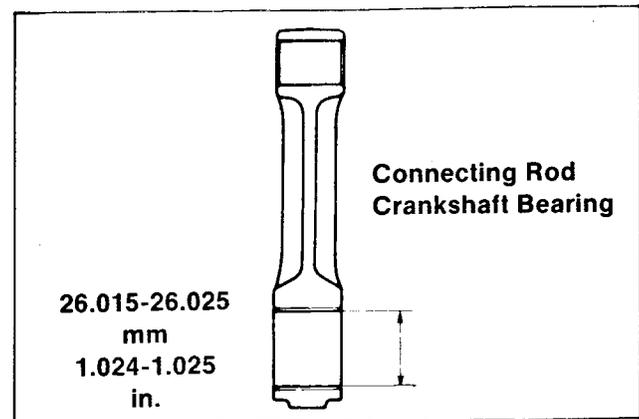


Figure 4-35

2. Measure the inside diameter of the connecting rod piston pin bearing. The diameter should be 14.989 — 14.981 mm (.5901 — .590 in.) See Fig. 4-36.

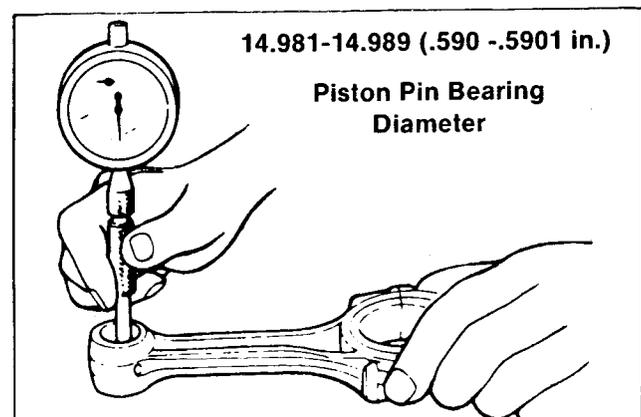


Figure 4-36

Piston

1. Measure the outside diameter of the piston. The piston should measure 63.960 — 63.975 mm (2.5181 — 2.5187 in.). If the piston measures less than 63.915 mm (2.5163 in.) replace it. See Fig. 4-37.

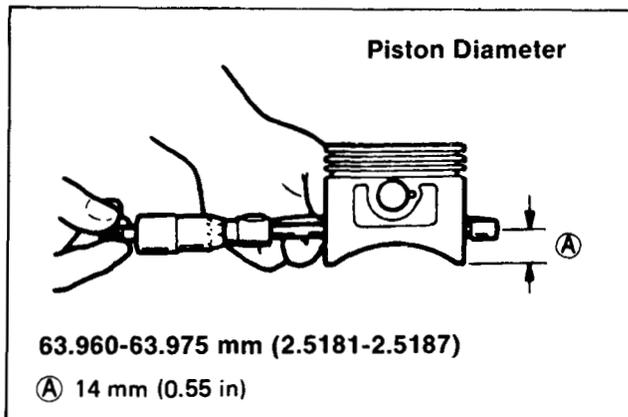


Figure 4-37

2. Measure the piston pin diameter. The pin should measure 14.995 — 15.00 mm (.5904 — .5906 in.) See Fig. 4-38.

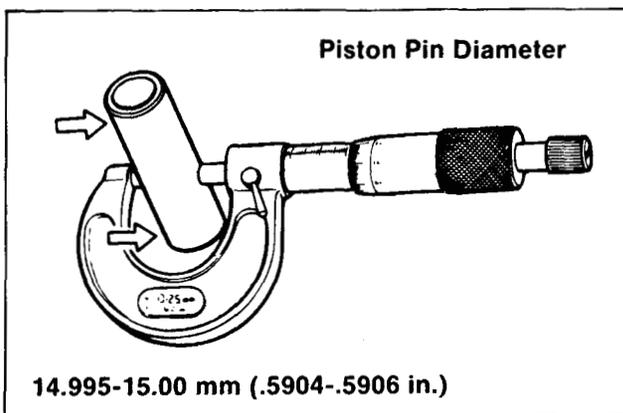


Figure 4-38

3. The clearance between the piston pin and connecting rod bearing should be .006 — .019 mm (.0002 — .0007 in.). The wear limit is .05 mm (.002 in.). Both the connecting rod and piston pin must be replaced if the wear limit is exceeded.

Cylinder

1. Diameter of the cylinder is 64 mm (2.52 in.). Cylinder bore condition is determined by establishing the total cylinder bore wear.
2. Take a total of 6 cylinder measurements as shown in Fig. 4-39. Take two measurements each at point A, B, C.

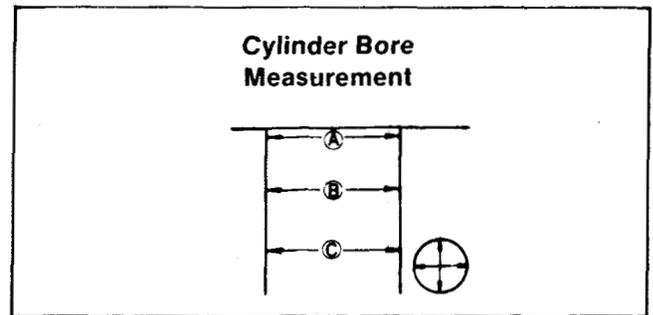


Figure 4-39

The amount of wear is the difference between the largest and smallest measurements.

3. The wear limit is .1 mm (.0039 in.).

Piston Rings

1. Measure the piston ring clearance in the piston ring groove. See Fig. 4-40. Clearance — .03-.07 mm (.0012-.0028 in.) Wear Limit — .1 mm (.0039 in.)

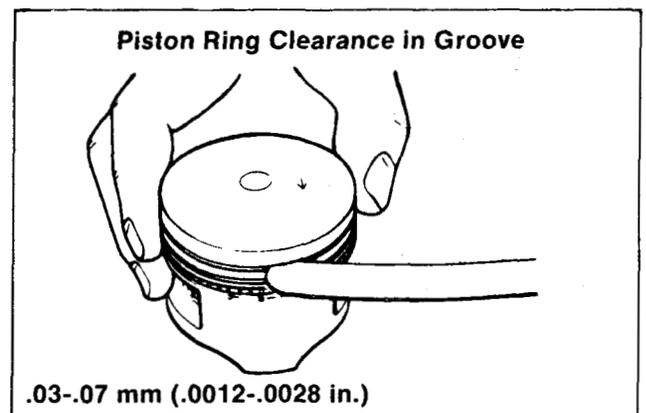


Figure 4-40

2. Measure the piston ring end gap where cylinder wear is at a minimum. This will be about 3 mm (1/8 in.) from the upper edge of the cylinder. The end gap measured with a feeler gauge is .20-.40 mm (.0079-.0158 in.). The limit is .7 mm (.027 in.).

Valves

1. Measure the valve stem diameter. See Fig. 4-41.
Intake Valve — 5.460-5.475 mm (.2150-.2156 in.)
Exhaust Valve — 5.440-5.455 mm (.2142-.2148 in.)
2. Use a small bore gauge and a micrometer to measure the valve guide I.D.
Intake & Exhaust — 5.500-5.512 mm (.2165-.2170 in.)

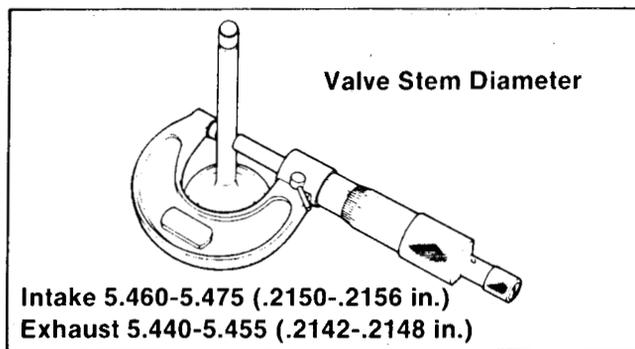


Figure 4-41

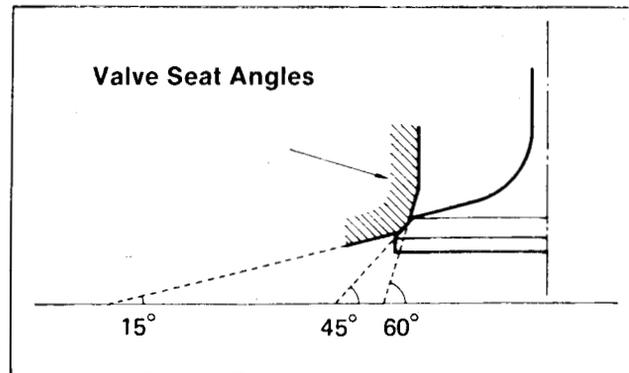


Figure 4-43

3. Calculate the valve stem to valve guide clearance wear limit. Subtract the valve stem diameter from the valve guide I.D. If these limits are exceeded, the valves and valve guides must be replaced.

Intake clearance limit — .08 mm
(.0032 in.)

Exhaust clearance limit — .100 mm
(.0039 in.)

See Valve Guide Replacement on page 30.

4. Valve seat contact is determined by coating the valve seat with Prussian Blue. Install the valve and rotate it in its seat. The width of the contact area for both intake and exhaust is shown in Fig. 4-42.

Intake and Exhaust Valve Contact Area —
.800-1.00 mm (.0315-.0394 in.)

The pattern must be a continuous ring without break. If the pattern is not within specification, the valve seat must be re-conditioned.

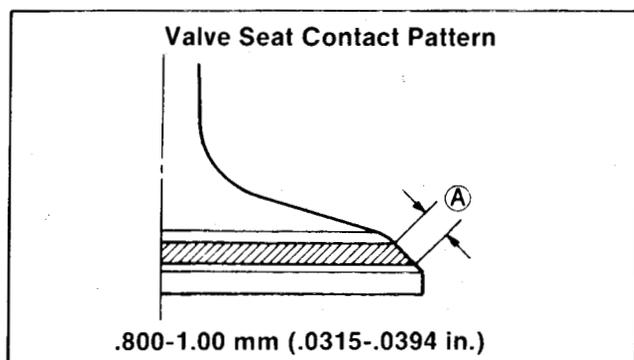


Figure 4-42

5. Recondition the valve seat. Three cuts are required to properly recondition the valve seat. See Fig. 4-43.

The special tools required are as follows:

"T" handle wrench	— 50-9480
Adaptor	— 50-9410
Expandable Pilot	— 50-9500
60 Degree Cutter	— 81-4830
15/45 Degree Cutter	— 81-4370

- A. Install the pilot shaft in the valve guide.
- B. Insert the 45 degree cutter and connect the "T" handle.
- C. Cut the seat to 45 degrees with one or two turns of the cutter.
- D. Coat the seat with Prussian Blue and measure the contact area on the valve face. Refer to step #4 on page 30.
- E. If the position of the contact area is low, see Fig. 4-44A, cut the seat with the 60 degree cutter to raise the contact area.
- F. If the contact area is high, see Fig. 4-44B, cut the seat using the 15 degree cutter to lower the contact area.

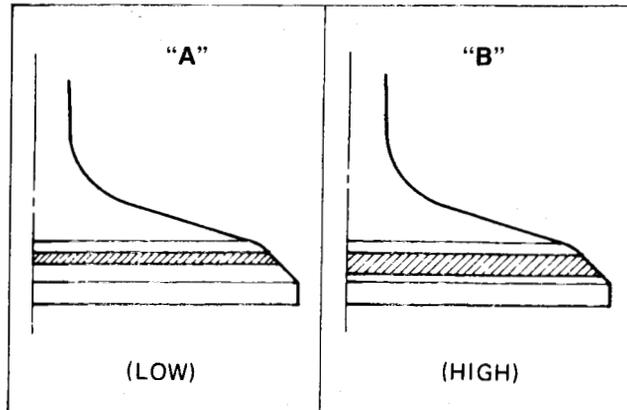


Figure 4-44 A & B

6. Valve Guide Replacement
The valve guides are shrink-fit in place. Use the following procedures to install replacement valve guides.
- A. Use valve guide installer and remover, part number 81-4880, to drive the old valve guide out of the head of the engine. Insert the remover from the combustion chamber side of the head.
 - B. Ream the hole with a valve guide reamer, part number 81-4850. Turn the reamer with handle, part number 81-4860. The

diameter of the hole after reaming will be 9.300-9.315 mm (.3661-.3667 in.) on both intake and exhaust.

- C. Use the valve guide installer, part number 81-4880, to drive in the new oversize valve guides, part number 81-3830. Drive the guides in from the valve cover side of the head. When properly installed, there will be 27.5 mm (1.08 in.) clearance between the end of the valve guide and the gasket surface of the head. See Fig. 4-45.

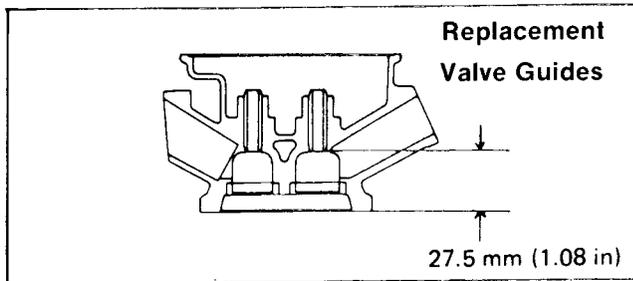


Figure 4-45

- D. Check the I.D. of the new guides against the diameter of the valve systems. If the clearance is too small:
 - intake guide — less than .025 mm (.001 in.)
 - exhaust guide — less than .045 mm (.0017 in.).
 you must ream the guide with valve guide reamer, part number 41-4840. This will enlarge the valve guide diameter to 5.5 mm (.2165 in.)

REASSEMBLY

Piston, Rings and Connecting Rod

1. Use a ring expander to install three piston rings. The top ring is chrome plated, the second ring is plain iron and the third is an oil control ring. See Fig. 4-46.

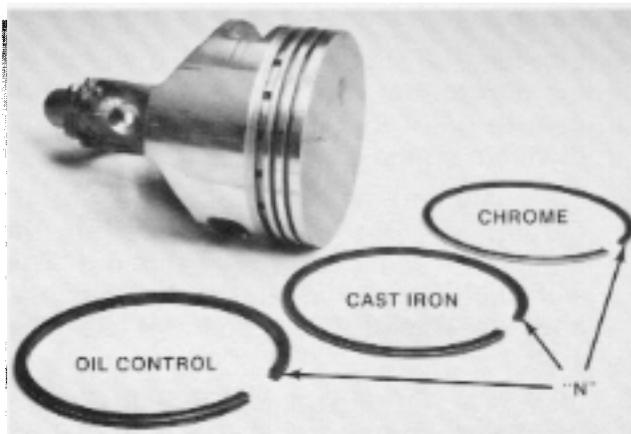


Figure 4-46

2. The letter "N" on each piston ring should face toward the top of the piston.
3. Before installing the piston, check the match marks on the rod cap and rod. This will ensure correct installation. Also note the arrow on the connecting rod, this should point to the push rod side of the engine on installation. See Fig. 4-47.

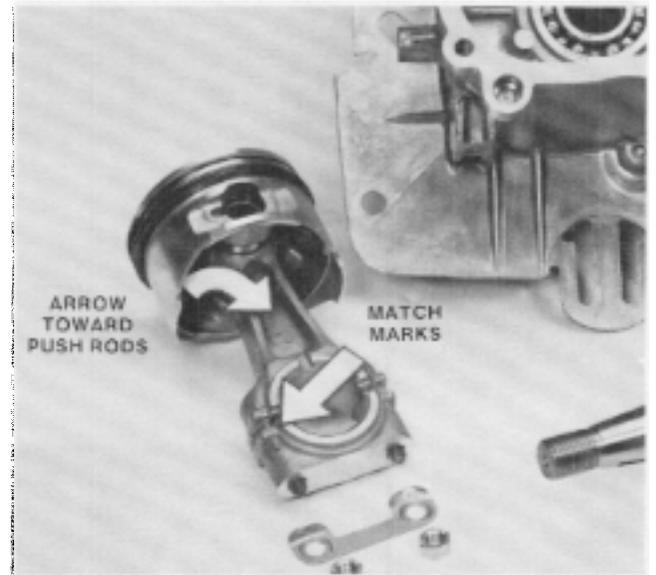


Figure 4-47

4. Lubricate the crankshaft with 30 weight oil and slide it into the ball bearing. Take care not to damage the seal. Lubricate the piston and install it with a piston ring compressor. See Fig. 4-48.

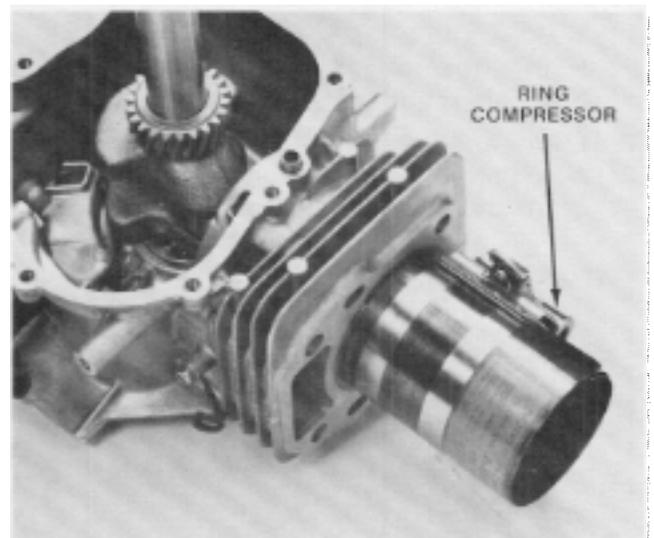


Figure 4-48

5. The arrow on the face of the piston should point the same direction as the arrow on the connecting rod — toward the push rods. See Fig. 4-49.

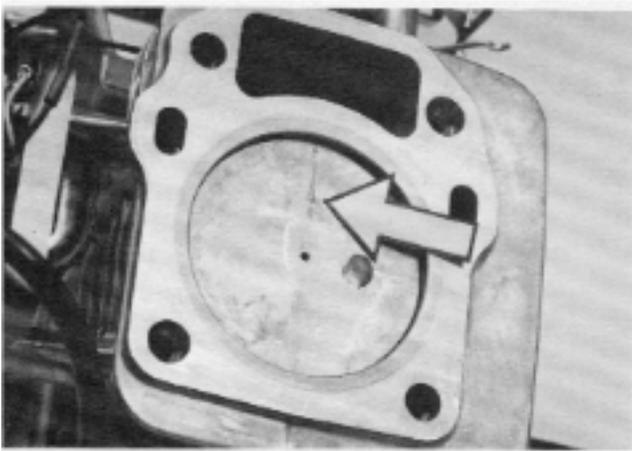


Figure 4-49

Camshaft and Followers

1. Install the cam followers. They are both the same, it makes no difference in which of the two openings they are installed. Oil before you insert them. See Fig. 4-50.

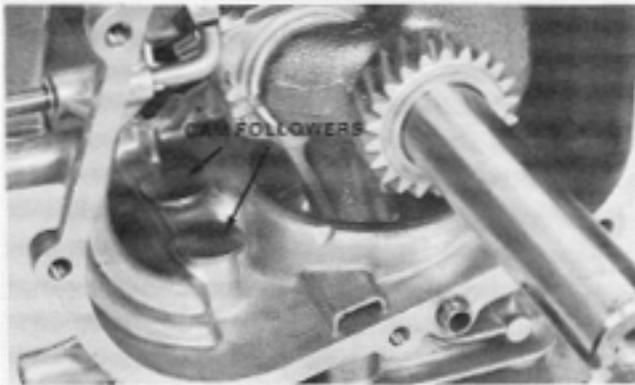


Figure 4-50

2. If the governor arm has been removed, lubricate it and install it at this time.
3. Lubricate and install the camshaft. Make sure the timing marks on the cam gear and crankshaft gear are in line. See Fig. 4-51.



Figure 4-51

Governor Assembly

1. Lubricate and install the thrust washer on the flyweight shaft. Lubricate and install the flyweight assembly. Push it down on the shaft until it snaps in place.
2. Place a small amount of grease on the governor plunger and thrust washer. Install them on the flyweight shaft. See Fig. 4-52.

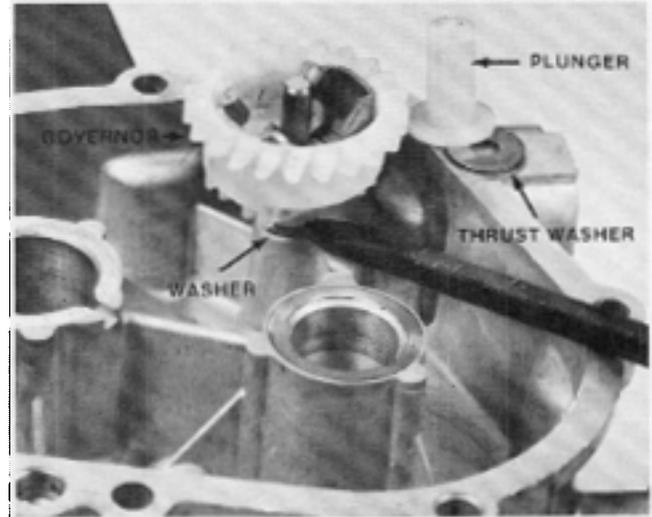


Figure 4-52

Crankcase

1. Place a new gasket on the block assembly.
2. Put a piece of protective tape over the crankshaft keyway; lubricate the shaft.
3. Install the sump assembly on the block. You may have to turn the crankshaft slightly to get the camshaft gear and governor gear to engage. Do not force the fit as damage to the nylon governor gear may occur. Take care that the governor plunger does not drop into the block assembly.
4. Tighten the seven sump screws to .4-.7 kg-m (3.0-5.0 ft-lbs).

Oil Pump

1. Lubricate and install the center drive gear of the gerotor set. You may have to turn the gear to get it to properly engage with the drive pin on the camshaft.
2. Lubricate and install the outer gear of the gerotor set. Put the gears back into the engine the same way they came out. This will maintain any wear pattern that may have developed in the gear set. See Fig. 4-53.
3. Install the "O" ring and cover plate. Torque the three screws to .4-.7 kg-m (3.0-5.0 ft-lbs).

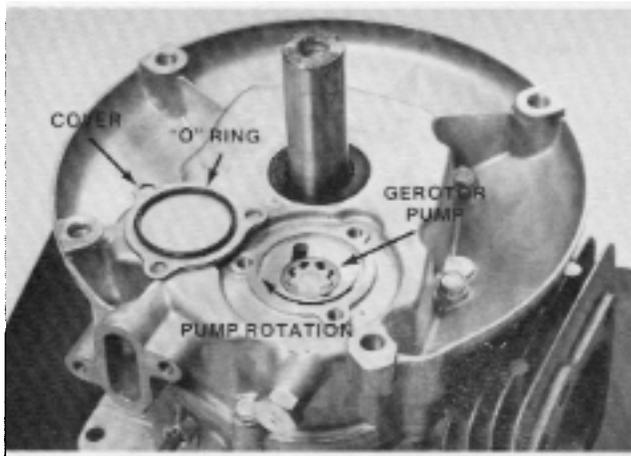


Figure 4-53

Valves

1. Lubricate the valve stems and install the valves in the head.
2. The valve heads are marked intake and exhaust. The intake valve is mounted in the large diameter opening and the exhaust valve is mounted in the small diameter opening. NOTE: It is possible to insert the valves in the wrong opening but they will not seal.
3. Install the valve springs and keepers. The keepers and springs are the same on intake and exhaust. See Fig. 4-54. Hold the head of the valve in place and push down with your thumbs to install the keepers.



Figure 4-54

Cylinder Head Assembly

1. Clean the mating surface of the head and cylinder block.
2. Install the two aligning pins in the head or block.
3. Install a new head gasket, part number 81-3680, and mount the head.

4. Insert the four head bolts and torque to 1.8 - 2.8 kg-m (13 - 20 ft-lb). See Fig. 4-55.

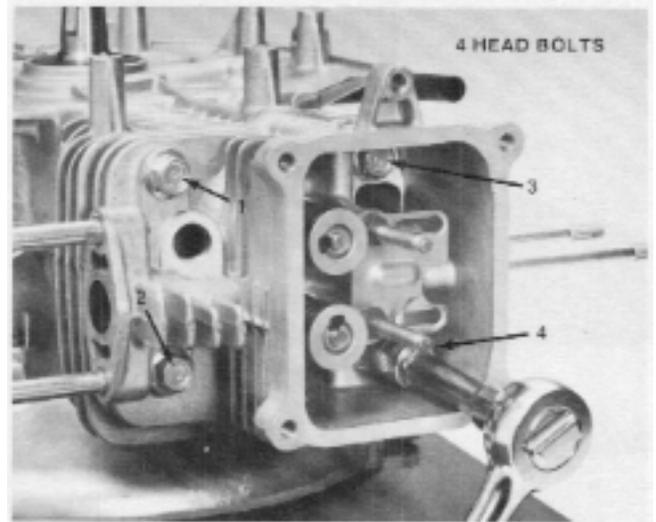


Figure 4-55

5. Install the two push rods — they are interchangeable.
6. Install the rocker arms — they are also interchangeable.
7. Install the adjusting nuts and jam nuts.
8. Move the piston to TDC of the compression stroke so both valves are closed.
9. Adjust the valve clearance to .02 - .13 mm (.001 - .005 in.). See Fig. 4-56.

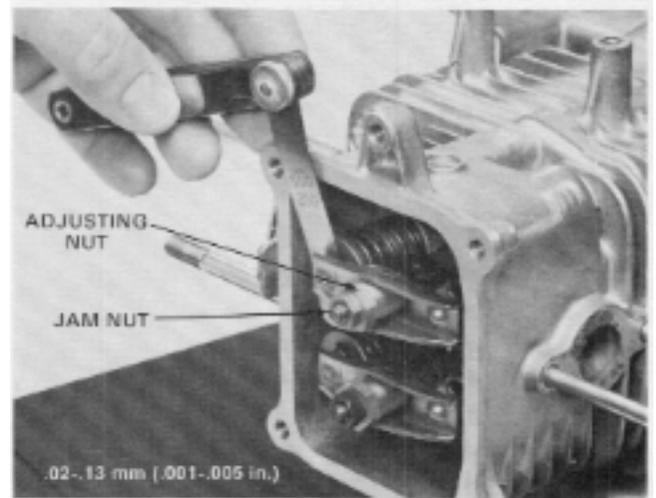


Figure 4-56

10. Tighten the jam nut against the adjusting nut.
11. Mount a new valve cover gasket and install the valve cover. The "cut out" on the cover edge goes toward the spark plug. See Fig. 4-57. A flat washer should be placed on each screw. Tighten the screws to .4 - .7 kg-m (3.0 - 5.0 ft-lbs).

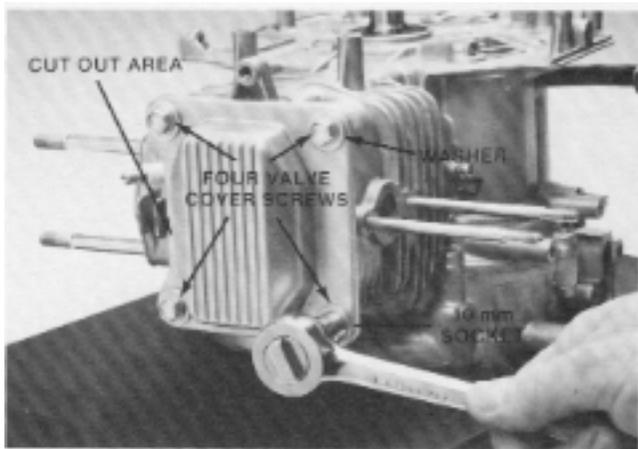


Figure 4-57

Breather

1. Install the reed plate assembly.
2. Make sure there is a gasket underneath and on top of the reed plate.
3. Install the cover plate. Use two 6 mm screws that are 12 mm long. If longer screws are used, the block may be damaged. Torque the screws to .4 - .7 kg-m (3.0 - 5.0 ft-lbs). See Fig. 4-58.

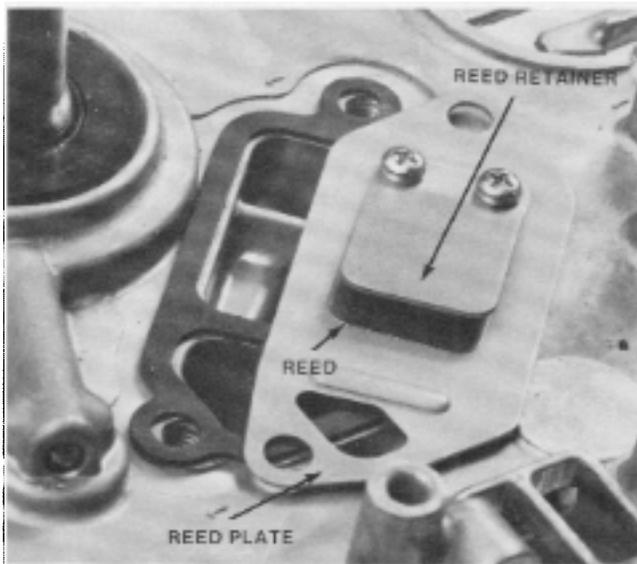


Figure 4-58

Flywheel

1. Inspect and install the key. Inspect and clean the crankshaft and flywheel tapers. Place the flywheel on the crankshaft.
2. Mount the starter cup with three screws.
3. Mount the flywheel nut and torque it to 5.6 - 6.4 kg-m (40.5 - 46.5 ft-lbs).

Throttle Control and Carburetor

1. Mount the throttle control assembly to the engine block with two screws. See Fig. 4-59.

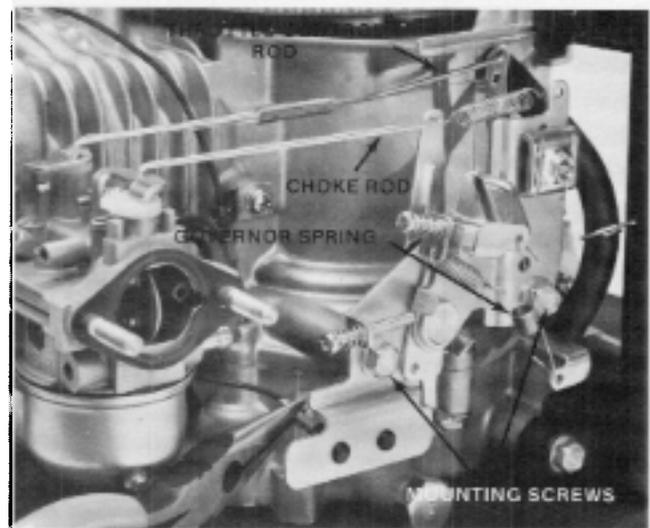


Figure 4-59

2. Install the throttle control arm (governor arm) on the governor shaft — do not tighten the retaining nut at this time. See Fig. 4-60.

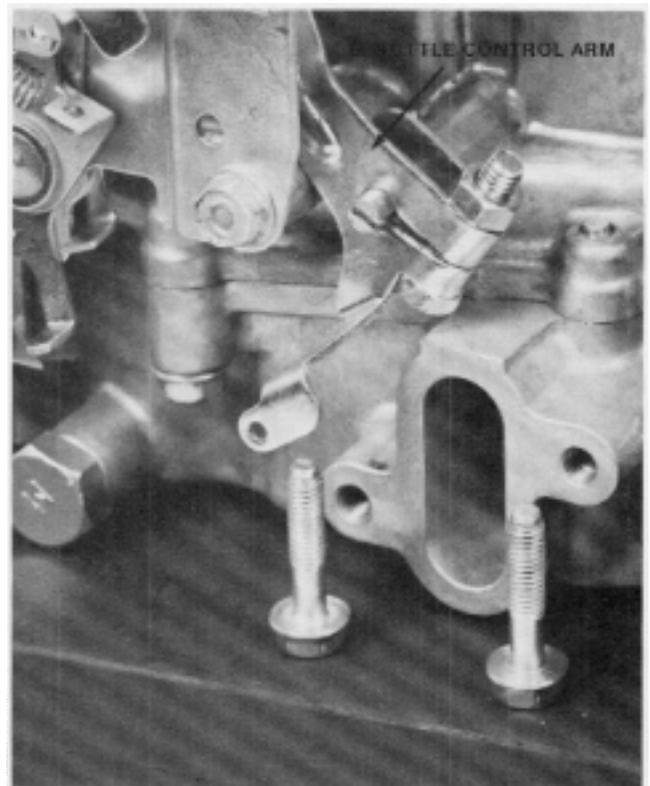


Figure 4-60

3. Connect the throttle control rod, choke rod and governor spring as shown in Fig. 4-59.
4. Mount a gasket, spacer and gasket on the carburetor mounting studs.
5. Hook the throttle control rod and spring into the throttle shaft on the carburetor.
6. Mount the carburetor on its mounting studs. See Fig. 4-61.

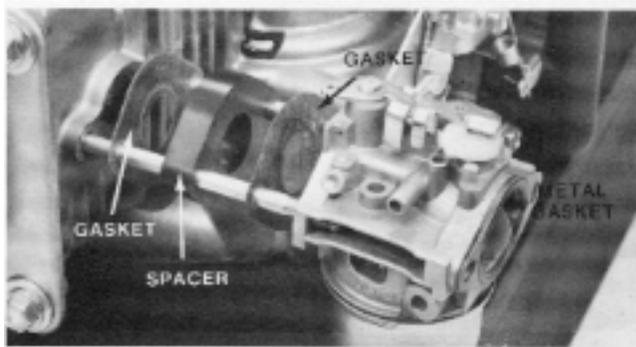


Figure 4-61

Oil Fill Tube

1. Install "O" ring fully into the groove on the oil fill tube. See Fig. 4-62.

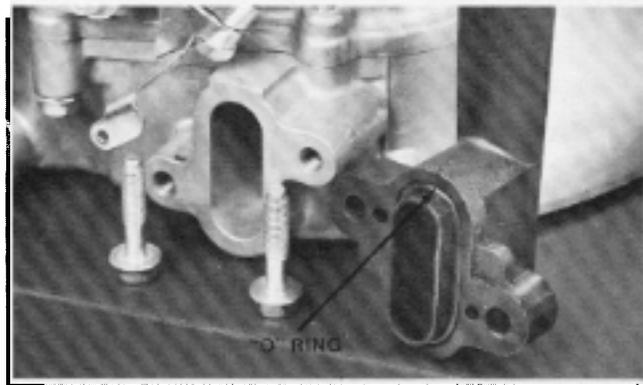


Figure 4-62

2. Mount the tube with two screws. Make sure the "O" ring is not pinched between the tube and the block of the engine.

Ignition Coil

1. Mount the ignition coil to the engine with an air gap of .38 mm (.015 in.).
2. If the engine is a BBC model, mount the kill wire retainer to the mounting screw on the carburetor side of the engine. If the engine is zone start, mount the kill wire retainer on the muffler side of the engine. See Fig. 4-63.

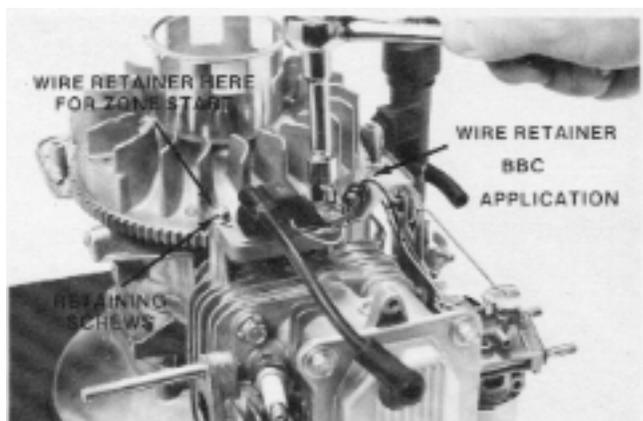


Figure 4-63

Alternator Coil and Starter Motor

1. If the engine is electric start, mount the alternator coil on its bosses as shown in Fig. 4-64.

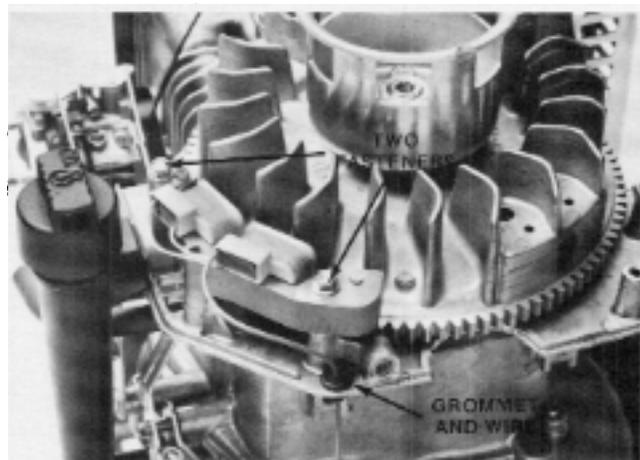


Figure 4-64

2. The air gap on the alternator coil is not adjustable.
3. Be sure to route the alternator wire through the rubber grommet. Take care not to pinch the wire behind the starter motor.
4. Mount the starter motor on its bosses with two screws.

Muffler

1. Install a new gasket on the muffler studs.
2. Install the muffler and secure it with two nuts tightened to 1.0 - 1.6 kg-m (7.0 - 11.5 ft-lbs).
3. Make sure the exhaust pipe faces toward the spark plug end of the engine when mounting. See Fig. 4-65.

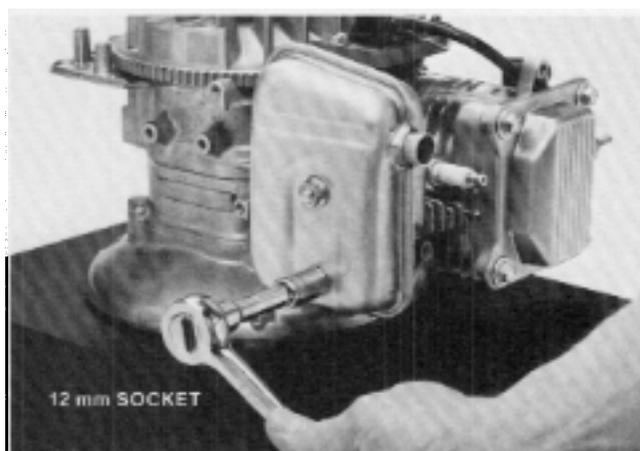


Figure 4-65

Muffler and Cooling Shroud

1. Mount the muffler shroud with two screws only.
2. Mount the cooling shroud and secure it with three screws. Do not install the screw through the oil fill tube at this time.
3. Install the third screw through the muffler shroud and cooling shroud.

Air Cleaner

1. Place a metal gasket on the carburetor studs. The rib on the gasket goes away from the carburetor and toward the air cleaner.

2. Mount the air cleaner as shown in Fig. 3-2.

Fuel Tank

1. Route the fuel hose behind the governor arm.
2. Connect the fuel hose to the carburetor.
3. Mount the fuel tank with two screws.

Recoil Starter

1. Mount the recoil starter with four screws.
2. Make sure the starter handle points toward the air cleaner side of the engine.