Manual Part No. 81134

GROUP D
ENGINES

SERVICE MANUAL

V-TWIN OHV HORIZONTAL AND VERTICAL SHAFT ENGINES

GENERAC
CORPORATION

Revision 0 (08/15/90)

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IMPORTANT SAFETY NOTICE

This "Service Manual" covers the servicing, troubleshooting, testing and repair of Generac's "V-Twin" engine as used on several portable generator models, the "NP" series recreational vehicle generators, and on one or more air-cooled standby generator models.

Proper service and repair are inportant for the safe and reliable operation of all generator sets. The troubleshooting, testing and repair procedures recommended by Generac and described in this manual are effective methods of diagnosis and repair.

Some of the testing, diagnosis and service operations require the use of specialized test equipment, meters or tools. Such specialized equipment should be used when and as recommended.

The manual contains various DANGER, CAUTION and NOTE messages. These messages should be read carefully to minimize the risk of injury to service personnel, or the possibility that improper methods might be employed that might either damage equipment or render it unsafe. It is also important to recognize that these message blocks are not exhaustive. Generac could not possibly know, evaluate and advise the engine-generator service trade of all conceivable ways in which service and diagnosis might be performed, or of the possible hazardous consequences of each way. Consequently, Generac has not taken any such broad evaluation. Accordingly, anyone who uses a service procedure, method or tool not recommended by Generac must first satisfy himself that neither his nor the equipment's safety will be jeopardized by the service method he selects.

Service personnel who work on engine-generators must be made aware of the dangers of such equipment, which include the following:

- Generators produce extremely high and dangerous electrical voltages which can kill or cause serious injury.
- Engine exhaust gases contain deadly carbon monoxide gas. This dangerous gas, if breathed in sufficient concentrations, can cause unconsciousness or even death.
- Gasoline is extremely flammable and its vapors are explosive.
- Contact with moving parts will result in injury.

When working on engine-generators, use common sense and remain alert at all times. Never work on such equipment while you are physically or mentally fatigued. If you don't understand a device, component or system, don't work on it.

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SPECIFICATIONS

ENGINE PART NO.	73150	73154	78282	78283	78811	79204**	79250
RATED H.P.	14	14	14	14	14	16	14
DISPLACEMENT	480cc	480cc	480cc	480cc	480cc	480cc	480cc
BORE	68mm	68mm	68mm	68mm	68mm	68mm	68mm
STROKE	66mm	66mm	66mm	66mm	66mm	66mm	66mm
CYLINDER BLOCK	Alum.	Alum.	Alum.	Alum.	Alum.	Alum.	Alum.
CAST IRON CYL. SLEEVE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
STARTER*	Electric	Electric Recoil	Recoil	Electric Recoil	Recoil	Elec.	Recoil
IGNITION	Solid State with Flywheel Magneto						
CRANKSHAFT	Vert.	Horix.	Horiz.	Horiz.	Horiz.	Vert.	Horiz.

** Engine Part No. 79204 has a special high compression head.
* Electric starters are 12 volts d-c, require a 12 volts battery.

COMMON ENGINE SPECIFICATIONS

SPARK PLUG GAP	ARMATURE AIR GAP	CRANKSHAFT END PLAY	VALVE CLEARANCE*	VALVE GUIDE REJECT SIZE	PISTON RING REJECT SIZE	
					COMPRESSION	OIL
0.76mm (0.030")	0.20-0.30mm (0.008-0.012")	0.08-0.40mm (0.003-0.015")	0.10-0.15mm (0.004-0.006")	0.76mm (0.030")	0.76mm (0.030")	0.76mm (0.030")

*Clearances taken cold, apply to both intake and exhaust valves.

CYLINDER RESIZING

Resize the cylinder if wear exceeds 0.076mm (0.003") or more. Resize if out-of-round 0.038mm (0.0015") or more. Resize to 0.25mm (0.010"), 0.51mm (0.020"). or 0.76mm (0.030") over the standard bore.

TORQUE SPECIFICATIONS

Engine Flywheel ..... 175 N-m (125 foot-pounds)
Cylinder Head ..... 19 N-m (165 inch-pounds)
Connecting Rod ..... 13 N-m (115 inch-pounds)
Crankcase Cover ..... 17 N-m (150 inch-pounds)
Governor Lever Lock Nut ..... 8 N-m (70 inch-pounds)
Spark Plugs ..... (22.5 N-m (200 inch-pounds)
Starter Mounting Bolts (Electric Start Units Only) ..... 16 N-m (140 inch-pounds)

Section 1 - GENERAL INFORMATION

Introduction

This "Service Manual" has been prepared especially for the purpose of familiarizing engine service technicians with the servicing, testing, troubleshooting and repair of the Generac "V-Twin", overhead valve engine.

Every effort has been expended to ensure that the contents of this manual are both accurate and current. However, the manufacturer reserves the right to change, alter, or otherwise improve his product at any time without prior notification.

Generac recommends that the engine repair shop be equipped with proper tools, equipment and mechanics who are thoroughly familiar with Generac engine design and construction. If the shop is properly equipped, as recommended, this manual will become a useful guide in the servicing, testing, troubleshooting and repair of the V-Twin engine.

NOTE: Illustrations in this manual do not necessarily designate a particular engine model and should be used only to identify the applicable repair procedure(s).

Engine Applicability

Engines represented in this manual may have either a "horizontal" or a "vertical" crankshaft. See "Specifications" chart on Page 2.

UNITS WITH HORIZONTAL CRANKSHAFT:

"V-Twin" engines with horizontal crankshaft are generally used in portable a-c generator applications. In this application, the crankshaft is connected directly to the generator revolving field (Rotor) and turns at the same speed as the Rotor. See Figure 1. In most cases, the engine has a tapered crankshaft extension which is inserted into a tapered hole in the Rotor. The Rotor is then retained to the tapered crankshaft with a Rotor bolt.

Replacement horizontal crankshaft engines are generally available as complete engines, including the sheet metal shrouding around the engine.

UNITS WITH VERTICAL CRANKSHAFT:

These engines are generally used in RV (recreational vehicle) or standby generator applications. A pulley is retained to the engine crankshaft extension. A drive belt, driven by the crankshaft pulley, is used to drive the generator's revolving field. Because the revolving field (Rotor) is not attached directly to the crankshaft, engine and Rotor operating speeds may not be the same. This arrangement permits the engine to be operated at a lower, more economical speed while maintaining Rotor rpm at the desired speed.

NOTE: Replacement engines for vertical shaft models are generally available in "short block" versions that are shipped minus the sheet metal shrouding that surrounds the engine. This arrangement is a result of the special air flow and cooling requirements for RV and standby generator applications.

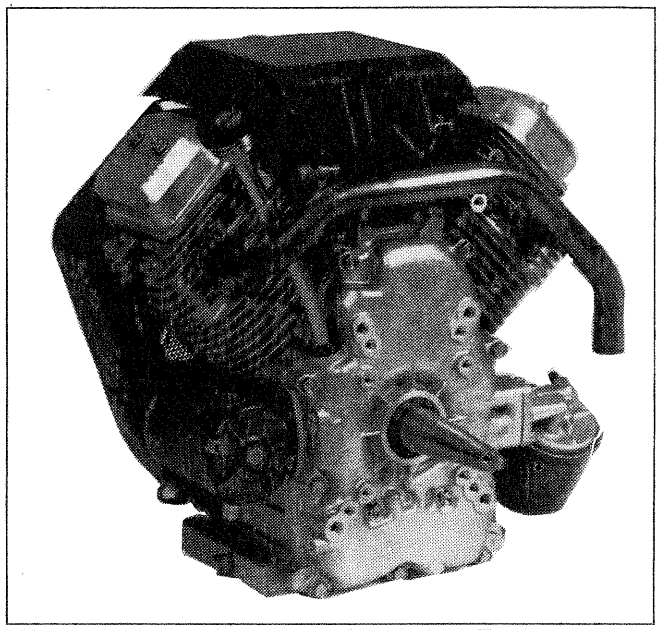


Figure 1. Typical Horizontal Crankshaft Engine

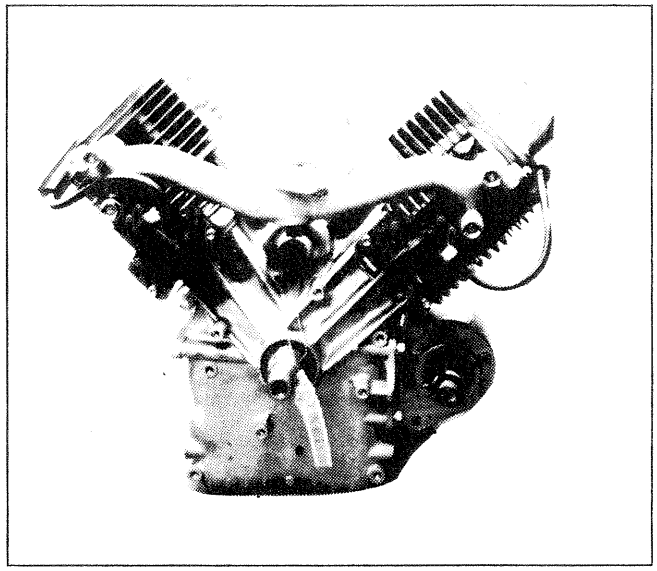


Figure 2. Typical Vertical Crankshaft Engine

Recommended Fuel

V-Twin engines with horizontal crankshafts and used with portable generators are generally equipped with a gasoline fuel system.

Engines with vertical crankshafts and used with RV or standby generators may be equipped with either an LP gas, natural gas, or gasoline fuel system.

GASOLINE:

If the engine is equipped with a gasoline fuel system, we recommend the use of clean, fresh, lead-free gasoline. Leaded gasoline may be used if lead-free is not available. Use of lead-free gasoline results in fewer combustion deposits and longer valve life.

We also recommend that gasoline be purchased in small quantities, not more than a 30 day supply. Fresh gasoline minimizes gum and varnish deposits and, in addition, ensures that fuel volatility is tailored for the season in which the engine is to be operated.

NOTE: Use of a fuel additive, such as "STA-BIL®" or an equivalent, will reduce the formation of fuel gum deposits during storage. Such an additive may be added to the gasoline in the engine-generator fuel tank, or to the gasoline in a storage container.

NOTE: Generac does NOT recommend the use of any gasoline which contains alcohol, such as "gasohol". If gasoline with alcohol must be used, it should not contain more than 10 percent ethanol and MUST be removed from the fuel system during storage. DO NOT use any gasoline containing methanol.

LP GAS:

Some vertical shaft engines, especially those used in RV and/or standby applications, may be equipped with an LP gas fuel system. LP gas is usually made up of propane, butane, or a mixture of the two gases. It is supplied as a liquid in pressure tanks and is easily adaptable to applications where complete independence of an outside fuel source is required. Because LP gas does not deteriorate during long periods of storage, a large supply of the fuel can be kept on hand. Refer to the section in this manual on LP gas fuel system for additional information on system requirements.

NATURAL GAS:

Some vertical shaft engines used in standby electric system applications may be equipped with a natural gas fuel system. Natural gas is supplied in gaseous form by means of a natural gas piping system. The gas distribution company will usually supply piping from the main transmission line to the generator set.

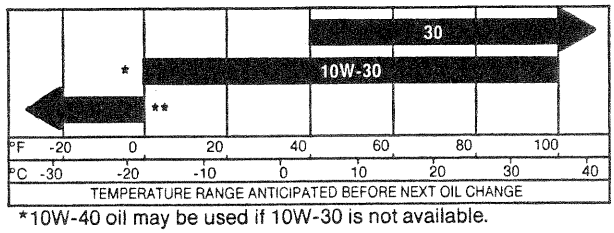
Recommended Oil

FOR PORTABLE AND RV GENERATOR USE:

For portable generator applications, use a high quality detergent oil classified "For Service SF, SE, SD or SC" and having a viscosity rating as follows:

- For ambient temperatures consistently above 40° F., use SAE 30 oil.
- For ambient temperatures consistently between 0° F. and 100° F., use SAE 10W-30 oil.
- If temperatures are below 0° F., use a synthetic oil having a 5W-20, 5W-30 or 5W-40 viscosity. If these are not available, a petroleum base oil may be used having 5W-20 or 5W-30 viscosity.

RECOMMENDED SAE VISCOSITY GRADES



*10W-40 oil may be used if 10W-30 is not available.

**Use synthetic oil having 5W-20, 5W-30 or 5W-40 viscosity. If not available, a petroleum-based oil may be used having 5W-20 or 5W-30 viscosity.

Figure 3. Oil Chart- Portable & RV Units

FOR STANDBY GENERATOR USE:

For standby generator applications, use a high quality detergent oil that exceeds API Service SF, SF/CC, or SF/CD warranty requirements for gasoline engines. The primary recommended oil for standby applications is a synthetic oil (such as MOBIL 1, Formula 5W-30). Synthetic oil promotes easier starting in cold weather and provides maximum protection in hot weather. If you use a synthetic oil, its viscosity MUST be suitable for the lowest temperature at which the generator will be operated. See CHART below.

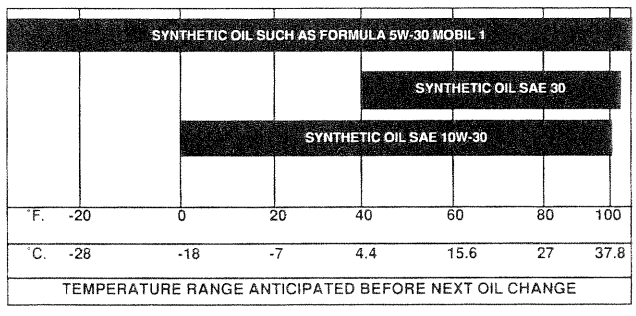


Figure 4. Oil Chart- Standby Generator Units

Recommended Oil (Continued)

Detergent oils keep the engine cleaner and retard the formation of gum and varnish deposits. No special additives should be used with the recommended oil.

CHANGE OIL:

Change oil after the first 8 hours of operation. Thereafter, change oil every 50 hours of operation. Change oil every 25 operating hours if engine is operated under heavy load or under high ambient temperatures.

NOTE: During operation small particles of metal from cylinder walls, pistons, bearings, and combustion deposits will gradually contaminate the oil. Dust particles from the air will also mix with the oil. Oil must be changed regularly or such foreign particles will shorten engine life. Old oil will become thick and lose its cooling and lubricating qualities.

CHANGE OIL FILTER:

Replace the oil filter every 100 hours of operation (every second oil change). Lightly coat the new replacement filter gasket with engine oil. Screw filter on by hand until gasket contacts the filter adapter. Then, tighten about 3/4 turn further. Start engine and run for at least 30 seconds, then shut down. Recheck oil level and fill to dipstick "Full" mark if required. Restart engine and check for oil leaks.

Clean Cooling System

The engine cooling system should be kept clean. Continued operation with a clogged cooling system may result in overheating and severe engine damage. This should be a regular, periodic maintenance operation performed once annually or every 100 operating hours, whichever comes first. Figure 5 shows a typical horizontal shaft engine with its blower housing removed and the areas of the engine to be cleaned.

Vertical shaft engines that are used in RV or standby applications must be installed properly to ensure an adequate flow of cooling air. All air openings must be kept clean and unobstructed. Inspect the air inlet screen (Figure 6) on these units periodically and keep it clean and unobstructed.

Tune-up Procedure

Relatively new engines that exhibit minor problems should be given a "tune-up". A "Tune-Up Procedure" chart is provided on Page 6. Completion of the tasks in the tune-up procedure will ensure that the engine is operating properly and will indicate any major repairs that might be required.

The "Tune-Up" tasks are also a part of the "Overhaul Procedure" on Page 7.

Overhaul Procedure

An "Overhaul Procedure" is presented on Page 7. The procedure is intended to help you become accustomed to a systematic method of repairing the V-Twin engine. The steps could be performed in a somewhat different order. However, efficiency is obtained when repair operations are accomplished in the same sequence each time. The exact procedure may vary according to the engine model being repaired.

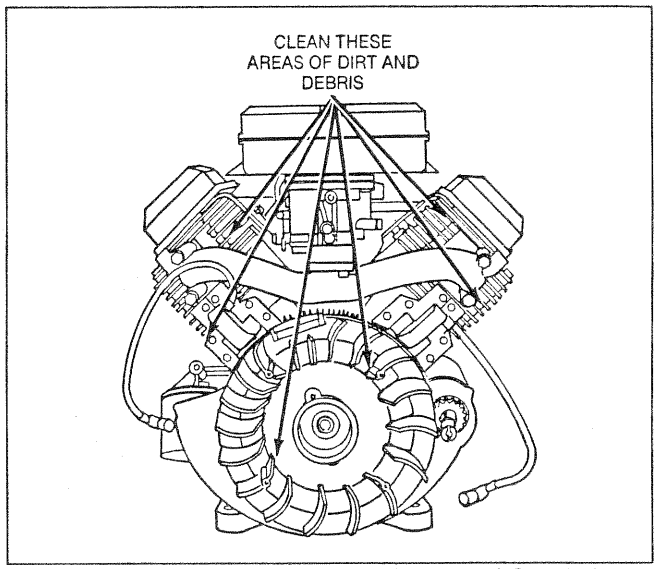


Figure 5. Areas to be Cleaned- Horizontal Crankshaft

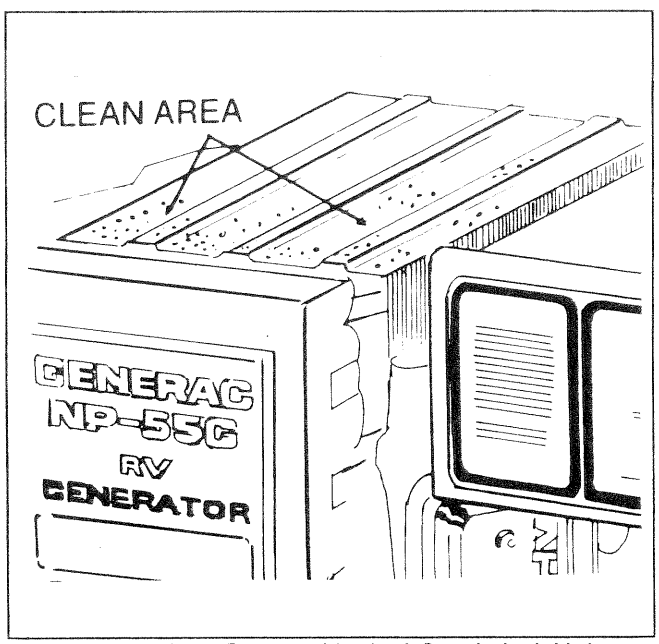


Figure 6. Air Inlet Screen- Vertical Crankshaft Unit

Tune-Up Procedures

STEP	TASK DESCRIPTION
1	Remove air cleaner and check for proper servicing.
2	Check oil level and drain oil. Also drain fuel, clean fuel tank and lines.
3	Remove blower housing and inspect recoil starter assembly (if so equipped).
4	Clean cooling fins and entire engine.
5	Remove carburetor, disassemble and inspect for wear or damage. Wash in solvent. Replace parts as required and reassemble. Set initial adjustment.
6	Inspect intake manifold for damaged gaskets.
7	Check governor, linkage and springs for damage and wear. Also check adjustment.
8	Remove flywheel. Check for oil seal leakage at both flywheel and PTO sides. Check flywheel key.

STEP	TASK DESCRIPTION
9	Check coils. Inspect all wires for breaks and/or damaged insulation. Check that lead wires do not touch the flywheel. Check stop switch and leads.
10	Install flywheel and set air gap. Check for spark with spark tester.
11	Remove cylinder heads and inspect gaskets. Remove spark plugs and clean carbon. Inspect valves for proper seating.
12	Install cylinder heads, tighten to specified torque. Set spark plug gaps or replace spark plugs, if necessary.
13	Replace oil and fuel.
14	Service air cleaner. Check gaskets, element and cartridge for damage.
15	Check exhaust muffler for restrictions and/or damage.
16	Run engine and adjust carburetor mixture (if required) and governed speed.

Overhaul Procedure

STEP	DISASSEMBLY PROCEDURE
1	Drain oil and remove oil filter.
2	Remove air cleaner; fuel lines, carburetor and linkage, carburetor intake manifold.
3	Remove muffler(s), exhaust manifold.
4	Check throttle shaft and bushings for wear.
5	Disassemble carburetor.
6	Remove electric starter (if so equipped). Remove blower housing.
7	Check compression.
8	Remove spark plugs. Clean them and set gap to 0.76mm (0.030 inch).
9	Inspect fuel tank.
10	Check armature to flywheel air gap.
11	Remove breather.
12	Check valve clearances.
13	Remove valves and springs. Remove rocker arms. Remove push rods. Remove cylinder heads and shields. Remove valve guides and seats.

STEP	DISASSEMBLY PROCEDURE
14	Remove recoil starter (if so equipped).
15	Remove flywheel.
16	Test coils and replace if necessary.
17	Check crankshaft end play.
18	Remove burrs from crankshaft extension.
19	Remove crankcase cover or sump.
20	Replace seals.
21	Remove mechanical governor parts.
22	Remove cam gear and tappets.
23	Remove connecting rods and pistons.
24	Remove crankshaft and inspect.
25	Remove and inspect oil pump.
26	Check cylinder bore and main bearing.
27	Disassemble connecting rods and bearings.
28	Inspect and check pistons, rings, connecting rods, piston pins.

Overhaul Procedure (Continued)

REPAIRS:

STEP	REPAIR
1	Clean all parts.
2	If required, resize cylinder bore to next oversize.
3	Replace intake and exhaust valve guides.
4	Reface valves and seats and lap.
5	Replace armature.
6	Repair carburetor.
7	Replace recoil starter spring and rope (if so equipped).
8	Replace main bearings.

REASSEMBLY:

STEP	REASSEMBLE
1	Tappets, crankshaft.
2	Cam gear.
3	Pistons, piston pins,
4	Mechanical governor.
5	Oil pump.
6	Sump or crankcase cover.
7	Flywheel and starter pulley.
8	Armature assembly.
9	Electric starter (if so equipped).
10	Adjust armature to flywheel air gap.
11	Check spark.
12	Breather.
13	Valves, springs, retainers, rocker arms.
14	Cylinder heads, push rods and shields.
15	Adjust valve clearances.
16	Exhaust manifold, muffler(s).
17	Intake manifold.
18	Carburetor, linkage and governor controls.
19	Check/adjust mechanical governor.
20	Blower housing/rewind starter (if so equipped).
21	Fuel filter parts, tank and fuel lines (as required in each case).
22	Spark plugs.
23	Clean and assemble air cleaner.
24	Fill crankcase with oil. Fuel supply. Start engine.
25	Adjust carburetor.
26	Retorque cylinder head screws.
27	Adjust governor.

Problem Solving

KINDS OF PROBLEMS:

Generally, problems that affect engine operation can be classified as one or a combination of the following:

- Engine will not start.
- Engine starts hard.
- Engine lacks power.
- Engine vibrates.
- Engine overheats.
- High oil consumption.

If the cause of an engine problem is not readily apparent, perform a check of the compression, ignition and carburetion systems. Such a check can be performed quickly and is the best method of determining the cause of a failure. In addition, the check may indicate the possible cause of future failures which can be corrected at this time.

CHECKING COMPRESSION:

Refer to Section 8, "Compression System", for proper procedures. If compression is poor, look for one or more of the possible causes:

Spark plug(s) loose.

- Cylinder head bolts are loose.
- Cylinder head gasket(s) have failed.
- Valves or valve seats are burned.
- Valve tappet clearances are inadequate.
- Cylinder head(s) are warped.
- Valve stem(s) are warped.
- Piston rings or cylinder bore worn or damaged.
- Connecting rod(s) broken.

IGNITION SYSTEM CHECKOUT:

Connect a spark tester to each spark plug wire. Ground the spark tester. Crank the engine and check for spark. If spark jumps the spark tester gap, you may assume the ignition system is functioning properly. Refer to "Ignition System" section for additional information.

If spark does NOT occur, the problem may be caused by one or more of the following:

- Incorrect armature air gap.
- Shorted or open run/stop switch wire.
- Shorted I.S.D. (ignition shutdown) module.
- Shorted start/stop switch.
- Armature failure.
- Interlock system malfunction.
- Fouled spark plugs.

If the engine runs, but misses during operation, install a spark tester between the spark plug wire and the spark plug. A spark miss will be easily seen.

CHECK CARBURETION:

Make sure the fuel tank is filled. Make sure the fuel shutoff valve (if so equipped) is open and fuel is flowing through the fuel line before starting the engine.

Gasoline Fuel System: Adjust carburetor needle valves as required. Make sure the choke closes all the way. If engine will not start, remove and inspect spark plugs. If plugs are WET, look for:

- Overchoking.
- Rich fuel mixture.
- Water in the fuel.
- Carburetor float needle sticking open.

If the spark plugs are DRY, look for:

- Carburetor mounting gaskets leaking.
- Gum or dirt in the carburetor, fuel line, or fuel tank.
- Carburetor float needle sticking closed.
- An inoperative fuel pump.
- Clogged fuel filter (if so equipped).

NOTE: One way to find out if fuel is reaching the engine combustion chamber is to remove either spark plug and pour a small quantity of gasoline into the spark plug hole. Install the spark plug. If the engine fires a few times and then stops, check for the same conditions as a dry spark plug.

Gaseous Fuel System: Some vertical crankshaft units may be equipped with an LP or natural gas fuel system. These units are currently used primarily in recreational vehicle (RV) and standby generator applications. Refer to "LP Gas Fuel System" and "Natural Gas Fuel System". Also see "Electrical System- RV Generators" and "Electrical System- Standby Generators".

Section 2 -CYLINDERS AND BEARINGS

Inspection

Always inspect the engine cylinder after the engine has been disassembled. A close visual inspection will reveal any cracks, stripped bolt holes, broken fins, damaged cylinder walls, etc. Use a telescoping gauge and a dial indicator, or an inside micrometer, to measure the size of the cylinder bore. Take measurements at right angles and at six points along the cylinder bore, as shown in Figure 7.

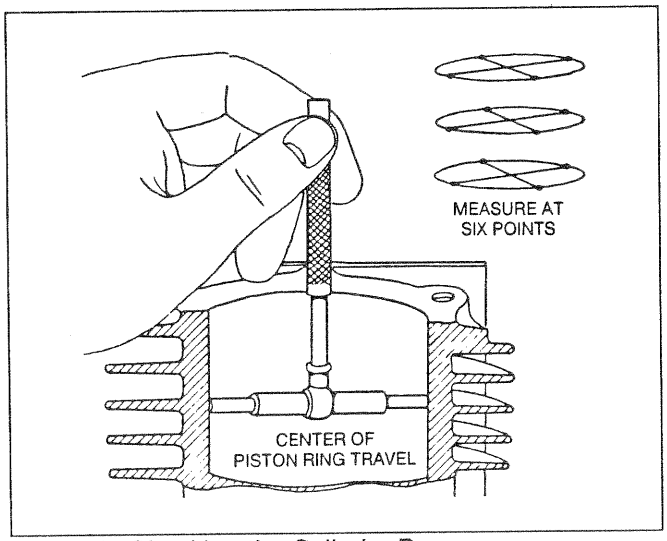


Figure 7. Checking the Cylinder Bore

The table below lists standard cylinder bore sizes. If the cylinder bore is (a) more than 0.076mm (0.003 inch) oversize, or (b) more than 0.038mm (0.0015 inch) out-of-round, it must be resized or replaced.

STANDARD CYLINDER BORE DIAMETER	
MAXIMUM	MINIMUM
68.025mm (2.768 in.)	68.000mm (2.677 in.)

Resizing

Always resize the cylinder bore to EXACTLY 0.25mm (0.010"), or 0.51mm (0.020"). or 0.76mm (0.030") over the standard size as shown in the "Standard Cylinder Bore Diameter" table above. If this is done accurately, the service oversize rings and pistons will fit and correct clearances will be maintained.

Cylinder bores can be resized with a good hone. Use the stones and lubrication recommended by the hone manufacturer to produce the proper cylinder bore finish.

NOTE: An acceptable honing oil can be made by mixing 4 parts of SAE 30 oil with 1 part kerosene. Automatic transmission fluid may also be used as a honing oil.

If a boring bar is used to resize the cylinder, a hone must be used after the boring operation is finished to produce the proper cylinder wall finish.

Honing is done with a portable electric drill and a honing fixture. Plans and dimensions for constructing your own honing fixture are shown in Figure 9 on next page.

SETUP FOR HONING:

Inspect cylinder bores at their top and bottom for burrs. All burrs must be removed. The cylinder head and the crankcase cover surfaces must be free of burrs and gasket material.

RESIZING THE BORE:

See Figure 8. Fasten the cylinder to a honing fixture as shown. Set the honing fixture and cylinder at a convenient work height and retain the fixture to prevent movement while honing. Install the hone drive shaft into chuck of drill and tighten securely.

Cut a wood block and place it inside the cylinder to prevent the hone from extending further than 19-25mm (3/4-1 inch) below the cylinder bore.

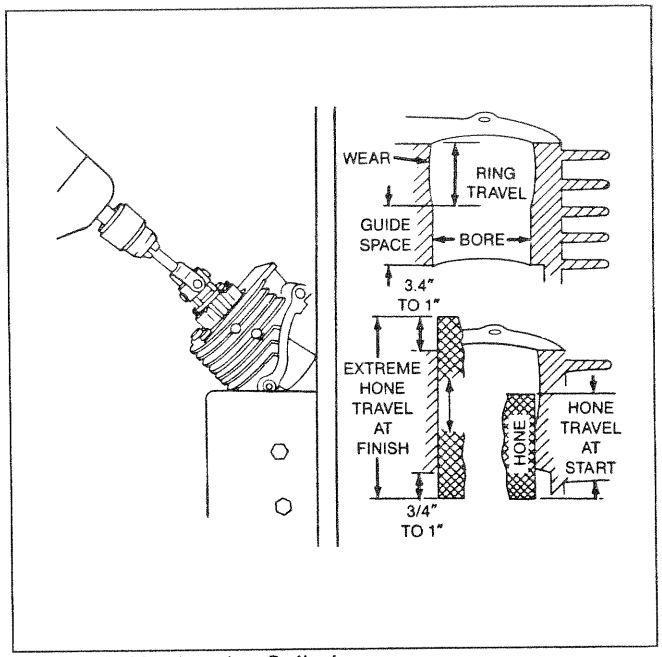


Figure 8. Honing the Cylinders

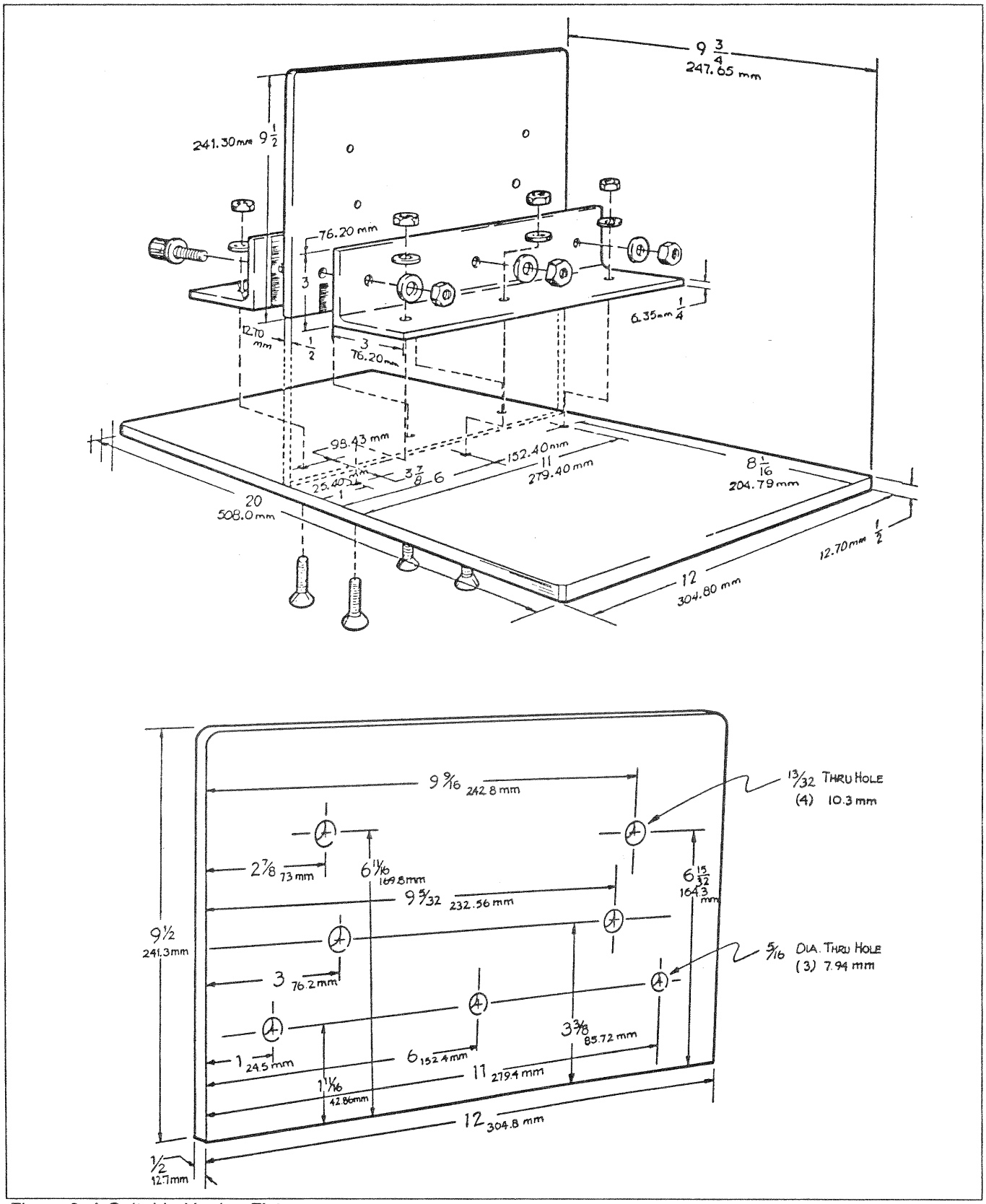


Figure 9. A Suitable Honing Fixture

Resizing (Continued)

TO HONE THE CYLINDER:

Hone the cylinder as follows:

- Place the hone in middle of cylinder bore.
- Tighten the adjusting knob with finger until stone fits snugly against cylinder wall. DO NOT FORCE.
- Connect drive shaft to the hone. Make sure cylinder and hone are centered and aligned with drive shaft and drill.
- Lubricate the hone as recommended by the hone manufacturer.
- Set portable drill to operate at 700 rpm maximum.
- Start the drill and, as the hone turns, move it up and down at bottom of cylinder, then gradually increase the up and down strokes. When honing the full length of the cylinder bore, honing stones should not extend more than 19-25mm (3/4"-1") beyond either end of cylinder bore.
- Each time the cutting tension decreases, stop the hone and tighten the adjusting knob (follow the hone manufacturer's recommendations).
- Check the cylinder bore frequently (Figure 7). ALWAYS HONE 0.25mm (0.010"), or 0.51mm (0.020"), or 0.76mm (0.030") ABOVE THE STANDARD DIMENSIONS GIVEN ON PAGE 11.

CYLINDER FINISH AND CLEANING:

The finish on the resized cylinder should have a crosshatch appearance (Figure 10). Using the proper stones, lubrication and drill speed during the last few strokes will produce this finish. Crosshatching is done to improve lubrication and ring rotation characteristics.

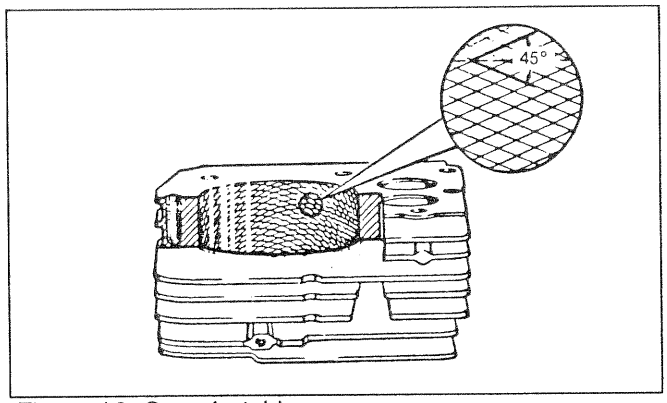


Figure 10. Crosshatching

After honing, the cylinder must be cleaned thoroughly. Wash the cylinder in a solvent such as kerosene or use a commercial solvent. Finally, use a brush, soap and hot water to finish cleaning the cylinder.

Magneto Bearing

CHECKING THE MAGNETO BEARING:

Remove the oil seal.

Replace the magneto bearing if scored or worn beyond **30.08mm (1.185 inch)**.

MAGNETO BEARING REMOVAL:

See Figure 11. Use a bearing pin driver (special tool) to drive the bearing locating pin into the crankcase.

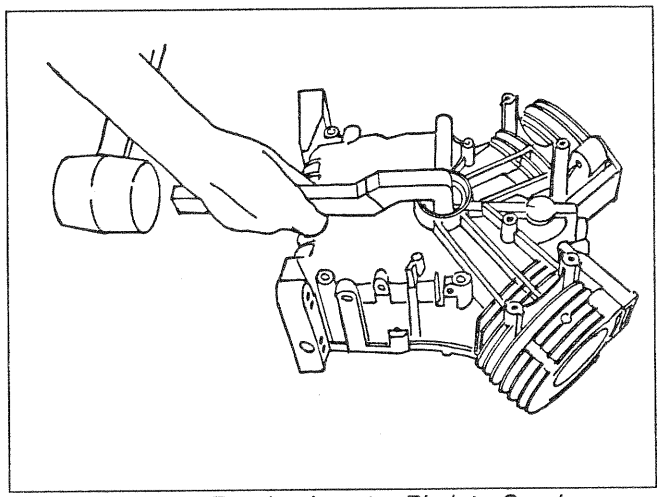


Figure 11. Drive Bearing Locator Pin into Crankcase

Place the cylinder on a cylinder support tool (special tool). Then, insert a bushing driver (special tool) into bushing and press the bushing out of the crankcase.

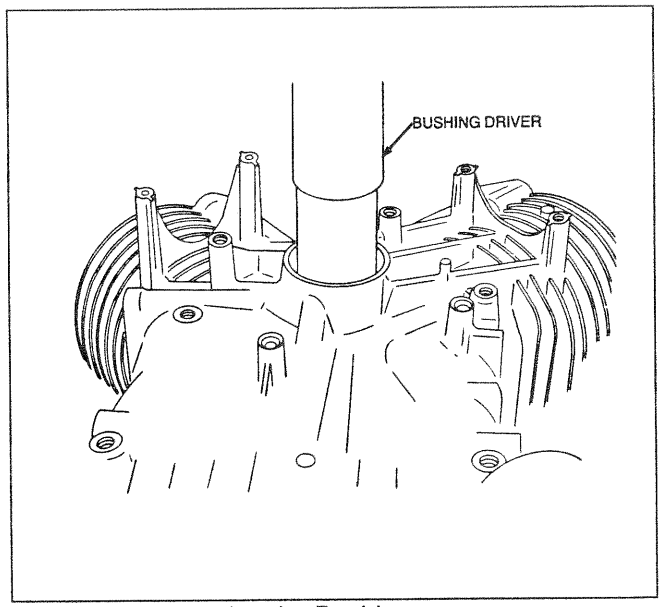


Figure 12. Removing the Bushing

Magneto Bearing (Continued)

MAGNETO BEARING INSTALLATION:

Place the cylinder on a cylinder support tool (special tool). Position the new replacement bushing against the counterbored bearing with its notched end away from the crankcase. This position will align the locating pin hole toward the top of the crankcase and the oil hole in bushing with oil hole in the crankcase. See Figure 13.

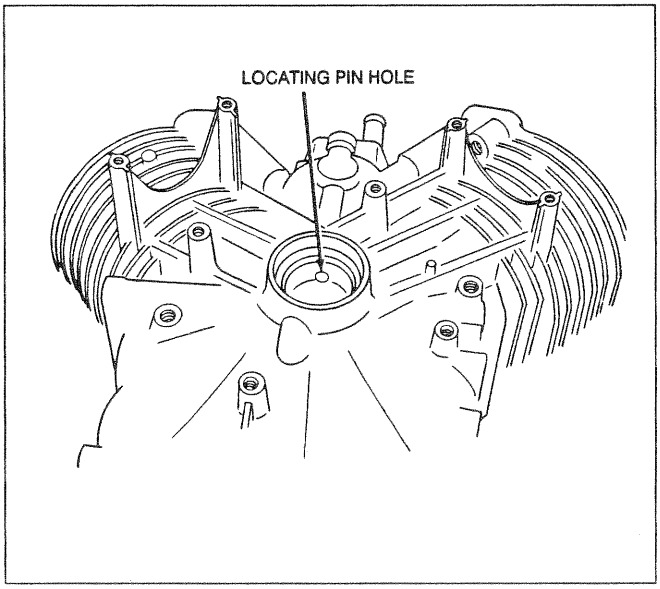


Figure 13. Installing the Bushing

PTO Ball Bearing

REMOVAL:

Remove the bearing seal.

Support the crankcase cover on work bench or on an arbor press and press the bearing out toward inside of the cover, using a bushing driver (special tool).

INSTALLATION:

Lubricate outside surface of bearing and place on inside of cover. Use an arbor press and a steel block or piece of pipe to press against outer face of bearing. EXERT PRESSURE ON BEARING OUTER RACE ONLY. Press the bearing into place until it is flush with surface of cover. Then, install the seal.

INSPECTION:

If the PTO bearing is scored or worn, the crankcase cover must be replaced. Replace the crankcase cover if bearing is less than **35.06mm (1.3805 inch)**.

Section 3 - CRANKSHAFT AND CAM GEARS

Cam Gear Removal

Before removing the crankcase cover, it is recommended that any rust, paint or burrs be removed from the power takeoff end of the crankshaft. This will reduce the possibility of damaging the oil seal in the crankcase cover or the bearing during removal.

Remove cylinder heads (see Section 8).

Remove the crankcase cover. If necessary, tap lightly with a soft hammer on alternate sides near the dowel pins. DO NOT REMOVE THE DOWEL PINS.

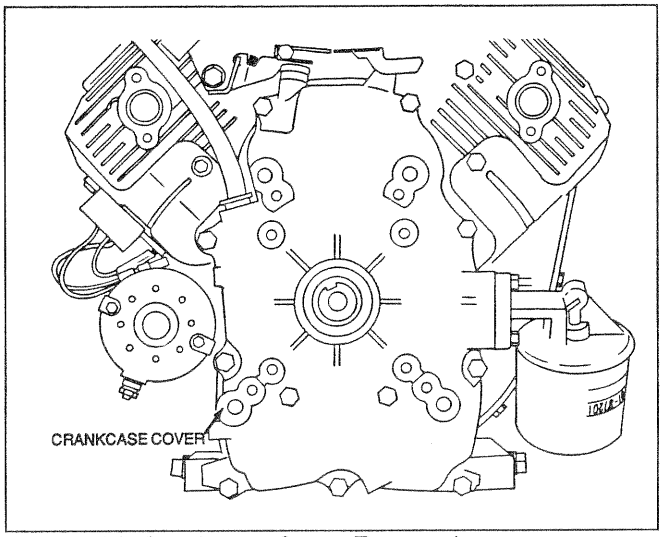


Figure 14. Crankcase Cover Removal

Tip engine over onto flywheel side of crankcase. Support the engine to prevent end of crankshaft from resting on workbench. Rotate crankshaft until timing marks are aligned. With cam gear in this position, valve tappets are clear of the cam lobes. Lift out the cam gear (Figure 15).

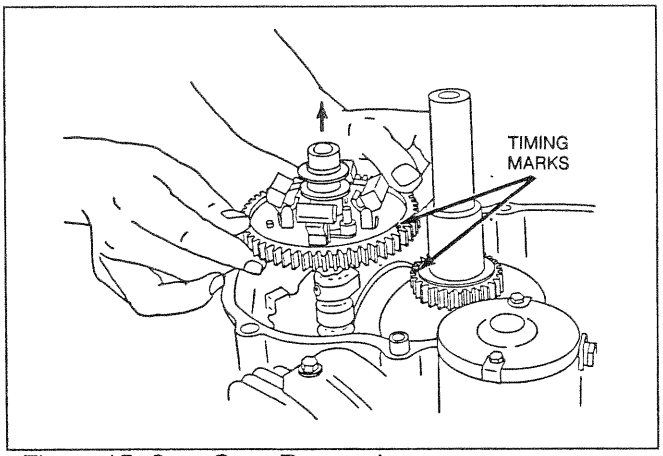


Figure 15. Cam Gear Removal

Crankshaft Removal

The engine flywheel, pistons and connecting rod assemblies must be removede before the crankshaft can be removed. See Section 4.

Mark the connecting rod caps to aid in reassembly. Remove piston and connecting rod assemblies. Finally, remove crankshaft from the crankcase.

Crankshaft Inspection

Reject sizes of the various wear points of the crankshaft are listed in the table below. Replace crankshaft if it is worn smaller than any of the sizes shown. Inspect keyways, make sure they are not worn or spread. Remove burrs from keyway edges to prevent scratching the bearing. Figure 16 shows the various points to check on the engine crankshaft.

NOTE: Connecting rods that are 0.51mm (0.020 inch) undersize are available for use on reground crankpin bearings. Complete instructions are included with the undersize connecting rod. Refer to the appropriate replacement parts list for the correct engine to find the right undersize rod.

Crankshaft Reject Sizes		
PTO JOURNAL	MAGNETO JOURNAL	CRANKSHAFT CRANKPIN
34.943mm 1.3757 in.)	29.95mm (1.179 in.)	36.957mm (1.455 in.)

Inspect timing gear teeth for chipping or cracking. Check keyway for wear. Replace crankshaft if timing gear is damaged.

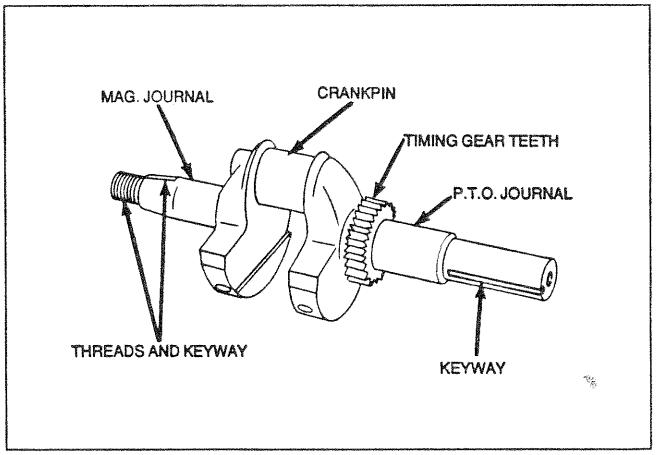


Figure 16. Points to Check on Crankshaft

Cam Gear Inspection

Carefully inspect the cam gear for wear, nicks, damage. See Figure 17. Reject sizes for cam gear journals and cam lobes are listed in the table that follows. All areas indicated in Figure 17 should be inspected for wear and freedom of movement.

Cam Gear Reject Sizes		
PTO JOURNAL	MAGNETO JOURNAL	CAM LOBES
19.913mm (0.784 in.)	15.913mm (0.627 in.)	30.25mm (1.191 in.)

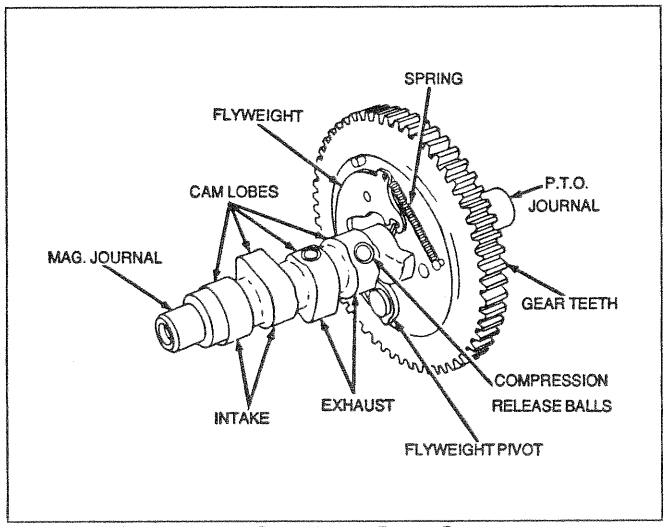


Figure 17. Points to Check on Cam Gear

Cleaning the Crankshaft

The crankshaft should be polished until polish lines over the entire journal are uniform (see Figure 18). The crankshaft must be thoroughly cleaned. Use a solvent, such as kerosene, to remove all emery residue.

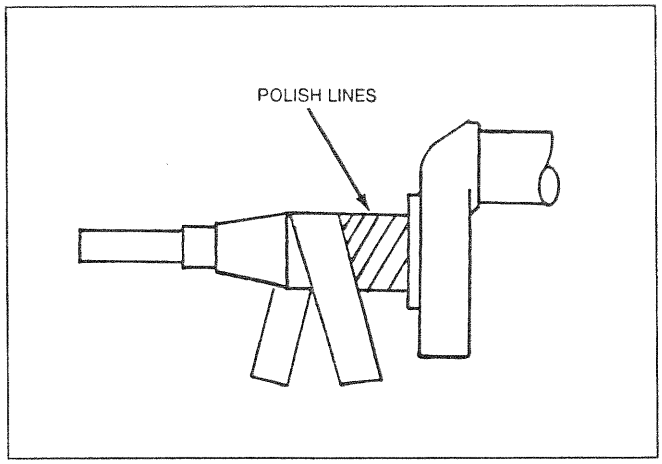


Figure 18. Polishing the Crankshaft Journal

Crankshaft Installation

Use the following procedure to install the crankshaft (see Figure 19):

- Install intake and exhaust valve tappets.
- Support both ends of the crankshaft and install into cylinder.
- Rotate the crankshaft until timing mark (Figure 19) is toward the cam gear side of the engine.

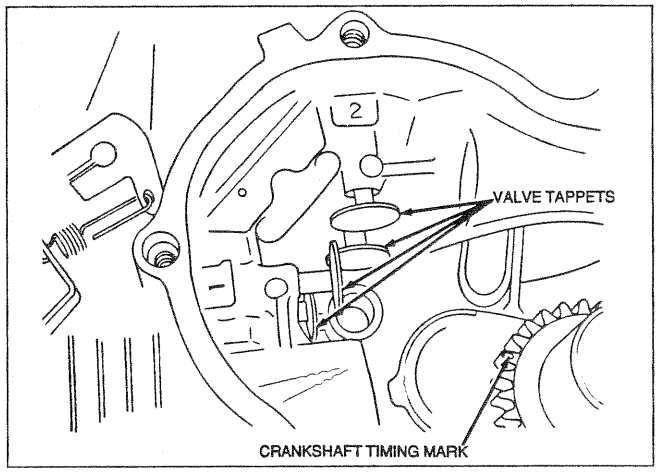


Figure 19. Positioning the Timing Mark

Cam Gear Installation

Install the cam gear as follows (see Figure 20):

- Install the cam gear. Make sure the valve tappets clear the cam lobes.
- Install the pistons and attach connecting rods to crankshaft (Section 4).
- Assemble the governor on the cam gear.
- Tip the engine to position the crankshaft horizontally.
- Turn governor shaft to its correct position (Section 9).
- Install crankcase cover (Section 9).
- Install cylinder heads and flywheel (Section 8).

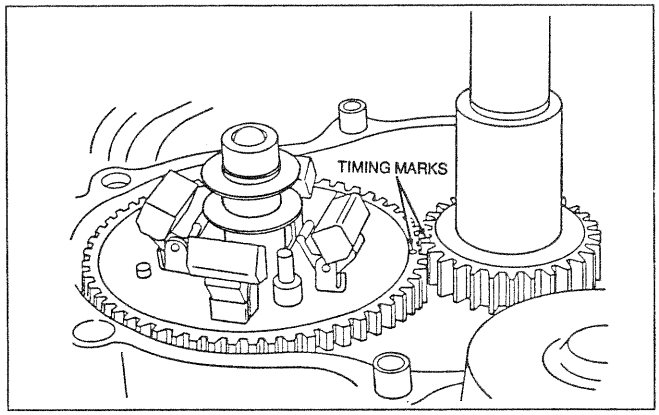


Figure 20. Aligning the Timing Marks

Section 4 - PISTONS, RINGS AND RODS

Piston and Connecting Rod Removal

NOTE: It is recommended that each rod, piston, piston pin and ring set be kept as a set for the cylinder from which it was removed. Mark each set before removing from the engine.

To remove the piston and connecting rod, first remove the connecting rod cap. Remove any carbon or any ridge from top of cylinder bore, to prevent ring breakage. Finally, push the piston and rod out through top of cylinder.

Connecting Rod Removal

The piston pin is a "push fit" in both the piston and rod. However, deposits may build up on the pin, requiring it to be pressed out. First, remove the piston pin locks with a screwdriver (Figure 21). Then, push the piston pin out and separate the piston and connecting rod.

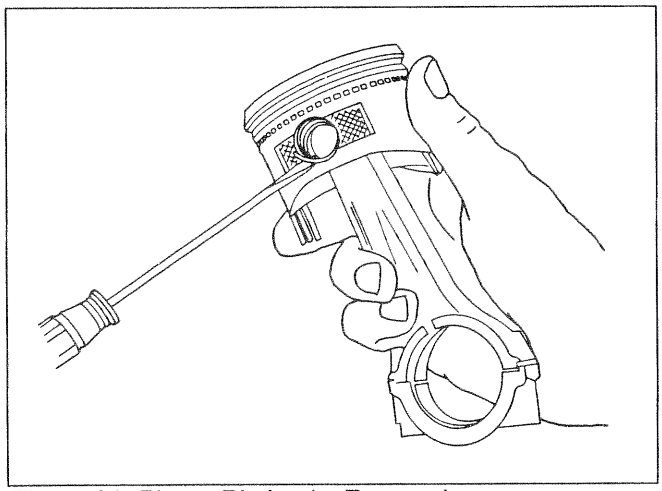


Figure 21. Piston Pin Locks Removal

Piston Rings Removal

Remove all piston rings one at a time, using a ring expander (Figure 22) to prevent damage to rings and piston.

Piston Inspection

NOTE: If the cylinder bore is to be resized, a new oversized piston will have to be installed and there is no reason to check the existing piston. See Section 2, "Cylinders and Bearings" for cylinder resizing instructions.

If a new oversize piston is not to be used, inspect the piston carefully. Replace any piston that shows signs of wear or scoring.

Clean carbon from the top ring groove in piston. Install a NEW piston ring into the ring groove. Use a feeler gauge to check clearance between the ring and the ring groove (Figure 23). Rejection criteria is as follows:

- If **compression ring** to groove clearance exceeds 0.10mm (0.004 inch), the piston is worn and should be replaced.
- If **oil ring** to groove clearance exceeds 0.20mm (0.008 inch), piston is worn and should be replaced.

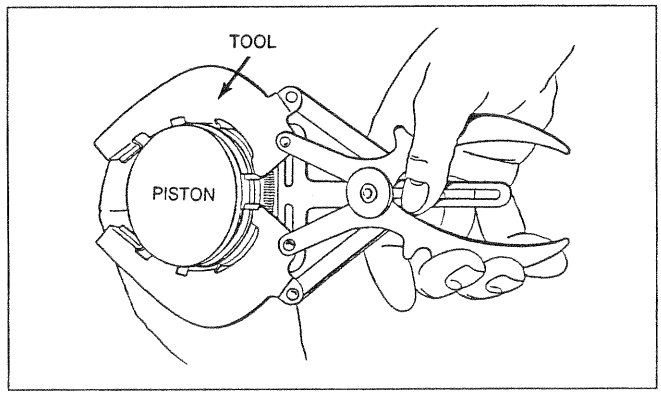


Figure 22. Removal of Piston Rings

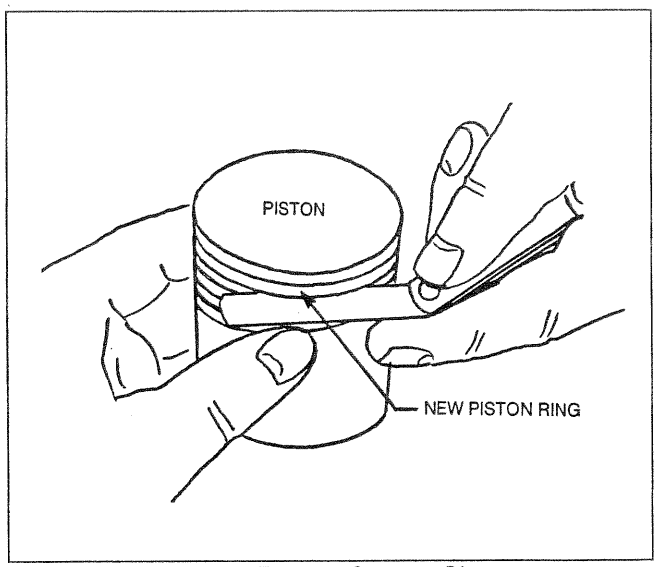


Figure 23. Checking Ring to Groove Clearances

Checking Piston Ring End Gap

Before attempting to check rin end gap, clean all carbon from ends of rings and from the cylinder bore. Then, check piston ring end gap as follows (Figure 24):

- Insert old piston rings one at a time and one inch down into the cylinder bore.
- Use a feeler gauge to check ring end gap as shown in Figure 24.
- If the ring gap is greater than shown in the following table, the ring should be replaced.

Ring End Gap Rejection Size	
COMPRESSION RING	OIL RING
0.76mm (0.030 inch)	0.76mm (0.030 inch)

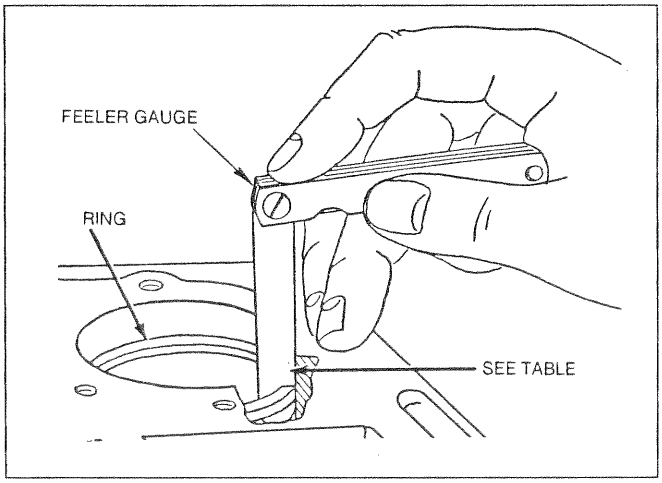


Figure 24. Checking Ring End Gap

Connecting Rod Inspection

Any scoring of the crankpin bearing in the connecting rod is cause for rod replacement. See Figure 25. Reject sizes of the crankpin bearing hole and the piston pin bearing hole are given in the table that follows.

If the connecting rod and piston have worn piston pin holes, piston pins are available that are 0.13mm (0.005 inch) OVERSIZE.

Check the crankpin bearing in the rod for wear. Also be sure to check the crankshaft crankpin for wear. DO NOT ATTEMPT TO FILE OR "FIT" THE CONNECTING ROD.

NOTE: Connecting rods having a crankpin bearing that is 0.51mm (0.020 inch) UNDERSIZE are available for use on reground crankpins. Complete instructions come with the undersize rod.

Connecting Rod Reject Size	
CRANKPIN BEARING	PISTON PIN BEARING
37.109mm (1.461 inch)	17.081mm (0.6725 inch)

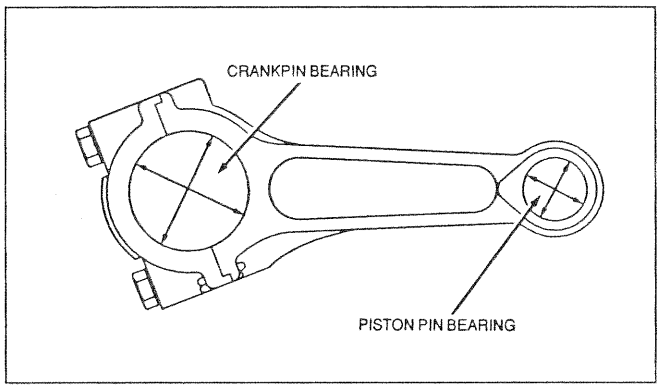


Figure 25. Connecting Rod Bearings

Piston Pin and Piston Pin Bore

If the piston pin is worn 0.01mm (0.0005 inch) out of round or more, it should be replaced.

If the piston pin bore is worn above the reject size, an OVERSIZE piston pin is available (0.13mm or 0.005 inch oversize).

Piston Pin & Piston Pin Bore	
PISTON PIN	PISTON PIN BORE
17.056mm (0.6715 inch)	17.109mm (0.6736 inch)

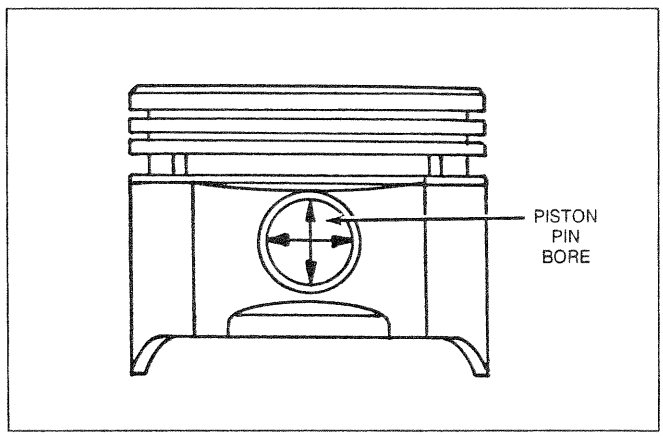


Figure 26. Piston Pin Bore

Piston and Connecting Rod Assembly

The piston pin is a slip fit in both the piston and the connecting rod. Assemble the connecting rod to the piston as follows:

- Install a piston pin lock ring into groove on one side of the piston.
- Align the connecting rod with the notch on the piston as shown in Figure 27.
- Install the piston pin through piston pin bore in piston and through the piston pin bore in connecting rod. Push the piston pin in until it stops against the piston pin lock ring.
- Use a pair of needle nose pliers or a screwdriver to install the second piston pin lock ring into the piston lock groove.
- Make sure that both lock rings are firmly set into their lock grooves on the piston.
- Make sure the connecting rod is properly aligned with the notch on the piston as shown in Figure 27.

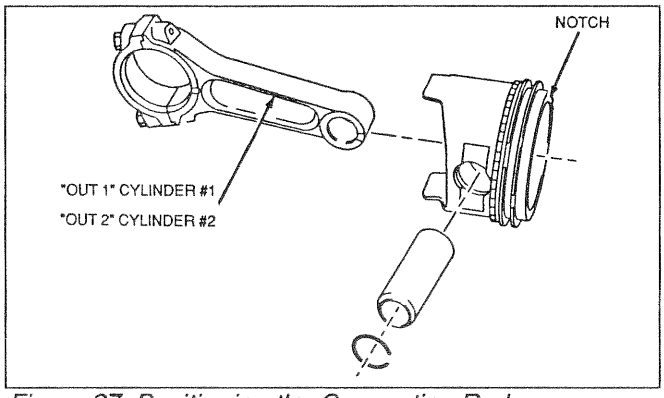


Figure 27. Positioning the Connecting Rod

Installing Piston Rings

Figure 28 shows the correct positioning for the rings. The oil ring must be installed with its expander between the two rails of the ring. The top and second compression rings must be installed with the letter "T" toward top of piston.

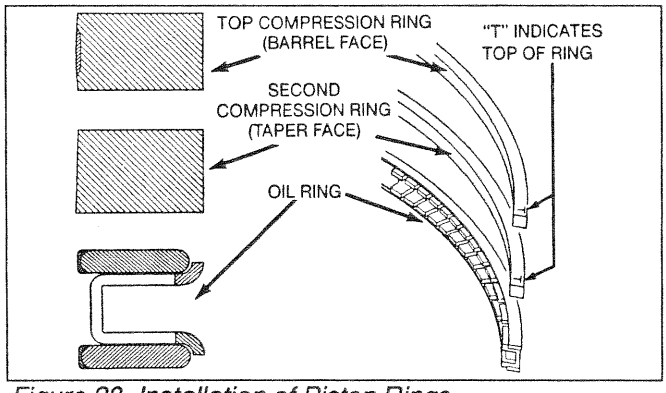


Figure 28. Installation of Piston Rings

Piston and Rod Installation

Apply clean, fresh engine oil to piston rings and to piston skirt. Use a ring compressor to compress the rings into the piston ring grooves. Then, install the piston and rod into the cylinder bore as follows:

- Place the piston (with ring compressor installed) upside down on a bench. Push down until end of ring compressor is even with the piston head.
- Tighten ring compressor until all rings are fully compressed. Then, loosen the ring compressor very slightly.

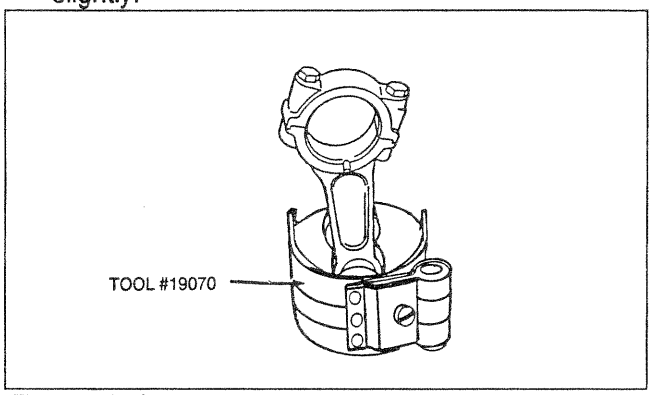


Figure 29. Compressing the Rings

- Thoroughly clean the cylinder bore.
- Apply clean, fresh engine oil to the cylinder bore.
- Rotate the crankshaft until its crankpin journal is at bottom of stroke. This will permit complete entry of the piston and rod assembly when they are pushed down through the cylinder.

NOTE: Pistons have offset piston pin bores. When notch on piston is facing toward the flywheel side of engine, the words "OUT1" for cylinder No. 1, and "OUT2" for cylinder No. 2 should face toward the PTO end of the crankcase. See Figure 30.

- Insert connecting rod and piston down through cylinder bore, with positioning correct as shown in Figure 30. As the piston enters the cylinder bore, the ring compressor will be pushed off the piston. When all rings are in the cylinder bore, remove the ring compressor.
- Repeat the installation procedure for the second piston and connecting rod assembly.
- Clean and oil the crankshaft crankpins.
- Pull the connecting rod against the crankpin , then install the connecting rod cap with its match marks aligned (Figure 32).
- Install the connecting rod screws. Tighten connecting rod screws to 13 N-m (115 inch-pounds).
- Install the second connecting rod cap in the same manner as the first.

Piston and Rod Installation (Continued)

- Rotate the crankshaft two revolutions and check for binding.
- Make sure the rod is free to slide sideways on the crankpin.

CAUTION: Failure to use a torque wrench and failure to apply the proper torque can result in excessively loose or tight rods. Loose rods will break. Tight rods will cause scoring.

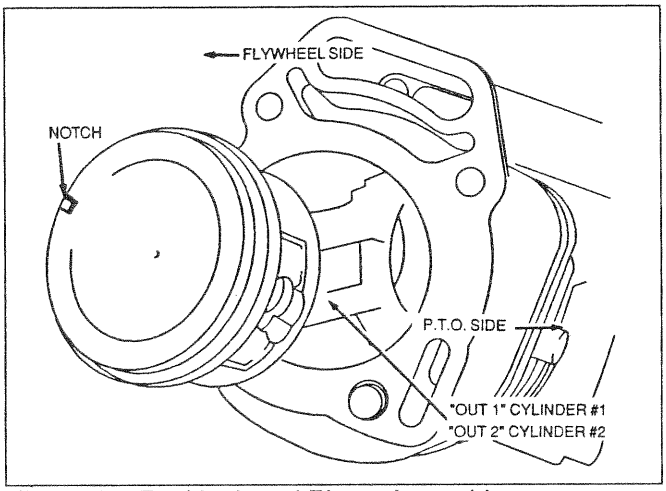


Figure 30. Positioning of Piston Assembly

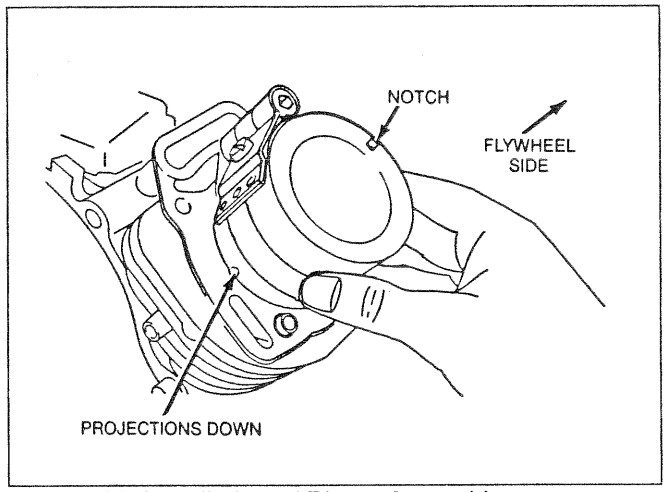


Figure 31. Installation of Piston Assembly

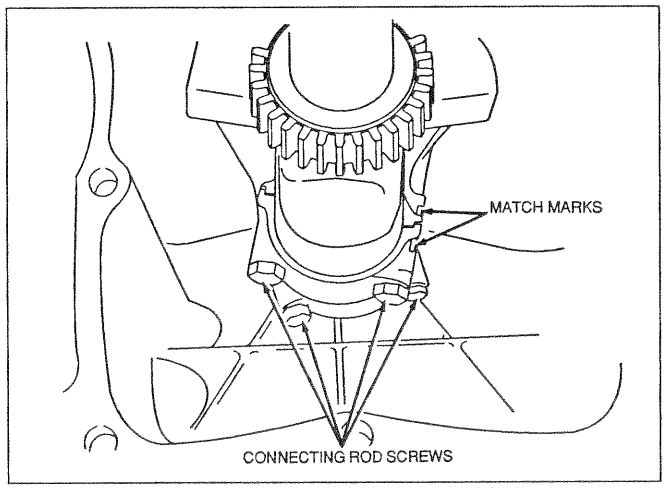


Figure 32. Connecting Rod Cap Match Marks

Section 5 - LUBRICATION SYSTEM

Introduction

Engine lubricating oil serves four functions. It (a) cools, (b) cleans, (c) seals, and (d) lubricates. The "V-Twin" engines are lubricated by means of a gear-driven oil pump.

Oil Recommendations

For recommended oils, refer to "Recommended Oil" on Page 4. Crankcase oil capacity of the engine is:

- 1.65 liters (3-1/2 U.S. pints) with oil filter change.
- 1.42 liters (3 U.S. pints) without oil filter change.

CAUTION: DO NOT OVERFILL CRANKCASE. Check and maintain oil level regularly. Change oil after the first eight hours of operation.

Extended Oil Fill and Dipsticks

UNITS WITH HORIZONTAL CRANKSHAFT:

Engines with horizontal crankshaft generally use an extended oil fill tube with screw-in dipstick and locator bracket. The oil fill tube is pressed into a rubber grommet in the cylinder block. See Figure 33. When installing the oil fill tube, push down firmly on tube until it seats in the sealing grommet. While pushing down on tube, install oil filler bracket and two screws.

UNITS WITH VERTICAL CRANKSHAFT:

Units with vertical crankshaft, usually used in RV and standby applications, are equipped with a combination oil fill tube and drain assembly as shown in Figure 34. A capped hose attaches to the assembly to permit oil to be drained with a minimum of spillage.

NOTE: Should leakage occur between the oil fill and drain tube and the oil sump, loss of crankcase vacuum and discharge of oil or smoke through the exhaust muffler can occur.

CAUTION: Owners and operators should be cautioned not to overfill the engine crankcase with oil. Overfilling with oil can cause a smoking or overheating condition because of oil foaming.

Breathers

Engine is equipped with a breather valve, designed to maintain a vacuum in the crankcase. The breather valve is a fiber disc which closes on the piston's upward stroke and opens on the piston's downward stroke. This vacuum prevents oil leakage past piston rings, valve guides, oil seals, governor shaft and gaskets.

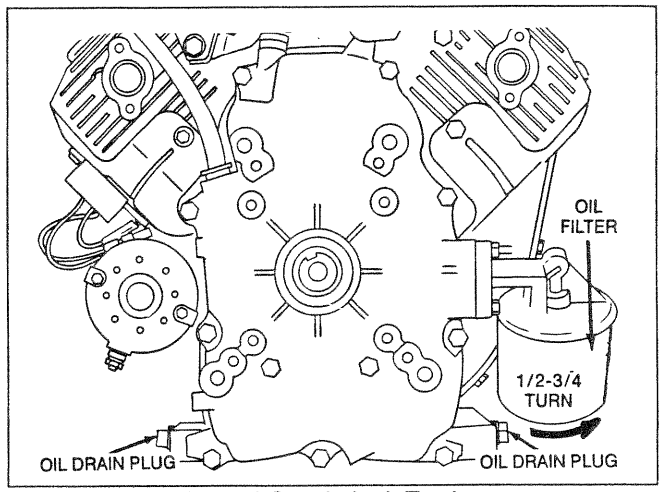


Figure 33. Horizontal Crankshaft Engine

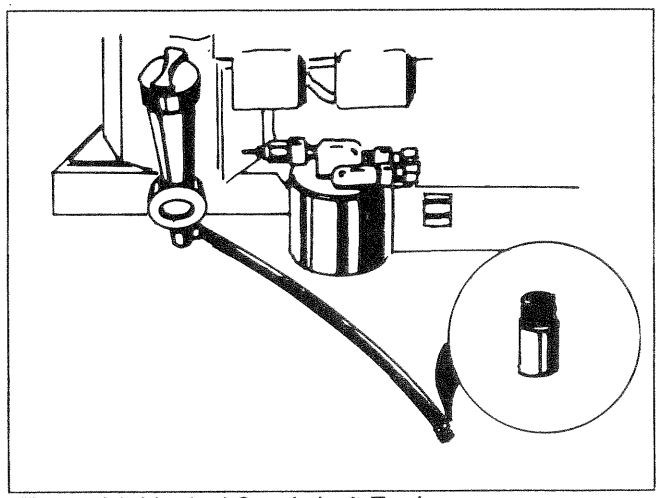


Figure 34. Vertical Crankshaft Engine

BREATHER VALVE REMOVAL:

See Figure 35. To remove the breather valve assembly, the air cleaner, back cover and support bracket must be removed. Finally, remove the breather.

BREATHER INSPECTION:

A sticking or binding fiber disc will result in failure of the breather to operate properly.

Use a 1.14mm (0.045 inch) wire gauge to check the breather (Figure 36). The wire gauge should not be able to enter the spacer between the fiber disc valve and the breather body. DO NOT FORCE THE GAUGE.

Breathers (Continued)

CAUTION: The fiber disc is held in place by an internal bracket. That bracket will be distorted if pressure is applied to the fiber disc valve. For that reason, do not force when checking with wire gauge.

Always use a new gasket when the breather has been removed for any reason. Tighten breather screw to a torque of 3 N-m (30 inch-pounds).

Breathers are vented through the air cleaner to prevent dirt from entering the crankcase. Make sure the vent tube is not damaged and is sealed properly.

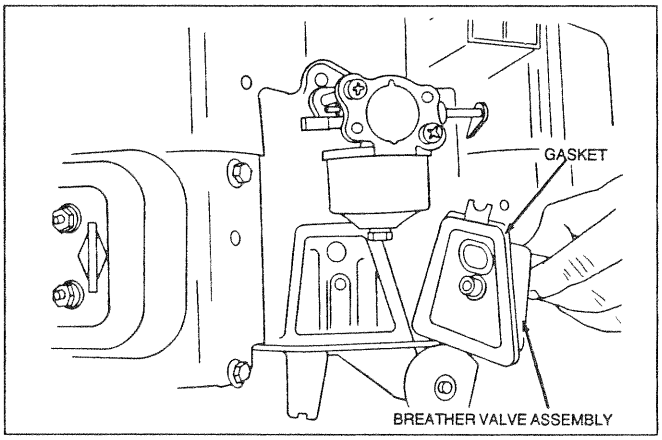


Figure 35. Breather Valve Removal

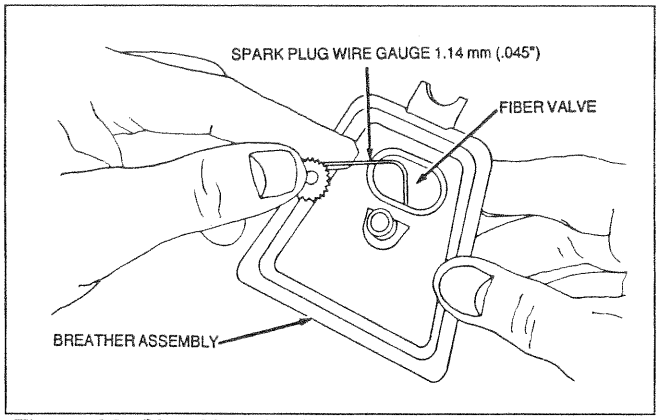


Figure 36. Checking the Breather

BREATHER INSTALLATION:

When installing the breather, its gasket must be located properly (Figure 37). Place the breather on its gasket. Slide washer and small o-ring on the mounting screw. Position the large o-ring on the cover, then install screw through cover and into crankcase. Tighten screw to 3 N-m (30 inch-pounds).

See Figure 38.

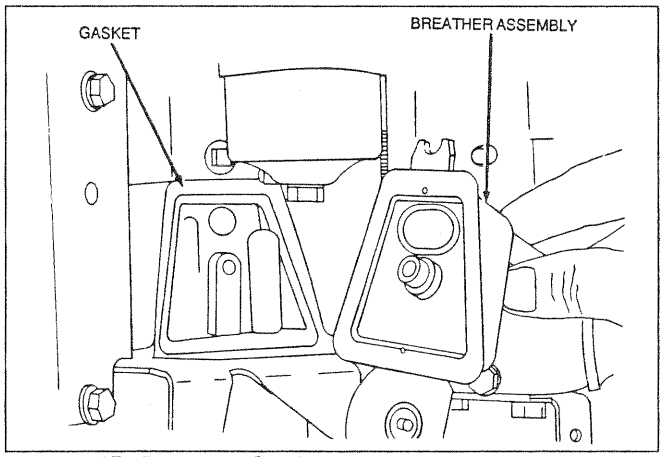


Figure 37. Breather Gasket Location

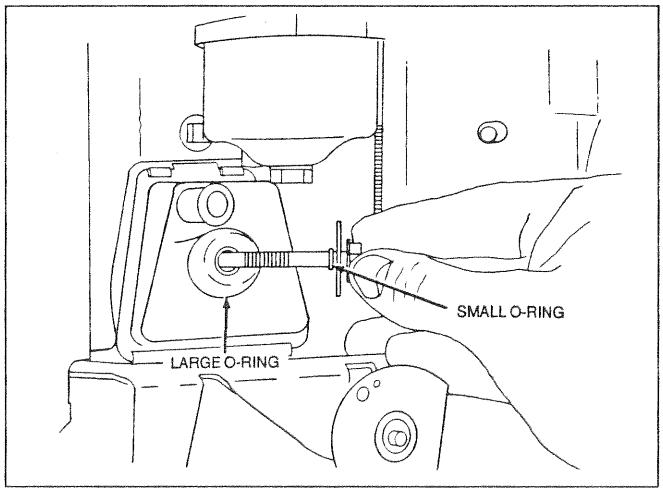


Figure 38. Breather Installation

BREATHER TUBE INSPECTION:

Inspect the breather tube for cracks, holes, hardening, damage. Replace if defective. See See Figure 39.

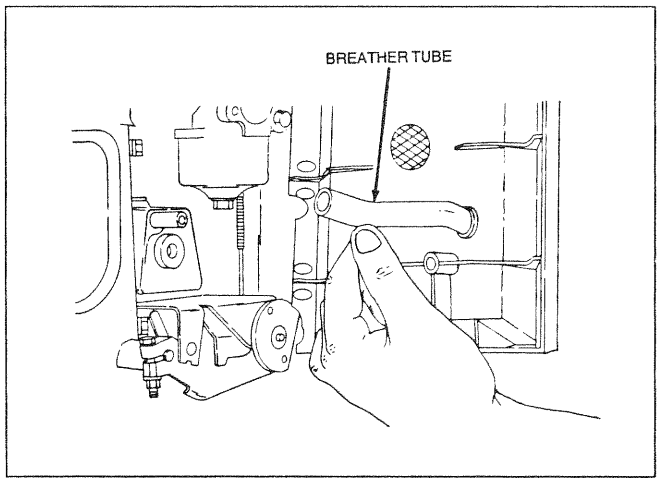


Figure 39. Breather Tube Inspection

Oil Pump

GENERAL:

The oil pump supplies oil to the crankshaft main bearings, connecting rod crankpin bearings and cam gear bearings.

OIL PUMP REMOVAL:

The oil pump is attached to the inside of the crankcase cover. To remove the pump, first remove the crankcase cover. Then, remove the windage plate (Figure 40). Remove two screws that retain the oil pump to the crankcase cover (Figure 41).

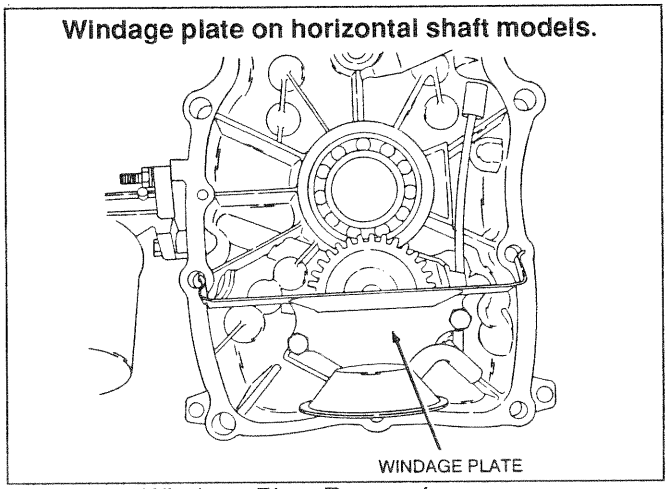


Figure 40. Windage Plate Removal

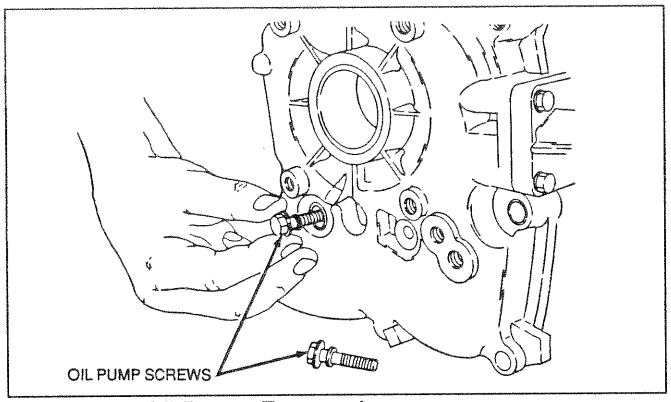


Figure 41. Oil Pump Removal

OIL PUMP DISASSEMBLY:

See Figure 42. Remove pickup screen and tube. Clean them thoroughly. The outer pump rotor can also be removed for cleaning.

OIL PUMP CLEANING AND INSPECTION:

Inspect pump drive gear for obvious wear, chipped teeth. Inspect pump rotors, housing and crankcase cover for wear or scoring.

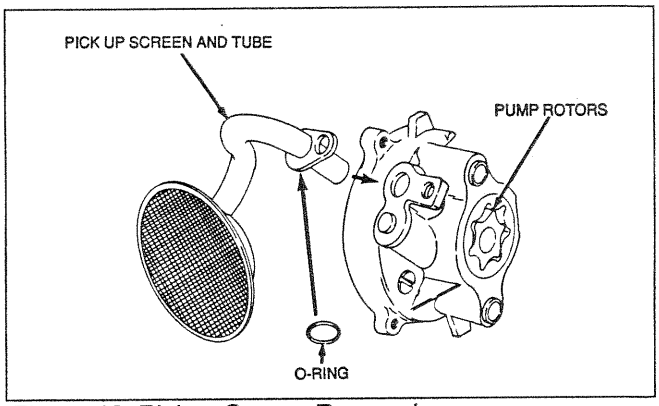


Figure 42. Pickup Screen Removal

OIL PUMP ASSEMBLY:

- Lubricate the pump outer rotor with clean, fresh engine oil and install into pump with dimples aligned (Figure 43).
- Install pickup screen and tube and a new o-ring onto pump.
- Attach oil pump to the crankcase cover. Tighten oil pump screws to 7 N-m (65 inch-pounds).
- Install windage plate (horizontal shaft models).

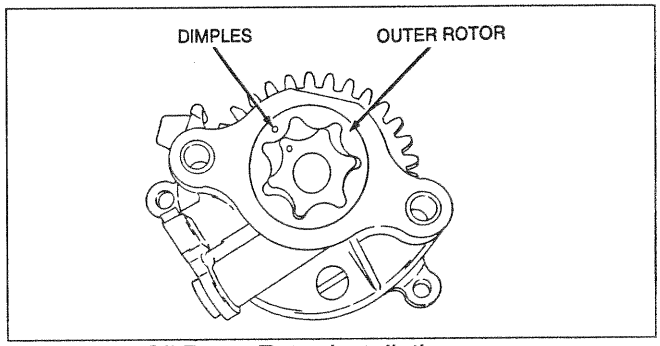


Figure 43. Oil Pump Rotor Installation

Low Oil Pressure Switch

SWITCH REMOVAL AND TESTING:

Unscrew switch to remove for testing.

To test the switch, proceed as follows:

- Set a volt-ohm-milliammeter (VOM) to its "Rx1" scale and zero the meter.
- Connect one VOM test lead to the switch terminal, the other test lead to metal body of switch.
- When no pressure is applied to switch, the VOM should read continuity.
- Switch contacts should open and VOM should read infinity when approximately 0.32 kg/cm^2 (4.5 psi) and above is applied to the switch.
- Operate engine and check the switch for leaks.

Low Oil Pressure Switch (Continued)

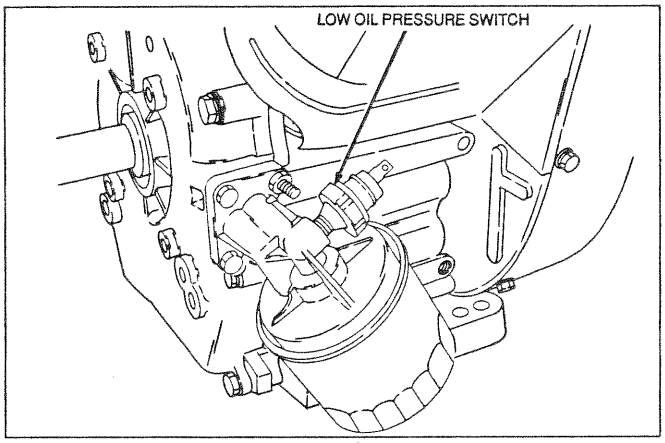


Figure 44. Low Oil Pressure Switch

Optional High Oil Temperature Switch

GENERAL:

Some units may be equipped with a high oil temperature switch (Figure 45). Should oil temperature exceed approximately 140° C. (284° F.), the switch contacts will close to effect an engine shutdown.

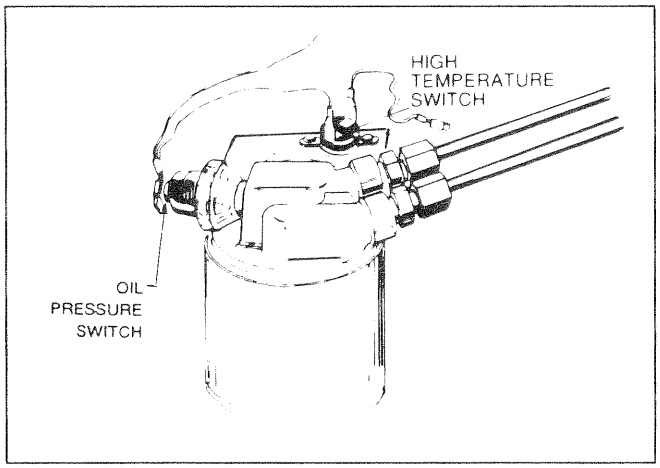


Figure 45. High Oil Temperature Switch

SWITCH REMOVAL AND TESTING:

To remove the switch, unscrew it.

Use a volt-ohm-milliammeter (VOM) to test the switch. Connect one VOM test lead to the switch terminal, the other test lead to metal body of switch. At normal temperatures, the VOM should read infinity. The switch contacts should close and the VOM should read continuity at temperatures above approximately 140° C. (284° F.).

Optional Oil Makeup System

PURPOSE:

Some units may be equipped with an optional oil makeup system. This system functions to help prevent dangerously low engine oil levels during long operating periods. The oil makeup system will NOT prevent serious engine damage if the unit is started before it has been properly serviced with oil.

CAUTION: Before starting the engine, it must be properly serviced with the recommended oil. Both the engine crankcase and the oil makeup tank must be properly serviced with oil. Any attempt to crank or start the engine before the crankcase is serviced with oil will result in an engine failure.

DESCRIPTION:

See Figure 46. The optional oil makeup system consists of (a) an oil makeup TANK, (b) an oil makeup PUMP, (c) an oil makeup PROBE, (d) a float operated SWITCH, and (e) interconnecting lines and fittings.

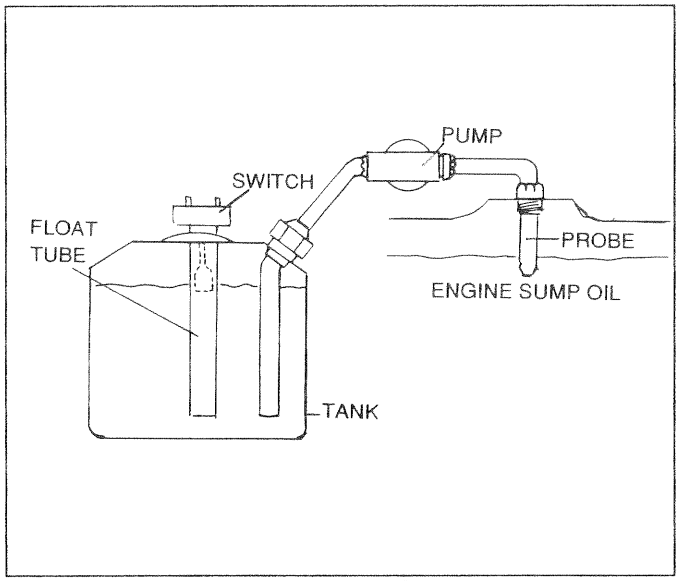


Figure 46. Optional Oil Makeup System

OPERATION:

The oil makeup PROBE extends into the engine crankcase. When oil is at a safe level, the probe tip is immersed in oil. Should oil level drop below the probe tip, however, crankcase vacuum pulses will operate the oil makeup PUMP. The diaphragm type pump will draw oil from the oil makeup TANK and deliver it through the hollow probe tip to the engine crankcase. Pump operation and oil replenishment will continue until the probe tip is again immersed in oil.

Optional Oil Makeup System (Continued)

SERVICING:

The most common oil makeup tank, used on V-twin standby generator units, has a 2.5 U.S. quart capacity. The tank should be filled with the same type and grade of oil used in the engine crankcase. See "Recommended Oil" on Page 4 of this manual.

NOTE: Any leak in the system that results in loss of crankcase vacuum will result in failure of the oil makeup system to replenish oil levels. This includes a defective breather valve, leaking oil fill tube, etc.

Section 6 - ELECTRIC STARTERS

Introduction

The V-Twin engine may be equipped with (a) a recoil starter only, (b) a recoil plus an electric starter, or (c) an electric starter only. See "Specifications" on Page 2.

When an electric starter is installed, it is the 12 volts d-c type requiring a 12 volts automotive or utility type battery for its operation. Refer to the Owner's Manual for each particular generator set for battery recommendations.

Description

Starter motors used on the V-Twin engines utilize a gear type engagement system, similar to that used on automotive systems. When the starter operates, a pinion gear on its shaft moves into engagement with the engine flywheel ring gear to crank the engine. Figures 47 and 48 show the starter motor locations for a typical horizontal shaft and vertical shaft engine.

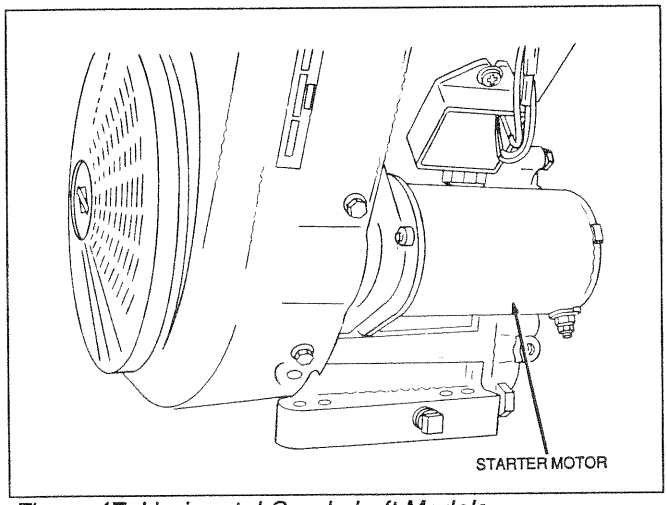


Figure 47. Horizontal Crankshaft Models

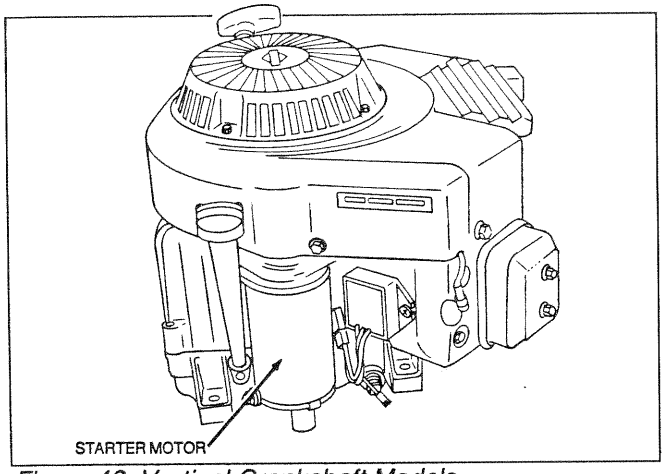


Figure 48. Vertical Crankshaft Models

Troubleshooting

If a starting problem is encountered, check the engine to eliminate it as a cause of the problem. Remove the spark plug and crank the engine over by hand, if possible, to make sure it rotates freely.

IF ENGINE CRANKS SLOWLY:

- Make sure the attached generator is at no-load condition.
- Check for binding or rubbing in engine and generator.
- Check for a discharged battery.
- Check for loose, corroded or defective battery cables.
- Dirty of worn starter motor commutator, bearing, weak magnets, etc.
- Worn starter brushes or weak brush springs.
- Wrong oil viscosity used in engine (oil too thick).
- Battery cables too long or too small.
- Battery too small.

ENGINE WILL NOT CRANK:

- Discharged or defective battery.
- Faulty electrical connections.
- Faulty starter switch.
- Open circuit in starter motor.
- Starter brushes sticking, worn or defective.
- Malfunction in engine electrical system (See Section 15, 16 or 17 as applicable).

STARTER MOTOR SPINS BUT DOES NOT CRANK:

- Starter pinion gear sticking (dirty).
- Starter pinion or ring gear damaged.
- Incorrect rotation due to reversed motor polarity. Motor should rotate counterclockwise as viewed from pinion gear end.

STARTER MOTOR SPINS, WILL NOT STOP:

The starter switch is probably defective. Test switch and replace if necessary.

Batteries

Battery requirements for engines used with portable generators and engines used with RV or standby generators may be quite different. Refer to the Owner's Manual for the particular generator for battery recommendations.

Batteries (Continued)

BATTERY SAFETY:

Storage batteries give off explosive hydrogen gas while charging. In addition, battery electrolyte fluid is highly caustic and can cause severe burns. The following safety precautions should always be complied with when handling storage batteries:

DANGER: STORAGE BATTERIES GIVE OFF EXPLOSIVE HYDROGEN GAS. DO NOT PERMIT SMOKING, OPEN FLAME, OR SPARKS NEAR A BATTERY. THESE CAN CAUSE AN EXPLOSION. STORAGE BATTERIES CAN EXPLODE WITH GREAT FORCE. SUCH EXPLOSION CAN CAUSE BLINDNESS OR SERIOUS INJURY.

DANGER: BATTERY FLUID IS AN EXTREMELY CAUSTIC SULFURIC ACID SOLUTION THAT CAN CAUSE SEVERE BURNS. DO NOT PERMIT FLUID TO CONTACT EYES, SKIN, CLOTHING, PAINTED SURFACES, WIRING INSULATION, ETC. IF SPILLAGE OCCURS, FLUSH THE AFFECTED AREA IMMEDIATELY WITH CLEAR WATER.

CAUTION: BEFORE SERVICING, ALWAYS DISCONNECT THE NEGATIVE (-) BATTERY CABLE FIRST, FOLLOWED BY THE POSITIVE (+) BATTERY CABLE.

CAUTION: BEFORE CONNECTING THE BATTERY TO A BATTERY CHARGER, ALWAYS DISCONNECT BATTERY CABLES AND REMOVE THE BATTERY FROM THE GENERATOR SET.

CHECKING THE BATTERY:

1. Visual Inspection
   a. Check for evidence of dirt and corrosion. Clean battery if necessary.
   b. Check cables, terminal and clamps for cleanliness, corrosion and tightness.
2. Charge battery to a 100% state of charge.
   a. Use a taper charger which automatically reduces the charge rate as battery state of charge improves.
   b. Fill battery cells with distilled water.
3. With battery fully charged, check specific gravity of fluid in each battery cell with a battery hydrometer. Record all readings.
   a. All readings should be above 1.250 (compensate for temperature).
   b. If the specific gravity difference between the highest and lowest reading cell differed by more than 0.50, replace the battery.
   c. If all cells (after charging) read less than 1.225, replace the battery.
4. Battery Voltage Test
   a. Attach leads of a d-c voltmeter to the battery posts.
      (1) Connect positive lead to positive battery post.
      (2) Connect negative lead to negative battery post.
   b. Prevent the engine from starting and crank the engine.
      (1) Voltmeter should read 9 volts or more while cranking engine.
      (2) If less than 9 volts while cranking, replace the battery.

STARTER SYSTEM TEST DEVICES:

The following test devices are available commercially and may be used to test the electric start system:

- A Volt-Ohm-Milliammeter (VOM).
- A "growler" or armature tester.
- A known good 12 volts battery (required for some tests).
- A tachometer that can measure about 10,000 revolutions per minute.
- A starter motor test bracket can be made, if desired, as shown in Figure 49.

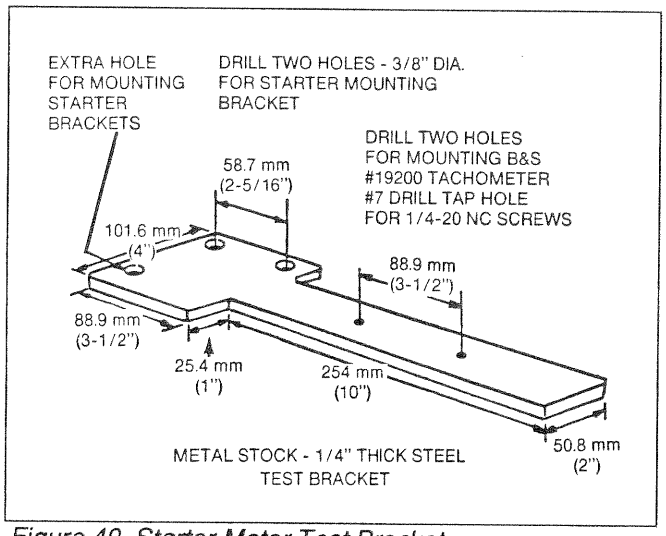


Figure 49. Starter Motor Test Bracket

Checking Starter Motor Performance

EQUIPMENT NEEDED:

- A tachometer capable of reading about 10,000 rpm.
- An ammeter capable of reading 0 to 100 DC amperes.

Checking Starter Motor Performance (Continued)

PROCEDURE:

- Connect the starter motor, battery and ammeter as shown in Figure 50.

CAUTION: DO NOT clamp the starter motor housing in a vise or strike with a steel hammer. Starter motors contain two powerful ceramic magnets which can be broken or cracked if the motor housing is dented or deformed.

- Operate the starter motor and note readings of tachometer and ammeter. A starter motor in good condition will be within the test specifications listed below:

Minimum Motor RPM - 6500
Maximum amperes - 35

If the starter motor does not perform satisfactorily, check the following and correct as necessary:

- Starter motor bearings binding or seizing.
- Starter motor brushes sticking in brush holders.
- Dirty or worn armature commutator or brushes.
- A shorted, open or grounded armature.

The following general rules apply:

1. A shorted armature will be indicated by low or no rpm. A shorted armature means that wire insulation is worn and wires are touching one another.
2. An open armature (broken wire) will be indicated by low or no rpm.
3. A grounded armature will be indicated by excessive current draw and low or no rpm.

Inspect Starter Motor Drive

When the starter motor is energized, the pinion gear should move outward to engage the flywheel ring gear and crank the engine. See Figure 51. If the pinion gear does not move properly, inspect the helix and pinion gear for binding and sticking. Any binding or sticking must be corrected.

Starter Motor Drive Disassembly

See Figure 52. Rest the starter drive retainer on a support block and use a hammer and a 4mm (5/32") pin punch to drive out the roll pin. Finally, remove the starter drive retainer. The starter drive assembly is illustrated in Figure 52A. Figure 52 shows a support block that can be fabricated locally.

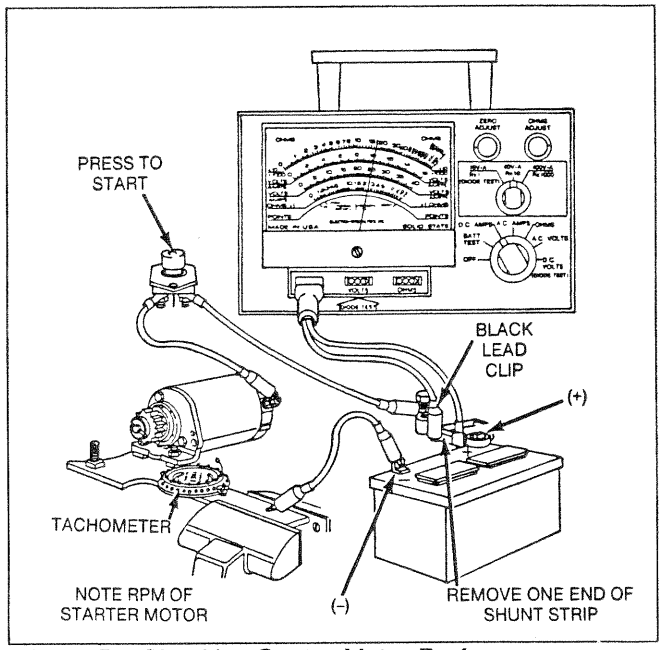


Figure 50. Checking Starter Motor Performance

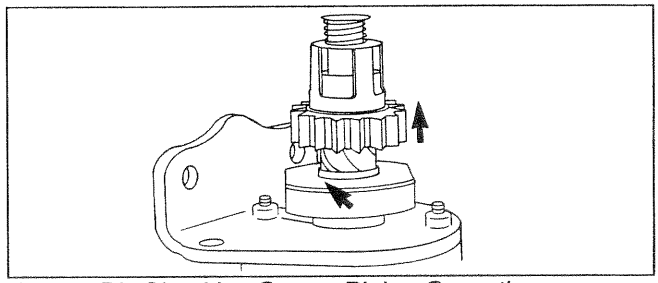


Figure 51. Checking Starter Pinion Operation

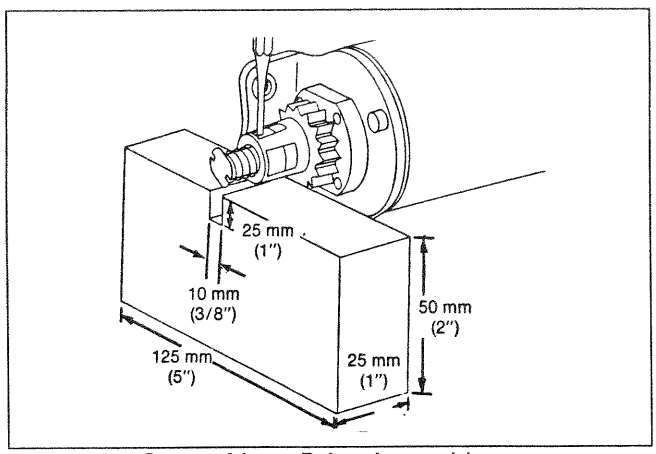


Figure 52. Starter Motor Drive Assembly

Starter Drive Inspection

Check pinion gear for damaged teeth. If pinion sticks on the helix, correct this problem. Parts may be washed in a solvent such as "Stanisol®" or "Varsol®". DO NOT OIL OR GREASE HELIX OR PINION GEAR.

Starter Drive Assembly

- Place the starter clutch on the armature shaft, then rotate the clutch until it drops into place.
- Install the pinion gear, with bevelled edges of gear teeth away from the motor, i.e., with the chamfered teeth up.
- Place thrust washer and clutch retainer on the armature shaft.
- Press or drive in a NEW roll pin with roll pin slot facing upward as shown in Figure 52. Roll pin must be centered in the armature shaft within 0.8mm (1/32 inch).
- Install cover over clutch retainer.
- Install return spring and spring retainer.

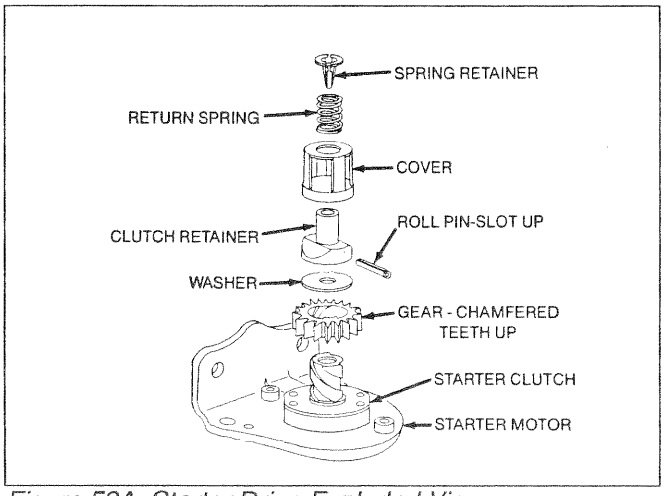


Figure 52A. Starter Drive Exploded View

Starter Motor Disassembly

CAUTION: DO NOT clamp the starter motor housing in a vise. DO NOT strike the housing with a steel hammer. The starter motor is equipped with two powerful ceramic magnets that can be broken or cracked if the motor housing is clamped, hit, deformed, dented or dropped.

A typical starter is shown in Figure 53. To aid in reassembly, mark the DRIVE END CAP in line with the starter HOUSING seam. Remove THRU BOLTS. Remove DRIVE END CAP. Inspect bushing in DRIVE END CAP for wear, replace if worn or damaged.

See Figure 54. Hold the ARMATURE and the BRUSH END CAP against a work surface and slide the HOUSING off the ARMATURE. This allows the ARMATURE to remain in the BRUSH END CAP for inspection of brush contact to commutator.

Check for proper brush contact with the commutator.

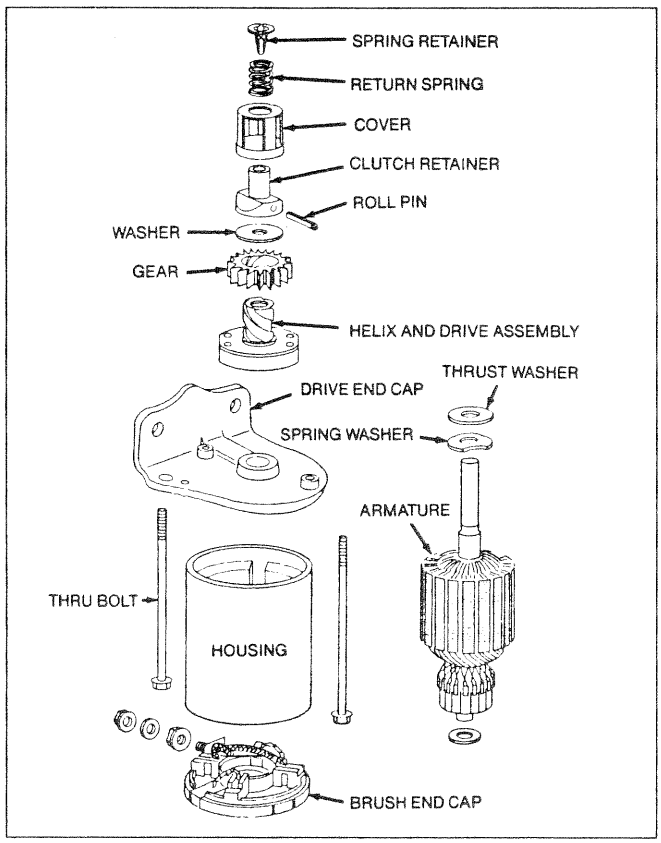


Figure 53. Exploded View of Starter

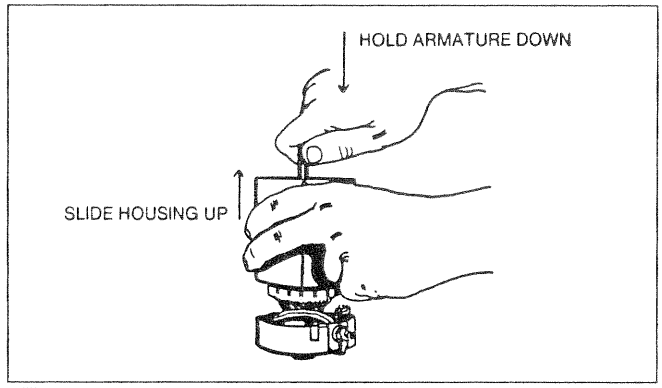


Figure 54. Motor Housing Removal

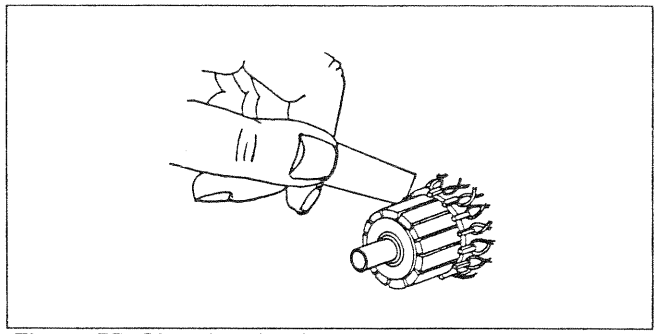


Figure 55. Cleaning the Commutator

Starter Motor Disassembly (Continued)

Remove the ARMATURE from the BRUSH END CAP. Clean all dirt and corrosion from the ARMATURE, BRUSH END CAP, etc. DO NOT SOAK BEARINGS, HOUSING OR ARMATURE IN ANY CLEANING SOLUTION.

The commutator may be cleaned with fine sandpaper. DO NOT USE EMERY CLOTH- THE METALLIC EMERY WILL BECOME IMBEDDED IN THE COMMUTATOR AND CAUSE RAPID BRUSH WEAR.

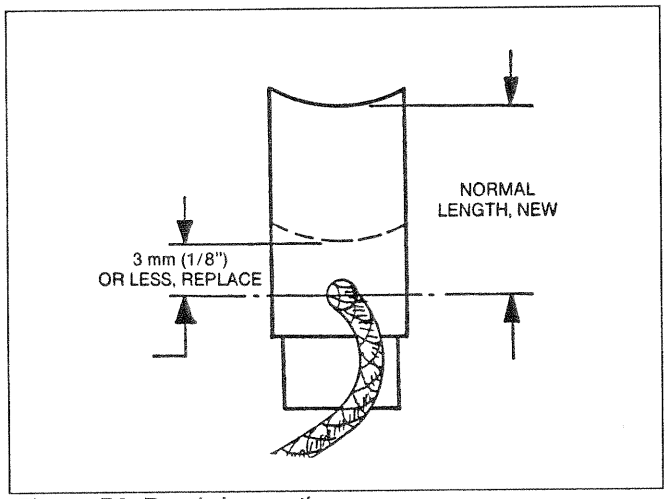


Figure 56. Brush Inspection

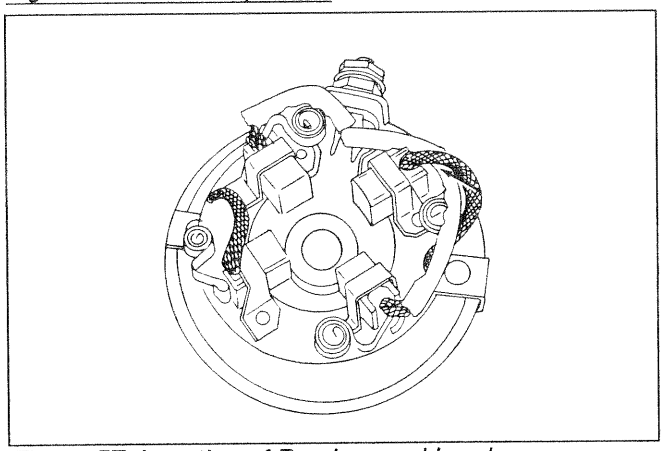


Figure 57. Location of Brushes and Leads

The commutator may also be machined with a diamond cutting tool to not less than 31.24mm (1.23 inch) diameter.

Slots between the commutator bars should be cleaned as shown in Figure 55, after the commutator has been cleaned or machined.

If proper test equipment is available, check the armature for open, shorted or grounded condition. Replace any armature, magnets or housing that is thought to be defective.

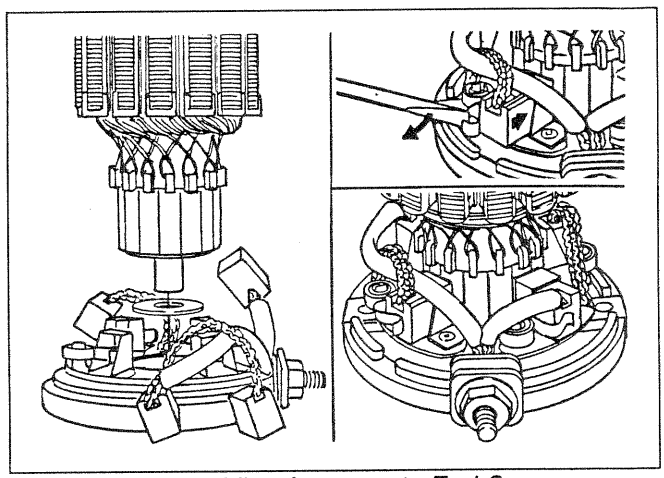


Figure 58. Assembling Armature to End Cap

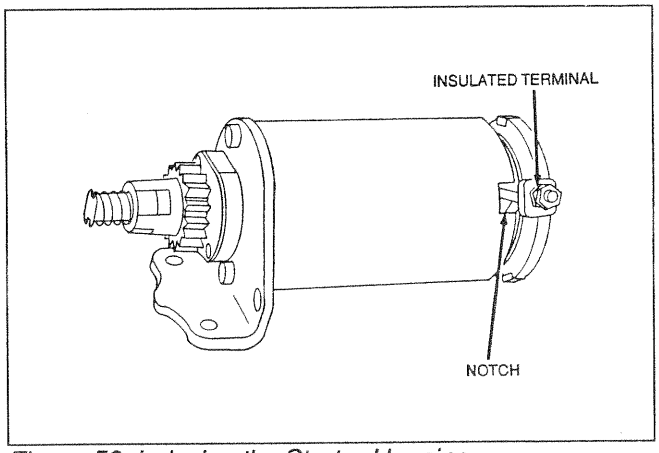


Figure 59. Indexing the Starter Housing

Brushes should be checked for proper seating, weak brush springs, dirt, oil or corrosion. Also make sure the brushes are not sticking in their holders.

Brush spring pressure should measure from 113.4-170.1 gr (4-6 ounces).

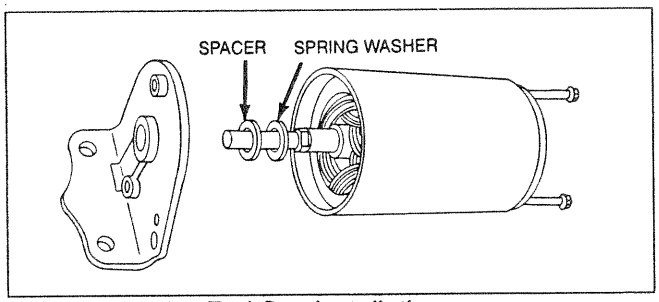


Figure 60. Drive End Cap Installation

Starter Motor Disassembly (Continued)

If brushes are worn as shown in Figure 56, replace them.

When replacing brushes, the brushes and brush leads must be located properly. See Figure 57.

Starter Motor Reassembly

After all parts have been inspected, lightly lubricate the bearings in both end caps with No. 20 oil. Insert brushes into their proper holders (Figure 57). Hold the brushes clear of the armature commutator (Figure 58) and install the armature into the brush end cap.

The starter housing has a large notch which indexes over the insulated terminal (Figure 59). Push down on the armature and brush end cap, then slide housing down until the large notch indexes.

USE CARE TO PREVENT DAMAGE TO MAGNETS IN STARTER HOUSING.

DRIVE END CAP INSTALLATION:

See Figure 60. Install SPRING WASHER and SPACER on armature. Slide drive end cap down armature shaft until the mark on drive end cap aligns with mark on starter housing. (Drive end cap should have been marked during disassembly.) Turn the armature to check for binding. Correct binding, if necessary.

Ring Gear Replacement

Use a center punch to mark centers of rivets that retain ring gear to flywheel. Use a 4.7mm (3/16 inch) drill to drill out the rivets.

Remove ring gear and clean epoxy from flywheel. Attach new ring gear to flywheel using four screws and locknuts provided with the new replacement ring gear.

NOTE: Epoxy is not required when installing the new replacement ring gear.

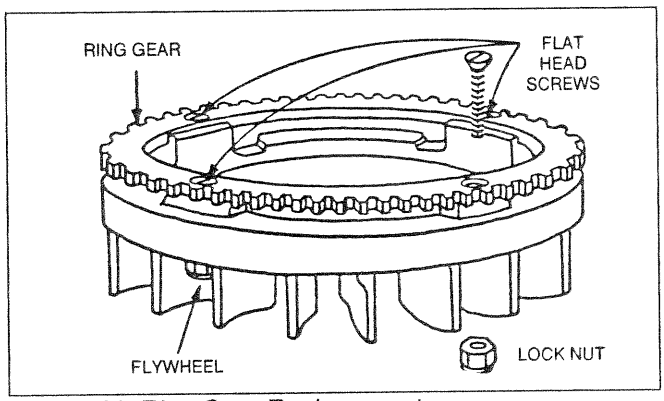


Figure 61. Ring Gear Replacement

Section 7 - REWIND STARTERS

Starter Removal

See Figure 62. Remove four screws that retain the rewind starter. Remove the starter.

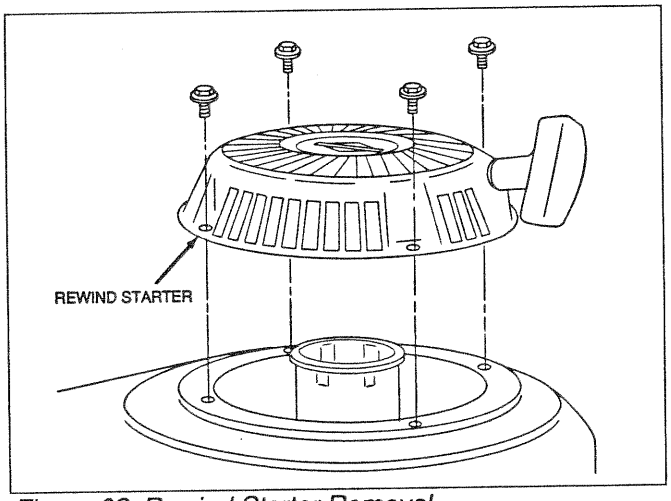


Figure 62. Rewind Starter Removal

Starter Rope Removal

Pull the rope out part way and tie a temporary knot. Remove rope insert from rope handle and pull knot out of rope insert. Untie knot and remove insert and handle from rope.

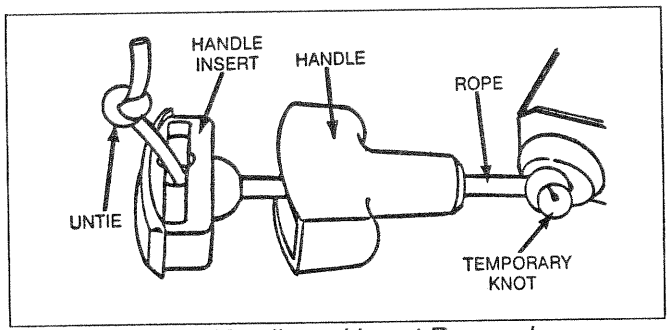


Figure 63. Rope Handle and Insert Removal

Pull the rope out as far as it will go. While holding the rewind pulley, grasp the knot with a pair of needle nose pliers and pull rope out of the pulley.

Slowly release spring tension on the pulley until it stops turning.

Starter Rope Inspection

Check rope for fraying, broken strands. Replace any damaged or defective rope. If you are re-using the old rope, burn its end with an open flame. Wipe the burned end with a cloth while rope is still hot, to prevent swelling and unravelling.

NOTE: Be sure to use rope of the correct length. Cut rope to 178cm (70 inches). The service replacement rope is cut to length as required.

Starter Rope Installation

Tie a "figure 8" knot at one end of rope (Figure 64).

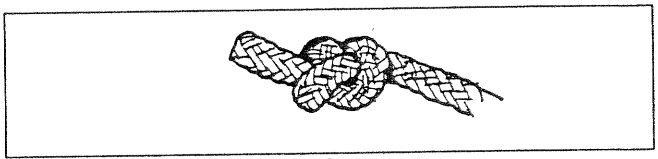


Figure 64. The "Figure 8" Knot

Turn the pulley counterclockwise until spring is wound tight. Then, rotate pulley clockwise until rope hole in pulley is aligned with starter housing eyelet. Hold the pulley at this position (Figure 65).

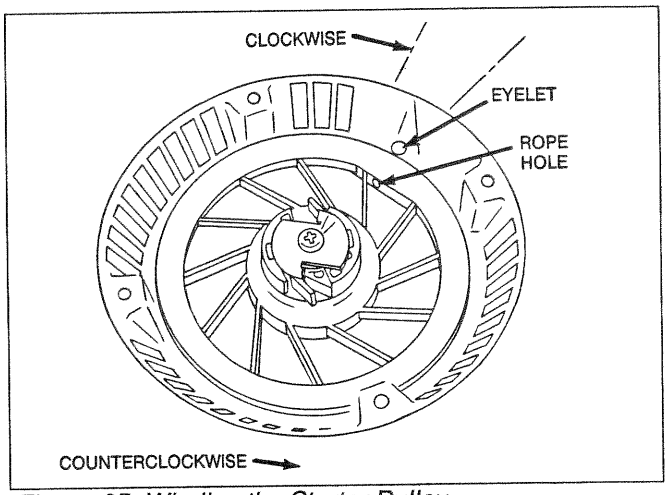


Figure 65. Winding the Starter Pulley

Insert other end of rope through knot cavity and rope hole in pulley. Thread the end of the rope through the housing eyelet. Pull rope until knot is in the rope cavity. See Figure 66.

While still holding the pulley, tie a temporary knot part way out on the rope. Allow the pulley spring to slowly pull the rope up to the temporary knot. Insert rope through starter rope handle and through starter rope insert (Figure 67). Tie a knot at end of rope. Pull the knot into the rope insert, then pull the insert into the rope handle. Untie temporary knot and slowly let rope rewind into starter. Check starter operation.

Starter Rope Installation (Continued)

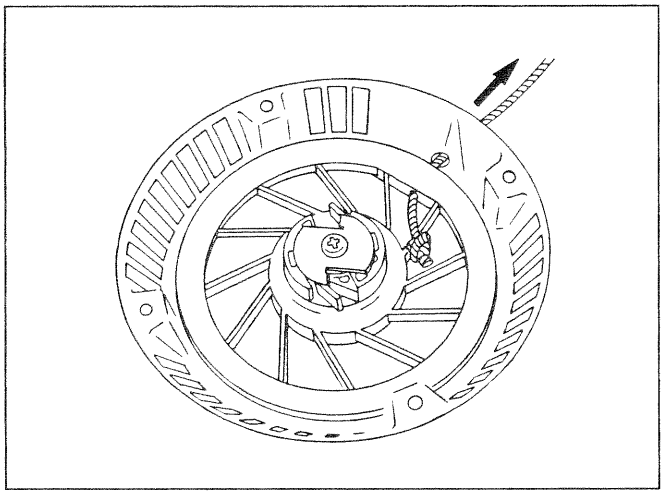


Figure 66. Installing the Rope

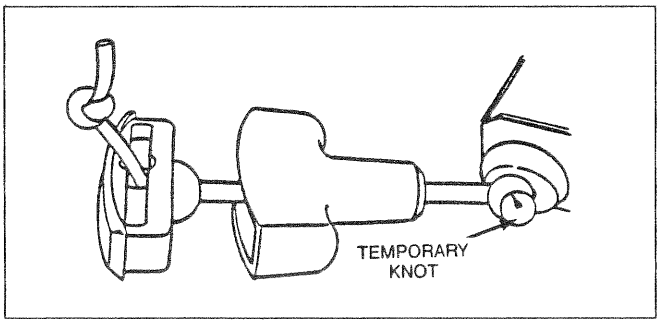


Figure 67. Rope and Handle Assembly

Starter Spring Replacement

ROPE REMOVAL:

Remove the recoil rope as previously described.

PULLEY AND SPRING REMOVAL:

See Figure 68. Remove SHOULDER SCREW, SMALL WASHER, RETAINER, BRAKE SPRING and LARGE WASHER.

Lift out the dogs and dog springs. Rotate pulley until it feels free. Then, carefully lift out the pulley. See Figure 69.

Remove SPRING AND CUP (Figure 70) from starter housing.

NOTE: The SPRING AND CUP are serviced as an assembly. DO NOT REMOVE THE SPRING.

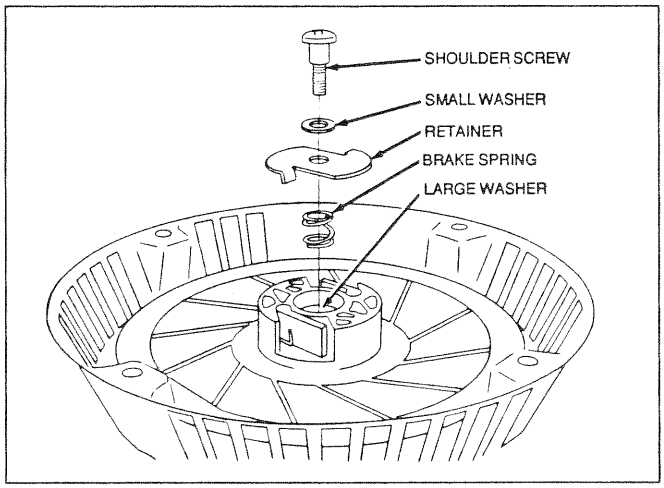


Figure 68. Retainer Removal

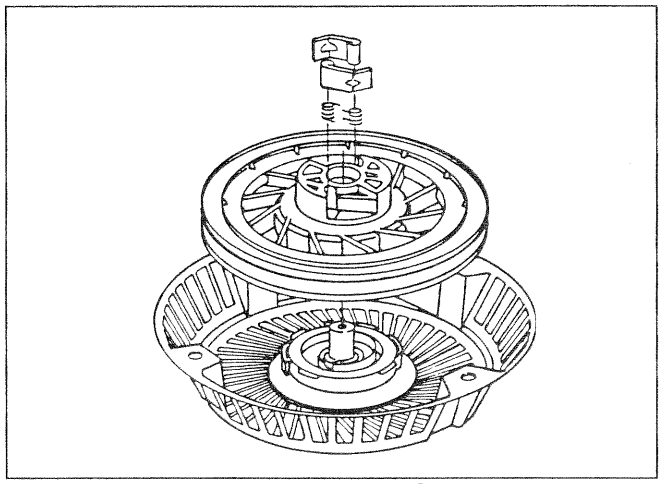


Figure 69. Removal of Dogs, Dog Springs, Pulley

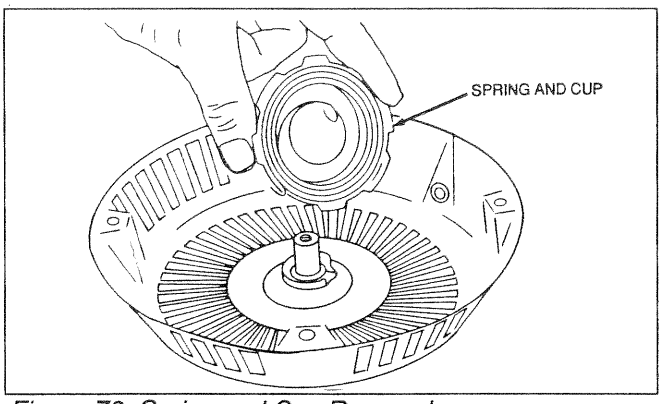


Figure 70. Spring and Cup Removal

Inspection

Check pulley for damage, cracks, rough edges, burrs in pulley groove, wear on spring cup lugs, and wear on center post. Replace pulley if damaged or worn.

Inspection (Continued)

Inspect starter housing. Look for wear at rope eyelet, center pivot post, and at inner spring anchor. Replace housing if worn or damaged.

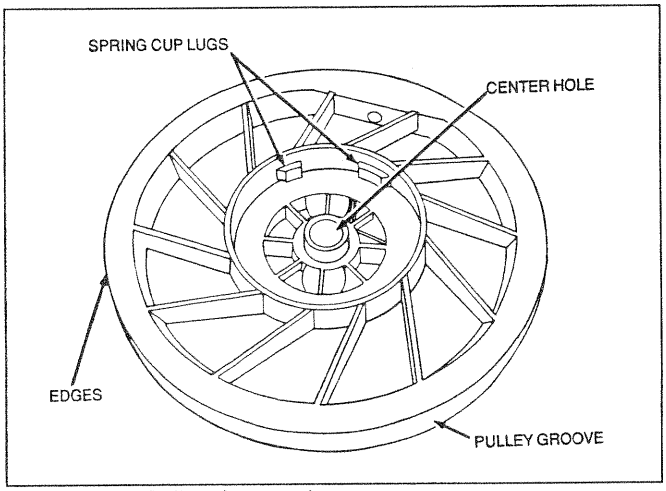


Figure 71. Pulley Inspection

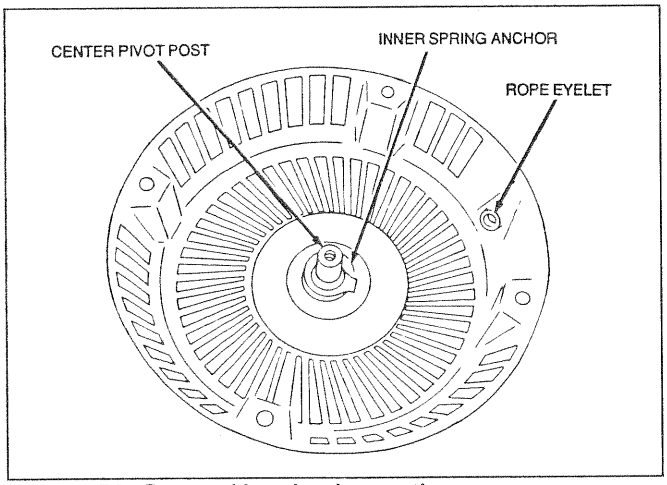


Figure 72. Starter Housing Inspection

Installation

SPRING AND CUP ASSEMBLY:

Install the spring and cup in pulley. Outer end of spring should be between the two wide lugs in pulley. Spring cup projections should be adjacent to the two wide lugs. See Figure 73.

PULLEY:

Note the location of the inner spring tab. Also note location of inner spring anchor at center post of starter housing. Lower the starter housing onto the pulley and spring assembly (Figure 74). Invert the assembly. Finally, rotate the pulley counterclockwise until inner spring tang engages spring anchor (Figure 75).

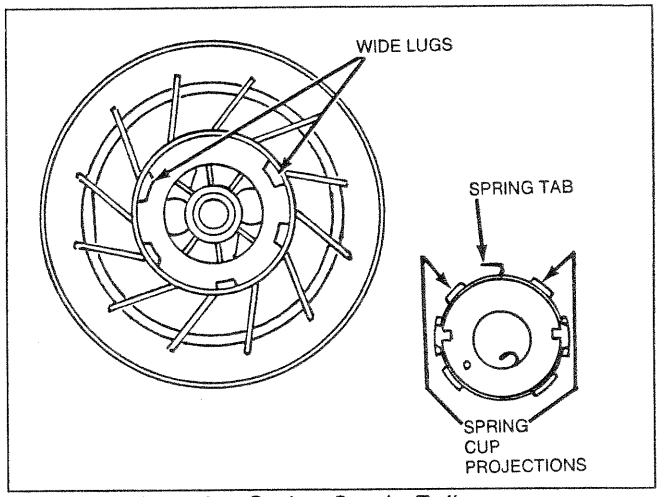


Figure 73. Locating Spring Cup in Pulley

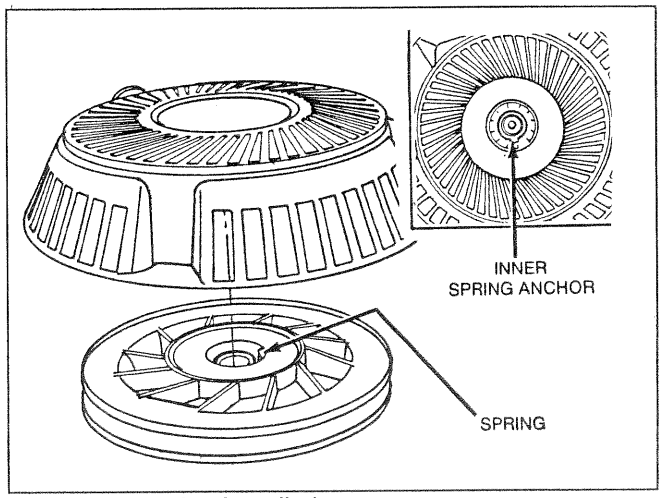


Figure 74. Pulley Installation

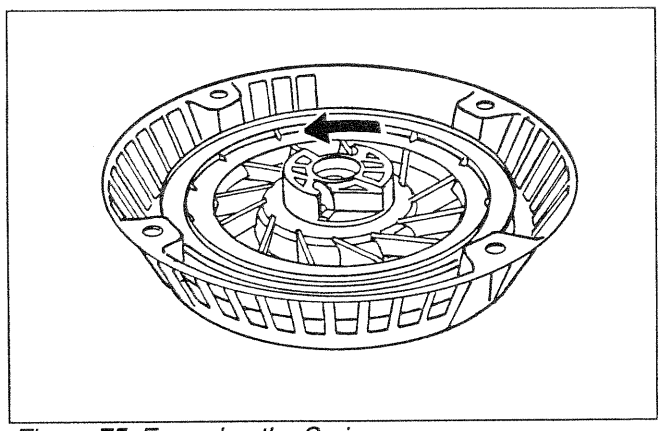


Figure 75. Engaging the Spring

DOGS, DOG SPRINGS, RETAINER:

Install dogs and dog springs onto pulley (Figure 76). See Figure 77. Install LARGE WASHER, BRAKE SPRING, RETAINER onto pulley.

Assembly (Continued)

Slide the SMALL WASHER onto SHOULDER SCREW. Install screw and washer into center pivot.

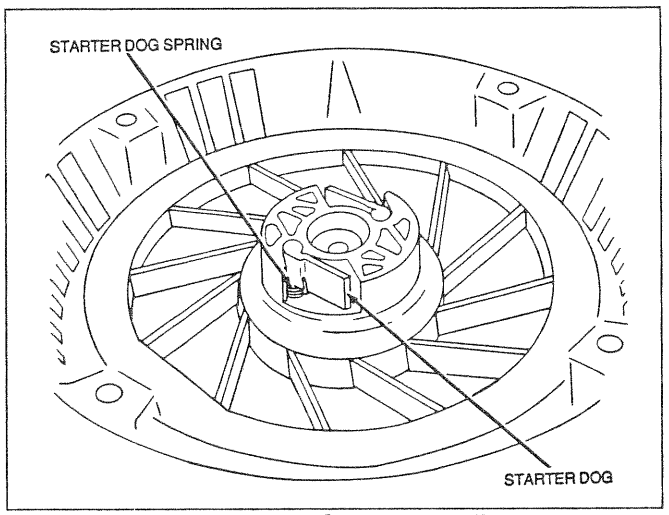


Figure 76. Dogs and Dog Springs Installation

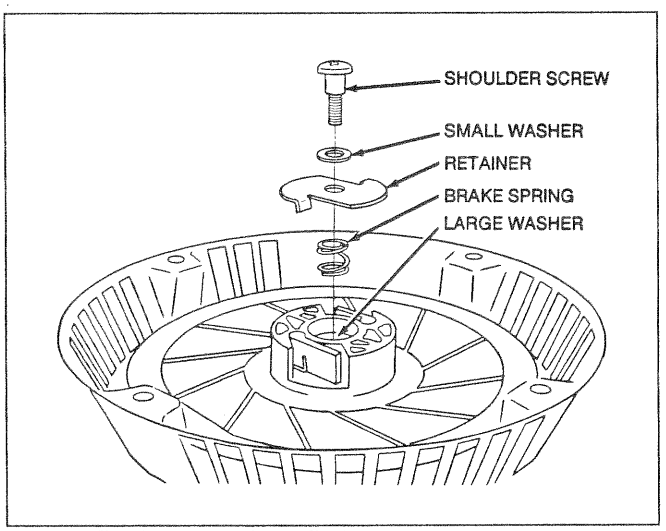


Figure 77. Retainer Installation

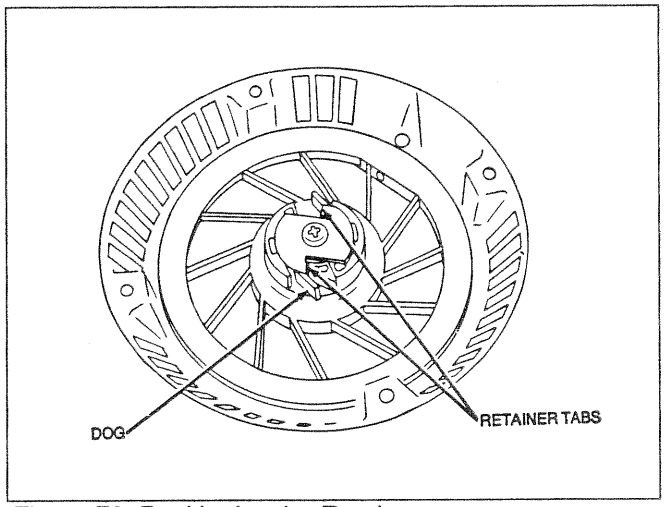


Figure 78. Positioning the Retainer

See Figure 78. Position tabs of retainer inside dogs. Tighten the retainer screw to 8 N-m (70 inch-pounds).

Complete reassembly of the starter as outlined in the rope installation instructions.

Rewind Starter Installation

Position starter on the blower housing. Install screws finger tight. Pull rope out to engage dogs in starter cup. While holding rope with dogs engaged, tighten screws to 7 N-m (60 inch-pounds).

Section 8 - COMPRESSION SYSTEM

Compression Test

It is extremely difficult to obtain an accurate compression reading without special equipment. For that reason, Generac does not publish compression pressure values for the V-Twin engine. Testing has proved that an accurate indication of engine compression can be obtained as follows:

- Remove both spark plugs.
- Insert a compression gauge into either cylinder.
- Crank engine until there is no further increase in pressure.
- Record the highest reading obtained.
- Repeat the procedure for the other cylinder. Record that reading.
- The difference between both cylinders should not exceed 25 percent. If the difference in pressure between the two cylinders exceeds 25 percent, loss of compression in the lowest reading cylinder is indicated.

Example:

CYLINDER NO. 1	CYLINDER NO.2	DIFFERENCE	PERCENT
4.5 kgcm^2 (65 psi)	3.9 kgcm^2 (60 psi)	0.3 kgcm^2 (5 psi)	7.6%
OR			
5.1 kgcm2 (75 psi)	3.8 kgcm2 (55 psi)	1.4 kgcm2 (20 psi)	26.7%

Loss of compression will usually be caused by one or more of the following:

1. Blown or leaking cylinder head gasket.
2. Improperly seated or sticking valve(s).
3. Worn piston rings or cylinder. (This will also result in high oil consumption.)

Combustion Chamber Deposits

Remove combustion chamber deposits every 500 hours of operation, or whenever the cylinder heads are removed.

Cylinder Identification

Numbers are cast on the cylinder facing the flywheel side of the engine (Figure 80). Cylinders are numbered "1" and "2" as shown in Figure 79.

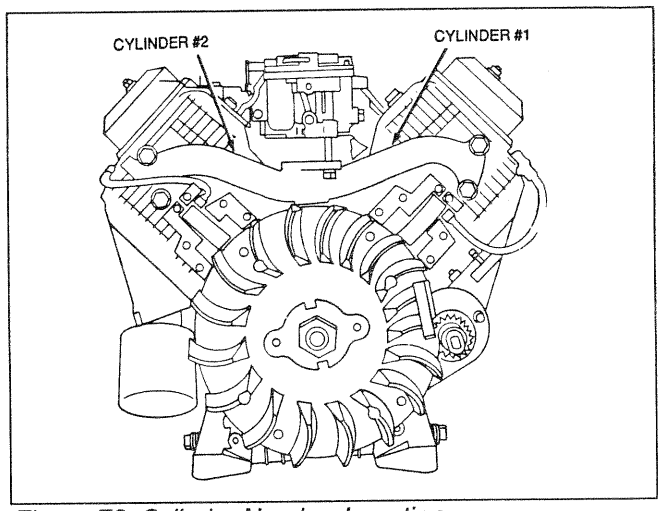


Figure 79. Cylinder Number Location

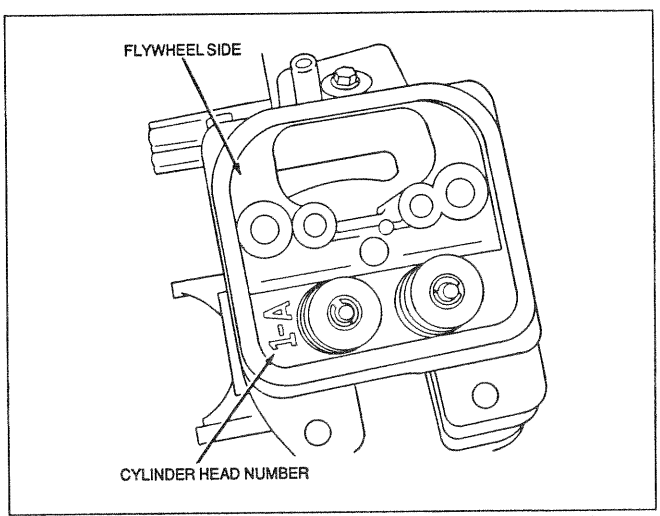


Figure 80. Location of Numbers on Cylinder Head

Cylinder Heads Removal

Cylinder air guides, engine shrouding, cylinder head shields, intake and exhaust manifolds must be removed before the cylinder heads can be removed. A typical horizontal shaft engine with cylinder head shields is shown in Figure 81.

NOTE: Engine shrouding on vertical shaft engines is quite different than that of horizontal shaft engines. Vertical shaft engines are generally surrounded by sheet metal "wrappers" and an engine top housing. Cooling air enters the shrouded engine through an air inlet screen and is forced downward and out of the unit bottom. Figure 82 shows typical engine shrouding for a vertical shaft engine.

Cylinder Heads Removal (Continued)

The valve rocker arm shaft must also be removed to disassemble the cylinder heads.

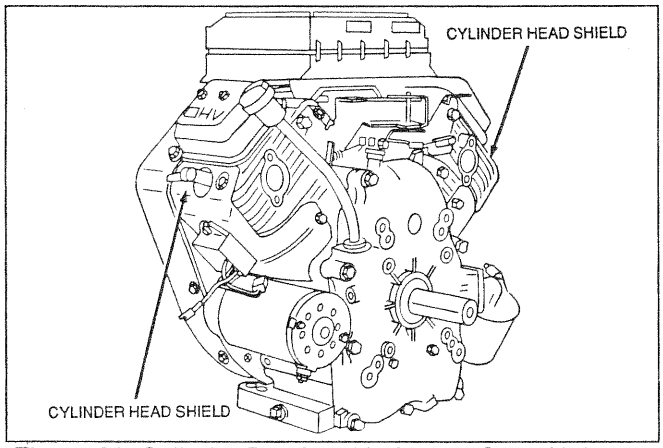


Figure 81. Cylinder Ducting- Horizontal Shaft Units

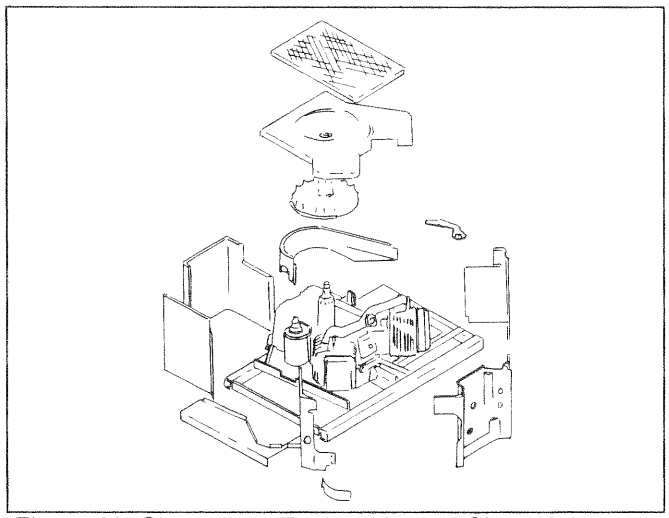


Figure 82. Shrouding- Typical Vertical Shaft Unit

ROCKER ARM SHAFT REMOVAL:

- See Figure 83. Remove two nuts and seals from valve cover. Remove valve cover and gasket.
- Refer to Figure 84. Release spring pressure from rocker arms by rocking the spring against spring pressure and permitting the push rod to drop out of the arm socket. The push rod will move out of alignment so that, when the arm is released, spring pressure is released from the arm.
- Remove two rocker studs.
- Remove shaft, rocker arms and shaft supports (Figures 85 and 86).
- Lift out the push rods.

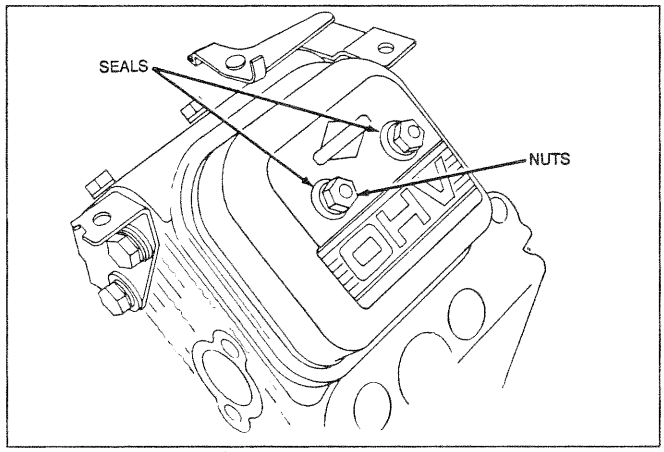


Figure 83. Valve Cover Removal

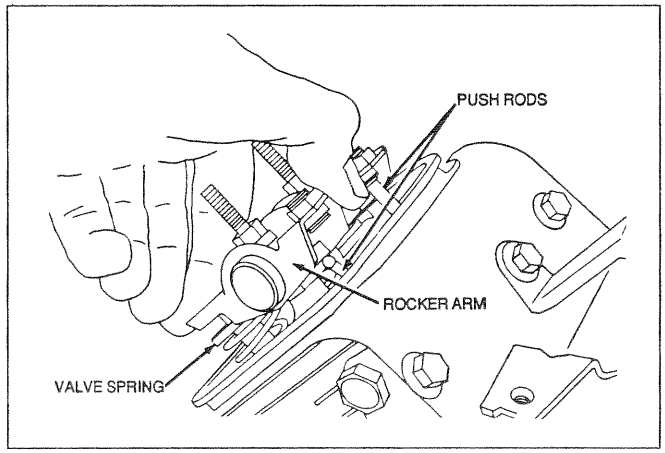


Figure 84. Releasing Spring Pressure

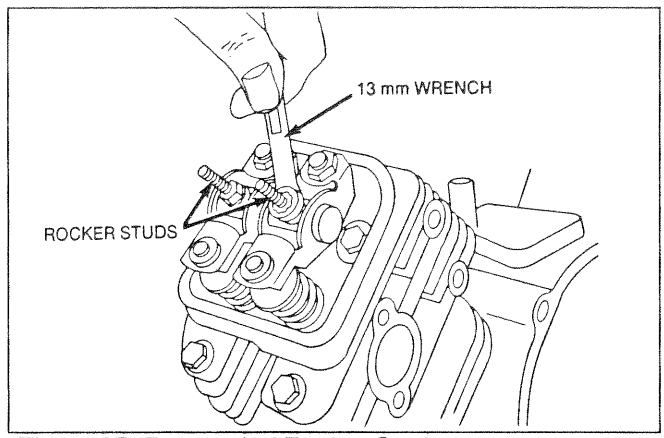


Figure 85. Removal of Rocker Studs

CYLINDER HEAD REMOVAL:

- See Figure 87. Remove four cylinder head bolts.
- Remove two sealing washers.
- Remove cylinder head, valve assembly and gasket (Figure 88).

Cylinder Heads Removal (Continued)

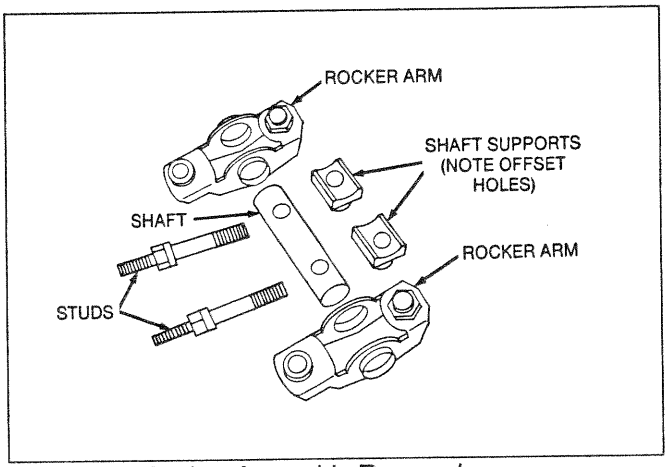


Figure 86. Rocker Assembly Removal

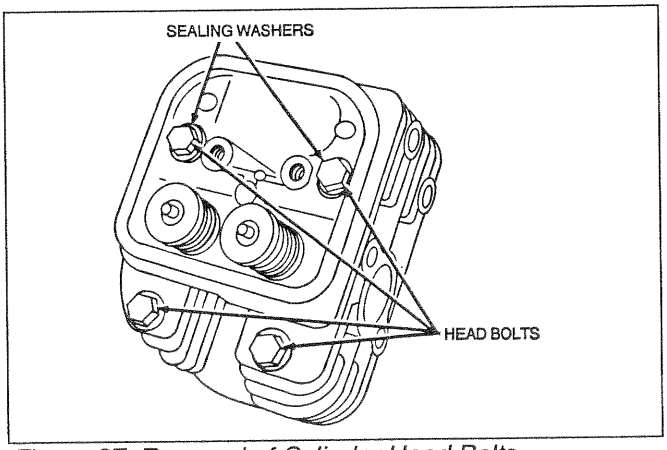


Figure 87. Removal of Cylinder Head Bolts

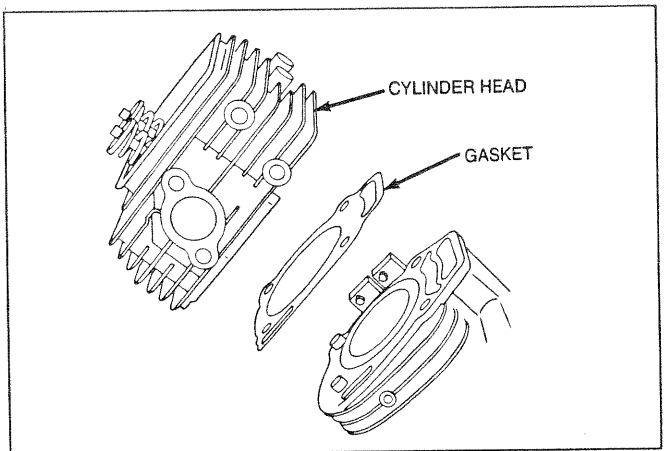


Figure 88. Cylinder Head Removal

Removal of Valves

Refer to Figures 89 and 90. To remove the valves, proceed as follows:

- Install the rocker studs into cylinder head but do not tighten.
- Insert end of a valve spring compressor (Figure 89) under the stud and over the valve spring.
- Press down on the tool handle to compress the valve spring and remove the split retainer.
- When split retainer is removed, release pressure on the tool and remove retaining washer, spring and seal.
- Remove the rocker studs.

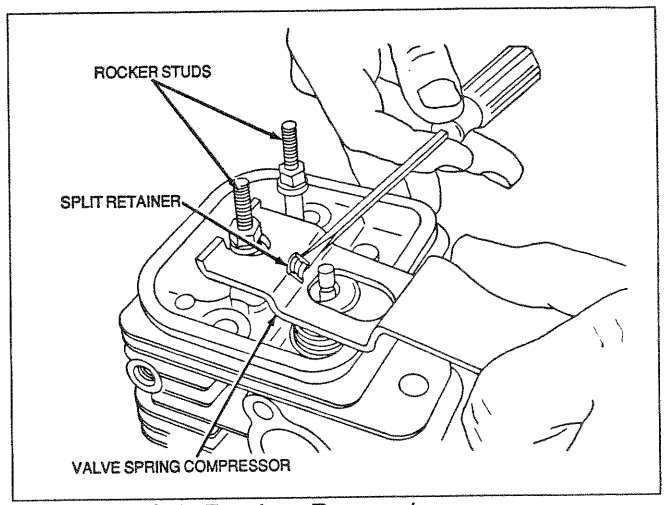


Figure 89. Split Retainer Removal

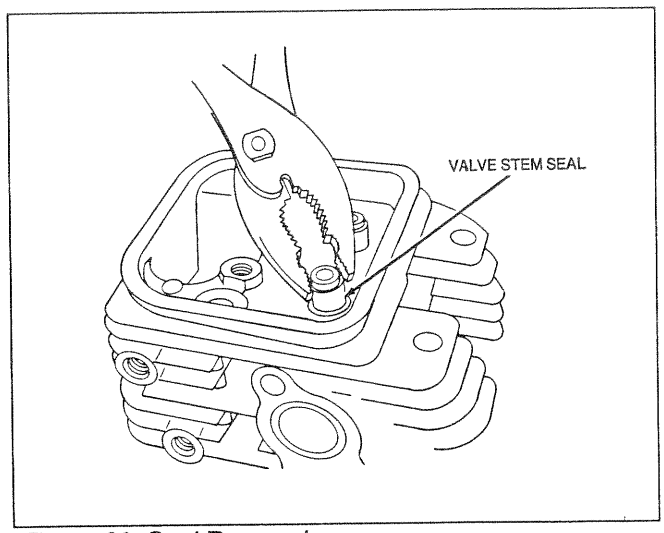


Figure 90. Seal Removal

Valves and Valve Seats Refacing

Use a valve grinder to resurface valve faces to 45°. To recondition valve seats, use a special valve seat cutter tool.

After the valves and valve seats have been reconditioned, they should be lapped with a suitable valve lapping tool and valve lapping compound.

Valves and Valve Seats Refacing (Continued)

NOTE: Proper lapping of valves and valve seats will remove grinding marks and ensure a good seal between the valve and its seats. Be sure to thoroughly clean lapping compound from the valve seats and faces.

Valve seat width should be 1.6mm (1/16 inch), and not less than 1.2mm (3/64 inch). If the seat is wider than specified, a narrowing stone or cutter should be used. Replace any valve(s) that is/are badly burned. Also, replace valve if margin is 0.4mm (1/64 inch) or less after refacing.

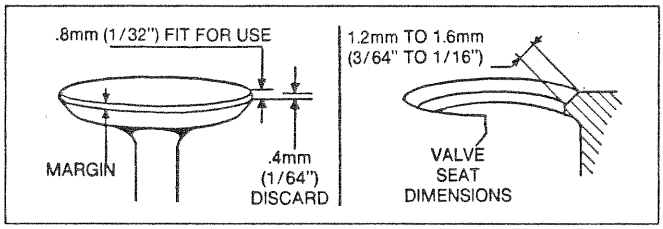


Figure 91. Valve and Valve Seat Dimensions

Valve Spring Inspection

Replace any broken or worn valve springs.

Valve Guide Inspection

Measure intake and exhaust valve guides. Replace any guide(s) that are worn. Intake and exhaust valve guide reject dimension is **6.057mm (0.238 inch)**.

Valve Guides Removal

Use a suitable tool (such as the bushing driver in Figure 92) to remove valve guides. Support the cylinder head and press valve guides out.

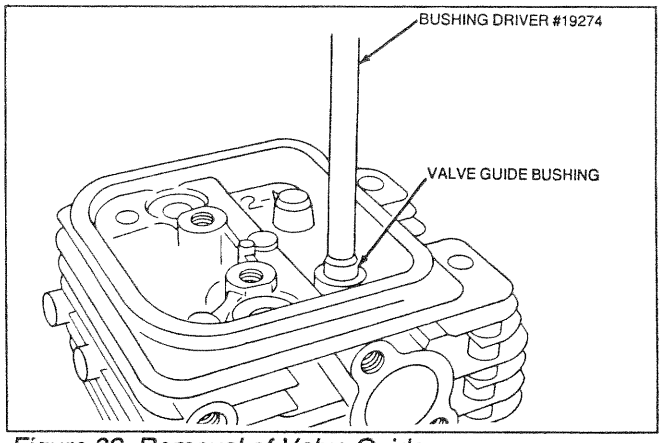


Figure 92. Removal of Valve Guide

Valve Guide Installation

Place valve guide on the bushing driver. The guide can be installed either way. Press valve guide in to the dimension shown in Figure 93 (7mm or 9/32 inch).

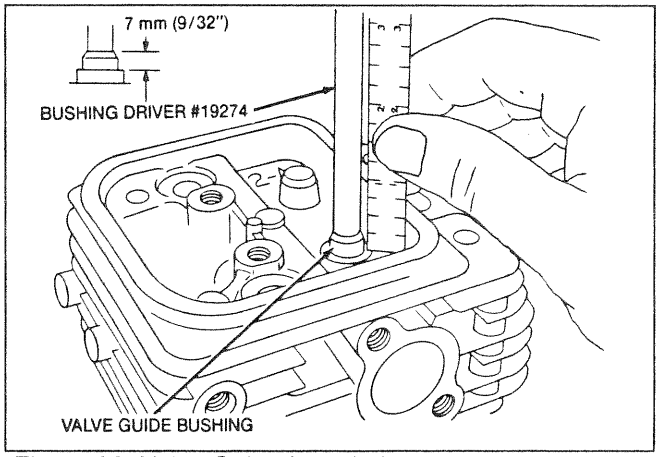


Figure 93. Valve Guide Installation

When installing valve guides, the following procedure is recommended to ensure that the guides are free of foreign material and clean:

Use a suitable finishing type reamer with a reamer pilot guide to finish ream the valve guides. "Stanisol®" or kerosene can be used to lubricate the reamer. Be sure to ream through the entire valve guide. When removing the reamer, turn the reamer clockwise. Flush out all chips.

Valve Installation

Prior to installation, make sure valve stems are free of burrs and foreign matter. Valve guides must also be free of burrs and foreign material. Lightly coat valve stems with valve guide lubricant (available commercially) and install into valve guides.

CAUTION: Make sure the valve guide lubricant is NOT on the valve face, valve seat, or on end of valve stem.

Install the valve as follows (Figure 94).

- Place cylinder head on work bench with support to hold valves in place.
- Install valve stem seals, springs and spring retainers over the valve stems.
- Install rocker studs into cylinder head.
- Use a valve spring compressor to compress the valve springs.
- With valve springs compressed, install the split retainers.
- Repeat the above procedure for remaining valves. Finally, remove the valve spring compressor.

Valve Installation (Continued)

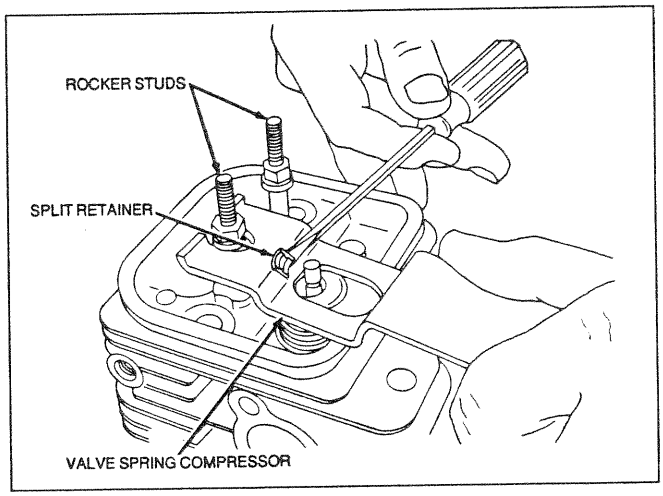


Figure 94. Valve Retainer Installation

Cylinder Head Installation

- Place the gasket and cylinder head onto cylinder.
- Position gasket and head on alignment dowels (Figure 95).
- Lubricate bolt threads and install four cylinder head bolts and two seals (Figure 96).

CAUTION: DO NOT use sealer of any kind on cylinder head gaskets. DO NOT tighten one cylinder head bolt down completely before the others as this might result in a warped cylinder head.

- Tighten cylinder head bolts down evenly by hand.
- Use a suitable torque wrench to tighten bolts in the sequence shown (Figure 96). Tighten to 19 N-m (165 inch-pounds).

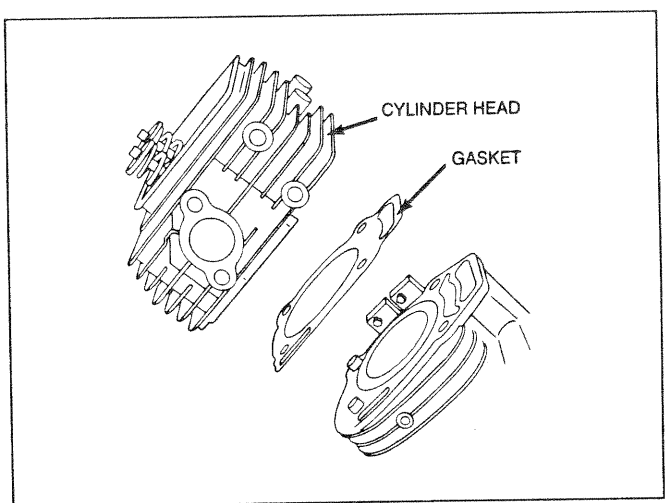


Figure 95. Cylinder Head Installation

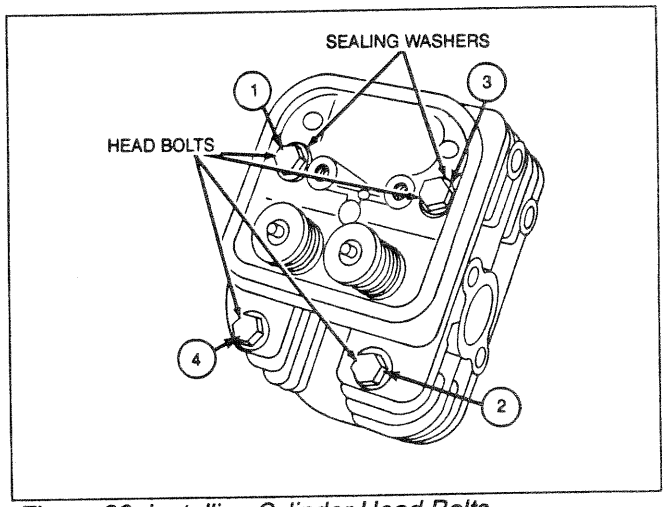


Figure 96. Installing Cylinder Head Bolts

Rocker Arm Installation

- Insert the push rods into position.

NOTE: Rocker shaft support holes are offset. Install with holes toward ends of rocker shaft. See Figure 97.

- Assemble the rocker arms, shaft, supports, and studs. Install onto cylinder head (Figures 97 and 98).
- Tighten studs to 16 N-m (140 inch-pounds).

See Figure 99. Compress the valve spring with rocker arm and align push rod with socket in rocker arm.

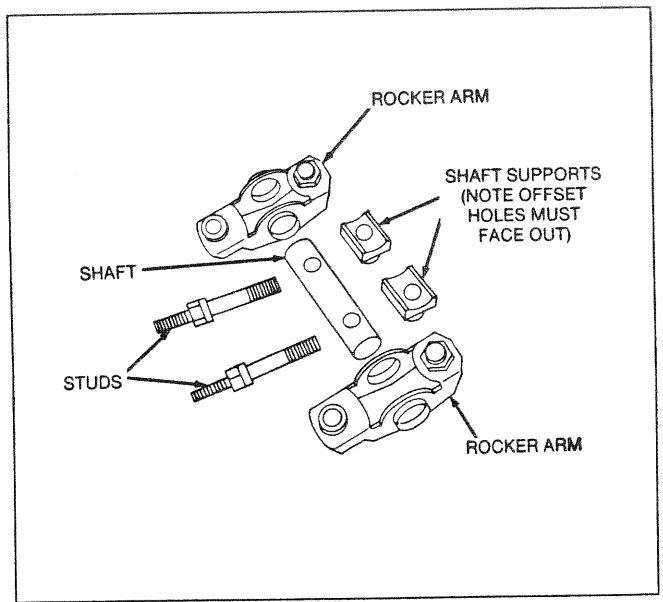


Figure 97. Assembling the Rocker Arms

Rocker Arm Installation (Continued)

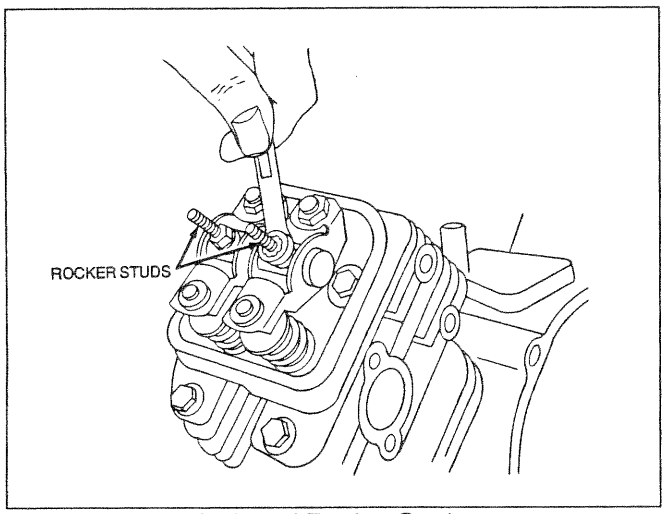


Figure 98. Installation of Rocker Studs

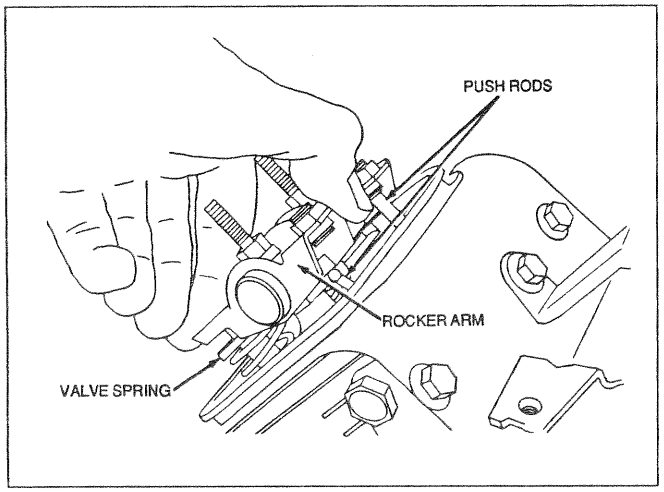


Figure 99. Alignment of Push Rods

Adjusting Valve Clearance

To adjust valve clearance, proceed as follows (Figure 100):

- Turn the crankshaft until piston in cylinder you are checking is at top dead center (TDC) of its compression stroke.
- Insert a screwdriver through spark plug hole so that it is in contact with top of piston.
- Continue to turn crankshaft past top dead center until it has moved downward 6.35mm (1/4 inch).
- Insert a feeler gauge between valve stem and rocker arm. Clearance should be 0.10-0.16mm (0.004-0.006 inch.
- Adjust clearance as necessary, until it is correct.
- When clearance is correct, hold the adjusting screw and tighten the locknut to 7 N-m (60 inch-pounds).
- Recheck valve clearance and readjust if required.

NOTE: It is necessary to correctly position the crankshaft to eliminate interference by the compression release mechanism when adjusting valve clearance.

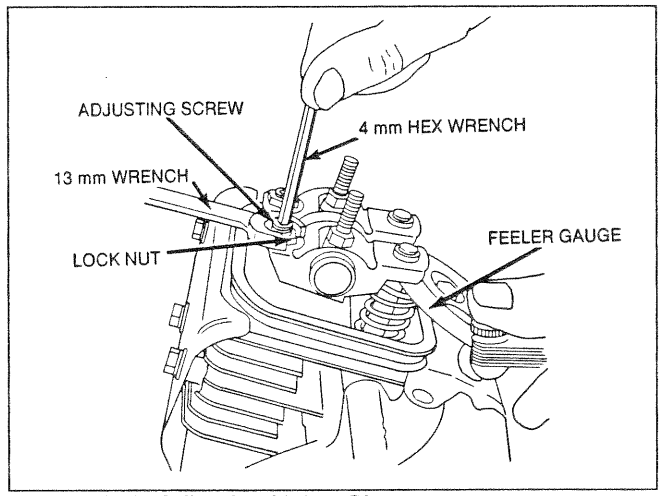


Figure 100. Adjusting Valve Clearance

Valve Cover Installation

See Figure 101. Install gasket and valve cover. Install seal washers and nuts onto studs. Tighten nuts to 3 N-m (25 inch-pounds).

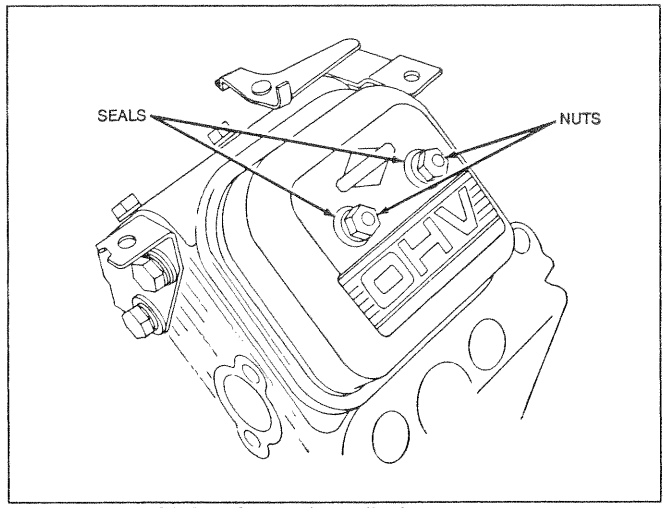


Figure 101. Valve Cover Installation

Section 9 - GOVERNORS

Introduction

V-Twin engines may be equipped with either remote controlled or fixed speed adjustable governor controls. However, generator applications almost always utilize the fixed speed adjustable application.

A typical fixed speed adjustable configuration for horizontal shaft engines is shown in Figure 102 below.

Figure 103 shows a typical governor configuration for vertical shaft units (RV and standby applications).

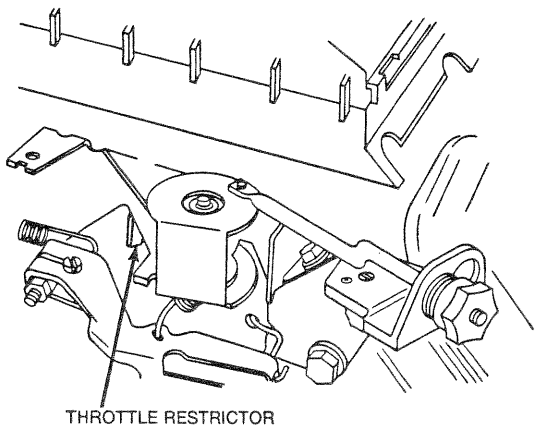


Figure 102. Typical Governor- Horizontal Shaft Units

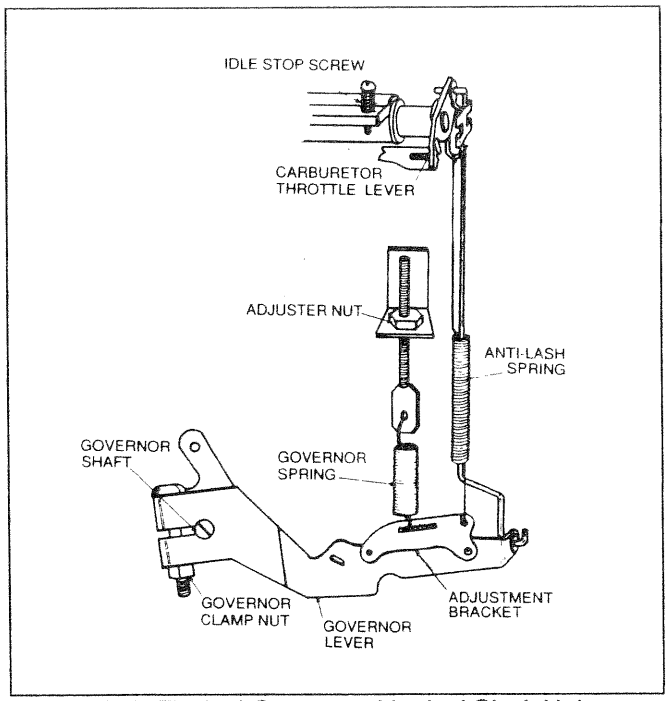


Figure 103. Typical Governor- Vertical Shaft Units

Governor Operation

The governor functions to maintain, within certain limits, a desired engine operating speed, even though loads on the engine may vary.

See Figure 104. The governor spring tends to pull the throttle open. Centrifugal force, acting on the governor flyweights, tends to close the throttle. The engine speed at which these two forces is balanced is called the governed speed. Governed speed can be varied by changing governor spring tension and hole location.

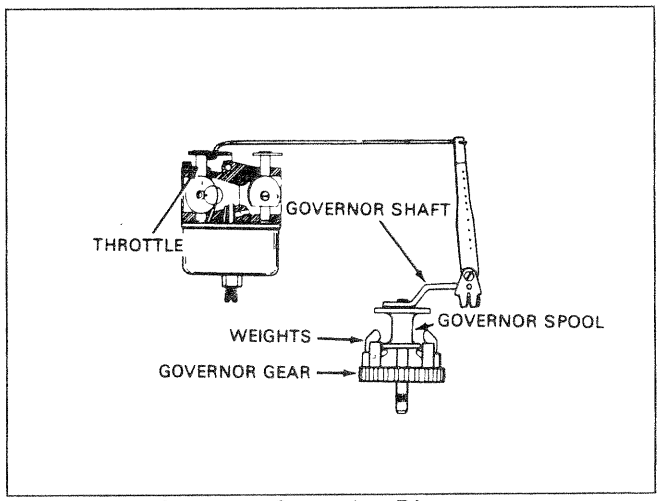


Figure 104. Governor Operating Diagram

Governed Speed for Generator Applications

In generator applications, the engine drives the generator's revolving field (Rotor). The generator's a-c frequency output is proportional to the operating speed of the generator rotor. The following facts apply:

- Generators may be equipped with either a 2-pole or a 4-pole rotor. A 2-pole rotor has one north magnetic pole and one south magnetic pole. A 4-pole rotor has two north magnetic poles and two south magnetic poles.
- A 2-pole rotor must be rotated at 3600 rpm to supply an a-c electrical output frequency of 60 Hertz (60 cycles per second); or at 3000 rpm to supply a 50 Hertz a-c frequency.
- A 4-pole rotor must operate at 1800 rpm to supply a 60 Hertz a-c frequency; or 1500 rpm to deliver a 50 Hertz a-c frequency.

If the rotor rpm and number of magnetic poles is known, a generator's a-c frequency can be determined using the following formula:

Governed Speed for Generator Applications (Continued)

$$\text{Frequency} = \frac{\text{RPM x No. of Rotor Poles}}{2 \times 60}$$

If the desired frequency and the number of rotor magnetic poles is known, the desired RPM can be calculated as follows:

$$\text{RPM} = \frac{2 \times 60 \times \text{Frequency}}{\text{No. of Rotor Poles}}$$

The governor should be adjusted with the engine running at no-load. Governed rpm is usually set slightly higher than the unit's rated rpm at no-load. For example, a generator having a rated frequency of 60 Hertz is normally set at no-load to maintain approximately 62 Hertz. That is, units with 2-pole rotor should be set to 3720 rpm at no-load. Units with 4-pole rotor should be set to 1860 rpm at no-load.

NOTE: The slightly high no-load governed speed setting helps prevent excessive rpm and a-c frequency droop under heavy electrical loading of the engine-generator.

Governor Lever Removal

The governor is located on the cam gear shaft. Drain oil from engine before starting disassembly (see Section 5). Then, Remove governor lever as follows:

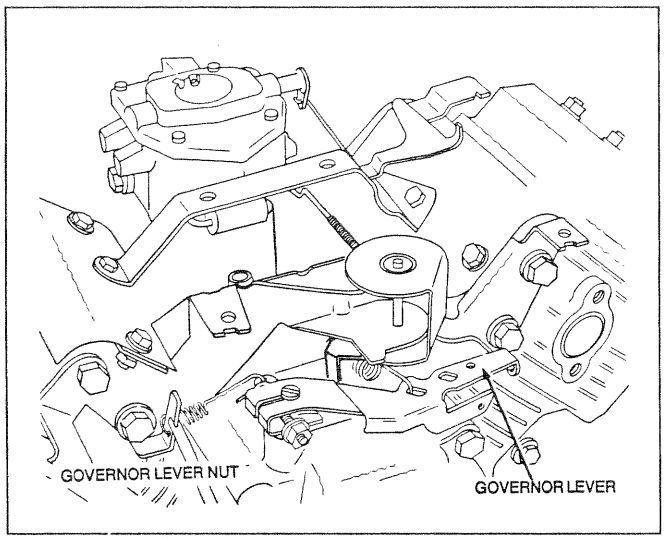


Figure 105. Governor Lever Removal (Typical)

- Loosen governor lever nut and remove governor lever.
- Disconnect governor springs, governor link and governor link spring.
- Remove rust, nicks and burrs from crankshaft PTO. Remove bolts that retain crankcase cover.
- Tap on side of crankcase cover to remove.

Governor Inspection

See Figure 106. Check governor weights for freedom of movement. Check pins for looseness.

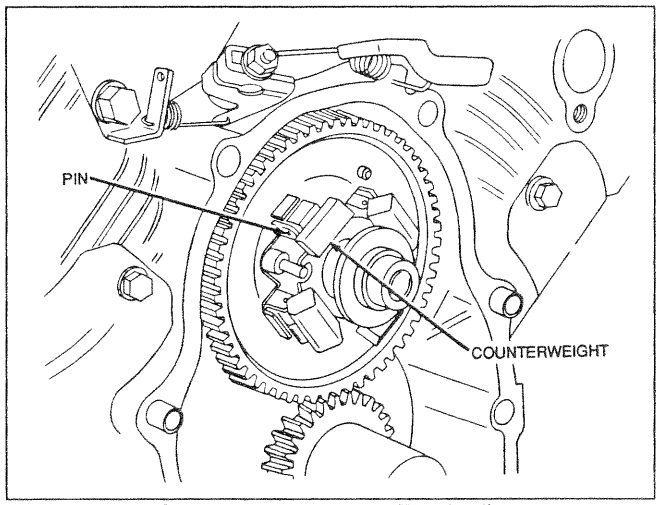


Figure 106. Governor Assembly (Typical)

Governor Shaft Removal

Remove cotter pin from upper end of shaft. Slide the shaft downward and out of the upper and lower bushings (Figure 107).

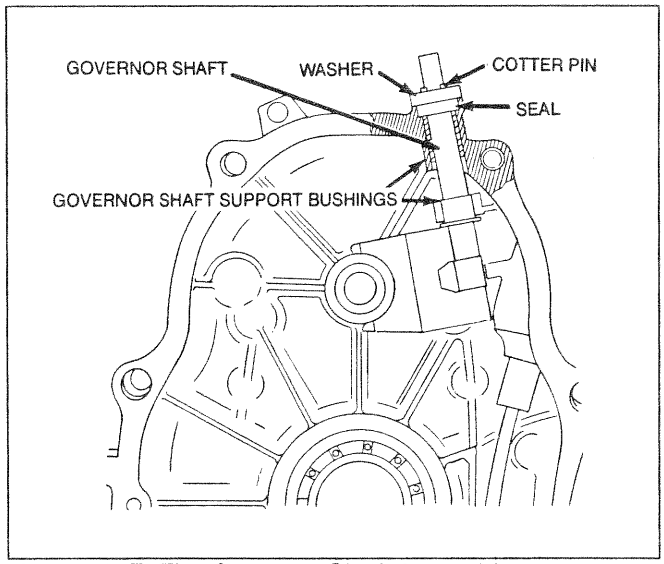


Figure 107. The Governor Shaft Assembly

Governor Shaft Removal (Continued)

Pry out the shaft seal with a small screwdriver. Press in a new seal.

Inspection of Governor Shaft Bushings

Inspect bushings for burrs, wear, foreign material. Replace bushings if worn or out of round.

The upper bushing can be removed using a 9.5mm (3/8 inch) rod to drive the bearing downward into the cover. Press in the new bushing using a bushing driver (Figure 108).

NOTE: If the lower bushing (in the crankcase cover) is worn, the crankcase cover must be replaced.

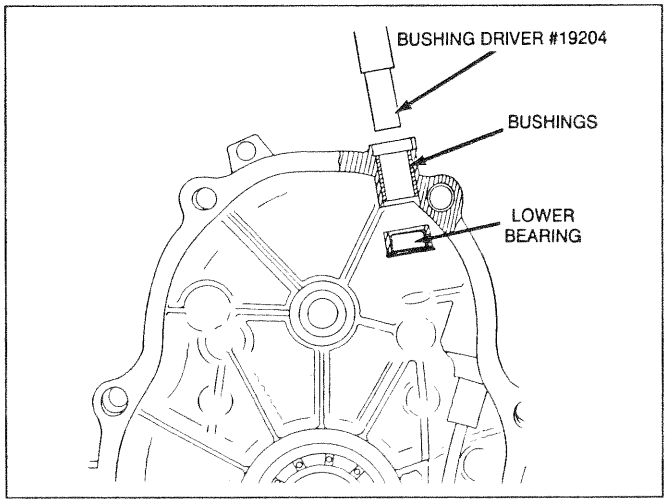


Figure 108. Upper Bushing Replacement

Governor Shaft Installation

Install lower bushing on governor shaft. Slide the shaft up through the lower and upper bushings. Install plastic washer and cotter pin to retain the shaft.

CAUTION: The governor shaft MUST be properly positioned before installing the crankcase cover. Refer to Figure 109. If the shaft is not properly positioned during assembly, it will be impossible to adjust the governor. This will result in overspeeding and possible damage to the engine and/or generator set.

Governor Installation

Install the governor as shown in Figure 110. Weights must be properly located and must move freely without binding.

Install the o-ring into crankcase hole as shown.

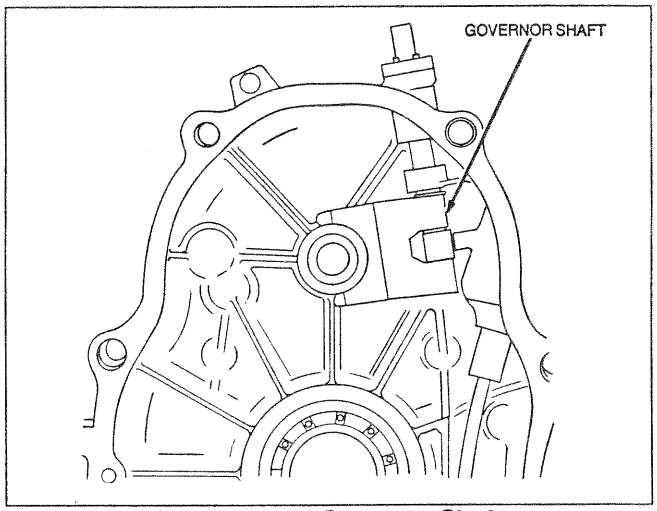


Figure 109. Positioning of Governor Shaft

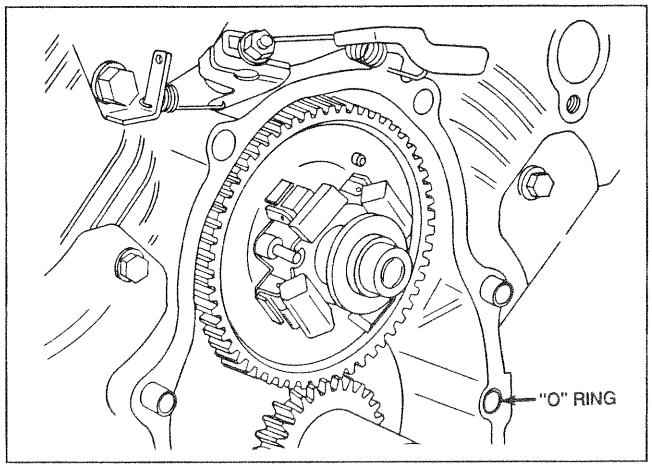


Figure 110. Governor Installation

Crankcase Cover Installation

Install the crankcase cover as follows (Figure 111):

- Install a new cover gasket onto the crankcase. Make sure the gasket is properly positioned over holes in crankcase.
- Carefully slide the cover onto the crankshaft. NO FORCE SHOULD BE USED.

CAUTION: Make sure the o-ring seal is properly installed in crankcase as shown in Figure 110.

- Torque cover bolts in the sequence shown (Figure 111) to 17 N-m (150 inch-pounds).

Static Governor Adjustment

The static governor adjustment must be completed before attempting to start and run the engine.

Static Governor Adjustment (Continued)

DANGER: STATIC GOVERNOR ADJUSTMENT MUST BE COMPLETED BEFORE ATTEMPTING TO START OR RUN THE ENGINE. FAILURE TO COMPLETE THE STATIC ADJUSTMENT COULD RESULT IN OVERSPEEDING OF THE ENGINE-GENERATOR. SUCH OVERSPEEDING MAY RESULT IN SERIOUS ENGINE-GENERATOR DAMAGE AND MAY ALSO RESULT IN PERSONAL INJURY OR PROPERTY DAMAGE.

ALL LINKAGE MUST BE INSTALLED TO MAKE THIS ADJUSTMENT.

- Loosen the governor lever bolt and nut.
- Push on the governor lever until throttle is wide open. DO NOT BEND GOVERNOR LINK.
- Hold the governor lever in this "wide open throttle" position and rotate the governor shaft counterclockwise (CCW) as far as it will go.
- Hold the shaft in the fully counterclockwise position and tighten the governor lever bolt and nut. Torque governor lever bolt and nut to 8 N-m (70 inch-pounds).

NOTE: Clearance is limited on ducted engines. A standard torque wrench and socket may not work. An M6 crowsfoot wrench and torque wrench will allow proper torquing.

Choke Adjustment- Horizontal Shaft Engines

See Figure 113. Move the choke control link to its "Choke" position. The carburetor choke plate should be fully closed.

Choke Adjustment- Vertical Shaft Engines

Vertical shaft engines, used with RV and standby generator sets having a gasoline fuel system, may be equipped with an automatic choke (Figure 114). For a discussion of choke operation, refer to Section 15, "Engine Electrical System-RV Generators". Adjust the automatic choke as follows:

PRE-CHOKE ADJUSTMENT:

With the SOLENOID CHOKE not actuated, the carburetor CHOKE PLATE should be about 1/8 inch from its full open position. If necessary, use needle nose pliers to bend tip of BI-METAL to obtain the desired setting.

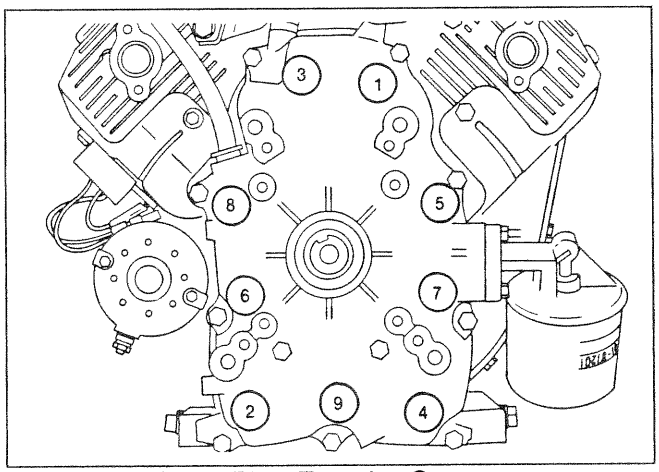


Figure 111. Cover Plate Torquing Sequence

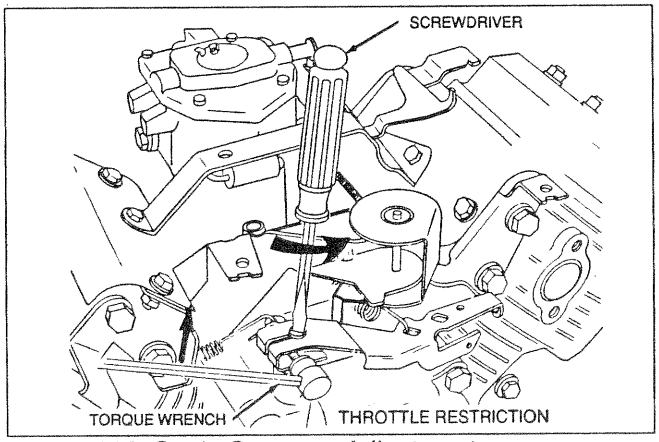


Figure 112. Static Governor Adjustment

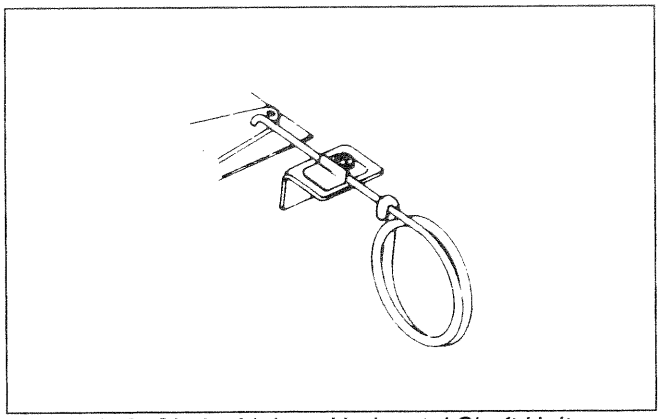


Figure 113. Choke Link on Horizontal Shaft Units

CHOKE SOLENOID ADJUSTMENT:

Loosen the screws that retain the SOLENOID CHOKE to its bracket. Slide the SOLENOID CHOKE in the slotted holes of bracket to adjust axial movement of SOLENOID PLUNGER. Adjust axial plunger movement so that, with the carburetor choke plate closed, the Choke Adjustment-

Vertical Shaft Engines (Continued)

SOLENOID CHOKE is bottomed in the solenoid coil (plunger at full actuated position. With the CHOKE PLATE closed and plunger bottomed in coil, tighten the two screws.

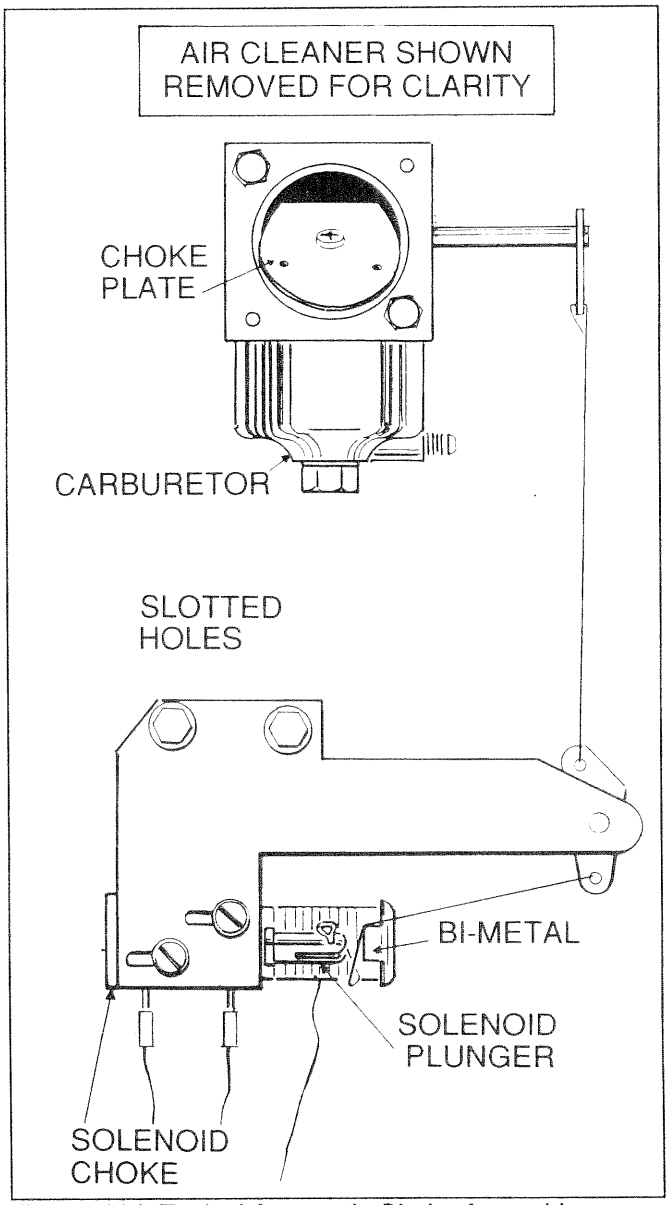


Figure 114. Typical Automatic Choke Assembly

Governor Adjustment- Engine Running

HORIZONTAL SHAFT ENGINES:

The carburetor must be properly adjusted before attempting to adjust governed speed.

- Connect an accurate a-c frequency meter to a generator receptacle.
- Unplug all electrical loads from the generator. Governor adjustment is made at no-load condition.
- Start the engine, let it stabilize and warm up at no-load.
- For generators rated at a frequency of 60 Hertz, turn the SPEED REGULATOR NUT (Figure 115) until the frequency meter reads as close as possible to 62 Hertz.
- For generators rated at a frequency of 50 Hertz, turn the SPEED REGULATOR NUT (Figure 115) until the frequency meter reads as close as possible to 51 Hertz.
- Test engine operation with electrical loads connected and turned on.

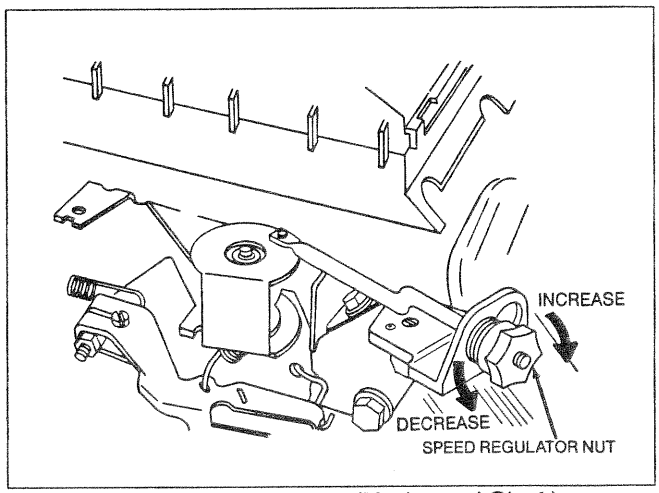


Figure 115. Governor Adjust (Horizontal Shaft)

VERTICAL SHAFT ENGINES:

The gasoline carburetor (gasoline units) or the load block (gaseous fuel system) must be properly adjusted before attempting to adjust governed speed. In addition, the "Static Governor Adjustment" outlined on Pages 46 and 47 must have been properly completed.

Adjust the governor on vertical shaft engines as follows (Figure 116):

- Inspect the ANTI-LASH SPRING. Make sure it is not broken or disengaged.
- Connect an accurate a-c frequency meter to the generator's a-c output leads.
- Start the engine, let it stabilize and warm up at no-load (all electrical loads disconnected from generator).
- Turn the ADJUSTER NUT to obtain a frequency reading as close as possible to 62 Hertz (units rated 60 Hertz); or as close as possible to 51 Hertz (units rated 50 Hertz).

Governor Adjustment- Engine Running (Continued)

- Apply electrical loads and test engine-generator operation with loads applied. Apply electrical loads as close as possible to the generator's full rated wattage capacity. Note the amount of frequency droop when loads are applied. Also note whether excessive "hunting" occurs when loads are disconnected.
- If frequency droops below about 59 Hertz with load applied, disconnect the load and move the GOVERNOR SPRING in the ADJUSTMENT BRACKET closer to the ANTI-LASH SPRING. Then, readjust with ADJUSTER NUT to obtain a no-load frequency as close as possible to 62 Hertz. Again apply a load and check droop.
- Continue the above procedures until no-load speed is as close as possible to 62 Hertz, until excessive droop does not occur under load, and until excessive "hunting" does not occur when load is removed.

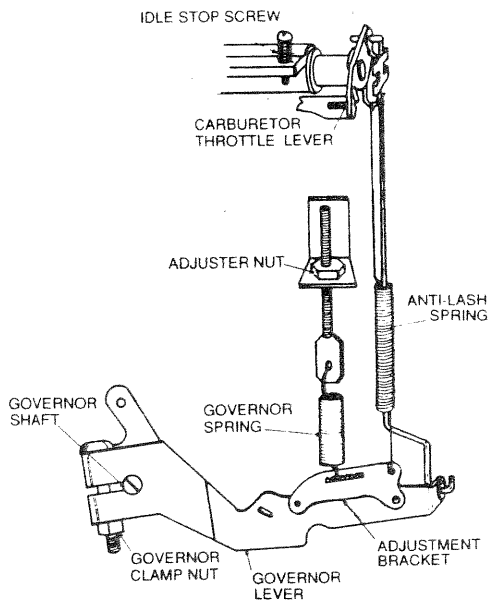


Figure 116. Governor Adjustment- Vertical Shaft Units

Section 10 - GASOLINE CARBURETION

Engine Air Cleaner

Without a properly serviced engine air cleaner, dust and dirt from the air will enter the engine and contaminate the engine oil. Dirt in the oil forms an abrasive mixture which will wear engine parts instead of lubricating them.

DANGER: DO NOT OPERATE THE ENGINE WITH THE AIR CLEANER REMOVED. FIRE CAN RESULT.

DANGER: ALWAYS REMOVE THE SPARK PLUG WIRES OR THE SPARK PLUG BEFORE WORKING ON THE ENGINE. THIS WILL PREVENT ACCIDENTAL STARTING.

CAUTION: DO NOT operate the engine with air cleaner removed as this will permit abrasive dust to enter the engine. Replace air cleaner gaskets that are worn or damaged, to prevent entry of dirt into engine through improper sealing. Replace the air cleaner mounting bracket if it is bent.

SERVICING THE PRE-CLEANER:

To service the dual element air cleaner (Figure 117), proceed as follows:

- Remove knob and cover assembly.
- Remove cartridge from carburetor.
- Either replace the pre-cleaner or wash it in liquid detergent and water.
- After washing, squeeze the pre-cleaner dry in a clean cloth.
- Saturate the pre-cleaner in engine oil. Squeeze in an absorbent cloth to remove excess oil.
- Install pre-clean in cover with foam toward the cover (nylon screen toward the paper element.
- Install paper cartridge in cover with tabs on cartridge in slots of cover.
- Install the cover assembly on air cleaner body.
- Tighten the knob securely.

SERVICING THE CARTRIDGE:

- Remove knob and cover assembly.
- Remove cartridge from cover.
- Clean cartridge by tapping gently on a flat surface.
- If cartridge is very dirty, replace it or wash in a low or non-sudsing detergent and warm water solution. After washing, rinse thoroughly with flowing water from mesh side until water runs clear. Let the cartridge air dry thoroughly before using.

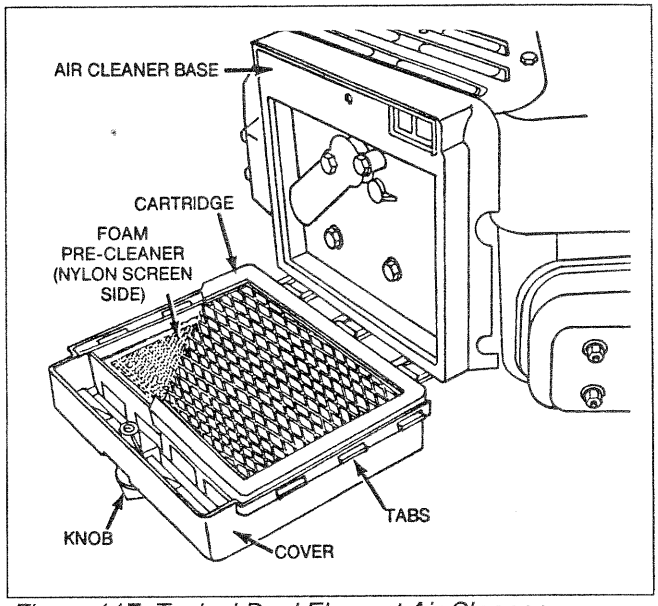


Figure 117. Typical Dual Element Air Cleaner

- Install paper carridge in cover with tabs on cartridge in slots of cover.
- Install cover onto air cleaner body.
- Tighten the knob securely.

CAUTION: DO NOT OIL CARTRIDGE. DO NOT USE PRESSURIZED AIR TO CLEAN OR DRY THE CARTRIDGE. DO NOT use any petroleum solvents, such as kerosene, to clean the cartridge. Petroleum solvents may cause deterioration of the cartridge.

Carburetor Operation

Either of two types of carburetors may be used on the V-Twin engine, as follows:

1. Single piece, side draft type.
2. Two piece down draft type.

Both types of carburetors have similar operating systems. The side draft type is shown in the following illustrations, to show carburetor operation.

FLOAT SYSTEM OPERATION:

See Figure 118. Gasoline is delivered from a fuel tank to the carburetor by means of either gravity feed or a fuel pump. Fuel enters the carburetor through the inlet nipple, flows through the inlet needle valve, and begins filling the carburetor bowl.

Carburetor Operation (Continued)

As the bowl fills, the float rises to move the inlet needle valve toward the inlet seat. When the needle valve contacts the seat, fuel flow into the bowl ceases. Fuel remains at this level until the engine begins to draw gasoline from the float bowl. Float movement then opens the needle valve again to refill the bowl.

The air space above the gasoline in the float bowl is vented to atmosphere, to maintain the bowl interior at atmospheric pressure.

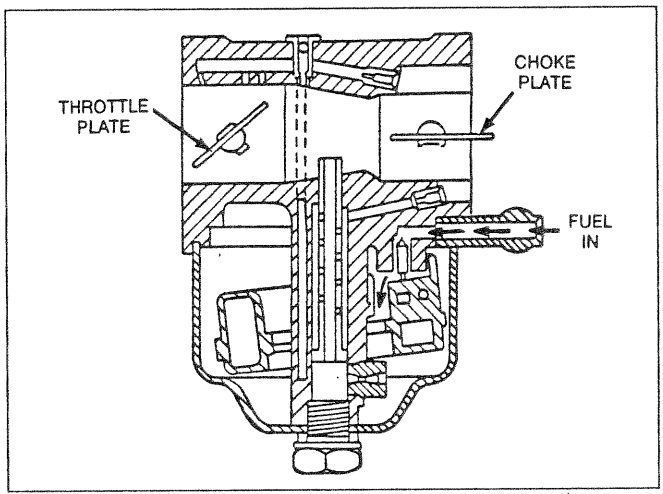


Figure 118. Fuel Enters the Float Bowl (Typical)

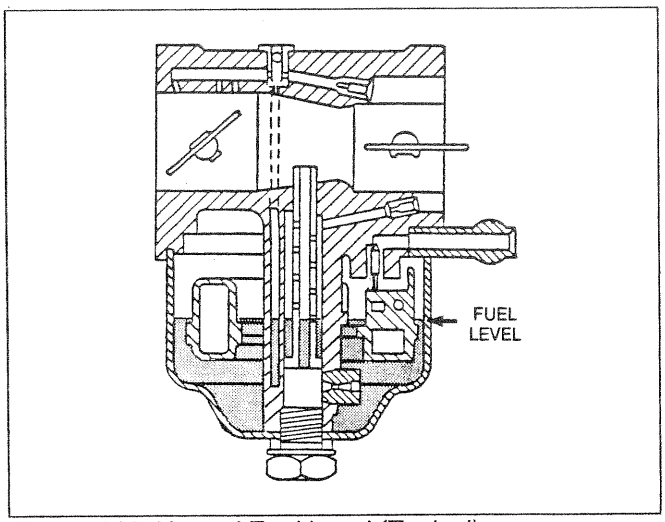


Figure 119. Normal Fuel Level (Typical)

IDLE SYSTEM OPERATION:

With engine idling and when the intake valve is open, a partical vacuum forms between the throttle valve and top of piston. Atmospheric pressure acting on the gasoline in the float bowl then pushes fuel through the fixed high speed jet (Figure 120) and up to the idle passage. Air is also pushed into the carburetor throat.

Atmospheric pressure enters through the idle air jet. Fuel is pushed up the idle passage and mixes with air from the idle air jet. The resultant fuel/air mixture is then pushed to the primary idle port and out into the carburetor throat. There it mixes with air that is flowing to the engine combustion chambers (cylinders).

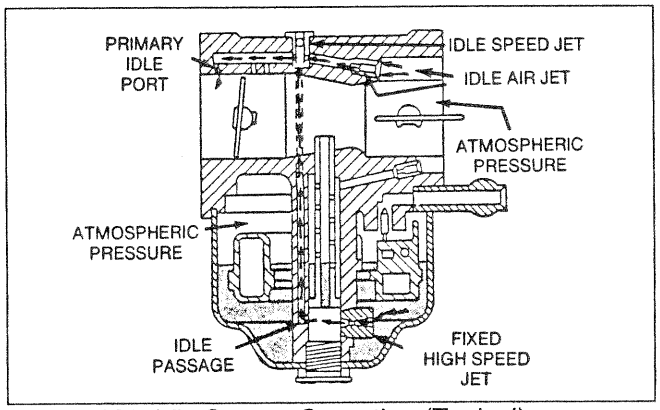


Figure 120. Idle System Operation (Typical)

PART THROTTLE OPERATION:

As the throttle opens and the fuel/air mixture increases from the primary and secondary idle ports, engine speed increases. See Figure 121.

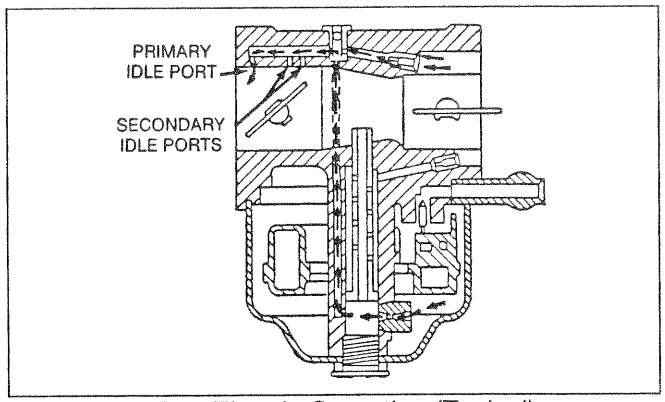


Figure 121. Part Throttle Operation (Typical)

HIGH SPEED OPERATION:

As engine speed increases, more air must flow through the carburetor's venturi throat. This causes an even greater pressure drop (vacuum) at the venturi throat. At the same time, atmospheric pressure pushes air through the main air jet to the outside of the main pickup tube. This air then enters through the main pickup tube bleed holes and mixes with the air inside the main pickup tube. This air/fuel mixture is moved up and out of the main pickup tube into the venturi, and then into the engine through the intake valve.

Carburetor Operation (Continued)

The throttle valve controls the air/fuel mixture flow to the engine as the governor responds to changing loads.

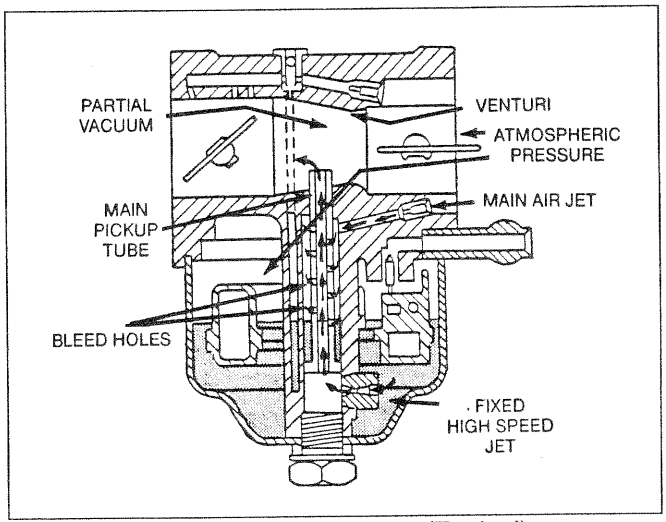


Figure 122. High Speed Operation (Typical)

Carburetor Removal- Vertical Crankshaft Models

CARBURETOR REMOVAL:

- See Figure 123. Remove air cleaner cover, pre-cleaner and cartridge.
- Remove four screws that retain the air cleaner base. Remove the choke link, between the automatic choke and the carburetor choke lever.
- Remove fuel line from carburetor.
- Disconnect the governor link spring (Figure 124) from governor lever and throttle lever link retainer.
- Remove link retainer from governor link and remove link from throttle and governor levers.
- Remove two screws and remove carburetor from intake manifold.
- Set spacers and gaskets aside.

CARBURETOR DISASSEMBLY:

- Remove bowl mounting screw, washer and bowl. See Figure 125.
- Use a small punch to drive the float hinge pin out of float hinge (Figure 126).
- Remove float and fuel inlet needle assembly.
- Remove the carburetor bowl gasket (Figure 127).
- Remove the fixed high speed jet (Figure 128).

NOTE: Special high altitude jets are available. Refer to the appropriate illustrated parts list.

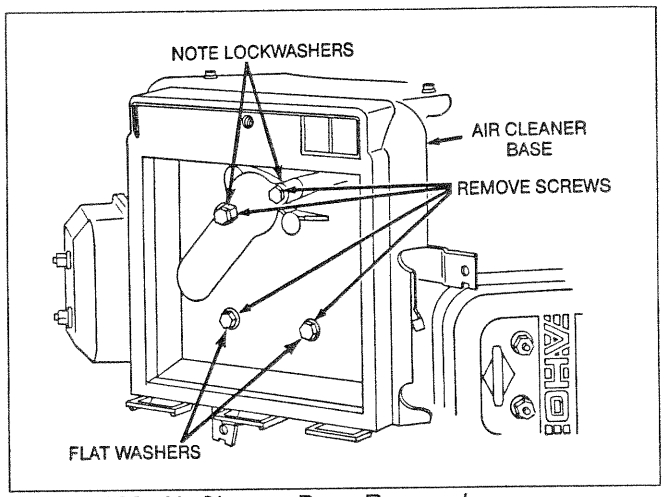


Figure 123. Air Cleaner Base Removal

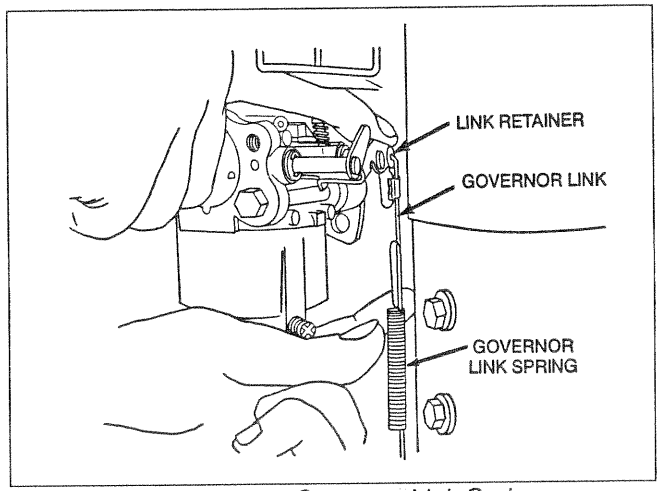


Figure 124. Disconnect Governor Link Spring

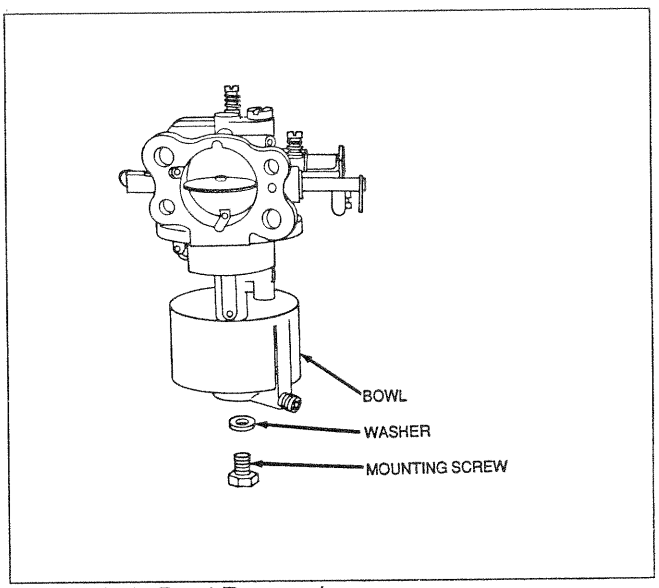


Figure 125. Bowl Removal

Carburetor Removal- Vertical Crankshaft Models (Continued)

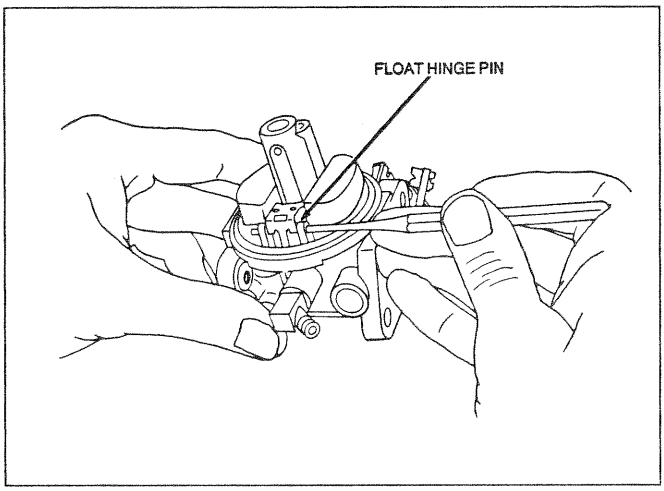


Figure 126. Float Hinge Pin Removal

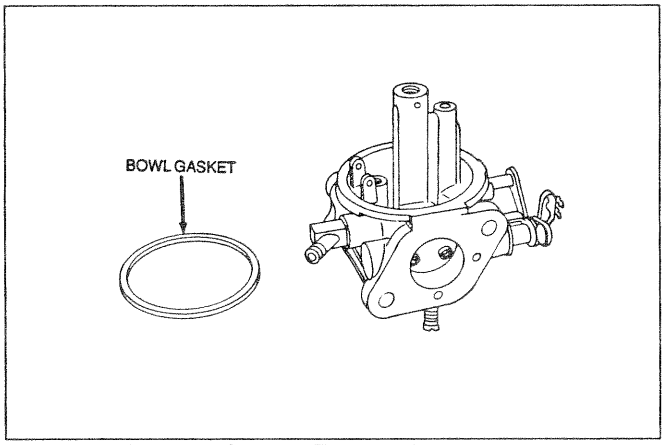


Figure 127. Bowl Gasket Removal

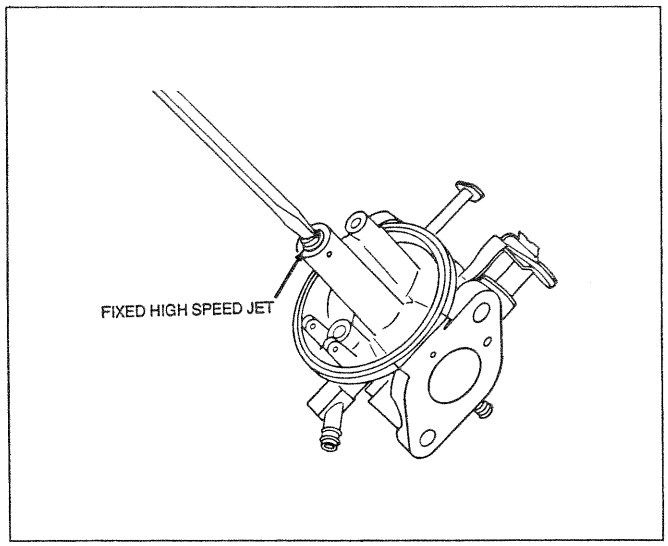


Figure 128. High Speed Jet Removal

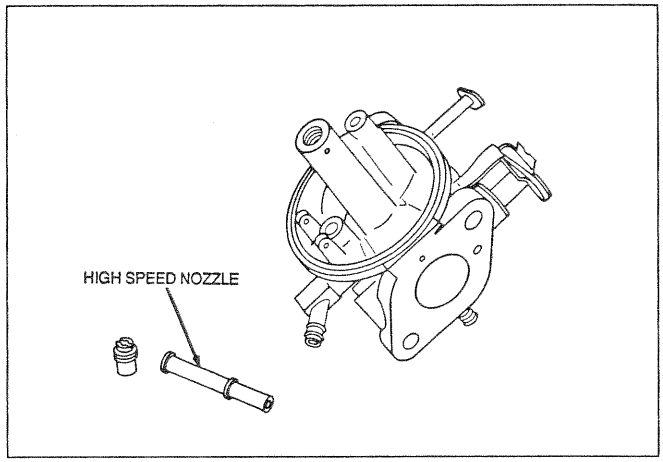


Figure 129. High Speed Nozzle Removal

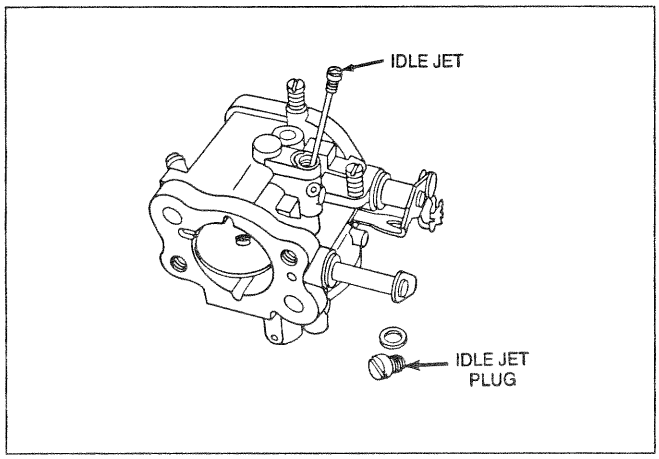


Figure 130. Idle Jet Removal

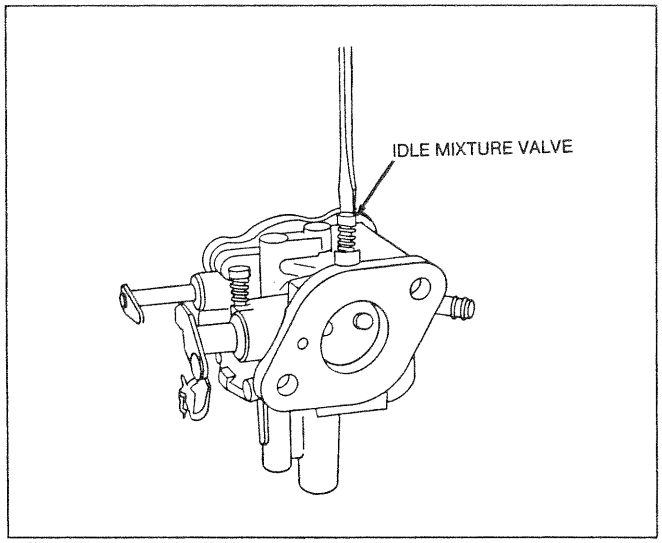


Figure 131. Idle Mixture Valve Removal

Carburetor Removal- Vertical Crankshaft Models (Continued)

- Remove the high speed nozzle (Figure 129). Reach into carburetor throat with a straight slot screwdriver and push down on end of nozzle.
- Remove idle jet plug and idle jet (Figure 130).
- Remove idle mixture valve (Figure 131).

CLEANING:

Clean fuel system parts, if necessary, in a commercial carburetor cleaner such as Bendix® carburetor cleaner (or equivalent). DO NOT SOAK RUBBER, PLASTIC OR NEOPRENE PARTS IN CLEANER.

REASSEMBLY:

- Always use new seals and gaskets when reassembling the carburetor.
- Install carburetor bowl gasket in carburetor body groove (Figure 132). Make sure the gasket does not twist or kink.

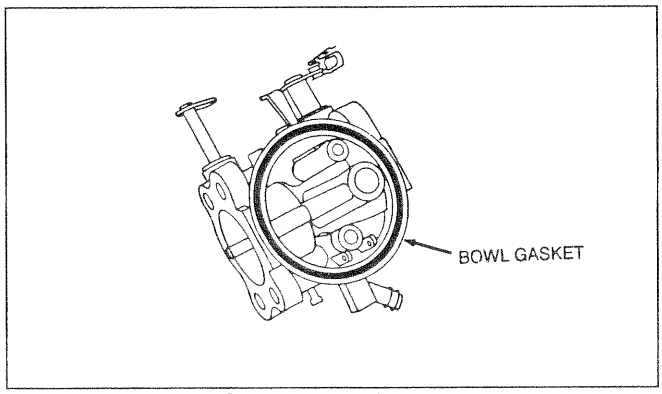


Figure 132. Bowl Gasket Installation

- Install fuel inlet valve spring into the valve groove (Figure 133).

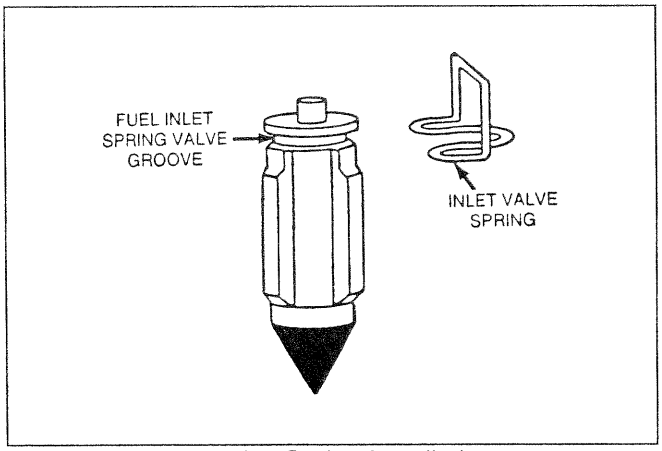


Figure 133. Inlet Valve Spring Installation

- Insert fuel inlet needle assembly onto float tang and place the assembly in the carburetor (Figure 134).

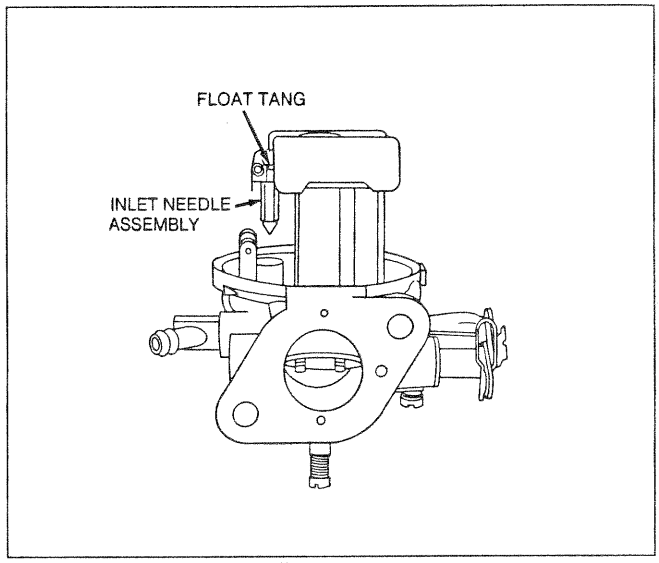


Figure 134. Float Installation

- Install float hinge pin (Figure 135).

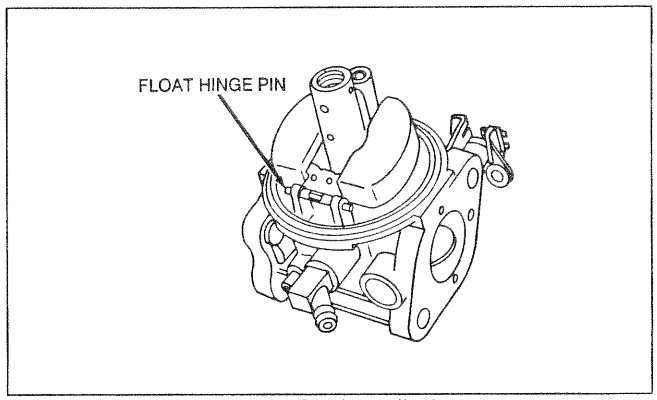


Figure 135. Float Hinge Pin Installation

- With the carburetor body upside down, float should be parallel with the bowl mounting surface. If it is not parallel, bend the float tang to adjust (Figure 136).
- Install the idle speed jet and plug (Figure 137). Tighten plug securely.
- Install idle mixture valve and spring (Figure 138). DO NOT TIGHTEN THE VALVE.
- Install high speed nozzle and fixed high speed jet (Figure 139).
- Install bowl, washer and screw (Figure 140). Position bowl drain as shown and tighten screw securely.

Carburetor Removal- Vertical Crankshaft Models (Continued)

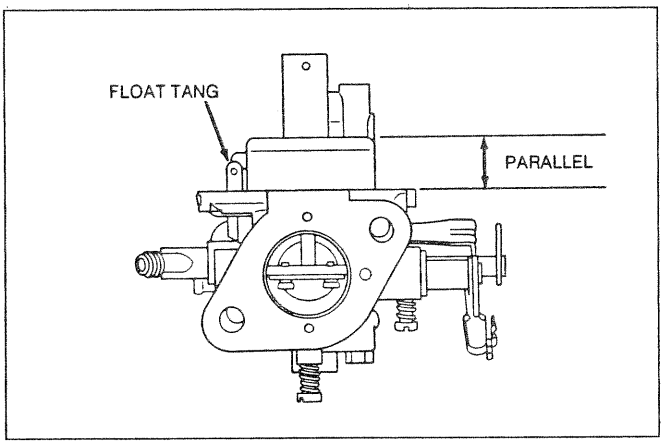


Figure 136. Float Adjustment

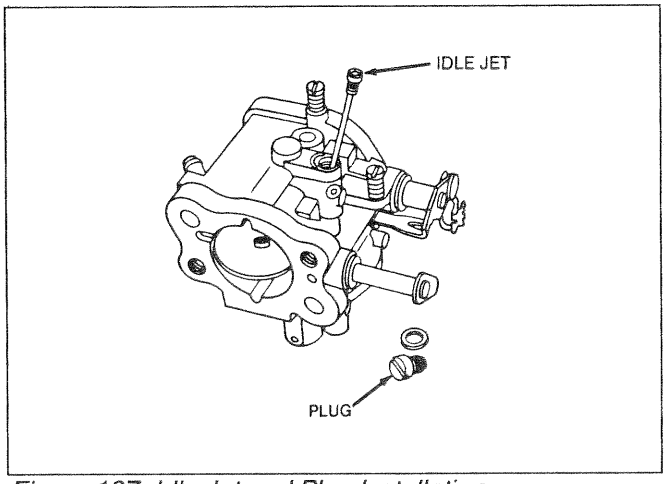


Figure 137. Idle Jet and Plug Installation

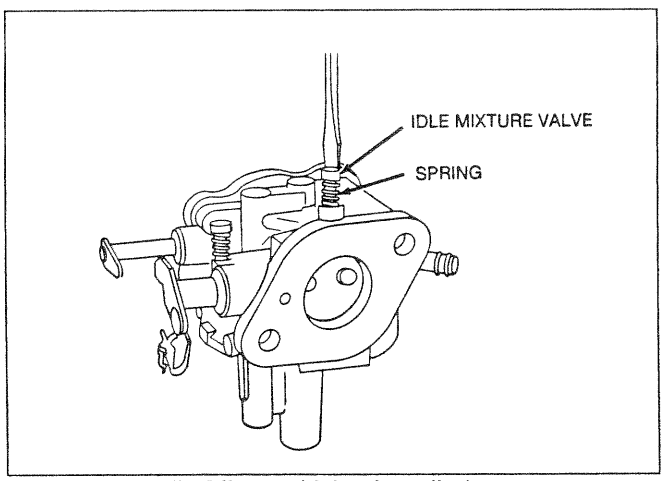


Figure 138. Idle Mixture Valve Installation

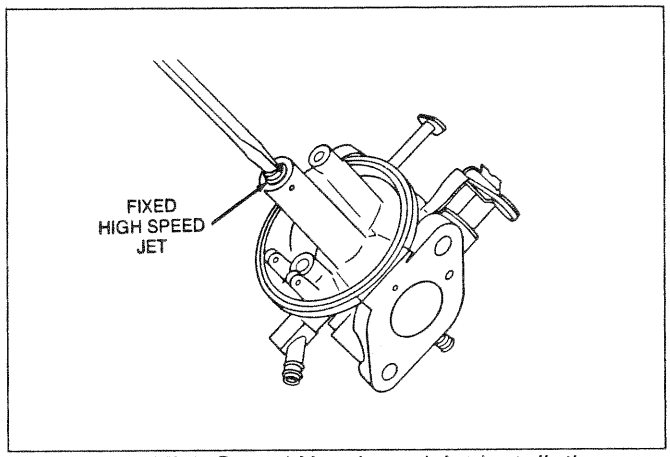


Figure 139. High Speed Nozzle and Jet Installation

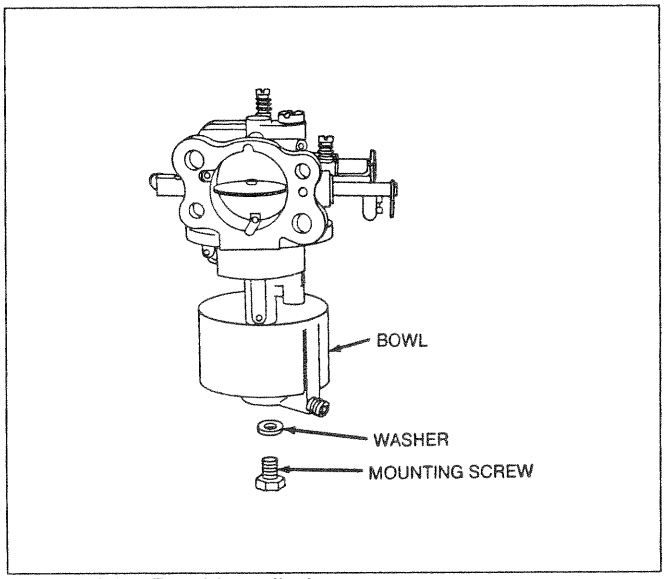


Figure 140. Bowl Installation

CARBURETOR INSTALLATION:

- Insert mounting bolts (Figure 141) through carburetor, gasket, spacer and gasket. Align carburetor spacer locating pin with recess in intake manifold. Install carburetor onto manifold. Tighten bolts to 7 N-m (65 inch-pounds).
- Connect governor link to throttle lever. Connect spring on governor lever and throttle lever link retainer (Figure 142).
- Connect choke link.
- Install fuel line and fuel line clamp.

NOTE: Static governor adjustment (Page 45 & 46) must be made whenever carburetor and/or manifold have been removed.

Carburetor Removal- Vertical Crankshaft Models (Continued)

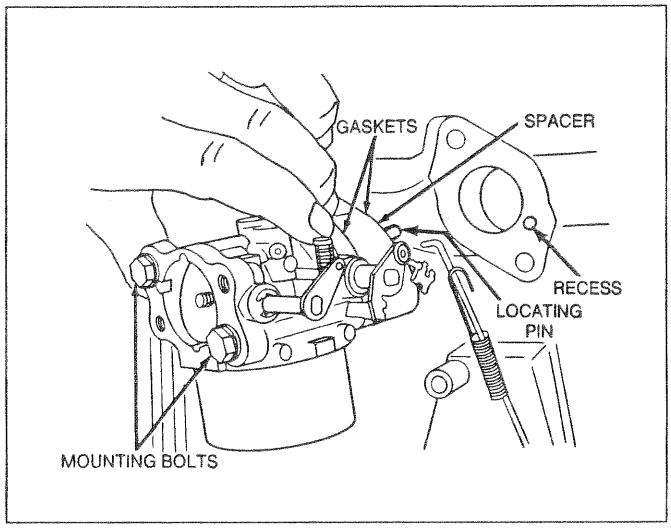


Figure 141. Carburetor Installation

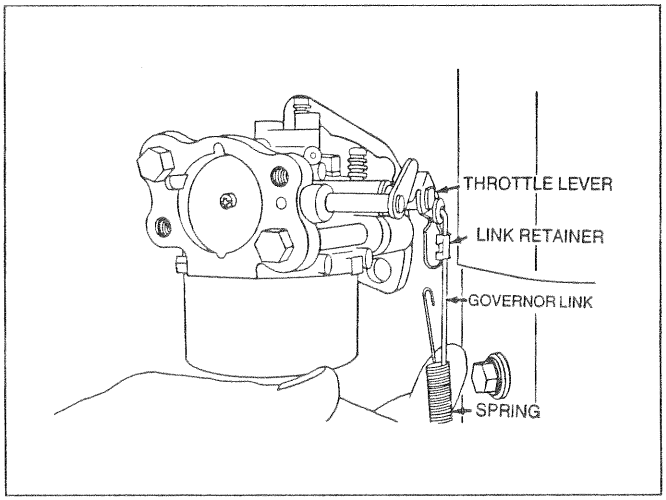


Figure 142. Connection of Governor Link

AIR CLEANER BASE INSTALLATION:

See Figure 143. Slide breather tube onto cover nipple. Install air cleaner base to carburetor mounting screws through the base. PLace the base to carburetor gasket on the screws. Guide the breather tube onto the cover nipple and install the base mounting screws into carburetor and the air cleaner base support bracket. Tighten the four screws to 7 N-m (65 inch-pounds).

Install the air cleaner cartridge, pre-cleaner and cover as described on Page 49.

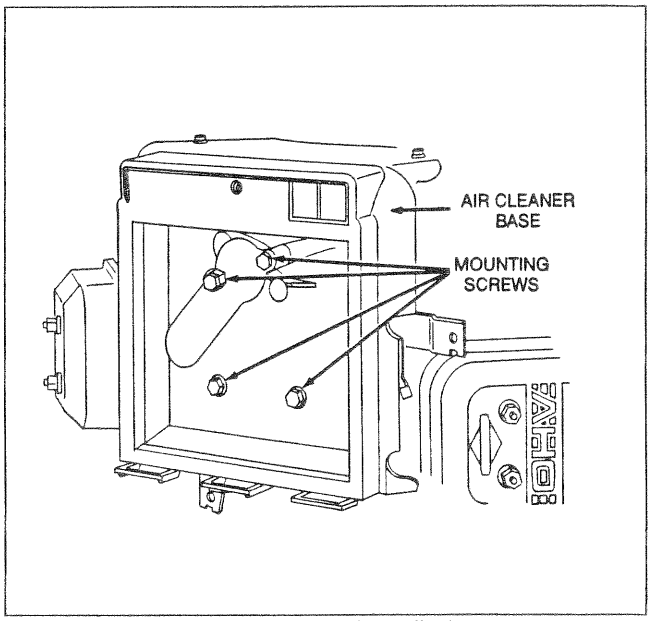


Figure 143. Air Cleaner Base Installation

Carburetor Removal- Horizontal Crankshaft Models

REMOVAL:

Remove air cleaner cover, pre-cleaner, and cartridge.

Remove four screws that retain the air cleaner base plate (Figure 144).

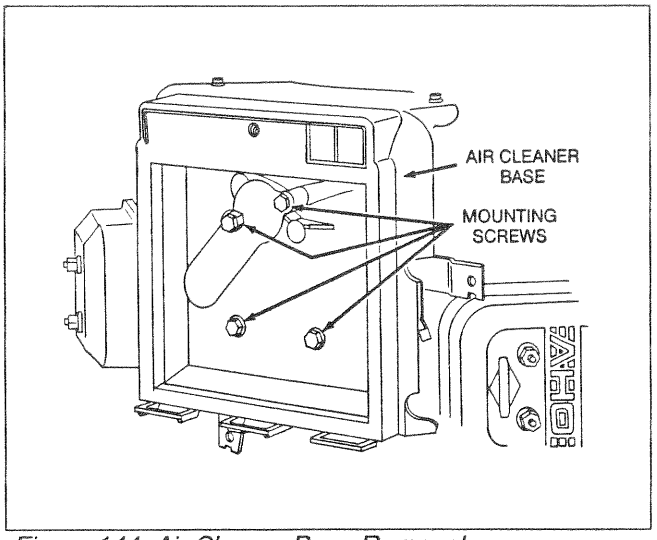


Figure 144. Air Cleaner Base Removal

Carburetor Removal- Horizontal Crankshaft Models (Continued)

Remove blower housing from engine. Remove screws from choke control bracket. Rotate choke control bracket and unhook the choke link (Figure 145). Swing bracket out of the way, then remove choke link from carburetor. Remove fuel line clamp and fuel line from the carburetor.

Unhook the governor link spring from governor lever and throttle link retainer. Remove link retainer from governor link. Remove link from throttle lever and from the governor lever.

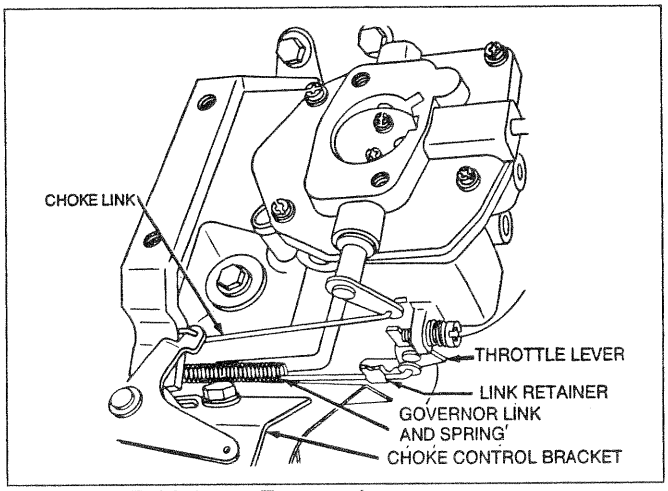


Figure 145. Linkage Removal

Remove four screws that retain the manifold to the cylinders. Remove the carburetor and manifold assembly from the engine (Figure 146).

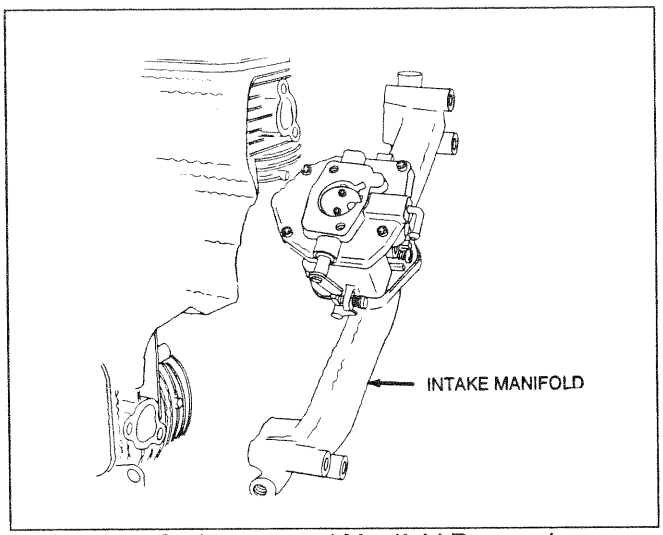


Figure 146. Carburetor and Manifold Removal

Remove two screws that retain the carburetor to the manifold. Remove carburetor, spacer block and gaskets. See Figure 147.

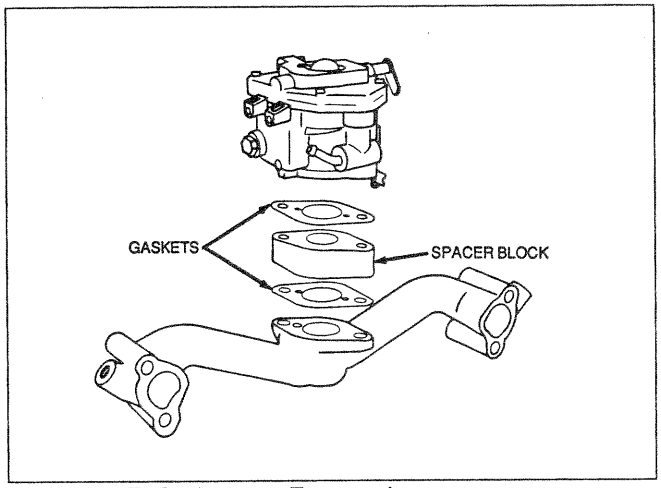


Figure 147. Carburetor Removal

CARBURETOR DISASSEMBLY:

Remove four screws that retain the upper body to the lower body. Separate the upper and lower bodies (Figure 148). USE CARE NOT TO DAMAGE HIGH SPEED PICKUP TUBE IN UPPER BODY.

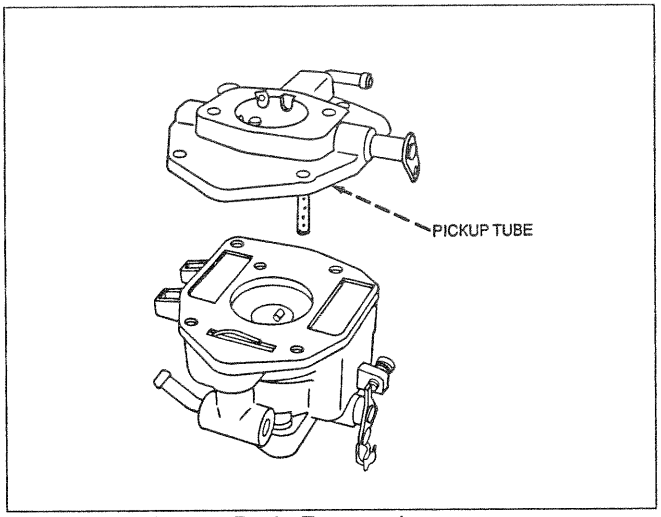


Figure 148. Upper Body Removal

Remove gasket and lift the float and hinge assembly from the lower body (Figure 149).

Remove the idle mixture valve and spring, plug, washer, and high speed jet (Figure 150).

Remove the idle jet (Figure 151).

Carburetor Removal- Horizontal Crankshaft Models (Continued)

Invert the lower carburetor body and remove the throttle valve screw (Figure 152).

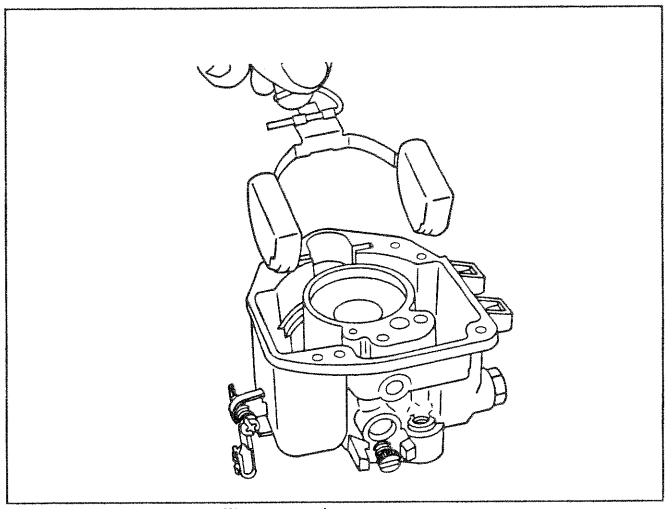


Figure 149. Float Removal

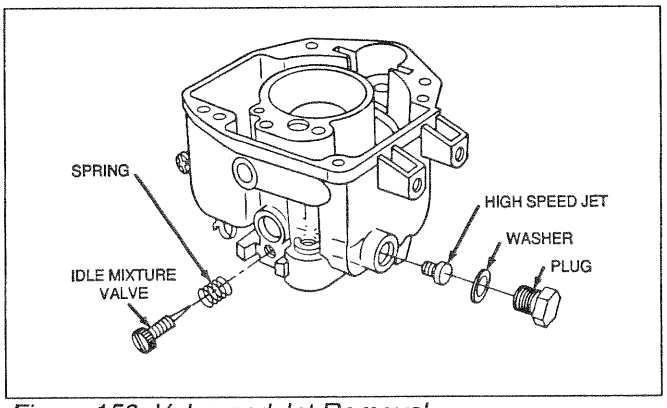


Figure 150. Valve and Jet Removal

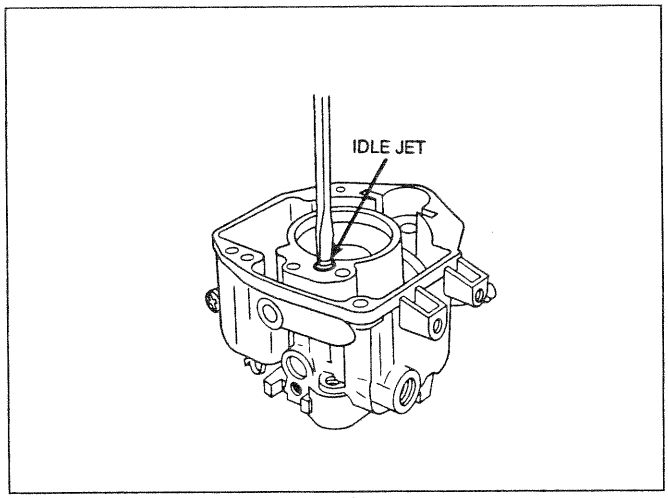


Figure 151. Idle Jet Removal

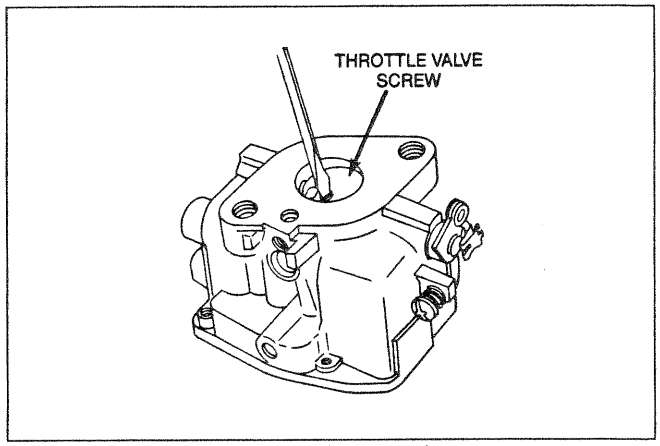


Figure 152. Throttle Valve Removal

Slide the throttle shaft out of the carburetor body. Remove the shaft seal from the body. See Figure 153.

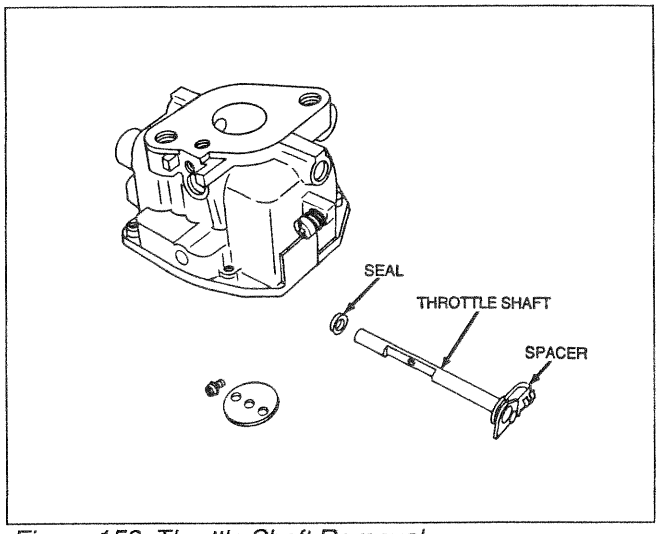


Figure 153. Throttle Shaft Removal

Support upper body on a vise or wooden block, to prevent damage to the high speed pickup tube. Remove choke valve screws, valve, choke shaft and spacer bushing (Figure 154).

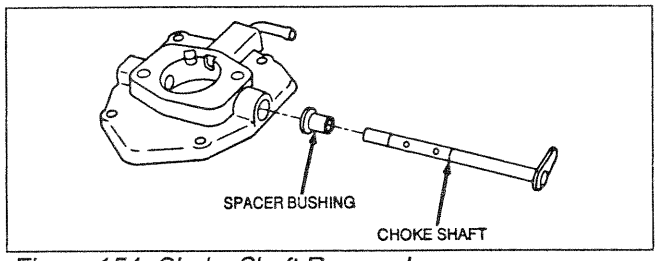


Figure 154. Choke Shaft Removal

Carburetor Removal- Horizontal Crankshaft Models (Continued)

CLEANING:

Fuel system parts may be cleaned in a carburetor cleaner such as the "Bendix®" carburetor cleaner or equivalent. DO NOT SOAK RUBBER, PLASTIC OR NEOPRENE PARTS IN CLEANER.

REASSEMBLY:

Always use new seals and gaskets when reassembling the carburetor. Reassemble the carburetor as follows:

Slide the choke shaft and bushing into the upper body. Lay the choke valve on flat of shaft with air hole positioned toward the bowl vent nipple. Install screws and tighten securely (Figure 155). Check the shaft and valve for freedom of movement.

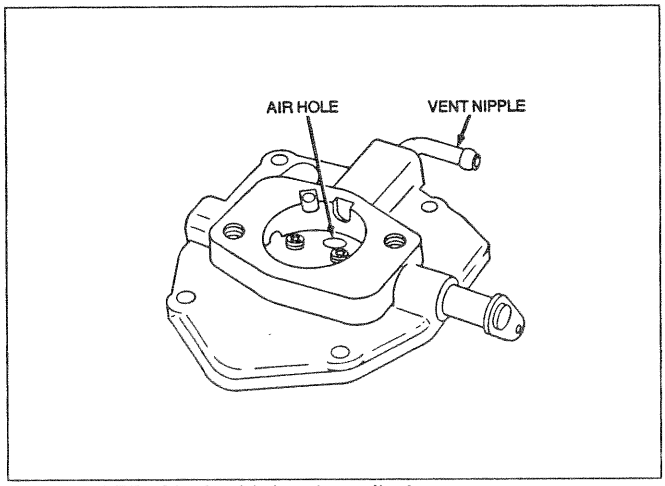


Figure 155. Choke Valve Installation

Install the throttle shaft seal. Insert the throttle shaft into the lower carburetor body. Position throttle valve on flat of shaft so the two outer holes are covered by the shaft and the chamfered edges of the valve are against the sides of the carburetor throat when the valve is closed. See Figure 156. Install and tighten the screw.

Install the idle jet and tighten securely (Figure 157).

See Figure 158. Install the high speed jet, washer and plug. Install spring on idle mixture valve and install valve into lower carburetor body. DO NOT TIGHTEN THE MIXTURE VALVE AGAINST ITS SEAT.

Slide the inlet valve into slot of float tang (Figure 159). Install valve and float assembly into lower carburetor body.

Lightly press on the float needle tang until resistance is felt (needle closed). Float should be parallel with the upper body mounting surface. If it is not bend tang until float is parallel with upper body.

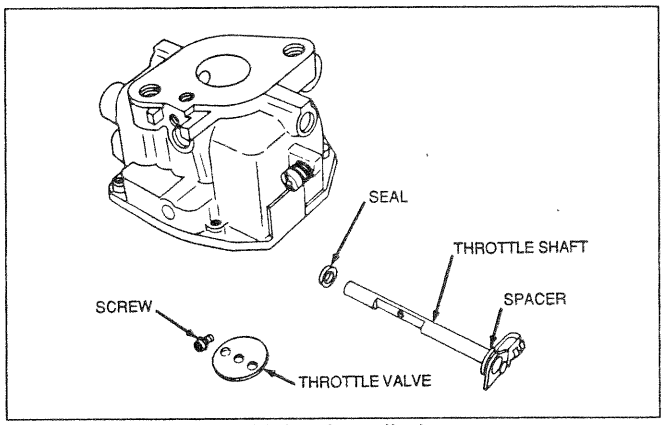


Figure 156. Throttle Valve Installation

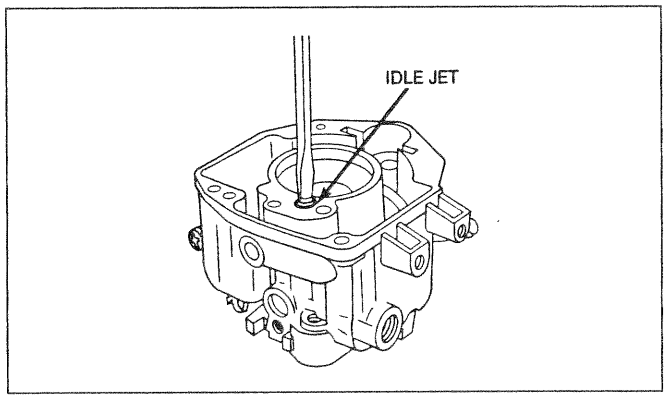


Figure 157. Idle Jet Installation

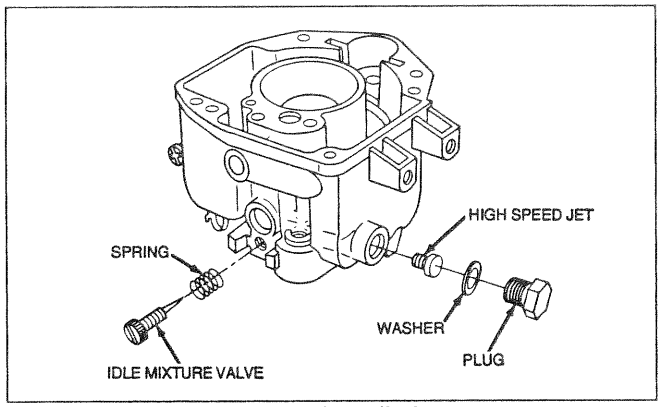


Figure 158. Valve and Jet Installation

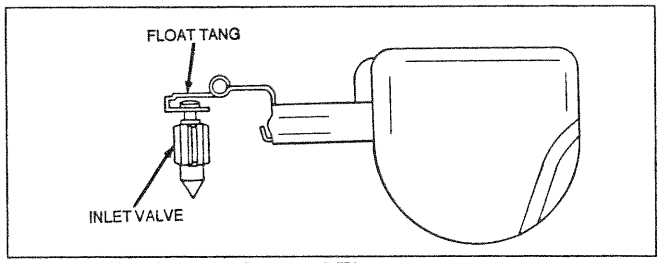


Figure 159. Inlet Valve and Float

Carburetor Removal- Horizontal Crankshaft Models (Continued)

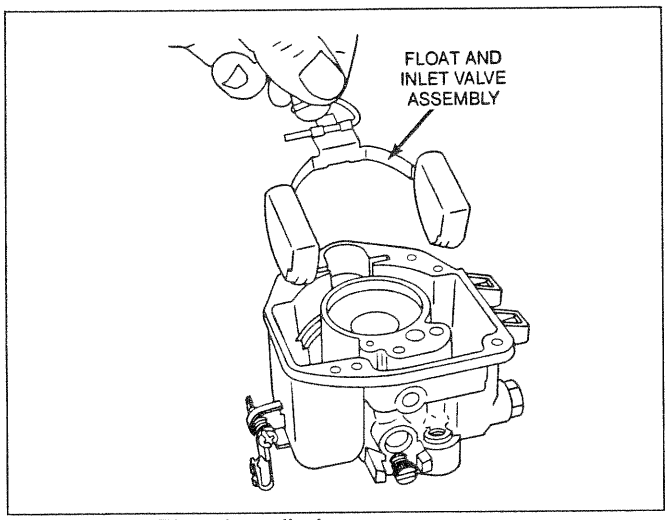


Figure 160. Float Installation

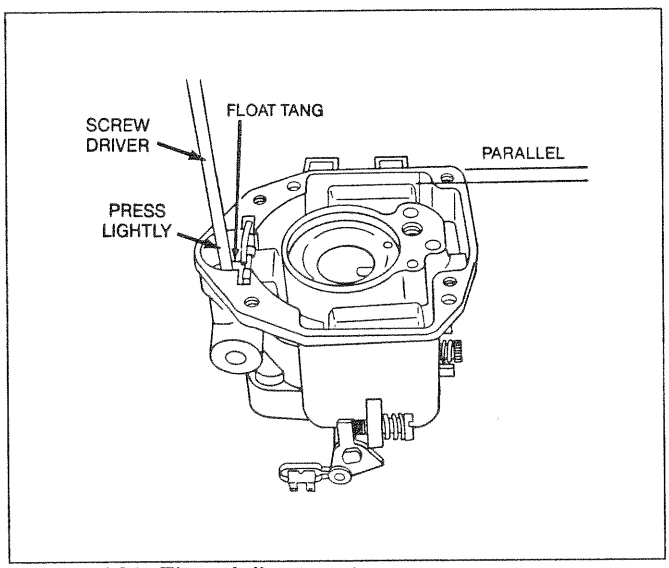


Figure 161. Float Adjustment

Place new gasket on lower carburetor body with screw holes aligned. Fasten upper body to lower body with four screws (Figure 162).

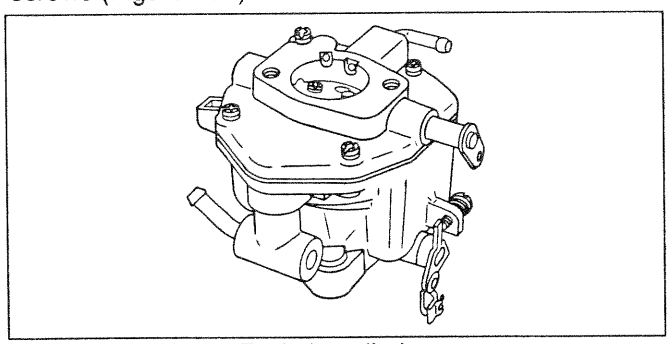


Figure 162. Upper Body Installation

Assemble gasket, spacer, gasket and carburetor over the intake manifold and install mounting screws. The carburetor spacer has a locating pin which fits into recess of manifold (Figure 163). Tighten screws to 7 N-m (65 inch-pounds).

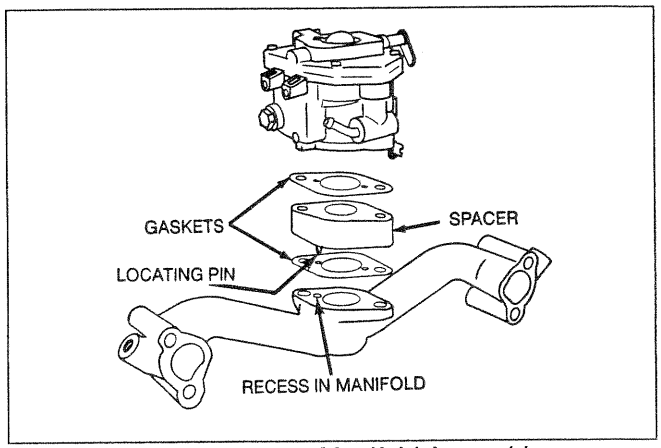


Figure 163. Carburetor to Manifold Assembly

Assemble the carburetor and manifold to the cylinder heads. Tighten four screws to 16 N-m (140 inch-pounds).

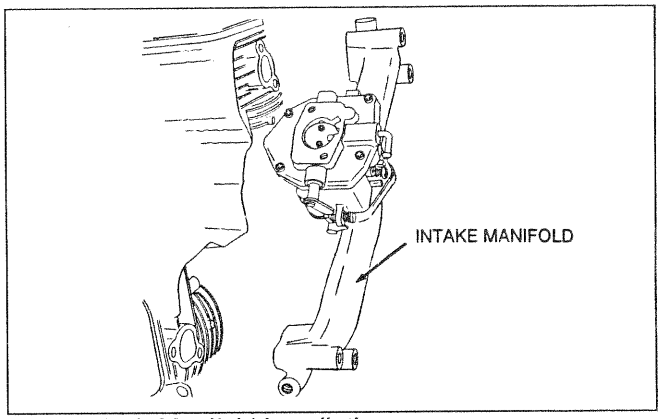


Figure 164. Manifold Installation

Install and connect links and springs (Figure 165.

Install the blower housing onto engine.

CAUTION: A STATIC GOVERNOR ADJUSTMENT must be completed whenever the carburetor and/or manifold have been removed from the engine. See Pages 45 and 46.

Carburetor Removal- Horizontal Crankshaft Models (Continued)

AIR CLEANER BASE INSTALLATION:

Install base to carburetor gasket onto carburetor. Slide the breather tube onto the air cleaner base and breather cover.

Position the air cleaner base onto carburetor and support bracket. Install base mounting screws into carburetor and bracket. Tighten screws to 7 N-m (65 inch-pounds).

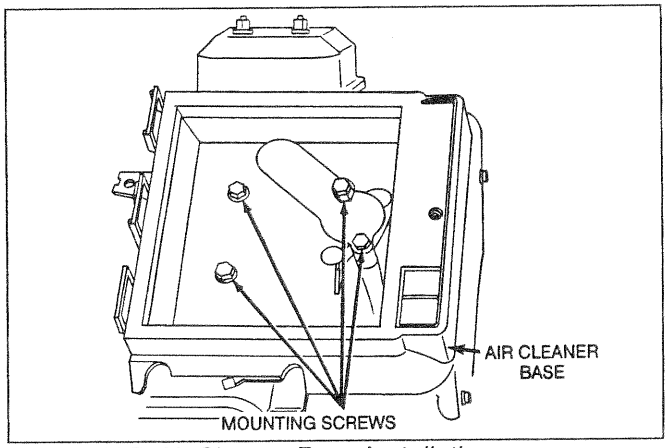


Figure 165. Air Cleaner Base Installation

Install the air cleaner cartridge, pre-cleaner (if so equipped), and cover.

Optional Anti-Dieseling System

Some models may be equipped with an optional anti-dieseling system. The system consists of a solenoid valve which is controlled by the generator panel ignition switch. System operation may be briefly described as follows:

- When ignition switch is set to "Off" position, the solenoid plunger moves against the fixed jet and stops fuel flow (Figure 168).
- When ignition switch is set to "On" or "Run" position, the solenoid plunger moves away from the fixed jet to allow normal fuel flow (Figure 169).

ON-ENGINE TEST OF SOLENOID:

The solenoid is operating properly if an audible "click" is heard when the ignition switch is turned "On" or "Off".

If solenoid does NOT click, disconnect wire from solenoid. Connect either terminal of a 9 volts transistor battery to the connector on solenoid and other battery terminal to body of solenoid. If the solenoid now clicks, problem is in the equipment wiring or in the ignition switch.

BENCH TEST OF SOLENOID:

When a 9 volts transistor battery is connected across the solenoid terminal and the solenoid body, the solenoid plunger should retract freely. When battery is disconnected, the plunger should return freely. If solenoid sticks or does not move, replace the solenoid.

NOTE: If the solenoid is not functioning, engine will not start or run.

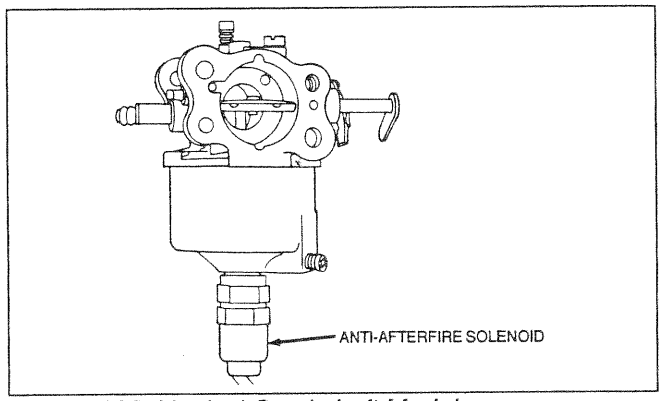


Figure 166. Vertical Crankshaft Models

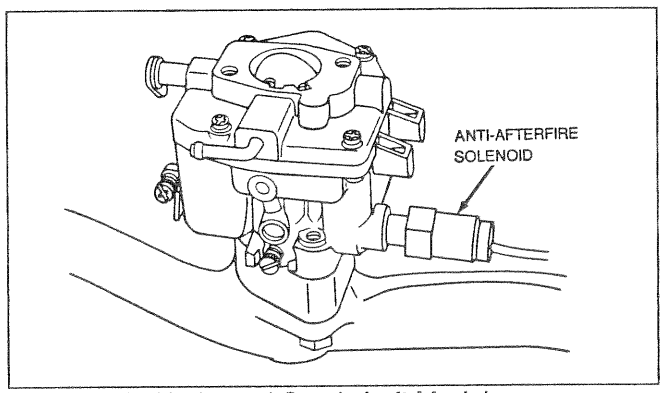


Figure 167. Horizontal Crankshaft Models

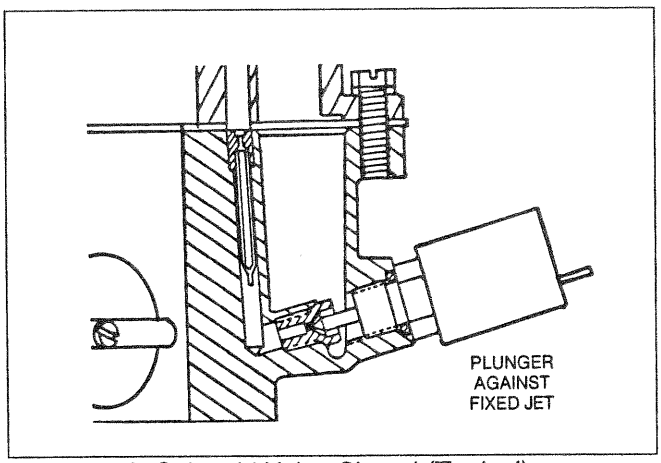


Figure 168. Solenoid Valve Closed (Typical)

Optional Anti-Dieseling System (Continued)

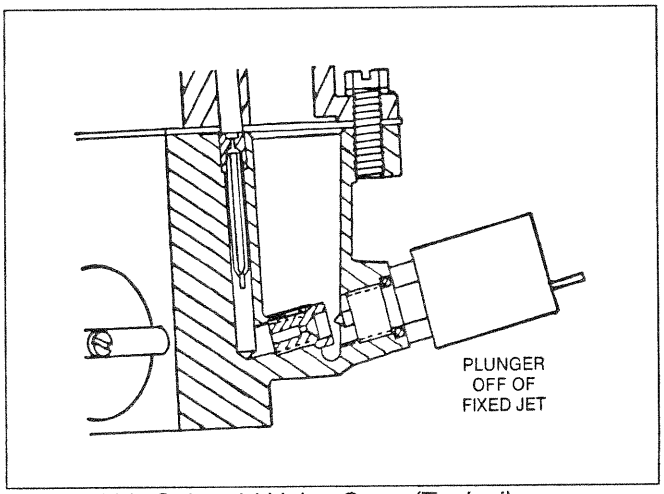


Figure 169. Solenoid Valve Open (Typical)

Carburetor Adjustment- All Models

After carburetor removal, disassembly, reassembly, and installation, complete the following initial adjustment of the idle mixture valve.

- Turn the idle mixture valve clockwise until it just seats. DO NOT FORCE.
- Turn the idle mixture valve counterclockwise 1-1/4 turns. This setting will permit the engine to be started and operated.

NOTE: The above procedure applies to horizontal crankshaft models (Figure 170) and vertical crankshaft models (Figure 171). For units equipped with automatic idle control, refer to "Automatic Idle Control" in this section.

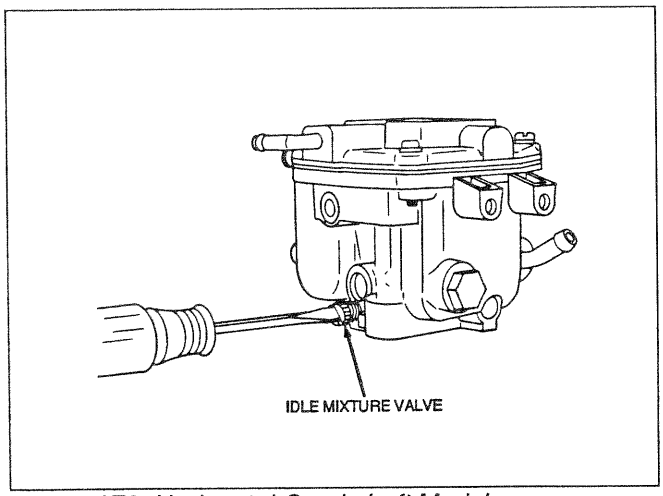


Figure 170. Horizontal Crankshaft Models

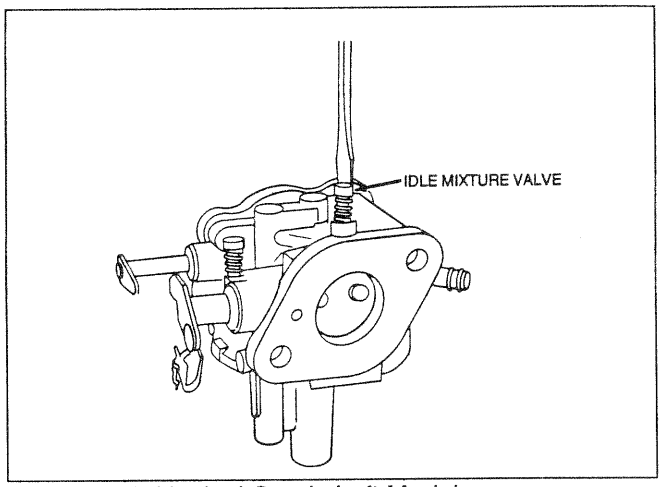


Figure 171. Vertical Crankshaft Models

Fuel Pump

DESCRIPTION:

The fuel pump is operated by engine crankcase vacuum pulses. If so equipped, it is mounted on the blower housing near the No. 1 cylinder valve cover. The pump permits remote fuel tanks to be installed.

FUEL PUMP REMOVAL:

Disconnect vacuum line and fuel lines from the pump. Remove two screws and nuts from pump and mounting bracket. See Figure 172.

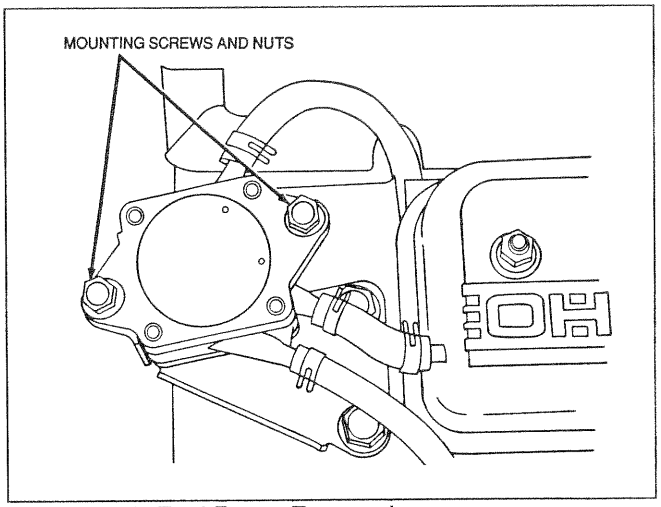


Figure 172. Fuel Pump Removal

FUEL PUMP DISASSEMBLY:

Remove four fuel pump cover screws (Figure 173). Then, separate the pump body and covers.

Fuel Pump (Continued)

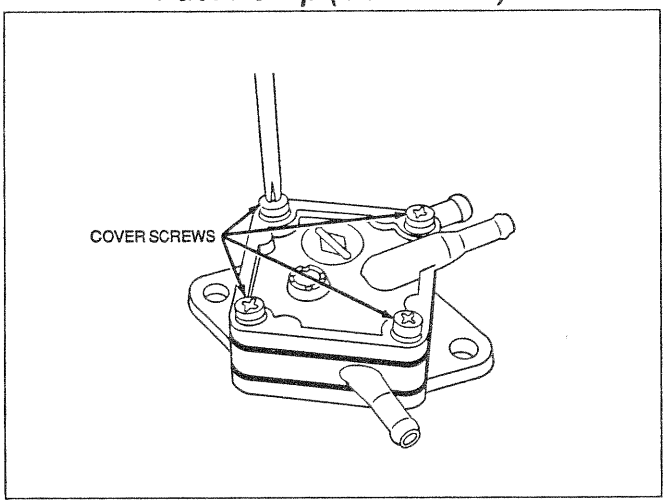


Figure 173. Removal of Fuel Pump Screws

FUEL PUMP INSPECTION:

Inspect the pump body and covers for cracks, nicks on mating surfaces, distortion. If parts are damaged, replace the fuel pump assembly. Replace the plastic diaphragm if it is cracked, perforated, or distorted. Replace fuel and vacuum lines if they have become stiff and brittle.

PUMP REASSEMBLY:

Align the bosses and place the pump body on cover and rubber diaphragm.

Install the plastic diaphragm and gasket on the pump body. Install cover with vacuum line nipple near the pump body inlet nipple.

Install screws and nuts in fuel pump and mounting bracket. Connect vacuum lines and fuel lines.

Start engine and check the pump for leaks.

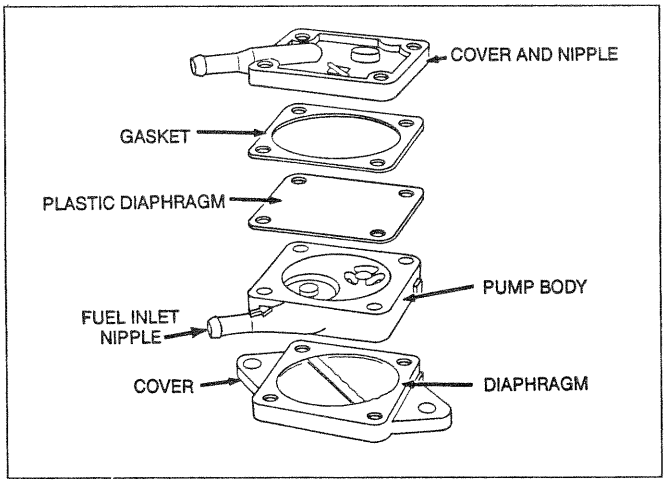


Figure 174. Fuel Pump Exploded View

Automatic Idle Control

INTRODUCTION:

Some horizontal crankshaft models, used in portable industrial generator applications, may be equipped with an automatic idle control system. This system, when so equipped, will provide greatly improved fuel economy by running the engine at normal governed speed when electrical loads are applied. When electrical loads are turned off or disconnected from the generator, the throttle will automatically drop down to idle speed. The engine will continue to run at idle speed until electrical loads are again connected and turned on.

COMPONENTS:

The automatic idle control system consists of the following components (Figure 175):

- A Sensing Transformer, housed inside the generator control panel.
- An Idle Control circuit board, housed inside the generator control panel.
- An Idle Control On-Off switch, mounted on the side of the generator control panel.
- An Idle Control Solenoid (electromagnet). The solenoid is attached to two mounting brackets which, in turn, attach to the gas tank heat shield.
- Interconnecting wires.

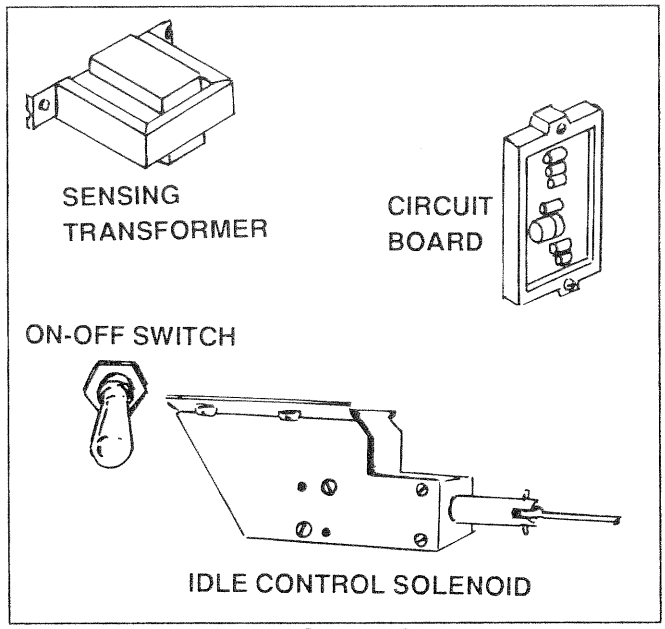


Figure 175. Idle Control System Components

OPERATING INSTRUCTIONS:

If the engine-generator is equipped with an automatic idle control system, the Idle Control Switch should always be set to its "Off" position before startup.

Automatic Idle Control (Continued)

Set the Idle Control Switch to its "On" position only after the engine has stabilized at high governed speed.

NOTE: If the engine is started with idle control switch set to "On", engine may start and then shut down. In some instances, a "surging" or "hunting" will occur as the idle control solenoid energizes and de-energizes. The idle control is powered by a-c output from the generator's stator a-c output leads. Stator a-c output at low (idle) speed may be insufficient to energize the idle control solenoid. The engine will continue to accelerate until stator a-c output power is sufficient to energize the solenoid. The solenoid will then energize, rpm will decrease to idle, the solenoid will de-energize, and rpm will again increase. This "hunting" action will continue. Always set the Idle Control Switch to "Off" before starting the engine.

SYSTEM OPERATION:

See Figure 176. Idle control system operation may be briefly described as follows:

- A-c power for system operation is supplied to the idle control circuit board via Wire 22, Wire 11A, the idle control switch, and Wire 11D. This operating power is supplied by the generator's a-c power windings.
- Stator a-c output leads 11 and 44 are wrapped tightly around the Sensing Transformer coil, and are then routed to the generator panel receptacles. Current will not flow through Wires 11 and 44 unless an electrical load is plugged into one or more receptacles and turned on.
- When an electrical load is plugged in and turned on, current flows through Wires 11 and 44. This current flow induces a voltage and current flow into the transformer coil which is delivered to the circuit board via Wires 155 and 156.
- When the idle control switch is set to "On" (closed), a-c power is available to the circuit board for system operation. However, circuit board action holds the Wires 81 and 82 circuit to the solenoid closed as long as no current is flowing in Wires 155 and 156 from the transformer coil.
- With the Wires 81 and 82 circuit held closed by circuit board action (no loads applied to generator), a-c power is delivered to the solenoid. The solenoid energizes and pulls the throttle down to idle speed.
- When current flows through Wires 155 and 156 from the transformer coil, circuit board action opens the Wires 81 and 82 circuit. The solenoid de-energizes and engine accelerates to normal governed speed.

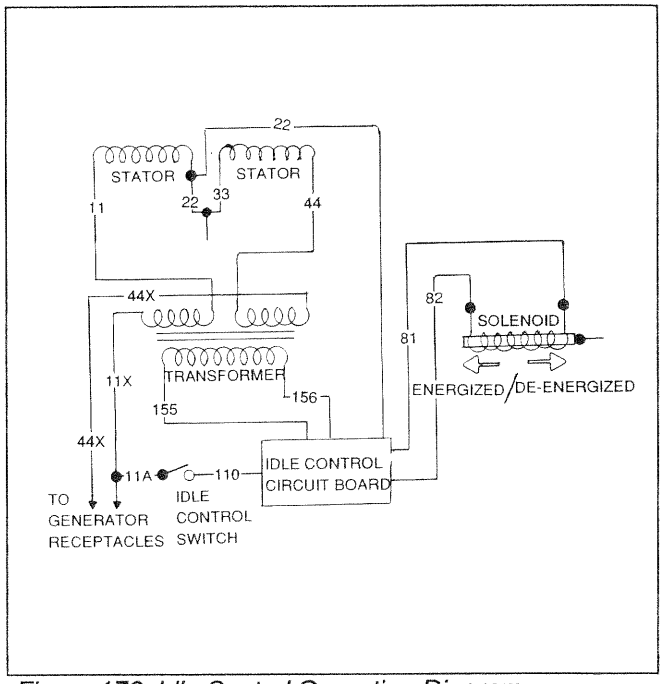


Figure 176. Idle Control Operating Diagram

NOTE: V-Twin engines with automatic idle control are equipped with a governed idle system.

BRACKETS, LINKAGE AND SPRINGS:

Refer to Figure 177. On units with idle control, the governor control has been reworked to accept a linkage mounting bracket. Linkage from the idle control solenoid is routed through an opening in the heat deflector shield, and connects into a hole in the linkage mounting bracket. Thus, idle control solenoid movement will result in movement of the linkage mounting bracket and the governor control. A governed idle spring also connects to the linkage mounting bracket and to a spring mounting bracket on the engine-generator.

The linkage mounting bracket is retained to the governor control by M4-0.70 screws, lockwashers and hex nuts.

IDLE CONTROL SOLENOID:

See Figure 178. Two solenoid mounting brackets are retained to the fuel tank heat shield with four M4-0.70 x 10mm screws and flatwashers. The brackets are slotted to permit adjustment of the solenoid. The solenoid is sandwiched between the two brackets and retained by No. 8-32 x 3/8 inch screws and lockwashers. A solenoid cover is also sandwiched between the two mounting brackets. A cotter pin passes through two nylon washers, the solenoid plunger shaft, and the solenoid link.

Automatic Idle Control (Continued)

ITEM	NOMENCLATURE
1	SPRING BRACKET
2	GOVERNOR BRACKET
3	LINKAGE BRACKET
4	M4 LOCKWASHER
5	M4-0.70 HEX NUT
6	M4-0.70 CAPSCREW
7	SPRING
8	IDLE CONTROL SPRING
9	M4-0.70 CAPSCREW

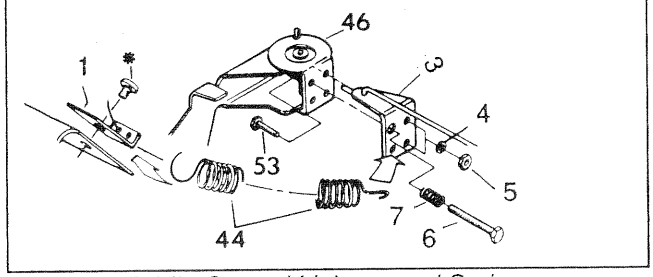


Figure 177. Idle Control Linkage and Springs

ITEM	NOMENCLATURE
1	SOLENOID BRACKET
2	SOLENOID BRACKET
3	NO. 8 LOCKWASHER
4	NO. 8-32 SCREW
5	NO. 8 LOCKWASHER
6	NO. 8-32 SCREW
7	NO. 8 FLATWASHER
8	M4-0.70 CAPSCREW
9	NO. 8-32 SCREW
10	NO. 8 LOCKWASHER
11	SOLENOID
12	SOLENOID COVER
13	NYLON WASHER
14	SOLENOID LINK
15	COTTER PIN

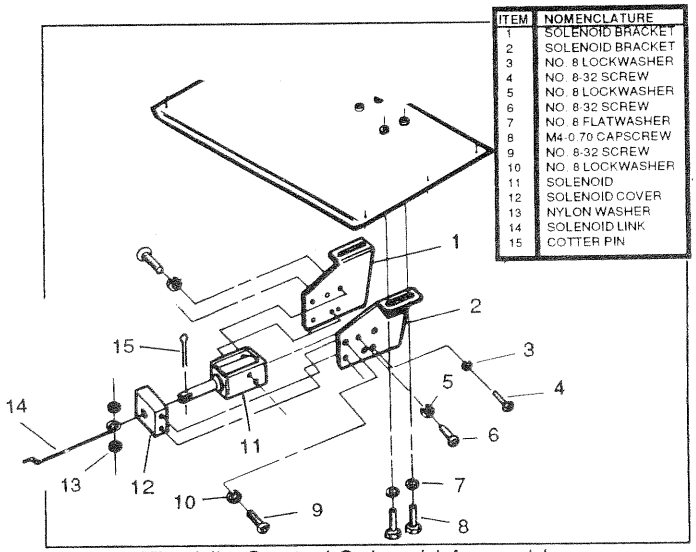


Figure 178. Idle Control Solenoid Assembly

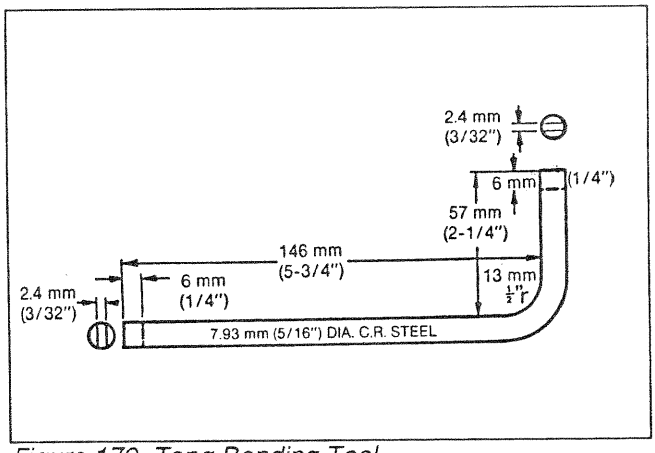


Figure 179. Tang Bending Tool

ADJUSTMENT PROCEDURE:

1. **Special Equipment Required:** The following will be required to adjust units with automatic idle control:
   a. An a-c frequency meter.
   b. A tang bending tool (fabricated locally as shown in Figure 179).
   3. A load bank.

2. **Initial Adjustment (Before Startup):** The following adjustment will permit the engine to be started and operated. Final adjustment will be made with the engine running.

- Turn the idle mixture valve on carburetor clockwise until it just bottoms. DO NOT FORCE. (See Figure 170 on Page 61.)
- Turn the idle mixture valve counterclockwise 1-1/4 turns.

3. **High Idle Speed Adjust (Engine Running):** Complete a high idle speed adjustment as follows:

- See Figures 177 and 178. Check that all springs, linkages and the idle control solenoid are properly installed. The capscrews that retain the solenoid mounting brackets to the fuel tank heat shield should be tight.
- Connect an a-c frequency meter into the generator's 120 volts a-c panel receptacle.
- Set the idle control switch to its "Off" position.
- Start the engine with no electrical loads applied to the generator.
- Let the engine stabilize and warm up at no-load.
- Check the no-load frequency. The frequency meter should read 62.0-62.5 Hertz.
- If necessary, adjust the no-load speed adjustment screw (Figure 180) to obtain a frequency of 62.0-62.5 Hertz. Turn the screw clockwise (CW) to decrease frequency; counterclockwise (CCW) to increase frequency.

4. Adjustments at Rated Load: With unit running at 62.0-62.5 Hertz (no-load), apply an electrical load to the generator equal to the unit's rated wattage/amperage capacity. Then, proceed as follows:

- If the engine speed droops below about 57 Hertz when the load is applied, remove the electrical load. Then, bend the throttle restrictor tang (Figure 181) approximately 1/16 inch toward the "DECREASE" side.
- Readjust the no-load speed adjustment screw (Figure 180) to obtain 62.0-62.5 Hertz frequency.

Automatic Idle Control (Continued)

4. **Adjustments at Rated Load (Continued):**

- Again apply an electrical load equal to the unit's rated capacity.
- With load applied, recheck the frequency droop. If frequency droops below about 58 Hertz, remove electrical loads and bend the throttle restrictor tang (Figure 181) approximately 1/16 inch toward the "DECREASE" side.
- Again readjust the no-load speed adjustment screw (Figure 180) to obtain a frequency of 62.0-62.5 Hertz.
- Continue to repeat adjustments until (a) the no-load frequency is 62.0-62.5 Hertz, and (b) frequency droop with load applied is not less than 58 Hertz.

5. **Low Idle Speed Adjustment:** After completing Step 4, proceed as follows:

- Hold the throttle against the low idle speed adjustment screw (Figure 181).
- While holding the throttle against the low idle speed adjustment screw, adjust that screw until engine is idling at 24-28 Hertz.
- Turn the carburetor idle mixture valve clockwise (leaner) until engine speed slows (Figure 170 on Page 61). Then, turn the idle mixture valve counterclockwise (richer) until engine again slows. Finally, turn the valve to its midpoint between the two previous settings.

6. **Idle Adjustment (Engine Running):** Complete idle adjustments as follows:

- Remove all electrical loads from the generator. Engine must be running at no-load before proceeding.
- Set the idle control switch to "On". The idle control solenoid should pull in and engine speed should drop to idle.
- Check the frequency reading. Engine should be running at 24-28 Hertz.
- If engine is not idling at 24-28 Hertz, loosen the four screws that retain the idle control solenoid mounting brackets (Figure 178, Items 8). Move the brackets toward the engine to increase frequency, or away from engine to decrease frequency.
- When correct idle speed (frequency) is obtained, tighten the four solenoid mounting bracket screws.
- Repeat the above procedure until engine idles at 24-28 Hertz.

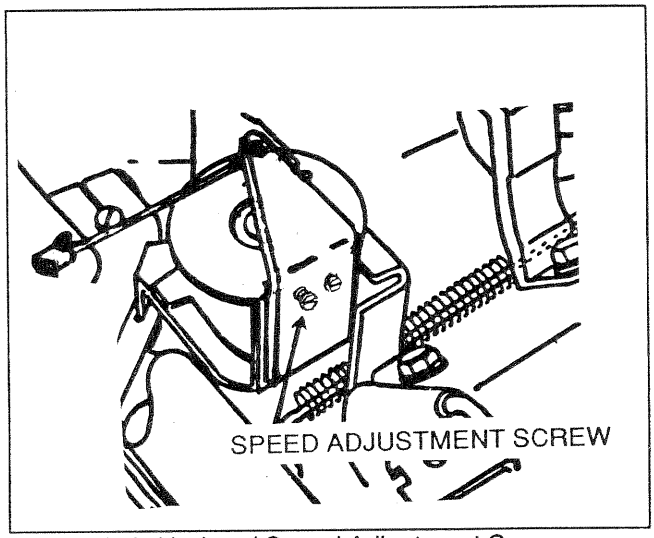


Figure 180. No-Load Speed Adjustment Screw

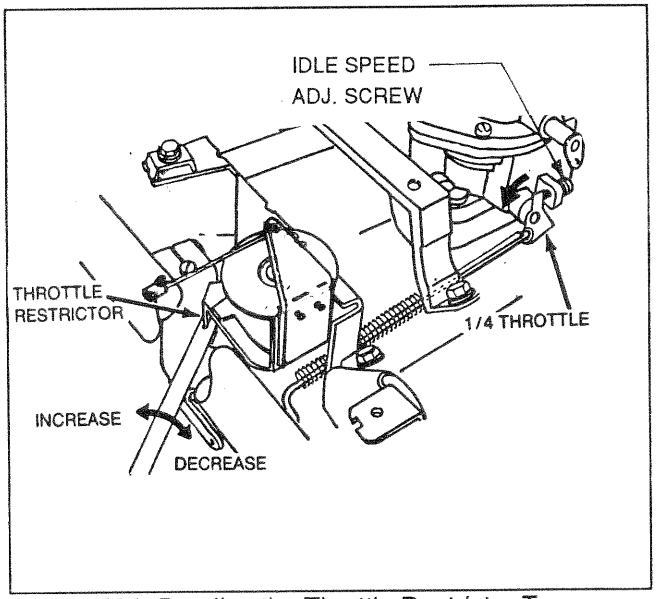


Figure 181. Bending the Throttle Restrictor Tang

Section 11 - GASEOUS FUEL SYSTEMS

Introduction

V-Twin engines with vertical crankshaft that are used in RV or standby applications may be equipped with an optional LP or natural gas fuel system. An LP gas fuel system may be used on either RV or standby generator applications. The natural gas system is generally restricted to use on standby applications only.

LP GAS:

LP stands for "liquefied petroleum". LP gas is usually stored in a pressure tank as a liquid. The gas may consists of propane, butane, or a mixture of the two gases. The liquid fuel must be converted to its vapor form before it enters the engine carburetor. Propane tends to maintain some vapor pressure even at temperatures as low as minus 20° F. Butane, however, will return to its liquid state when temperatures drop below about 32° F. (below freezing). There are two basic types of LP gas fuel systems. One type is called a "vapor withdrawal" system; the other a "liquid withdrawal" system. The type of system most commonly used with the V-Twin engine is the "vapor withdrawal" type system.

NATURAL GAS:

A gas distribution company usually provides piping from the main gas distribution line to the engine-generator site. A primary gas regulator may or may not be furnished by the gas supplier. It is the responsibility of the gas supplier to ensure that sufficient gas pressure is available to operate the primary regulator. Natural gas is supplied in gaseous (vapor) form only.

DANGER: GASEOUS FUELS SUCH AS LP AND NATURAL GAS ARE HIGHLY EXPLOSIVE. NATURAL GAS IS LIGHTER THAN AIR, TENDS TO SETTLE IN HIGH AREAS. LP GAS IS HEAVIER THAN AIR, SETTLES IN LOW AREAS. EVEN THE SLIGHTEST SPARK WILL IGNITE THESE FUELS AND CAUSE AN EXPLOSION. GASEOUS FUEL SYSTEMS MUST BE PROPERLY PURGED AND LEAK TESTED IN ACCORDANCE WITH APPLICABLE FUEL-GAS CODES. NO LEAKAGE IS PERMITTED.

Description

A typical LP (Propane) gas fuel system is shown in Figure 182. The system is equipped with (a) a supply tank with manual shutoff valve, (b) a primary regulator, (c) a fuel lockoff solenoid, (d) a secondary regulator, (e) load block adjustments, and (f) a carburetor.

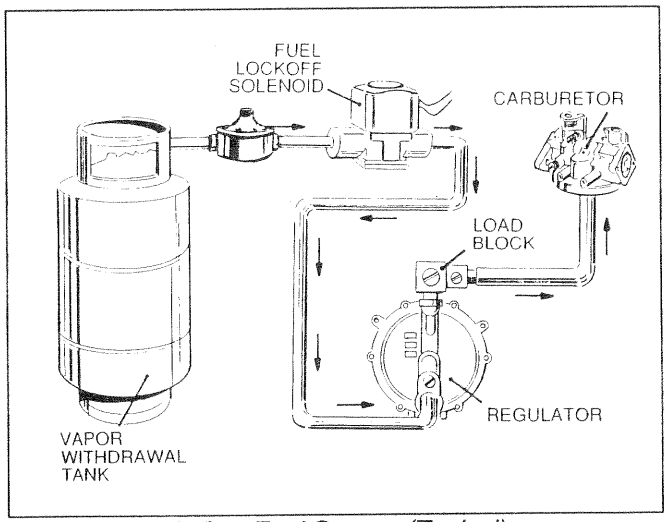


Figure 182. LP Gas Fuel System (Typical)

SUPPLY TANK:

The supply tank shown in Figure 182 is a "vapor withdrawal" type. That is, the system will utilize the vapors that form above the liquid fuel in the tank. The level of liquid fuel in the tank should never exceed about 90 percent of tank capacity. The temperature of the air around the tank must be high enough to sustain adequate fuel vaporization. In very cold climates, it may be necessary to use an independent heat source to warm the fuel and assist the natural vaporization process. Vaporization itself will reduce temperatures even further.

PRIMARY REGULATOR:

In most cases the primary regulator is not included with the engine-generator set. The primary regulator should be installed and adjusted by the gas system installer. Select the primary regulator with care. Some primary regulators will not operate if supply tank vapor pressure drops below 30 psi. Other regulators will operate at incoming pressures down to 3-1/2 to 5 psi. Obviously the fuel mixture (butane to propane ratio) and the vapor pressure at the anticipated ambient temperatures should influence the selection of a primary regulator.

The primary regulator used with the V-Twin engine should provide an output pressure of approximately 11 inches water column (0.4 psi). A primary regulator should be used that (a) will operate well at the anticipated tank vapor pressure, and (b) can be adjusted to supply an output pressure of 11 inches water column (0.4 psi).

Description (Continued)

FUEL LOCKOFF SOLENOID:

The fuel lockoff solenoid is opened by d-c voltage when the engine is started. It provides a positive shutoff of fuel when the engine is shut down.

SECONDARY REGULATOR:

The secondary regulator reduces the vapor pressure output from the primary regulator to a slightly negative value and delivers the vapors through a load block and to the carburetor.

Operation

See Figure 183. Gas vapors at positive pressure are delivered to the inlet side of the secondary regulator. These gas vapors then flow through a diaphragm controlled metering valve and to the carburetor.

During the engine intake stroke, the engine draws air in through the carburetor venturi. A low pressure area is created at the venturi throat that is proportional to the air being pumped. This low pressure air (vacuum) acts on a diaphragm in the secondary regulator, to pull the diaphragm toward the source of low pressure. An attached lever then opens a metering valve to regulate gas flow to the carburetor. The more air being pumped, the lower the pressure on the diaphragm. The lower the pressure on the diaphragm, the greater the metering valve opening and the more gas that is drawn into the carburetor.

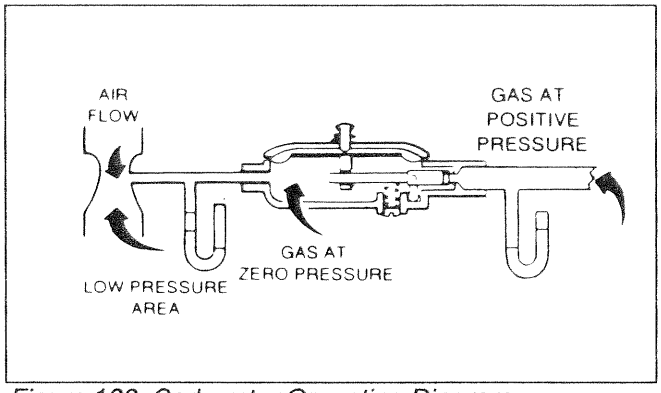


Figure 183. Carburetor Operating Diagram

Leakage Tests

The engine should not be operated until the gaseous fuel system has been tested for leakage. To test for leaks, a separate 12 volts d-c source must be used to open the fuel lockoff solenoid. The leak test must comply strictly with NFPA 58 (Paragraph 31-318) which states that all connections, hoses, valves, regulators and fittings must be tested under a gas or air pressure of not less than 90 psi (620 kPa) while using a soap and water (or equivalent) solution to check for leaks. Other approved methods of leak testing may be used, if appropriate. DO NOT USE ANY FLAME TO TEST FOR LEAKS.

DANGER: BEFORE ANY GASEOUS FUEL SYSTEM IS PLACED INTO SERVICE, IT MUST BE PROPERLY TESTED FOR LEAKS. NO LEAKAGE IS PERMITTED. LEAK TESTING MUST BE ACCOMPLISHED IN STRICT COMPLIANCE WITH ANSI A119.2/NFPA 501C.

Load Block Adjustment

PRELIMINARY ADJUSTMENT:

Prior to startup (engine stopped), complete a preliminary adjustment of the load block as follows (Figure 184):

1. Turn both the idle adjust and the slotted adjustment clockwise until they are softly seated. DO NOT FORCE.
2. Now, turn the idle adjust and the slotted adjustment counterclockwise as follows:
   a. Units rated 6500 watts, 6600 watts, 7200 watts, and 8000 watts, turn both adjustments counterclockwise 1-1/2 turns.
   b. For units rated 4500, 5200 and 5500 watts, turn both adjustments counterclockwise 2 turns.
3. Hold the adjustment and tighten the LOAD BLOCK LOCK NUT.

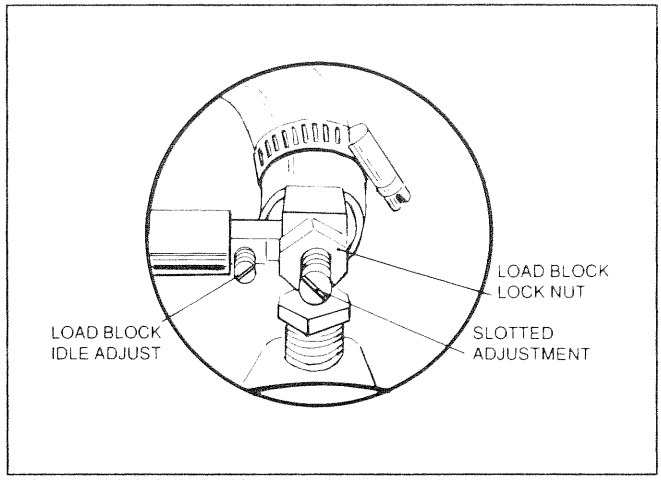


Figure 184. Load Block Adjustments

FINAL ADJUSTMENT:

1. Connect an accurate a-c frequency meter across the generator's a-c output leads (line to neutral).
2. With all electrical loads disconnected, start the engine. Let it stabilize and warm up.
3. If the engine runs rough, turn the slotted adjustment counterclockwise until engine runs smoothly. Do not run

Load Block Adjustment (Continued)

adjustment too far. Turn only far enough for smooth operation.

4. Turn on electrical loads equal to about 50 percent of the unit's rated current (amperes) at 120 volts or line to neutral.

5. With the recommended 50 percent load applied, turn the slotted adjustment slowly counterclockwise until the engine runs smoothly. Turn the adjustment only enough to obtain smooth operation. DO NOT TURN TOO FAR.

6. With unit under the recommended electrical load and running smoothly, turn the slotted adjustment as follows:

   a. Units rated 6500, 6600, 7200 or 8000 watts, turn the slotted adjustment an additional 1-1/2 turns counterclockwise.

   b. Units rated 4500, 5200, and 5500 watts, turn the slotted adjustment an additional 2 turns counterclockwise.

7. Hold the adjustments of Step 6 and tighten the load block locknut.

8. Disconnect all electrical loads. Engine must be running at no-load before proceeding.

9. If the no-load engine speed is not steady, turn the load block idle adjust screw in or out until engine runs smoothly.

Engine Power Check

With the engine running under no-load condition and following adjustment of the load block, check the a-c frequency. Then, turn on electrical loads equal to the full rated amperage capacity of the applicable generator set. Allowable frequency range from no-load to full load is as follows:

- Under its full rated electrical load (amperes), frequency should be at least 58 Hertz or above.
- With unit running at no-load frequency should be close to 62 Hertz.

If necessary, adjust the engine governor to 62 Hertz at no-load.

Section 12 - IGNITION SYSTEM

Introduction

The V-Twin engine is equipped with a solid state (breakerless) ignition system.

Checking Ignition

Test ignition system operation as follows:

- Remove the spark plug leads from the spark plugs.
- Attach the clamp of a suitable spark tester tool to the cylinder head. Attach the spark plug wire to the spark tester terminal. See Figure 185.
- Spin the flywheel rapidly with starter. If spark jumps the spark tester gap, you may assume the ignition system is good.

NOTE: The engine flywheel must rotate at 350 rpm (or higher) to obtain a good test of the solid state ignition system.

To determine if an engine miss is ignition related or not, connect the spark tester in series with the spark plug wire and the spark plug. Then, test the system as follows:

- Start engine.
- With engine running, if the spark jumps the spark tester gap regularly but the miss continues, the problem is in the spark plug or in the fuel system. A spark miss will be readily apparent.

NOTE: A sheared flywheel key will change ignition timing but sparking will still occur across the spark tester gap.

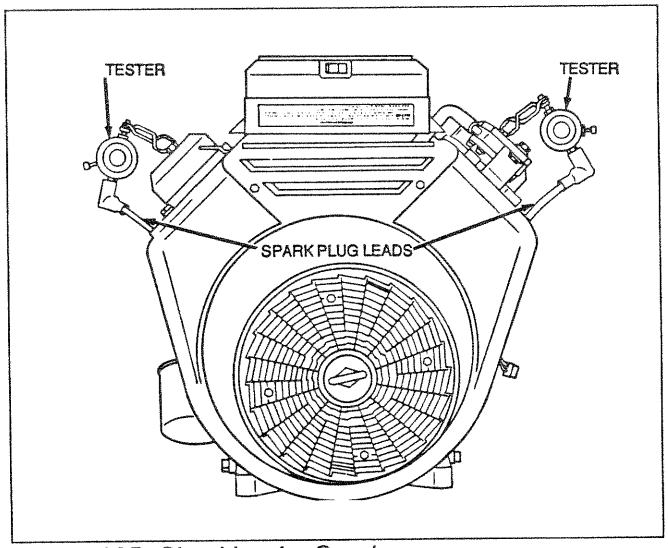


Figure 185. Checking for Spark

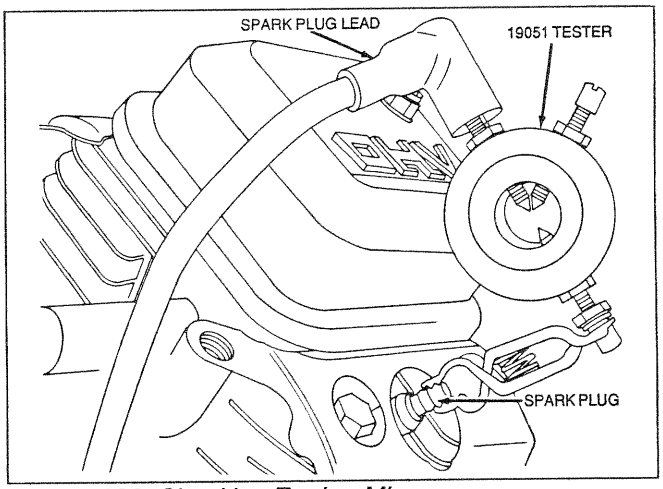


Figure 186. Checking Engine Miss

Spark Plugs

RECOMMENDED SPARK PLUGS:

Use a resistor long plug as follows:

Champion.....RC12YC
Autolite.....3924

CLEANING THE SPARK PLUGS:

Clean spark plugs with a pen knife or use a wire brush and solvent. Set spark plug gap to 0.76mm (0.030 inch). Replace any spark plug that has burned electrodes, or cracked porcelain. DO NOT USE ANY ABRASIVE CLEANING MACHINE.

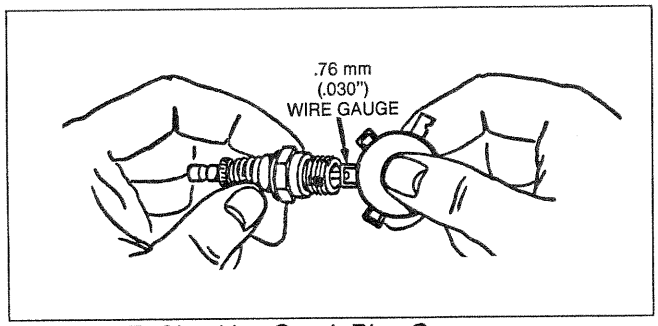


Figure 187. Checking Spark Plug Gap

Engine Flywheel

INTRODUCTION:

It is not necessary to remove the flywheel to service the solid state ignition system except to inspect keyways and the flywheel key. Replace any damaged parts.

Engine Flywheel (Continued)

ARMATURE REMOVAL:

Disconnect the stop switch wire. Remove armature screws and lift off the armature.

FLYWHEEL REMOVAL:

Use a 30mm socket and wrench to remove the flywheel nut (Figure 188). Place a wood block under one of the larger cast iron fins.

Install the flywheel nut onto crankshaft threads. Turn the nut down so that it is flush with top of threads.

Install a suitable puller tool (Figure 189). Tighten the puller screws evenly until the flywheel loosens.

FLYWHEEL INSPECTION:

Inspect flywheel for cracks, broken fins, burrs on taper or keyway, and distortion of keyway.

NOTE: Also check the crankshaft taper for burrs, rust, damage, etc. Replace crankshaft, if damaged.

FLYWHEEL INSTALLATION:

Clean flywheel and crankshaft tapers. Remove all dirt, oil, grease, etc. Slide the flywheel onto the crankshaft and align both keyways. Install the flywheel key.

Install the flywheel nut. Tighten the flywheel nut to 175 N-m (125 foot-pounds).

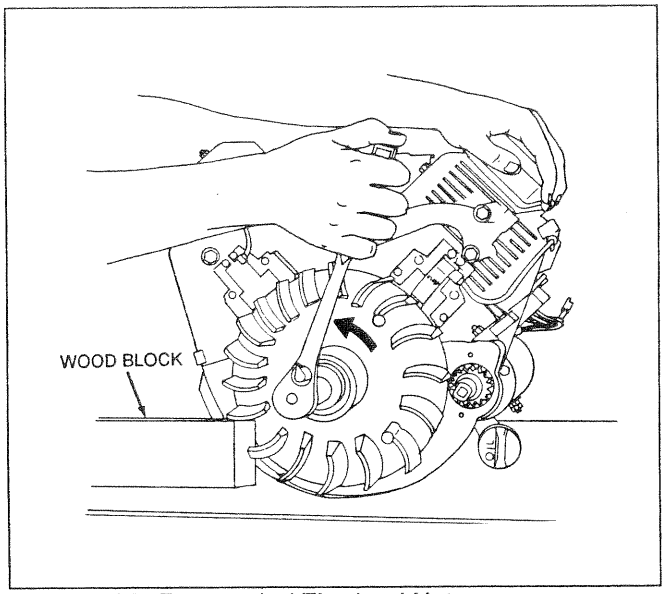


Figure 188. Removal of Flywheel Nut

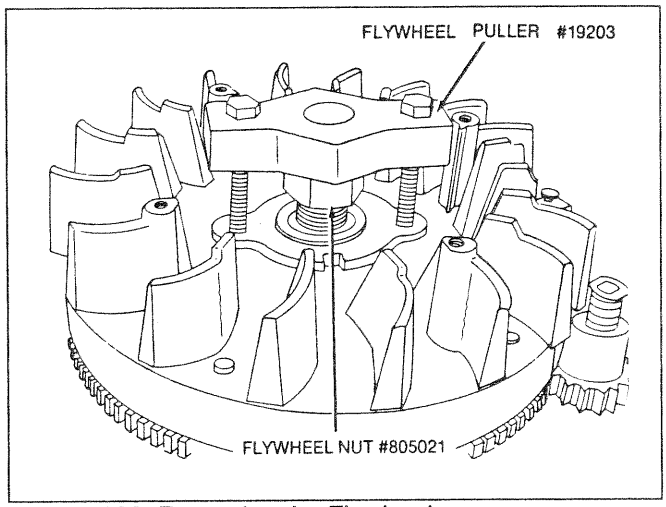


Figure 189. Removing the Flywheel

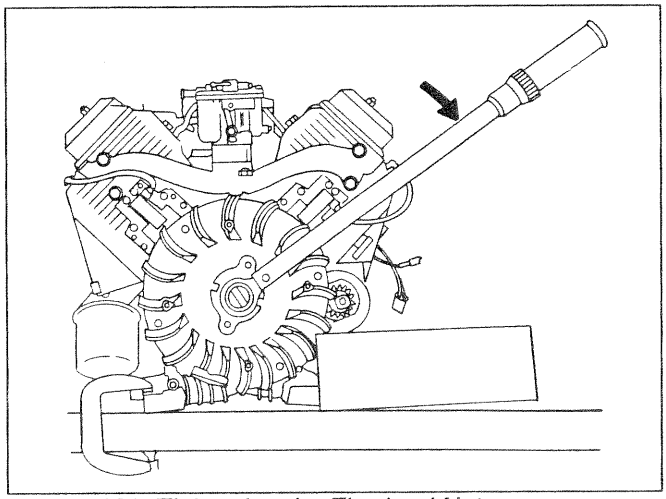


Figure 190. Tightening the Flywheel Nut

DANGER: EVEN IF THE FLYWHEEL KEY IS SHEARED, SPARK CAN STILL OCCUR. A SEVERE SHOCK HAZARD EXISTS.

ARMATURE INSTALLATION:

Install stop switch wire onto armature. Turn the flywheel so the magnet is away from the armature. Install armature as shown in Figure 191. Mounting holes in the armature are slotted. Push the armature away from flywheel as far as possible, then tighten one screw to hold the armature in place. Repeat this procedure for the second armature.

NOTE: The stop switch wires may be attached to either terminal on the ignition shutdown module (ISD).

Engine Flywheel (Continued)

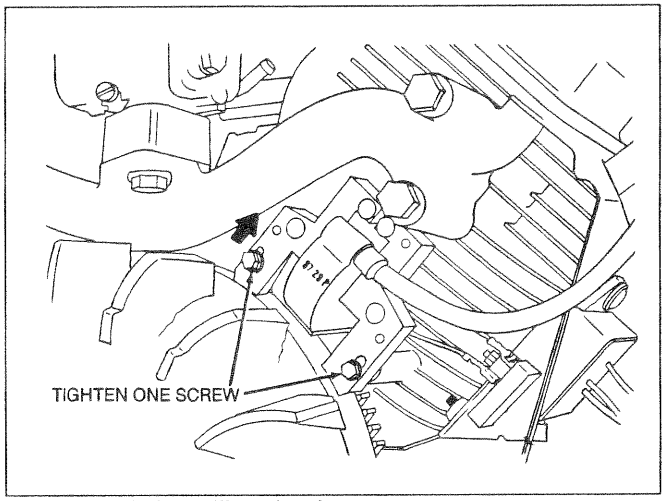


Figure 191. Installing the Armature

DANGER: TO PREVENT ACCIDENTAL STARTING AND POSSIBLE INJURY, THE SPARK PLUG WIRES MUST BE REMOVED FROM BOTH SPARK PLUGS.

ADJUSTING ARMATURE AIR GAP:

Rotate the flywheel until the magnet is under the armature laminations. Place a 0.20-0.30mm (0.008-0.012 inch) thickness gauge between the magnet and the armature laminations. See Figure 192. Loosen mounting screws so the magnet will pull the armature down against the thickness gauge. Then, tighten both mounting screws. To remove the thickness gauge, rotate the flywheel.

Repeat the above procedure for the second armature.

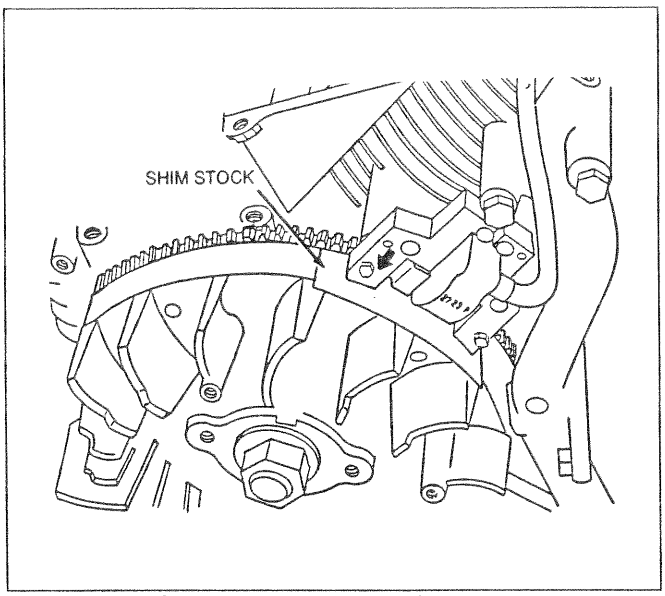


Figure 192. Setting Armatiure Air Gap

Testing the ISD Module

Use an accurate, high quality volt-ohm-milliammeter (VOM) to test the ISD module. Use the following test procedure:

- Set the VOM to its "Rx1" scale and zero the meter. If the VOM has a polarity switch, set it to "+DC".
- See Figure 193. Attach the VOM's positive (+) test lead to test point "A". Attach the common (-) VOM test lead to test point "B".
- Check the VOM for needle movement.
- Now, reverse the VOM test leads, i.e., connect the VOM positive (+) test lead to test point "B" and its negative (-) test lead to test point "A". Again check for VOM needle movement.

The VOM should move upscale and indicate a reading at one polarity only. If the VOM needle swings upscale at both polarities, the ISD module is defective and should be replaced. If the VOM does not indicate a reading at either polarity, the module is defective and should be replaced.

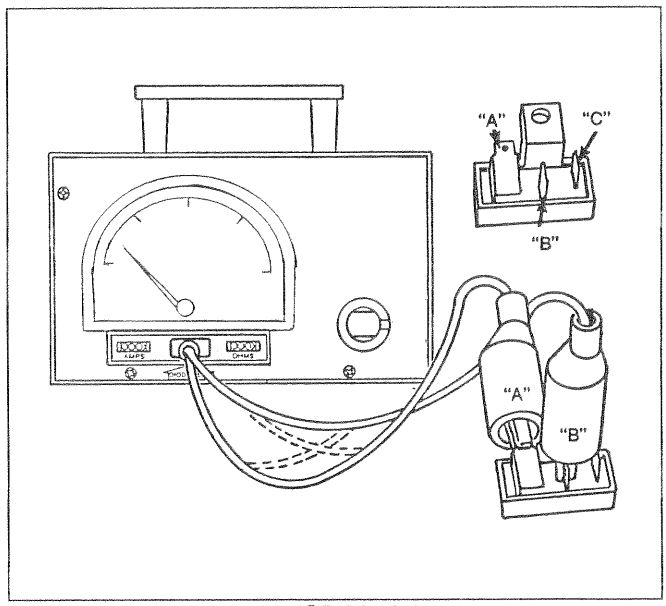


Figure 193. Testing the ISD Module

- See Figure 194. Now, attach the VOM positive (+) test lead to test point "B" and the common (-) test lead to test point "C". There should be no movement of the VOM needle. Reverse the test leads and, again, there should be no needle movement.

Testing the ISD Module (Continued)

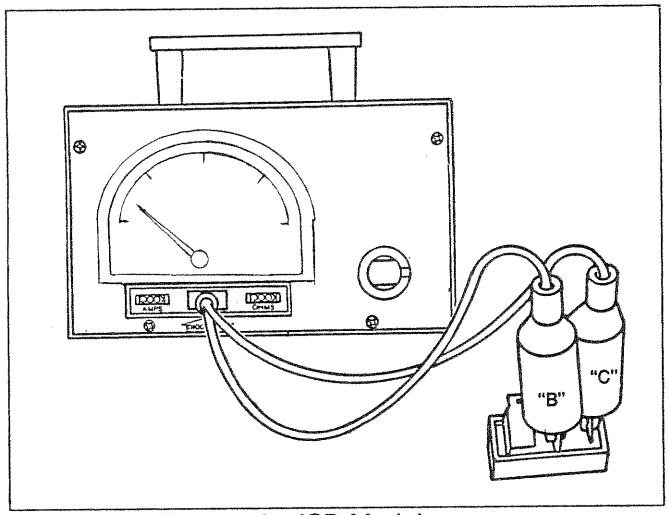


Figure 194. Testing the ISD Module

Section 13- ELECTRICAL SYSTEM- HORIZONTAL CRANKSHAFT UNITS

Introduction

Horizontal crankshaft engine models are typically used on portable a-c generator sets. Electrical systems on these units may be divided into two categories, i.e., manual start and electric start engines.

Manual Start Units

DESCRIPTION:

The engine electrical system on manual start units includes the following components:

- A Run/Stop Switch (Figure 195).
- A low oil pressure shutdown switch (Figure 196).
- A time delay relay (Figure 197).
- Interconnecting wires.

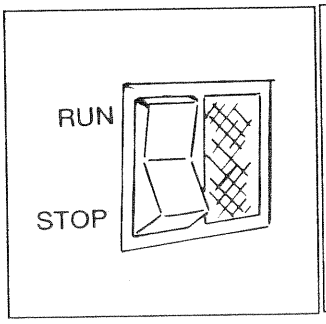


Figure 195.

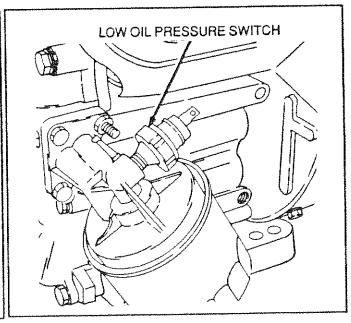


Figure 196.

OPERATION:

See Figure 198. Setting the Run/Stop switch to "Run" position opens the ignition circuit to ground and permits the engine to be started and run. Setting the switch to "Stop" connects the engine ignition circuit to ground, ignition terminates and the engine shuts down.

The engine is equipped with a low oil pressure switch. The switch has normally-closed contacts which are held open by engine oil pressure during operation. Loss of oil pressure below a safe value (approximately 0.32 kg/cm^2 or 4.5 psi) will close the switch contacts and ground the engine ignition circuit. An engine shutdown will then occur.

NOTE: Also see Section 5 for additional information on the low oil pressure switch.

The time delay relay is a "thermal" type relay, which holds the low oil pressure switch circuit open for a time during cranking, to allow oil pressure to come up to normal. The relay has normally open contacts. During startup, when 120 volts a-c is applied across the relay coil (heater) windings, the relay contacts will close the low oil pressure switch circuit. After application of 120 volts a-c, contacts closure time is approximately 8 seconds. Reset delay time is also approximately 8 seconds.

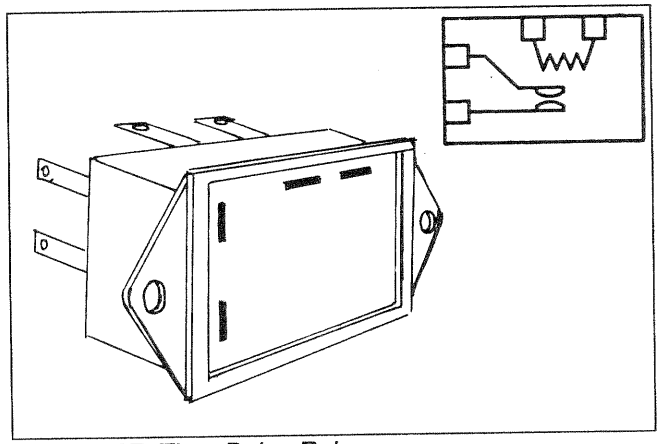


Figure 197. Time Delay Relay

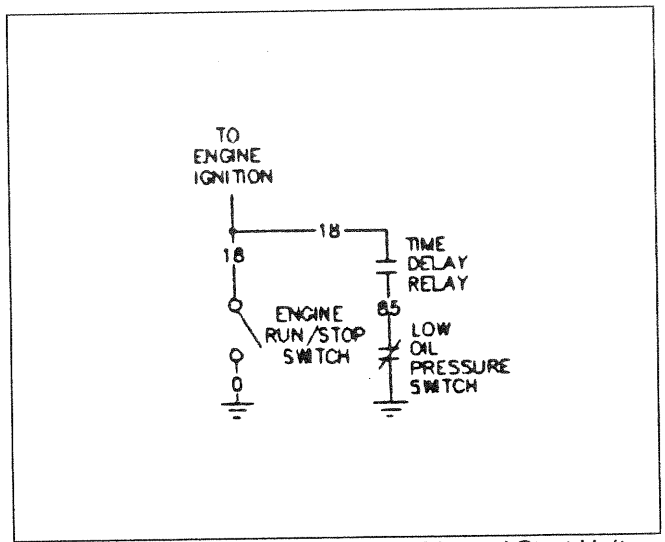


Figure 198. Operating Schematic- Manual Start Units

Electric Start Units

DESCRIPTION:

A typical electric start unit will have an electrical system exactly like that of manual start units, with a run/stop switch, a low oil pressure switch, time delay relay. However, a cranking battery and a heavy duty cranking switch have been added to the electric start units.

Electric Start Units (Continued)

OPERATION:

Battery cables are connected to a cranking (starter) switch. Closure of the starter switch contacts delivers full battery power to the engine starter to crank the engine.

NOTE: Also see Section 6, "Electric Starters" for information on the battery and on the electric starter.

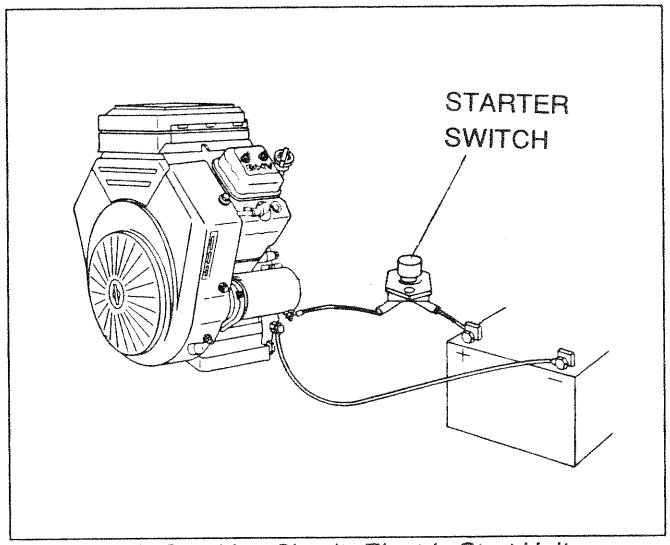


Figure 199. Cranking Circuit- Electric Start Units

Section 14- ELECTRICAL SYSTEM- VERTICAL SHAFT GENERATORS

General

Vertical crankshaft engines, usually used with RV and home standby generator applications, are equipped with engine electrical systems somewhat more complex than that of horizontal crankshaft units. These systems are often called the "Engine d-c Control" system on RV and home standby units.

RV Generator Control System

For the reader's convenience, a schematic representation of the engine d-c control system for RV type generators is provided here.

For an operational analysis of the d-c control system, refer to "Diagnostic Repair Manual- Air-Cooled Recreational Vehicle Generators". This manual can be ordered by specifying Manual Part No. 75239. The manual also contains troubleshooting and testing information for the d-c control circuits.

Home Standby Generators

A schematic representation of the engine control circuits is provided in this manual as a convenience to the user.

An operational analysis, along with troubleshooting and testing instructions, can be found in the "Diagnostic Service Manual-Standby Electric Power Systems". To order the manual, specify Part No. 79247.

NOTE: Complete electrical schematics and wiring diagrams may be found in the Owner's Manual for each applicable generator set. Circuits and components may differ between specific models. When testing or troubleshooting, we recommend that the appropriate schematic and/or wiring diagram for the specific model be used.

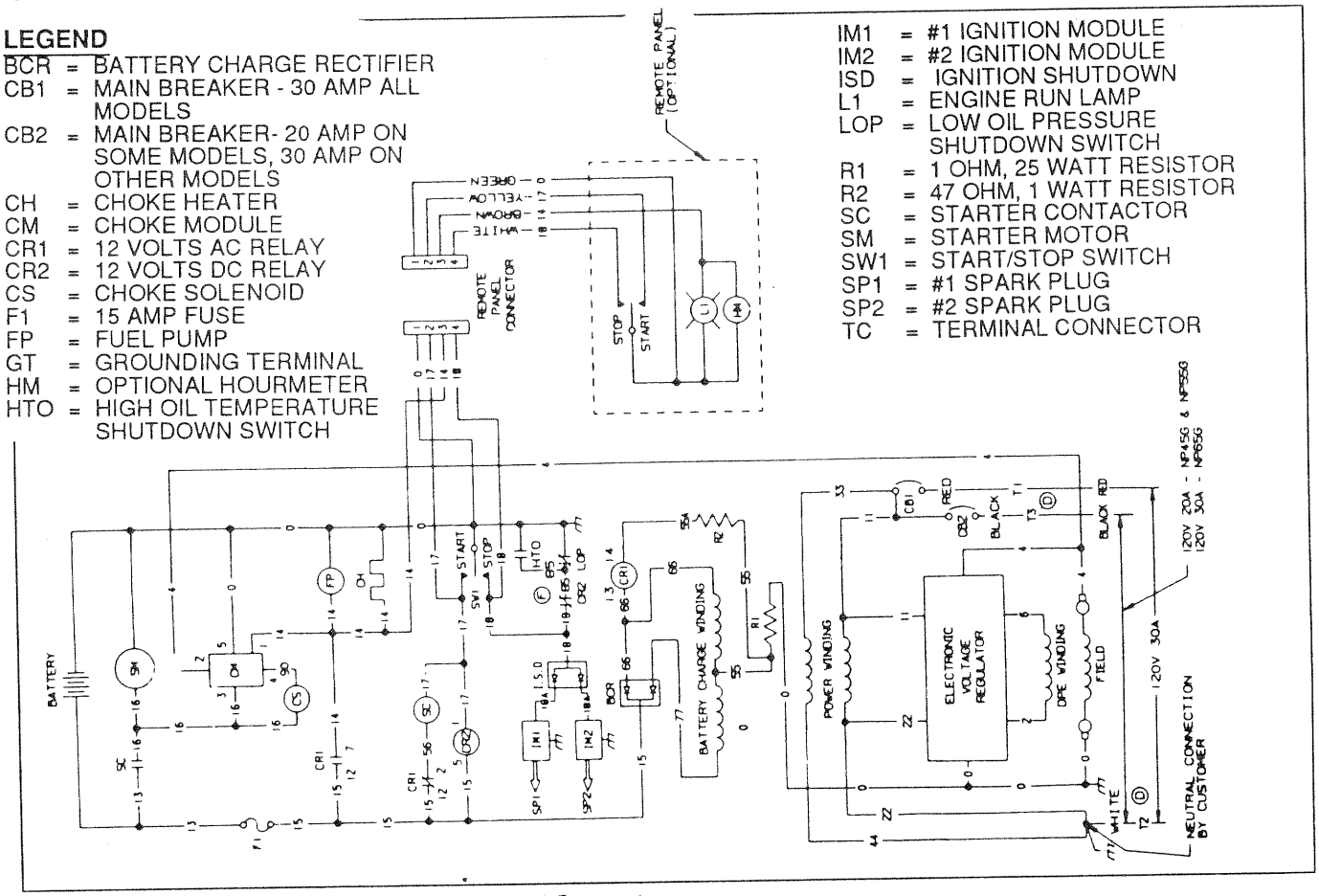
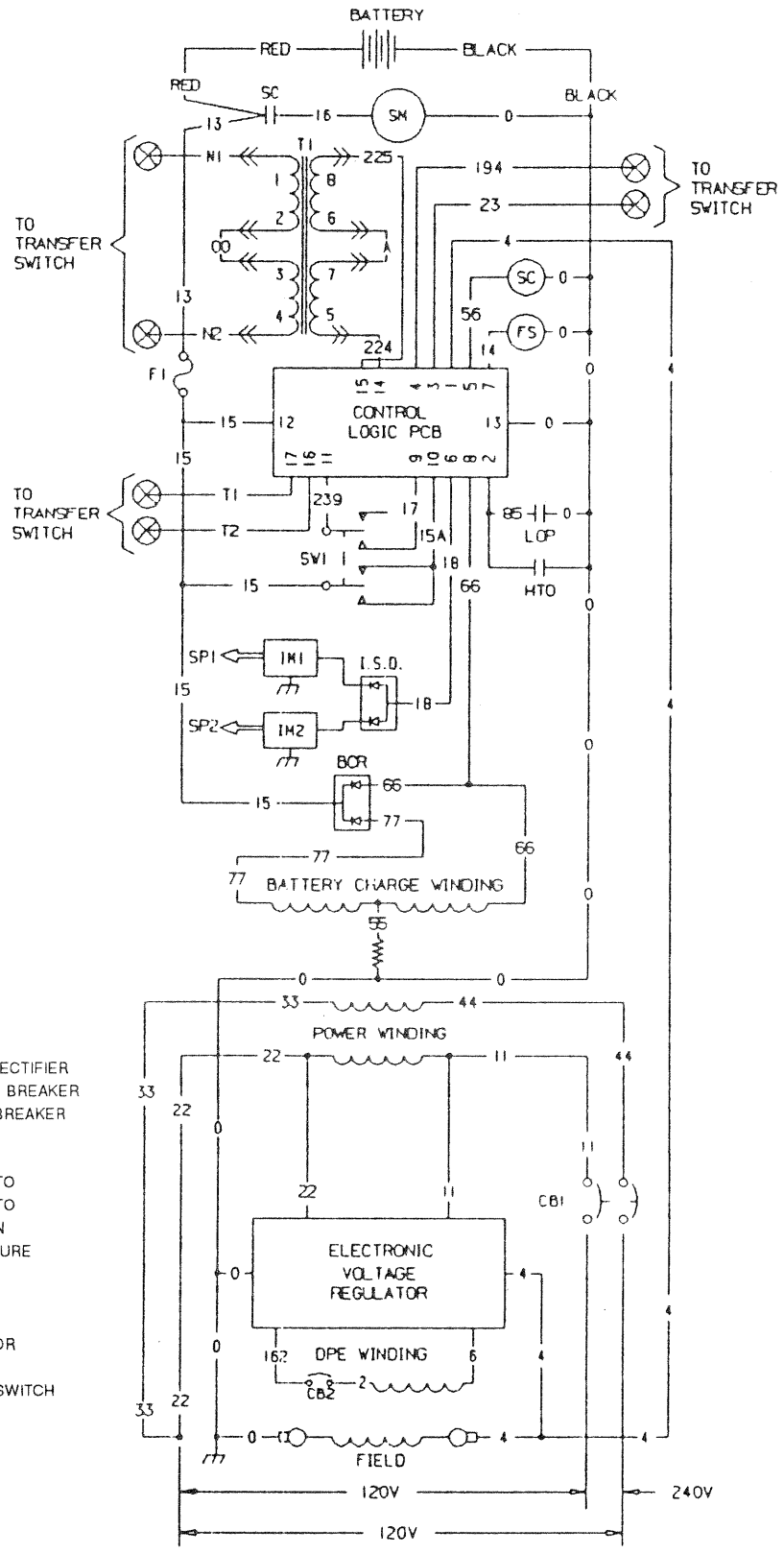


Figure 200. Typical Electrical Schematic - RV Generators



LEGEND

BCR	=	BATTERY CHARGE RECTIFIER
CB2	=	EXCITATION CIRCUIT BREAKER
CB1	=	MAIN LINE CIRCUIT BREAKER
F1	=	15 AMP FUSE
FS	=	FUEL SOLENOID
IM1	=	#1 IGNITION MAGNETO
IM2	=	#2 IGNITION MAGNETO
ISD	=	IGNITION SHUTDOWN
HTO	=	HIGH OIL TEMPERATURE SHUTDOWN SWITCH
LOP	=	LOW OIL PRESSURE SHUTDOWN SWITCH
SC	=	STARTER CONTACTOR
SM	=	STARTER MOTOR
SW1	=	AUTO-OFF-MANUAL SWITCH
SP1	=	#1 SPARK PLUG
SP2	=	#2 SPARK PLUG
T1	=	UTILITY SENSING TRANSFORMER

Figure 201. Typical Electrical Schematic- Air-Cooled Home Standby Generators

A

B

C

E

F

G

I

L

O

P

R

S

V

V (continued)

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