KOHLER GENERATORS

ENGINE SERVICE MANUAL

SECTION E-7

MODELS: L600, L654

CONTENTS

KOHLER CO. KOHLER, WISCONSIN 53044

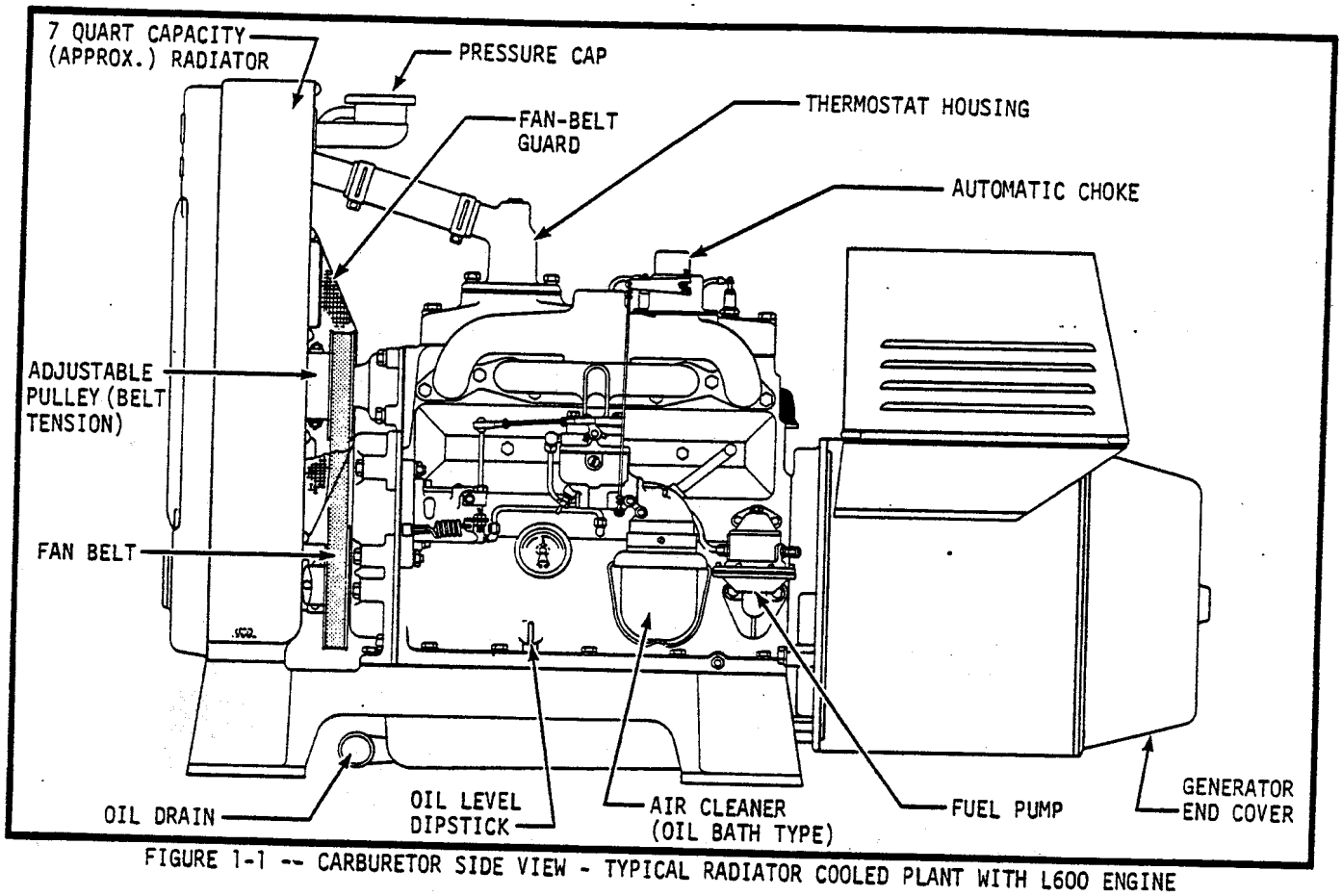


FIGURE 1-1 -- CARBURETOR SIDE VIEW - TYPICAL RADIATOR COOLED PLANT WITH L600 ENGINE

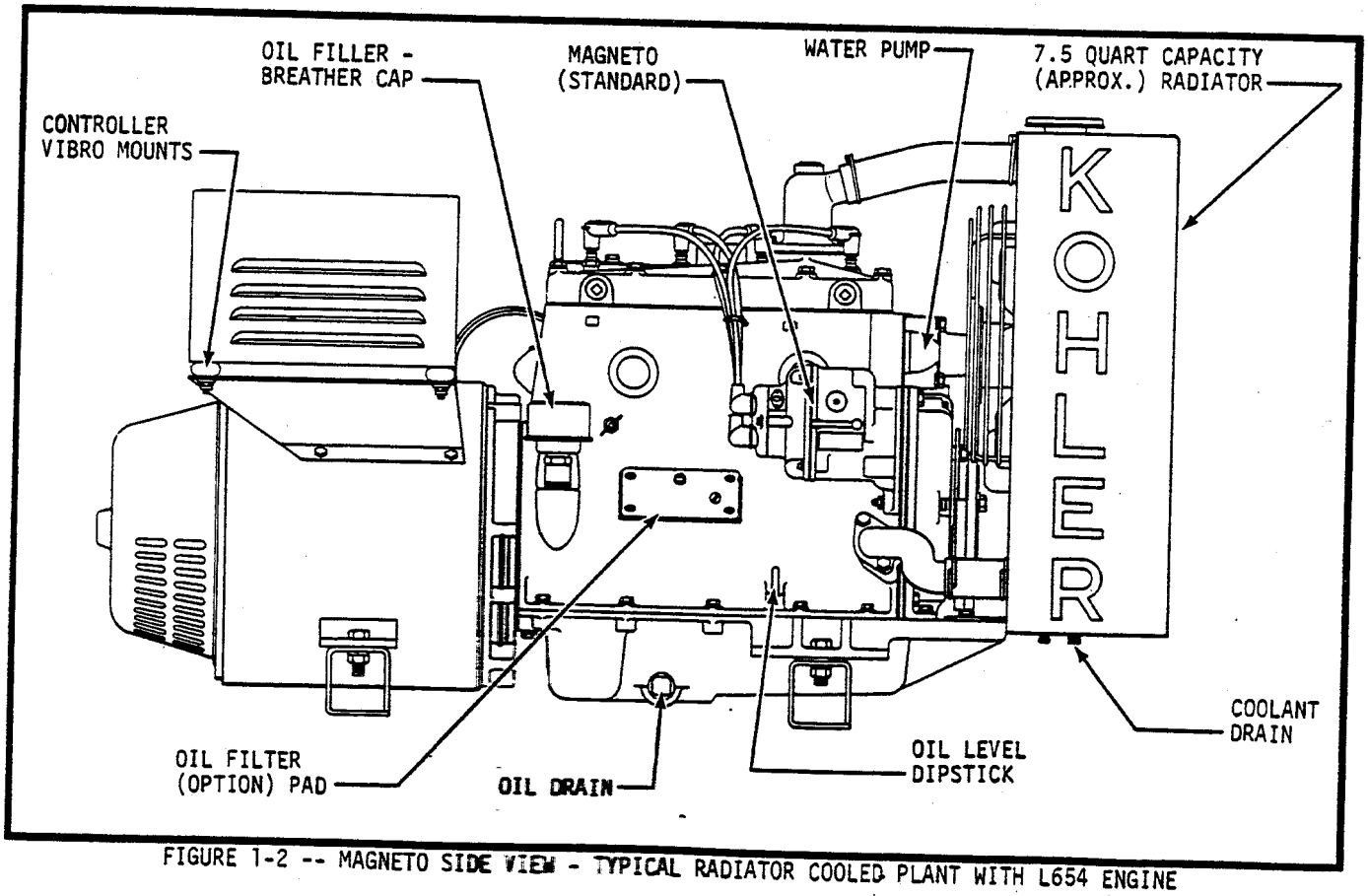


FIGURE 1-2 -- MAGNETO SIDE VIEW - TYPICAL RADIATOR COOLED PLANT WITH L654 ENGINE

PRESTART CHECKLIST

Lubricating Oil: Check crankcase oil level on dipstick--fill as needed to bring level up to Full mark. Refer to Page 2.1 for oil specifications.

Cooling System: On closed type cooling systems, remove radiator cap or cap on water cooled exhaust manifold, then add clean fresh water until level is just below overflow tube. 7 to 7-1/2 quarts are required for initial fill on radiator models, 5 to 5-1/2 quarts for heat exchanger models. If freezing temperatures are anticipated, add antifreeze to radiator cooled and heat exchanger models. On direct water cooled models, make sure cooling system is properly installed to insure sufficient coolant. Direct systems are of the open type and cannot therefore be protected with antifreeze.

Air Cleaner: If oil bath type used, unfasten bowl retaining clamp and add oil to level marking (bead) in bowl. Use same weight and grade of oil as used in engine. Dry type and flame arrestor units require no prestart service except to make sure elements are in place so that unfiltered air cannot enter engine.

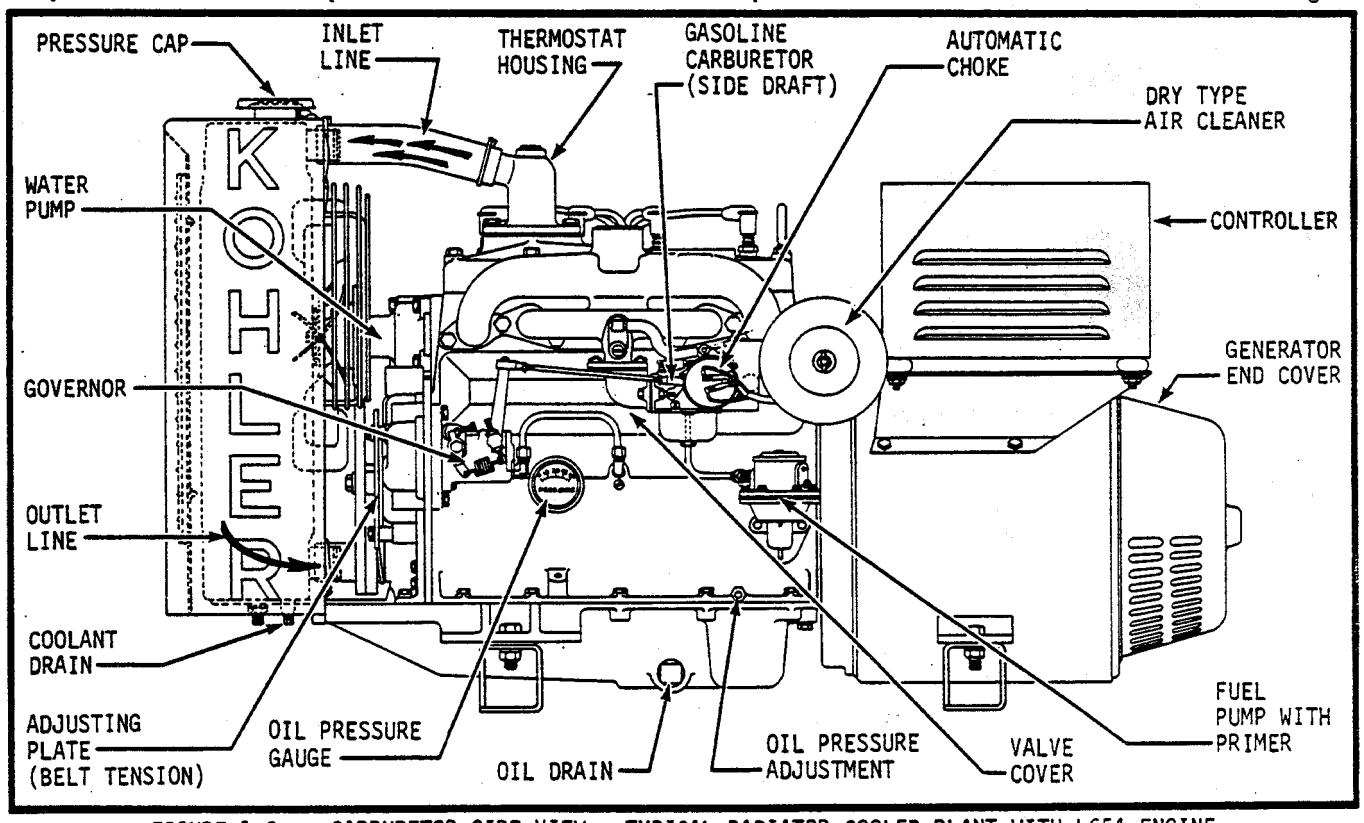


FIGURE 1-3 -- CARBURETOR SIDE VIEW - TYPICAL RADIATOR COOLED PLANT WITH L654 ENGINE

Fuel System: On gasoline fueled plants, connect lines from storage tank to the fuel pump. Fill tank with regular grade (80 octane minimum) gasoline. Use priming lever on fuel pump to prime system before initial start up. On gas fueled plants, make sure system is properly hooked up before starting. Refer to Fuel Section for typical arrangement and preliminary adjustments.

Battery: These electric plants feature exciter cranking which offers higher cranking speeds for more positive starting. When battery current is applied to the generator, it functions as a motor and cranks the engine during starting then is automatically switched back to its generating function after the engine starts.

A 24 volt battery is required for DC generator models and a 12 volt battery for AC generator models. 32 volt cranking is available for marine models. Connect the positive (+) terminal of the battery to the P terminal of controller and the negative (-) battery terminal to the N terminal on controller. (Stamped on base of controller near starting solenoid or C coil.)

To start three-wire automatic start plants, it will be necessary to center tap the 12-volt battery or use two 6-volt batteries to create a difference in voltage between leads L1 and L2. Without this, both leads have to be connected to the battery positive (+) terminal, and cranking relays in L2 will not operate when the voltage is the same. With the center tap, lead L1 is connected to battery + terminal, L3 to the center tap and L2 to ground which is battery negative (-).

SERVICE

Kohler Model L600 and L654 engines are covered in this Service Manual. Both are liquid cooled, 4-stroke cycle gas or gasoline fueled engines. Differences are called out whenever significant throughout the manual. Some of the general specifications are listed below for convenience--refer to the appropriate section for more specific details.

SPECIFICATION	L600	L654
BORE X STROKE	2-5/8 x 2-3/4"	2-5/8 x 3"
DISPLACEMENT (CUBIC INCH)	59.4	65
LUBE OIL CAPACITY (U.S. STD.)	4 Quarts	5 Quarts
RADIATOR CAPACITY (U.S. STD.)	7.0 Quarts	7.5 Quarts
MARINE (CLOSED) COOLING CAPACITY	5 Quarts	5 Quarts
SPARK PLUG SIZE (USE J-8 OR EQUIVALENT)	14mm	14mm
SPARK PLUG GAP (STD. PLUG - GASOLINE)	.025"	.025"
SPARK PLUG GAP (STD. PLUG - GAS)	.018"	.018"
SPARK PLUG GAP (SHIELDED PLUGS)	.018"-	.018"
PLUG TIGHTENING TORQUE	22 ft. lbs.	22 ft. lbs.
BREAKER POINT GAP (INSIDE MAGNETO)	.015"	.015"

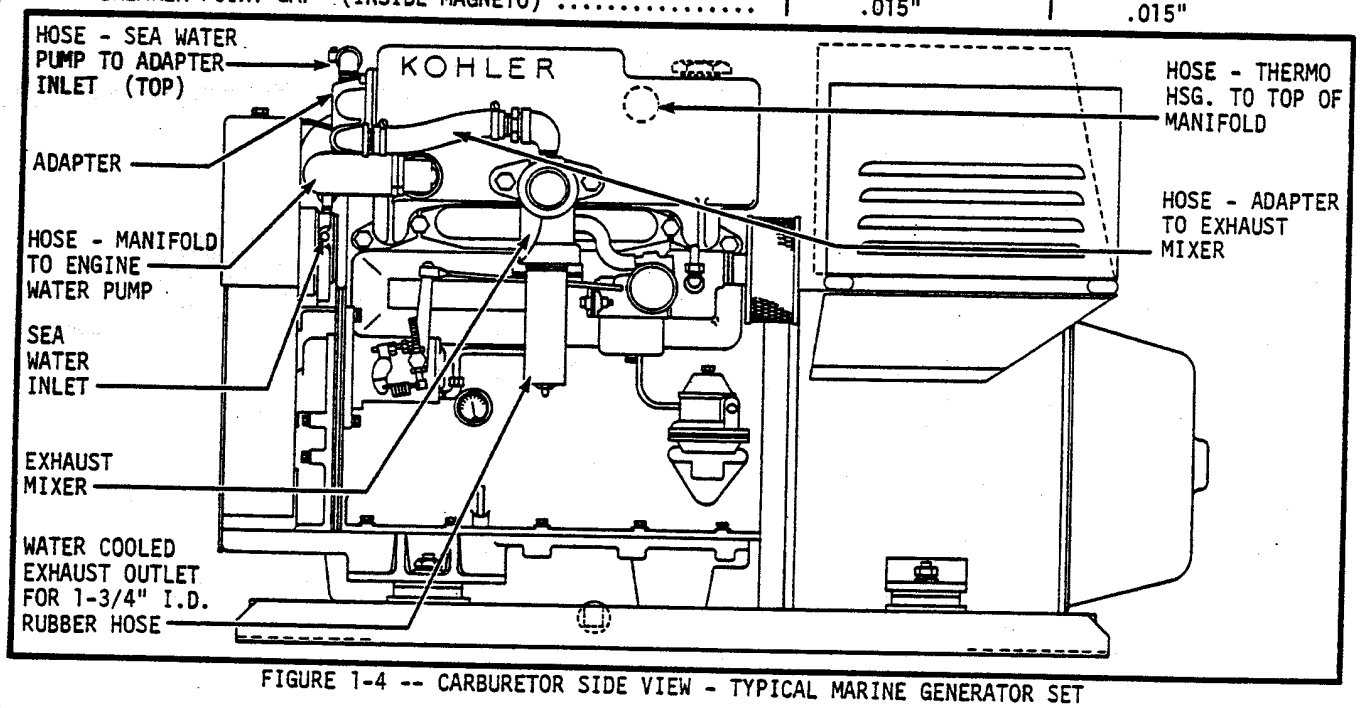


FIGURE 1-4 -- CARBURETOR SIDE VIEW - TYPICAL MARINE GENERATOR SET

SERVICE SCHEDULE

PERFORM SERVICE AT INTERVALS INDICATED (X)	BEFORE EACH START-UP	EVERY 50 HOURS (OR 3 MONTHS)	EVERY 100 HOURS (OR 6 MONTHS)	EVERY 200 HOURS (OR YEARLY)
Check oil level	X			
Check coolant level	X			
Check condition of compartment	X			
Change oil		X		
Check fan belt and tension		X		
Check air intake silencer		X		
Check spark plugs			X	
Check electrolyte level in battery			X	
Check electrical connections			X	
Check valve clearance				X
Check breaker points				X
Check ignition timing				X
Clean crankcase breather				X
Check generator brushes				X

NOTE: Intervals stated are for normal operating conditions--perform services more frequently under severe conditions.

LUBRICATION

LUBRICATING OIL

To be on the safe side, check oil in engine crankcase before each start to insure that the level is between the L and F marks on dipstick. Do not operate plant if level exceeds the "F" mark or if below "L" mark. Remove oil filler-breather cap and add oil here. Use only oils meeting the requirements of the American Petroleum Institutes (API) Service classification SC. Oils with this classification are detergent type oils. The classification is usually stamped or printed on the oil cans.

SERVICE SC	Use SAE 30 weight for temperatures above 30° F.
	Use SAE 10 weight for temperatures below 30° F.

Oil Change: On a new plant, change oil after the first 5 hours of operation and thereafter at 50 hour intervals (or every 6 months--whichever occurs first). Change oil more frequently if plant is operated under extremely dusty or dirty conditions. Whenever possible, drain oil while hot as it will flow more freely and carry away a greater amount of contamination.

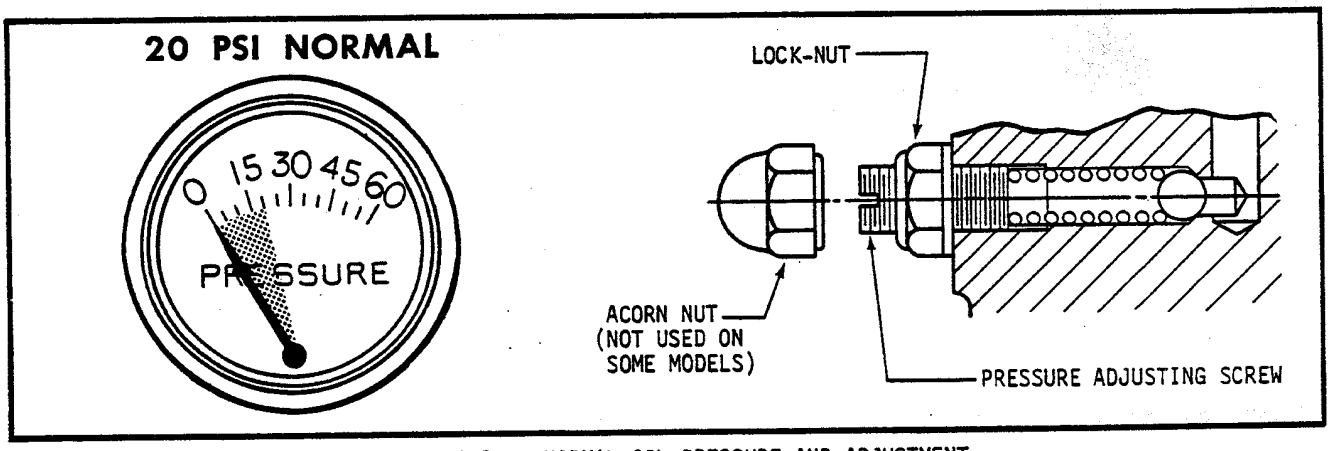


FIGURE 2-1 -- NORMAL OIL PRESSURE AND ADJUSTMENT

OIL PRESSURE ADJUSTMENT

Oil Pressure: After the engine has been thoroughly warmed up and is operating with proper weight of oil in crankcase, the oil pressure should be about 20 psi. An external oil pressure adjusting screw is provided on the crankcase just below and to the rear of the carburetor. If normal operating pressure is lower than 20 psi, remove acorn nut, loosen lock nut then turn screw until pressure is correct. Secure lock nut at new setting and reinstall protective acorn nut. When engine is cold, pressure may be as high as 50 - 60 psi but should gradually return to about 20 psi as the engine warms up.

OIL FILLER - BREATHER CAP

After about every fourth oil change (200 hours), service oil filler-breather cap. Do this more often under dusty, dirty conditions. A clogged breather can lead to build up of abnormal crankcase pressures and result in leakage around seals, gaskets, etc.

Service breather by washing in solvent such as kerosene--swish element in solvent to dislodge dirt. After cleaning, allow a few moments for it to drip dry then apply light amount of oil to the mesh element. Use same weight and grade of oil as used in engine. Always make sure cap is in place before placing engine in operation.

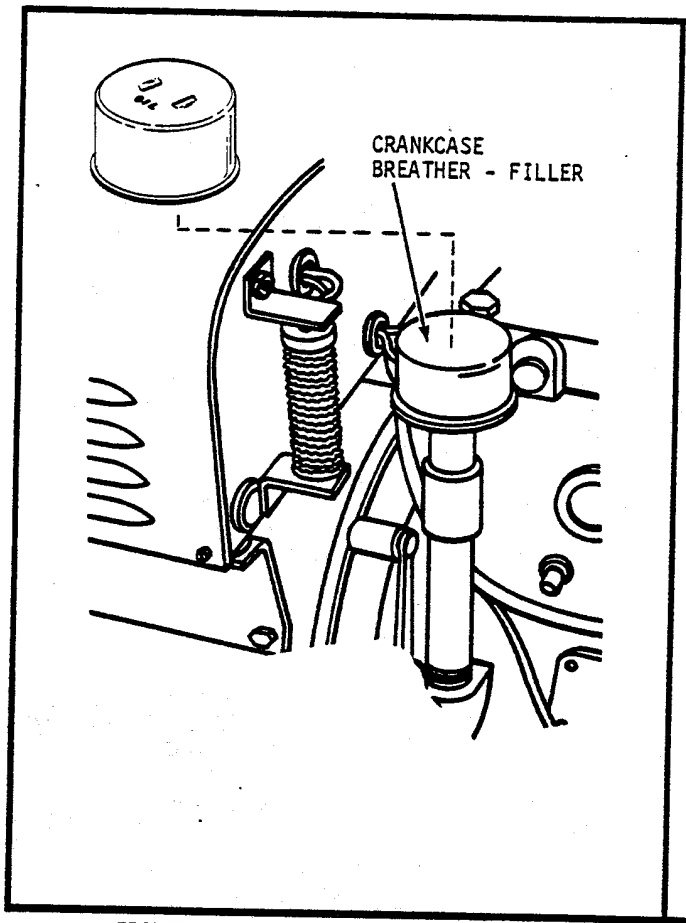


FIGURE 2-2 -- OIL FILLER - BREATHER

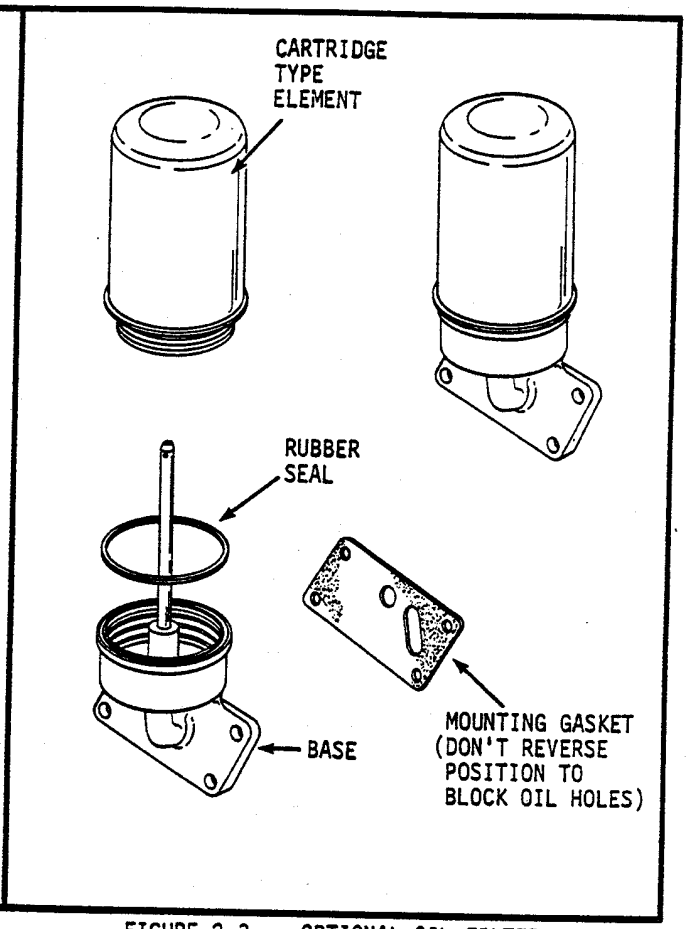


FIGURE 2-3 -- OPTIONAL OIL FILTER

OIL FILTER - OPTION

If your engine is equipped with the optional oil filter, change the filter cartridge after each 200 hours of operation. This should be done at the same time the oil is drained during every fourth oil change. Wrap rags around the base and use pan to catch any oil trapped in the cartridge. Twist cartridge off by hand--turn in counterclockwise direction to remove. Hand tighten new cartridge--after engine oil is replenished and engine is again placed in operation, check area around filter for signs of leakage--retighten element as needed to stop leaks. Don't use substitute cartridge elements for replacement--use only genuine Kohler parts.

If the engine does not have a filter but is operating in high dust, dirt areas, the oil filter feature can be quickly added. Simply remove the two plugs from the filter mounting, position a new gasket on the pad (make sure holes in gasket match oil holes) and secure the filter assembly with 4 capscrews.

AIR INTAKE

AIR CLEANER SERVICE

An air cleaner must be maintained in proper condition to insure satisfactory performance and prolonged engine life. Operating with an "overrich" fuel mixture caused by a poorly serviced, clogged air cleaner leads to formation of harmful sludge deposits. An inadequate element or improperly installed air cleaner permits entrance of dirt which can wear out piston rings in a very short time. The service intervals stated for air cleaners are for good clean conditions--service cleaners more frequently under dusty or dirty conditions (even daily, if extreme conditions warrant this). Dry and oil bath type cleaners are used--carefully follow instructions for type in use. A flame arrestor type cleaner is used on many marine models.

DRY TYPE AIR CLEANER

Replace element after 100-200 hours if operating under good clean air conditions--sooner in dusty, dirty conditions. Use only genuine Kohler replacement elements of correct part number.

Every 50 hours (or 3 months), remove element and lightly tap rubber rim against flat surface to dislodge any loose dust from surface. Replace element if it has too many dark spots or extensive dark area as this indicates dirt trapped in the filter material. Do not wash dry element in any liquid or attempt to clean element with air hose as this will ruin or rupture the paper fiber material. When handling element, avoid crushing material or bending element as this could allow unfiltered air to enter the engine--note air flow shown in the figure below.

When installing a new or serviced element, make sure rubber gasket surfaces are flat against the filter base and cover--secure wing nut (with washer in place when used) finger tight--washer is not required with plastic type wing nuts.

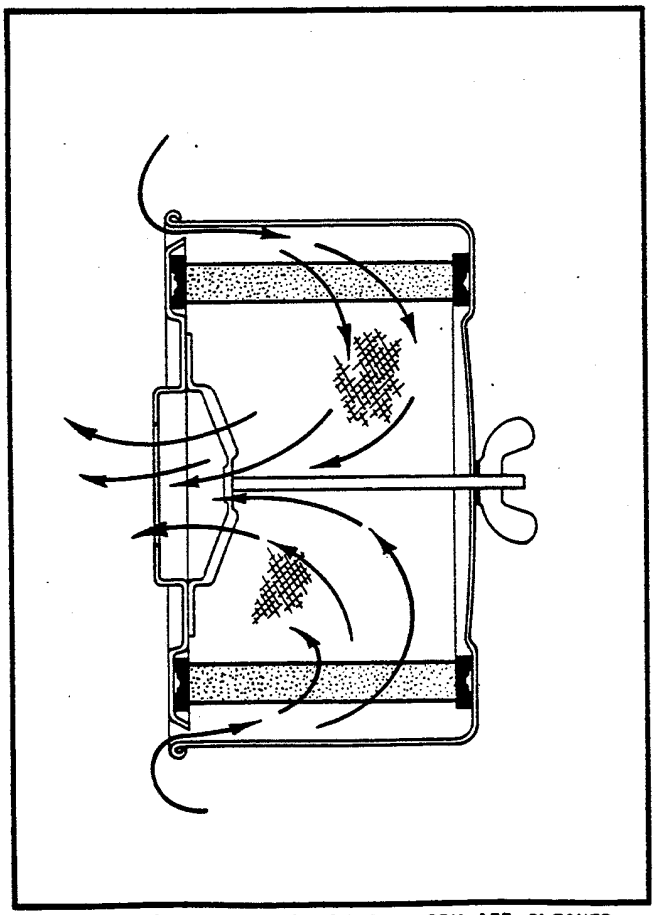


FIGURE 3-1 -- CIRCULATION THRU DRY AIR CLEANER

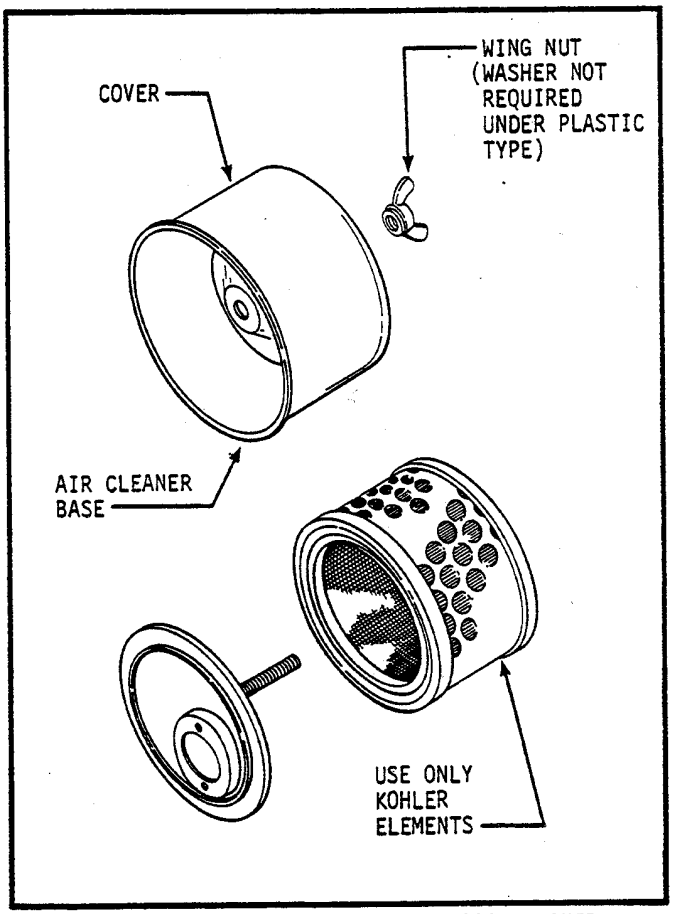


FIGURE 3-2 -- TYPICAL DRY TYPE AIR CLEANER

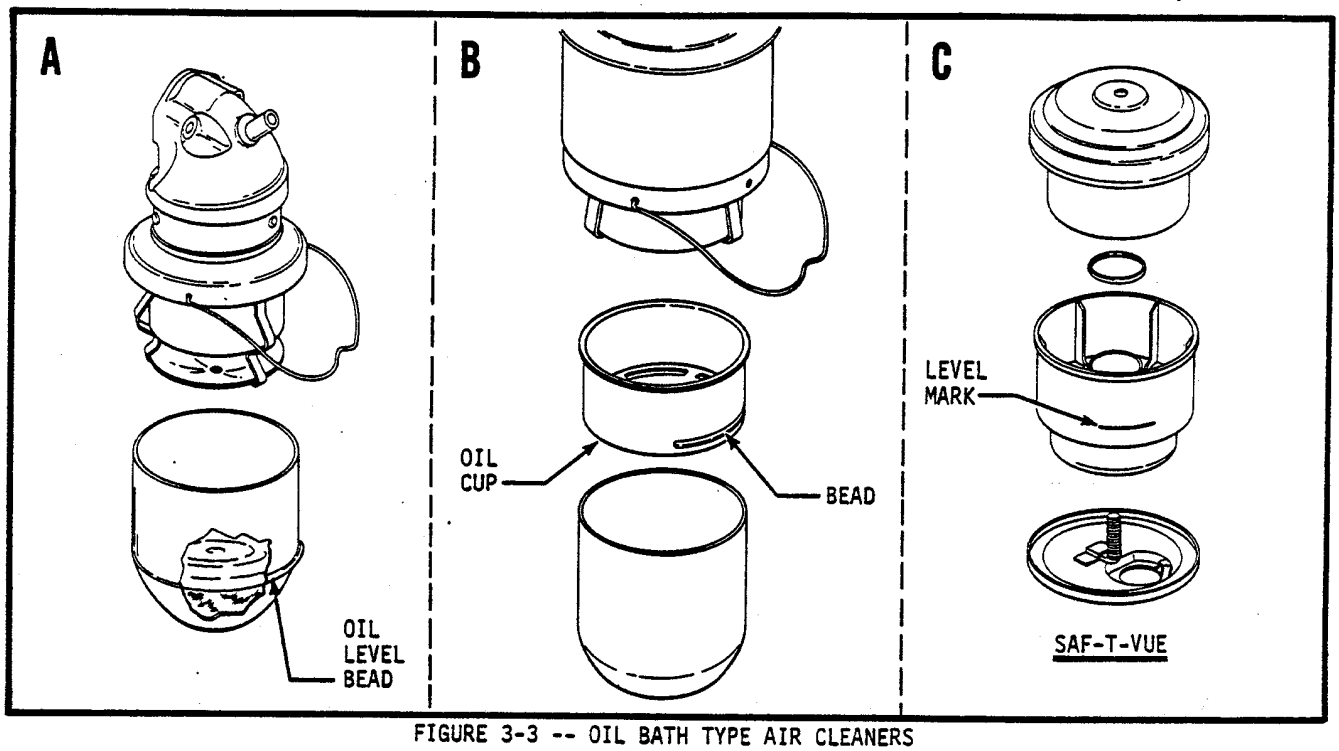


FIGURE 3-3 -- OIL BATH TYPE AIR CLEANERS

OIL BATH TYPE AIR CLEANERS

There are several different types of oil bath air cleaners in use; however, the same general service recommendations apply to all. After every 50 hours operation (or every third month) remove oil bowl, clean out dirty oil, fill to level indicated with same grade of oil used in engine or, with see thru "SAF-T-VUE" type use SAE 40 in summer, SAE 20 in winter.

Every 100 hours (or more often under severe conditions) service the filter element. On types shown above, as A & B, remove bowl and breather hose then disconnect air cleaner with elbow attached at the carburetor--do not attempt to separate cleaner from the elbow. On all types, swish element unit in solvent such as kerosene, then allow it to drip dry before reinstalling. Service oil bowl as described in the foregoing.

FLAME ARRESTOR (MARINE MODELS)

Marine Models use an approved flame arrestor which also serves as an air cleaner to a certain degree. This unit does not require regular service because of the clean operating conditions normally encountered in marine applications. When the element starts to appear dirty, disassemble the unit and swish element in a cleaning solvent that does not leave a film, then allow it to drip dry before reinstalling on the engine. Keep the element dry--do not oil. Make sure parts are reassembled exactly as shown below to insure that the unit can function as a flame arrestor.

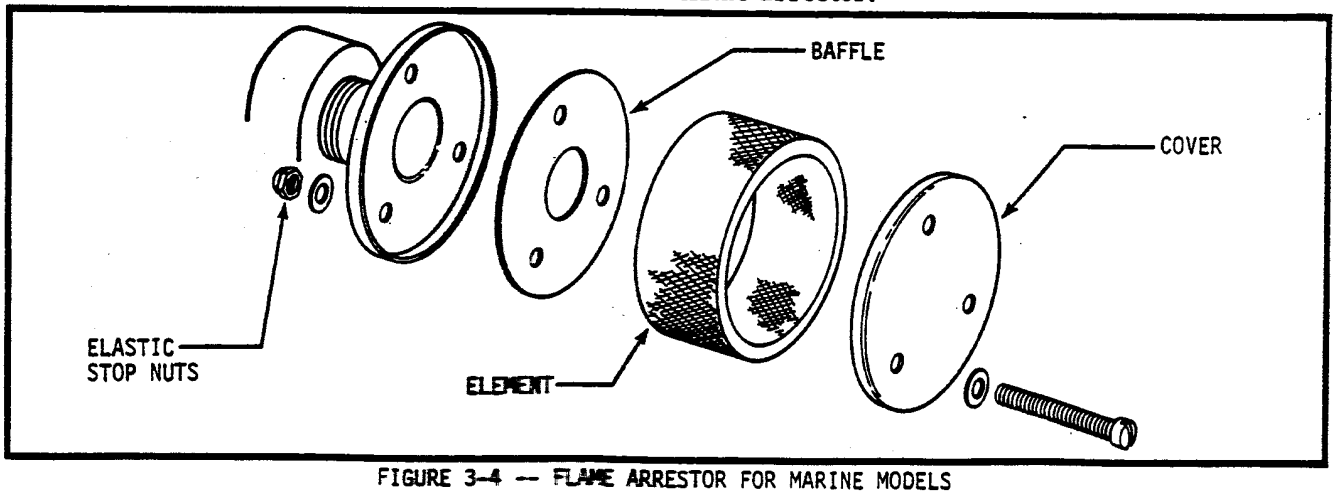


FIGURE 3-4 -- FLAME ARRESTOR FOR MARINE MODELS

FUEL SYSTEMS

GENERAL

Carburetor Adjustment: The following procedure covers the initial adjustment of both up draft and side draft type carburetors. An idle adjusting needle is provided on the horizontal carburetor even though engine operates at idle speed only for a brief moment as it comes up to speed after it is started or when it slows after being shut down--the idle adjustment is therefore not critical and can be permanently set at 2 turns open. The up draft type carburetor does not have an idle adjustment.

CARBURETORS - GASOLINE

Carburetors are adjusted in the factory and readjustment is not normally needed unless plant is operated at a much higher altitude or if carburetor problems develop after extended usage. If engine misses and backfires, this could indicate carburetor is set too lean. If black, sooty exhaust smoke is noted and engine is sluggish, the fuel mixture is probably set too rich. Do not neglect carburetor problems for continued operation with improperly adjusted or dirty carburetor can result in overheating, fouling of spark plugs, excessive valve wear and other problems.

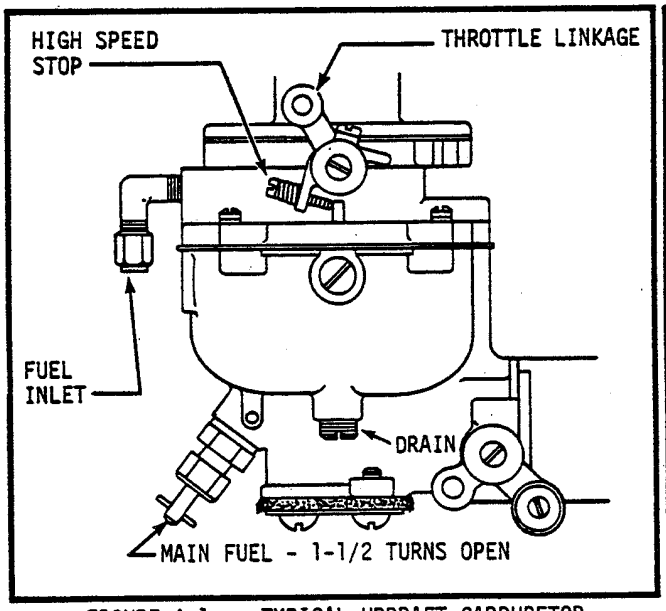


FIGURE 4-1 -- TYPICAL UPDRAFT CARBURETOR

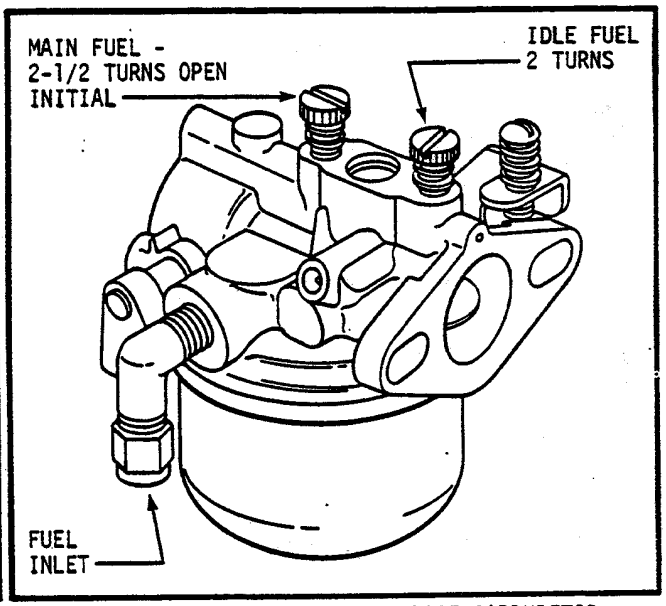


FIGURE 4-2 -- TYPICAL SIDEDRAFT CARBURETOR

STEP 1 - Stop engine and carefully turn Main Fuel adjustment all the way in (clockwise) until the needle bottoms lightly--do not force as this will damage needle or seat.

STEP 2 - For preliminary adjustment, turn Main Fuel adjustment out (counterclockwise direction) 2-1/2 turns on side draft carburetor or 1-1/2 turns open on up draft carburetor.

STEP 3 - Start engine and allow it to warm up to normal operating temperatures. Place engine under normal load when making final adjustment.

STEP 4 - For final adjustment, move Main Fuel needle in until engine starts to slow down from too lean a mixture (note position), then back out until speed increases--continue turning richer until speed again starts to drop from overrich setting then turn needle back in until it is positioned about halfway between lean and overrich settings.

Carburetor Reconditioning: If readjustment does not remedy problems attributed to carburetor, carburetor should be disassembled and reconditioned. Always use carburetor repair kit for best reconditioning results. After carburetor is completely disassembled, all metal parts should be cleaned in a solvent such as alcohol or acetone or commercial cleaner which readily remove gum and carbon deposits. Blow out all passages with compressed air and replace all gaskets and worn parts. Repair kits contain essential parts. Disassembly and reassembly of carburetors is accomplished as follows:

Disassembly of Carburetor - Up Draft

1. After removing carburetor from engine, remove 4 capscrews and separate throttle body (includes float) from lower carburetor body.

2. Remove float pin, float and body gasket. Remove fuel inlet needle. Check needle for damage and float for dents, leakage or excessive wear on lever or in hinged area.

3. Remove throttle plate retaining screw (and lock washer) then slip plate out of slot in shaft. Slide throttle shaft out of body. Inspect bushing and shaft -- unfiltered air could enter in this area if worn.

4. Remove main fuel needle - inspect for wear or damage. Blow out main fuel nozzle, thoroughly clean venturi and fuel bowl areas.

5. Do not remove choke plate or choke shaft unless loose or damaged. Further disassembly of lower body is not normally necessary.

Reassembly of Carburetor - Up Draft

Reassembly is essentially the reverse of the disassembly procedure. Special instructions are needed, however, to properly set the level of float before throttle body is reinstalled to carburetor body.

Float Level: Turn throttle body upside down, install new gasket and fuel inlet needle then position float and insert float pin. With float lever resting on inlet needle, measure distance between gasket and bottom of float at free end. The distance should be 5/16" - if adjustment is needed, carefully bend float lever to attain proper level. After carburetor is reinstalled on engine, recheck for proper level by removing fuel level plug - if properly set, fuel level should be just below this hole.

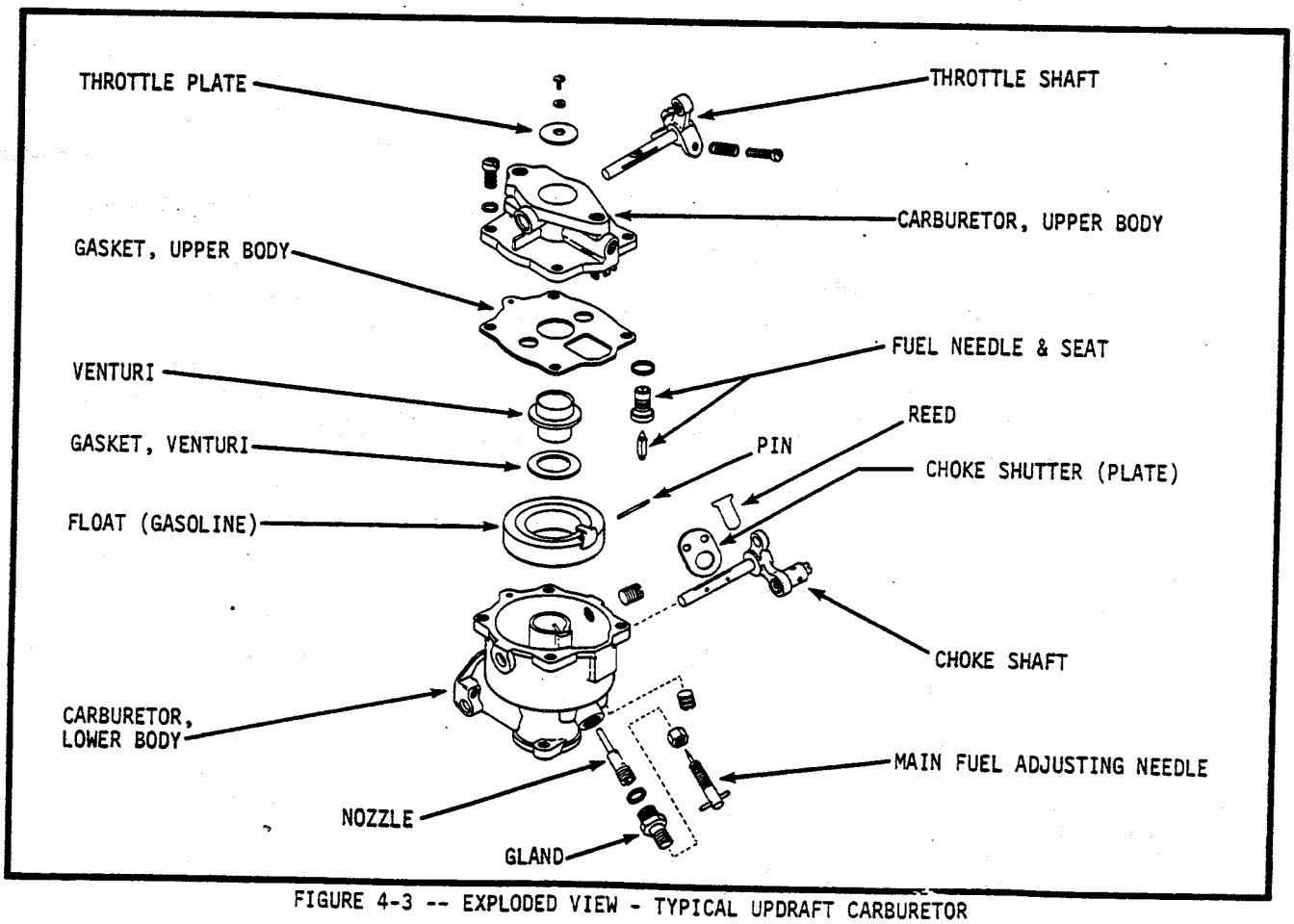


FIGURE 4-3 -- EXPLODED VIEW - TYPICAL UPDRAFT CARBURETOR

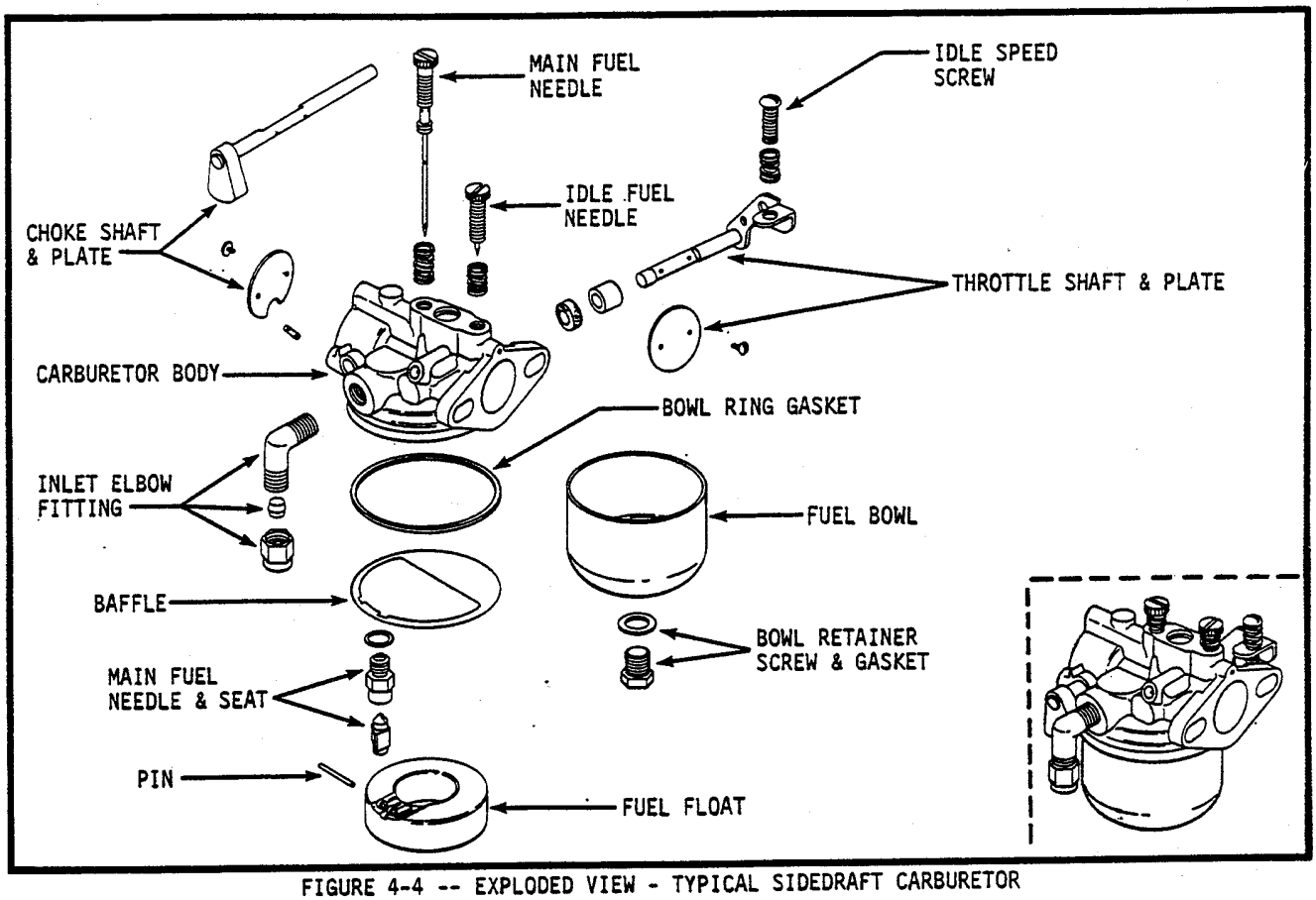


FIGURE 4-4 -- EXPLODED VIEW - TYPICAL SIDEDRAFT CARBURETOR

Disassembly of Carburetor - Side Draft

1. Remove carburetor from engine.
2. Remove bowl nut, gasket and bowl. When carburetor has bowl drain, remove drain spring, spacer (when used) plug and gasket from inside of bowl.
3. Remove float pin, float, needle and needle seat. Check float for dents, leaks and wear on float lip or in float pin holes.
4. Remove bowl ring gasket.
5. Remove idle fuel adjusting needle, main fuel adjusting needle and springs.
6. Do not remove choke and throttle plates and shafts. If these parts are worn, replace carburetor assembly.

Assembly of Carburetor - Side Draft

1. Install needle seat, needle, float and float pin.
2. Set float level. With carburetor casting inverted and float resting lightly against needle in its seat, there should be 11/64" plus or minus 1/32 of an inch clearance between machined surface of casting and free end of float (side opposite needle seat).
3. Adjust by bending lip of float with small screwdriver.
4. Install new bowl ring gasket, new bowl nut gasket (when required) and bowl nut. Tighten securely after making sure bowl is centered on gasket.
5. Install main fuel adjustment needle. Turn in until needle seats in nozzle and back out two turns.
6. Install idle fuel adjustment needle. Back out approximately 1-1/2 turns after seating lightly against jet. CAUTION: DO NOT USE FORCE ON ADJUSTMENT NEEDLES.

GASOLINE FUEL PUMP

The fuel pump does not require regular service but may have to be rebuilt to restore normal efficiency after extended hours of operation. If your engine falters or stumbles each time the load is increased, this may be due to a worn-out fuel pump. The repair kit listed in the parts manual for this pump includes all parts necessary to restore normal efficiency of the fuel pump. Remove fuel pump from engine and rebuild as follows:

DISASSEMBLY

STEP 1: Scribe matching marks on fuel head and pump body before disassembly.

STEP 2: Remove cover capscrew and cover. Discard cover gasket.

STEP 3: Remove 6 screws from around perimeter of fuel head, then separate head from body. Note direction of valves then press old fuel valves out of fuel head--discard valves and valve gaskets.

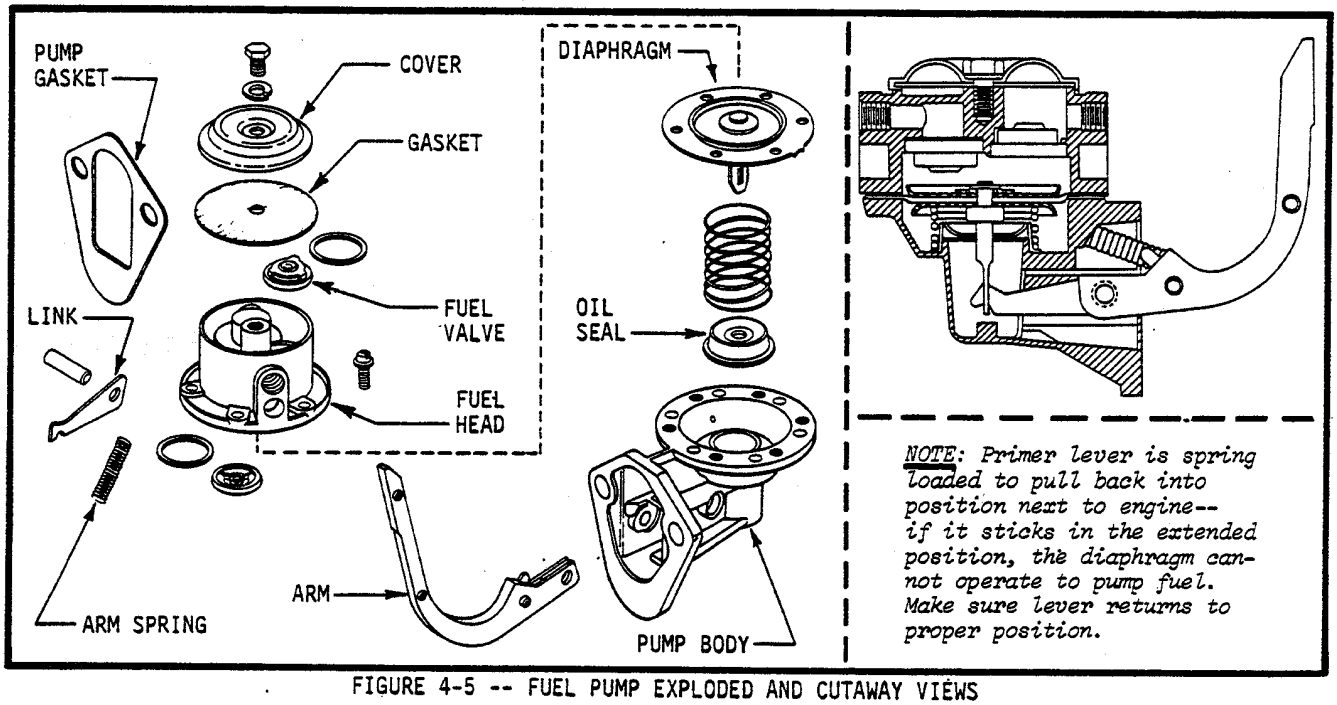


FIGURE 4-5 -- FUEL PUMP EXPLODED AND CUTAWAY VIEWS

STEP 4: To disassemble pump body, first insert screw driver blade into coils of pump arm spring and compress spring to remove. Next compress the diaphragm spring then lift the link to disconnect and remove the diaphragm and oil seal--discard these parts. Push pin out to release pump arm and link to complete disassembly.

RECONDITIONING

Wash fuel head, body and cover in gasoline and clean with stiff bristle brush. Make sure all traces of gasket material is removed from surfaces. Recondition components as follows:

FUEL HEAD: Position new valve gaskets then press new valves from kit into place. Position new cover gasket on head, then install cover and tighten capscrew.

PUMP BODY: Position link and pump arm, then install and stake new pin. Place new oil seal and spring then install new diaphragm assembly and hook it to the arm link. Replace pump arm spring. Don't reassemble the body to the fuel head at this time.

INSTALLATION ON ENGINE

To attain proper operation of the rebuilt pump be sure to follow this reinstallation procedure.

STEP 1: Use a new pump body gasket then reinstall pump body assembly on engine. Turn engine until diaphragm is flat against the pump body then position fuel head (with scribe marks aligned), then temporarily tighten the six screws only about three turns--again turn the engine until the diaphragm pulls down into the body then securely tighten the six screws. After this is done, reconnect fuel lines to complete the reinstallation.

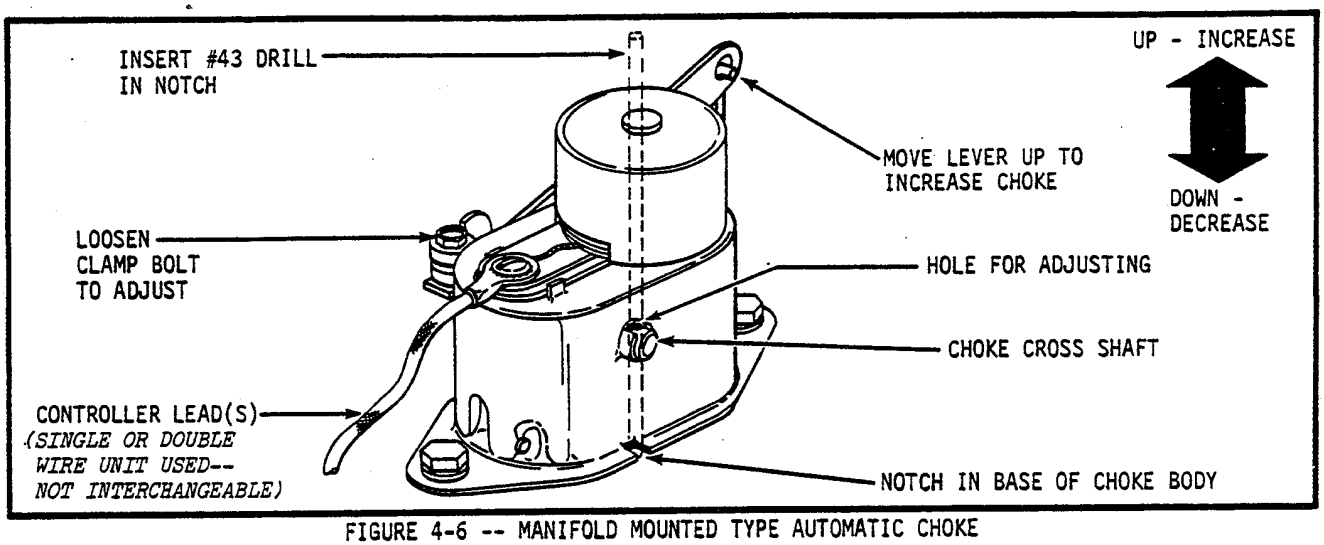


FIGURE 4-6 -- MANIFOLD MOUNTED TYPE AUTOMATIC CHOKE

AUTOMATIC CHOKES

Two different electric - thermostatic type automatic chokes are used. One type is an integral part of the carburetor while the other type is mounted on the exhaust manifold and connected through external linkage to the choke plate in carburetor. The electrical leads to the choke are connected so that current flows to the thermostatic element only when the ignition is turned on. Tension of the thermostatic spring is set to allow full choke at starting. On manifold type, heat from the manifold controls tension of the thermostat spring which causes the choke plate to be gradually returned to the open position as the engine warms up. On carburetor units, vacuum from intake manifold pulls the choke open. Chokes are adjusted in the factory, however, slight readjustment may be necessary initially to account for different starting conditions. Adjust chokes as follows:

Carburetor Unit: Choke unit is set for average conditions. To readjust, loosen three screws on outside of cover plate then shift cover in clockwise direction (arrow) for richer setting or in counterclockwise direction for leaner setting. Tighten cover screws after final adjustment.

Exhaust Manifold Mounted Unit: Remove air cleaner from carburetor to observe position of choke plate. Choke adjustment must be made on cold engine. If starting in extreme cold, choke should be in full closed position before engine is started. A lesser degree of choking is needed in milder temperatures. If adjustment is needed, proceed as follows:

1. Move choke arm until hole in brass shaft lines up with slot in bearings.
2. Insert #43 drill (.089) and push all the way down to engine manifold to engage in notch in base of choke unit.
3. Loosen clamp bolt on choke lever, push arm upward to move choke plate toward closed position. After desired position is attained, tighten clamp bolt then remove drill.

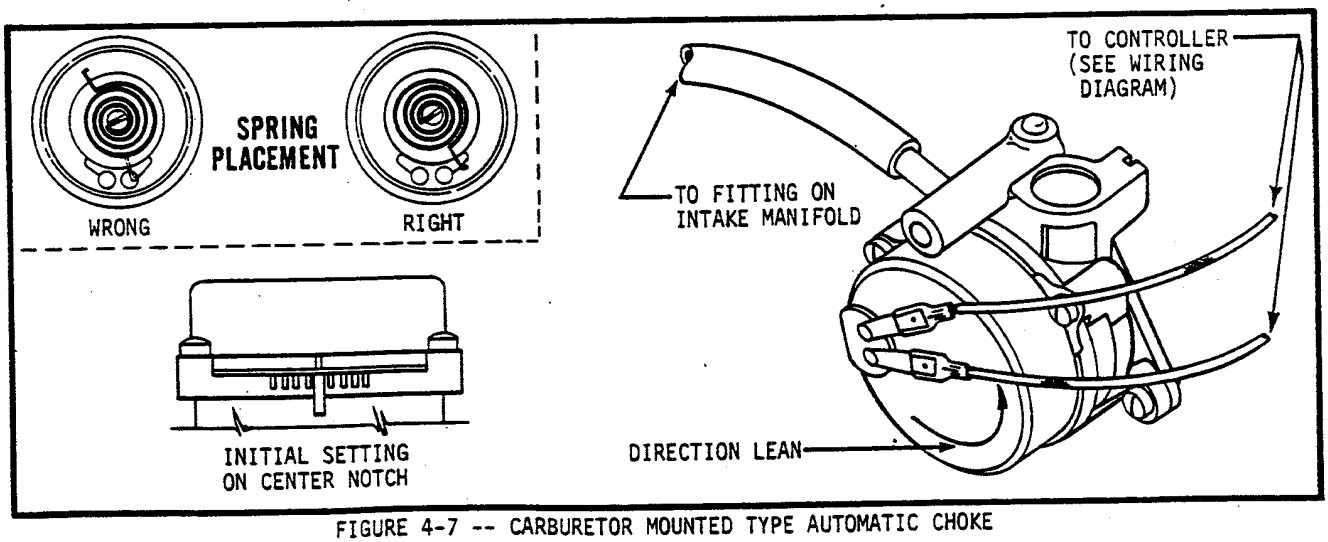


FIGURE 4-7 -- CARBURETOR MOUNTED TYPE AUTOMATIC CHOKE

GAS SYSTEMS

Natural gas supplied from main transmission line is normally received at pressures not greater than 50 pounds per square inch (psi) while with LPG, which is Butane or Propane or usually a mixture of the two gases, the pressure may go as high as 180-200 psi depending on the mix ratio and temperature. To be used by the engine the pressure must be reduced to ounce values. The reduction is normally accomplished in two stages by a primary regulator which reduces line pressures to about 6 ounces per square inch and a secondary low pressure regulator which further reduces the pressure in accordance with engine demand. The primary regulator is often furnished by the fuel supplier. The fuel supplier should also insure that gas pressure is sufficient to operate the primary regulator. If pressure drops too low, the regulator may not function at all. While propane, for example, tends to maintain some vaporizing pressure even at temperatures down to -20° F., butane returns to liquid state and offers little or no vapor pressure when the temperature drops to freezing or 32° F. For this reason, fuel suppliers usually supply LPG of higher butane content in hot weather but will alter this to a higher percentage of propane during cold weather. If this ratio is not changed, starting and operating difficulties may be encountered in cold weather.

Straight gas and combination gas/gasoline systems are used. The combination system uses a gas mixer or adapter attached to a standard gasoline carburetor. Some common carburetors, adapters, and regulators are discussed in the following.

GAS CARBURETORS - ADAPTERS

In a venturi type carburetor, the gas nozzle is located at the point of greatest pressure drop inside the venturi. This creates a suction within that nozzle that varies with changing rate of air flow and causes a greater volume of gas to be metered at heavier loads and a lower volume at lighter engine load. The throttle valve regulates the rate of air flow through the carburetor. When an engine is at top speed, this valve is wide open and offers little restriction to air flow. Closing the throttle causes a decrease in air flow and lowers engine speed and power. As the valve closes, it reduces pressure through the venturi and past the fuel nozzle.

On engines with the gasoline carburetor, an adapter with venturi is installed between the carburetor and air cleaner. The adapter consists of a gas jet and venturi. Accurate metering of the gas is accomplished by load and starting or idle adjustment screws in the body of the adapter.

Most gas carburetors are simple devices having only one moving part--the throttle shaft and plate (or butterfly valve as it is sometimes called). Because of this, they should require very little attention and readjustment should seldom be needed. If needles wear out or venturi is damaged, these

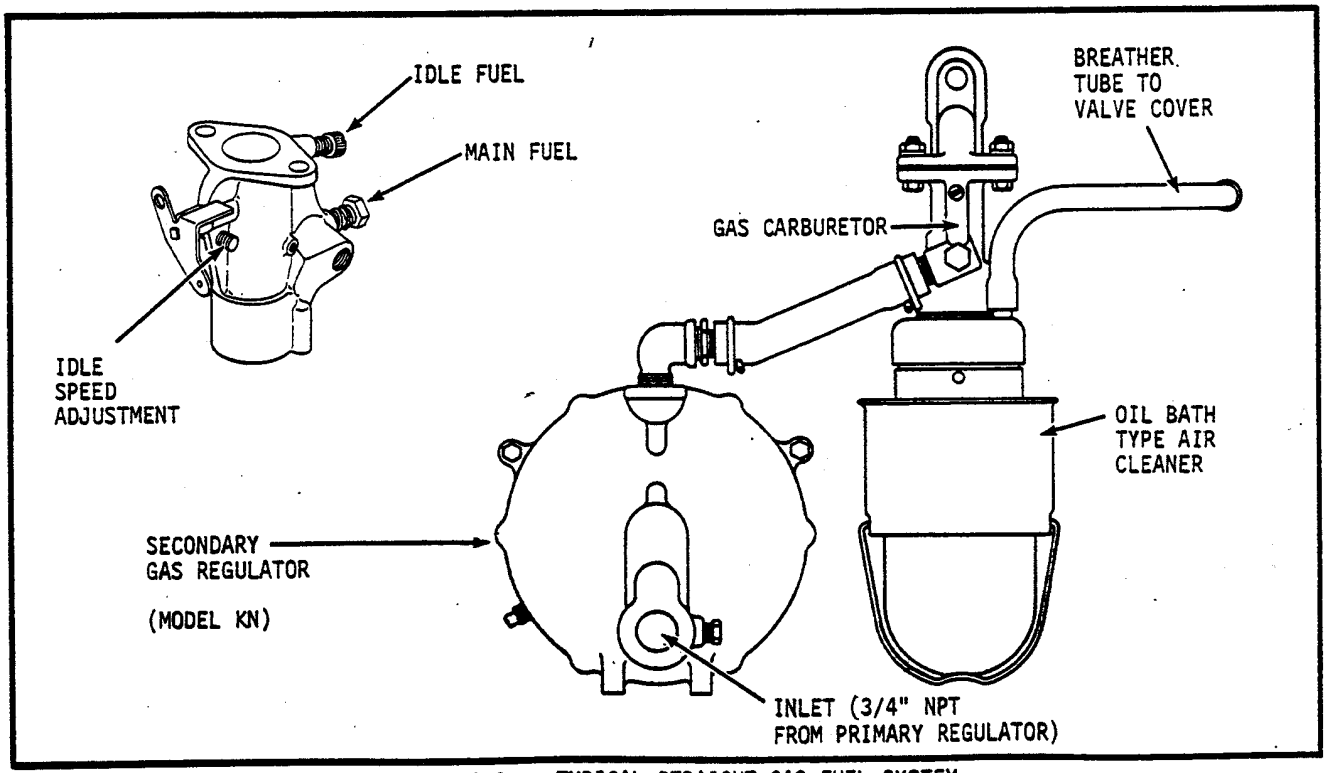


FIGURE 4-8 -- TYPICAL STRAIGHT GAS FUEL SYSTEM

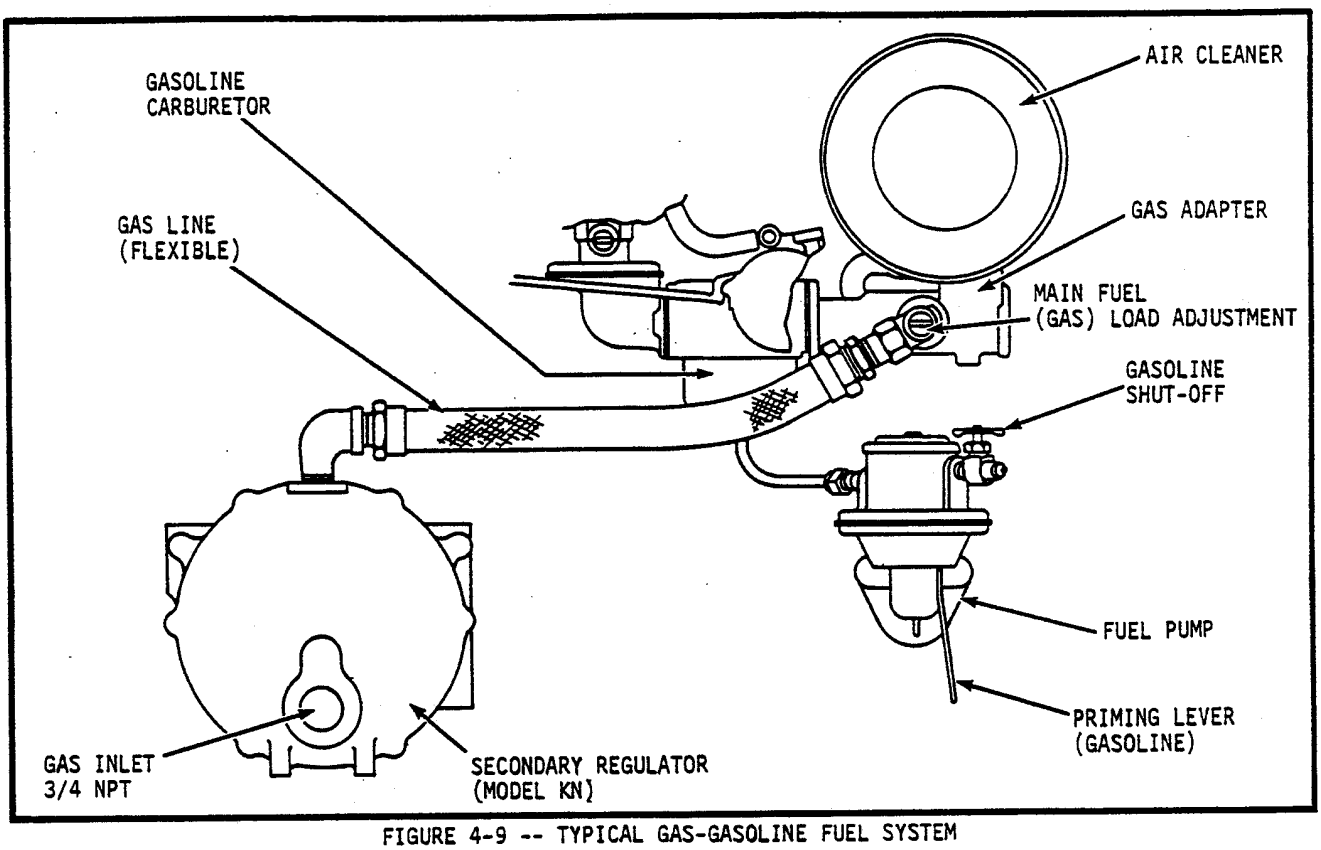


FIGURE 4-9 -- TYPICAL GAS-GASOLINE FUEL SYSTEM

can be replaced. After replacing these parts, use the following procedure to adjust carburetor.

1. Turn the idle stop screw in about 2 turns or until the butterfly valve is held slightly open.

2. Turn IDLE FUEL screw (gas carburetor only) all the way in until it bottoms lightly.

3. Turn the MAIN FUEL or LOAD screw all the way closed then back out 5 turns for initial setting.

After preliminary adjustments are made, start the engine and adjust the MAIN FUEL until the engine runs smoothest at governed speed no load, then put the engine under normal load and readjust as needed for final power adjustment. The idle fuel adjustment can remain completely closed if the engine is not required to run at any other speed than load speed.

On the combination systems, use the same general procedure as stated for adjusting the gas adapter and that stated earlier for adjusting the gasoline carburetor.

GAS REGULATOR -- MODEL KN SECONDARY

The orifice size and maximum inlet pressure are stamped on the cover of the KN--do not permit inlet pressure to exceed maximum (usually 6 oz.). If an electric solenoid is used, it should be mounted close to the model KN. The orifice size of the solenoid must be at least as large as orifice in regulator. To check inlet pressure, remove plug on fuel inlet, insert manometer or ounce pressure gauge. Adjust inlet pressure to 4-7 ounces (7-12" water column)--inlet pressure is adjusted on primary regulator.

Reconditioning: Thoroughly wash all metal parts in cleaning solution, blow out all passages. Replace all worn, damaged parts. Inspect diaphragm and gaskets bonded to both sides of diaphragm--replace as unit if diaphragm or gasket damage is evident. Check brass orifice--replace if nicked. Replace rubber seat if crushed or if foreign material imbedded in rubber. Before reassembling regulator, make sure all parts are clean and free of dirt, lint, etc.

Adjustment (Lock Off): The lock off adjustment is provided only to shut off fuel when engine is not operating--it is not for adjusting fuel mixture or engine speed. Readjustment should be necessary only after

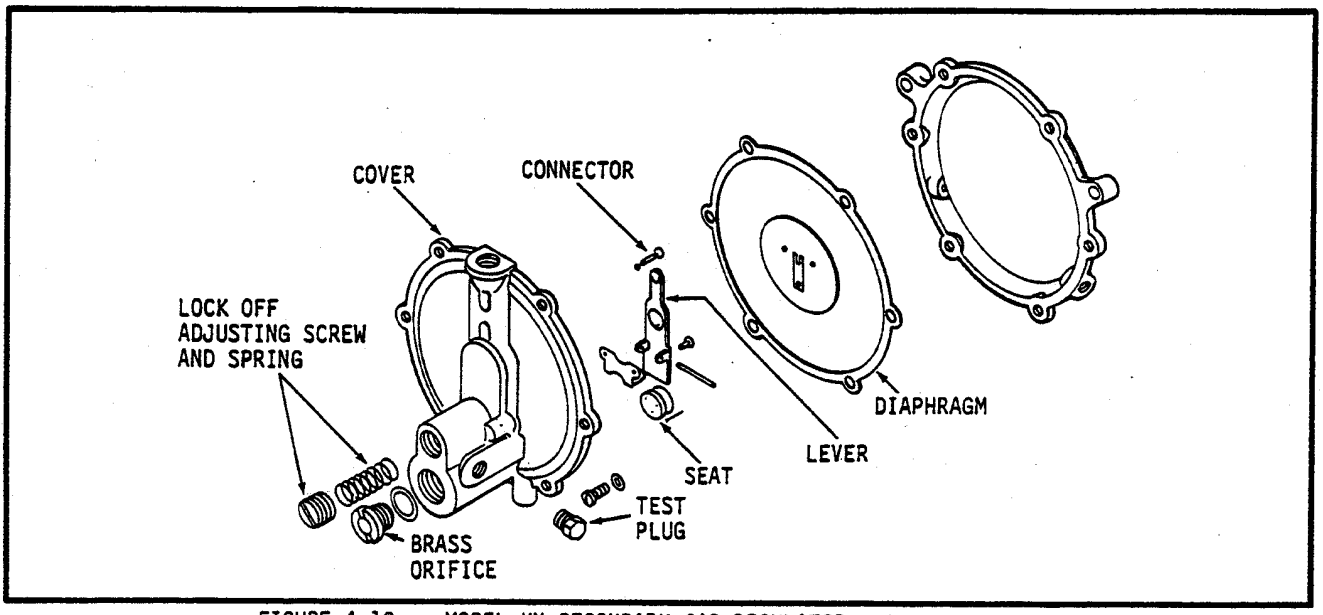


FIGURE 4-10 -- MODEL KN SECONDARY GAS REGULATOR - EXPLODED VIEW

regulator has been completely disassembled or if fuel is not being shut off properly after engine stops. Use following procedure to adjust:

With engine stopped, slowly turn lock off screw out (counterclockwise direction) until fuel starts to flow through the regulator then turn screw in (clockwise) until the flow stops--note position of screw when flow stops then turn in one more turn for final setting.

IGNITION SYSTEM

Several factors contribute to the overall performance of an ignition system - all components must be in good condition and the spark must be properly timed. Hard starting, low power and erratic operation can often be attributed to faulty ignition. If poor ignition is suspected, the first thing to do is to determine if this system is actually at fault. A simple operational test will determine this.

OPERATIONAL TEST: Remove the high tension lead at the spark plug, bend paper clip and insert into boot then hold the end about 1/16" to 1/8" away (with insulated pliers to prevent electrical shock) from the cylinder head while cranking the engine. If a sharp snappy spark occurs, the trouble is apparently not in the magneto although it could still be attributed to a poor spark plug. If no spark or a very weak spark occurs, ignition trouble is indicated. When checking out an ignition system, the components most commonly requiring service or adjustment should be checked first.

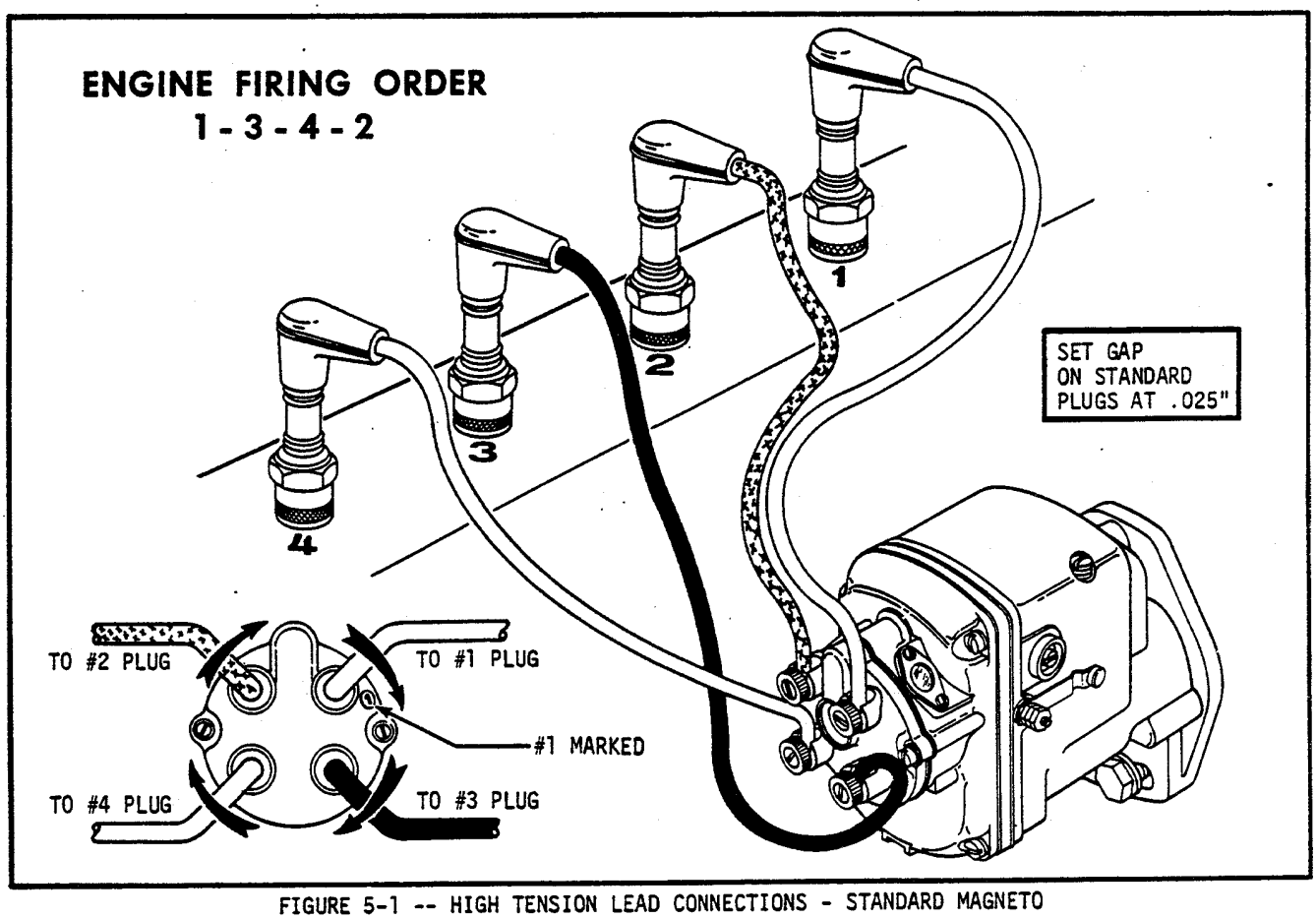


FIGURE 5-1 -- HIGH TENSION LEAD CONNECTIONS - STANDARD MAGNETO

SPARK PLUG SERVICE

Engine misfire or generally poor operation is often caused by spark plugs in poor condition or with improper gap setting. Plugs fail for various reasons. Often the porcelain insulator cracks or becomes coated with oil, carbon or other deposits which causes the high voltage ignition impulse to pass from the center electrode to ground without jumping the plug gap. As an engine operates, the electrodes are gradually burned or worn away. In time, the gap becomes so wide that the available ignition voltage cannot jump the gap and the engine misses.

Spark Plug Service: Every 100 hours, remove plug, check condition and reset gap. Good operating conditions are indicated if plugs have a light coating of gray or tan deposit. A dead white, blistered coating could indicate overheating. A black (carbon) coating may indicate an "overrich" fuel mixture caused by clogged air cleaner or improper carburetor adjustment. Do not sandblast, wire brush, scrape or otherwise service plug in poor condition - best results are obtained with new plug. Use Champion J8 or equivalent spark plugs with standard ignition and Kohler #240705-S with the shielded ignition system. For gasoline operation, set spark plug gap at .025", or at .018" on gas fuel and on shielded plugs. Tighten plugs to 22 ft. lbs. torque.

MAGNETO

Two different magnetos are in use on these engines--the standard type is shown on page 5.1 and the optional radio shielded type is shown below. Both are flange mounted on the front support plate and driven off an idler gear which is, in turn, driven off the crankshaft gear. The breaker points, coil and condenser are located inside the unit. A built-in impulse coupling imparts a strong spark for starting when rotational speeds are low. Avoid removing magneto from the engine since it must be retimed to the engine when reinstalled--this should be done only by a qualified mechanic.

Magneto Service: After each 500 hours of operation, remove magneto end cap and check condition of breaker points--if dirty, clean with lacquer thinner and a coarse (lint free) cloth. If slight amount of pitting and metal transfer is noted, dress contacts with tungsten file or a fine stone. Replace points if badly worn or pitted. Reset gap as follows after servicing or replacing points:

1. Turn engine over until points are wide open (at highest point on cam). Maximum opening should be .015". Proceed with Step 2 if adjustment is necessary.

2. Loosen clamp screws slightly so that contact plate can be moved--insert blade in adjusting slot then shift plate until .015" maximum clearance is measured between contacts. Retighten clamps after adjustment.

3. Lubricate cam wick with Rycon grease each time breaker points are serviced.

Wiring: When viewed from the terminal end, the standard unit rotates in a clockwise direction while the shielded unit rotates in the opposite direction. The number 1 terminal is marked on each end cap. Firing order of the engine is 1 - 3 - 4 - 2. Refer to Figure 5-1 for proper connection of the high tension leads from the standard type magneto to spark plugs--refer to Figure below for connections to shielded type magneto. The leads must be properly connected to make the engine fire in the correct order.

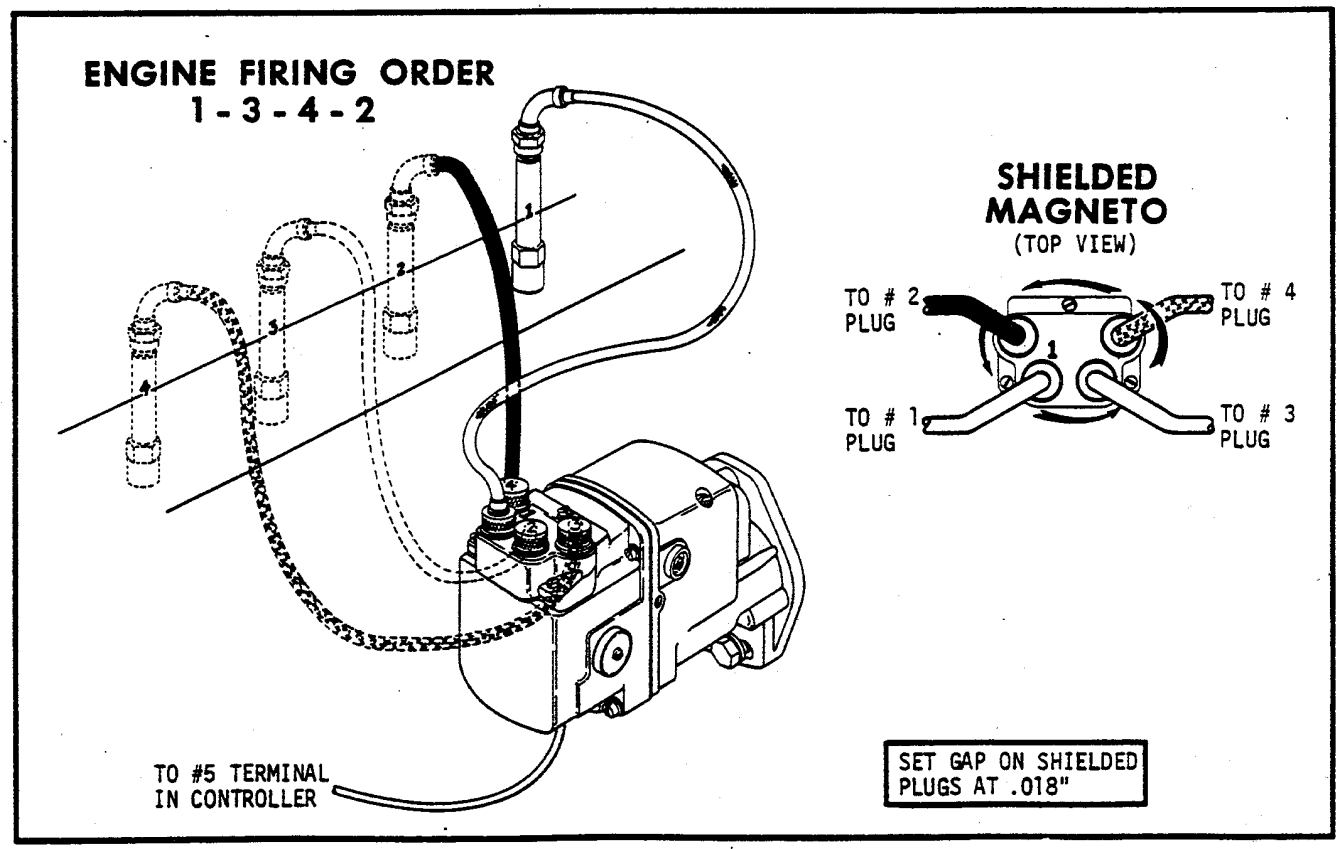


FIGURE 5-2 -- WIRING CONNECTIONS - SHIELDED TYPE MAGNETO

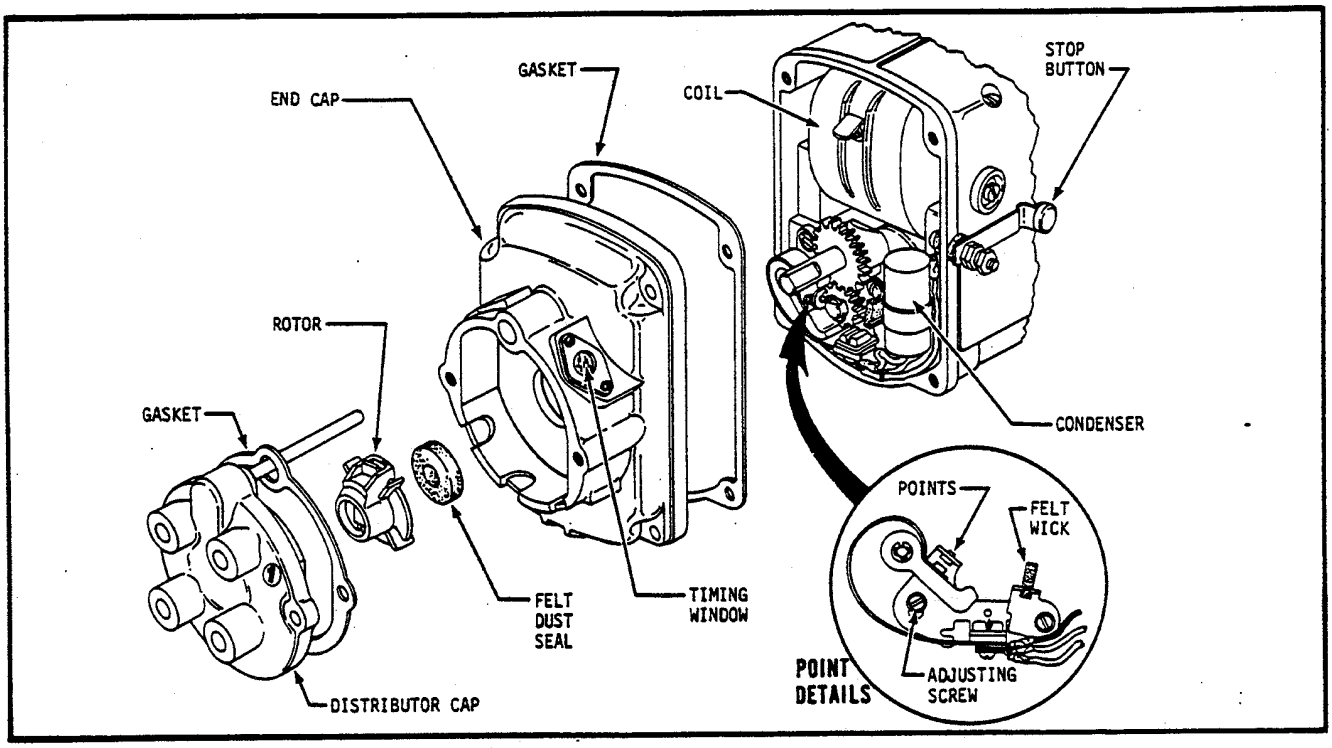


FIGURE 5-3 -- BREAKER POINT SERVICE - STANDARD MAGNETO

INSTALLING MAGNETO

Timing Standard Magneto To Engine: The magneto is timed to the engine at the factory - retiming should not be necessary unless unit has been removed from the engine for reconditioning or other reasons. Use the following steps to retime magneto to engine:

1. Turn engine over until SPK mark on flywheel - generator fan is lined up with timing line and pointer on the bell housing. (Remove #1 spark plug--check to insure #1 cylinder is at top of compression stroke.)

2. On magnetos with timing window, turn magneto gear (counterclockwise) until white mark lines up with indicator. This positions distributor for firing #1 spark plug--hold in this position.

3. Position gasket then carefully guide magneto gear into engagement with idler gear--make sure whit timing mark remains centered when installing. Secure magneto to engine.

4. Reconnect high tension leads then check ignition timing with timing light.

Timing Shielded Magneto To Engine: Use the following procedure to insure that shielded magneto is in time when reinstalled to engine.

STEP 1 - To establish firing position of #1 cylinder, rotate engine by hand until timing mark on generator fan (SPK) lines up with timing mark (line) on generator housing and compression is felt in #1 cylinder (place thumb over spark plug hole).

STEP 2 - To establish #1 firing position of magneto, connect lead to magneto terminal marked #1. Carefully hold end of this lead about 1/8" away from case and turn magneto gear in clockwise (viewed from gear end) direction through each impulse release. Considerable resistance will be felt as the coupling approaches the trip point and a loud click will be heard as it releases. Continue turning until spark is observed between #1 lead and the case, then turn gear backwards (counterclockwise) until notch in gear (and hub) lines up with yellow timing mark on magneto flange.

STEP 3 - Make sure #1 timing position of both engine and magneto are held while magneto is installed on engine. Connect leads as shown in the accompanying illustration for shielded type magneto. Make sure ground strap is connected to controller terminal #5. Install radio shielded plugs.

STEP 4 - After completing installation, use timing light for precision timing of the ignition.

IGNITION TIMING (MAGNETO)

Timing Magneto Ignition: For precision timing, use timing light per instructions furnished by the light manufacturer. Do not connect a battery to the magneto as this will ruin the coil windings. To time ignition, proceed as follows:

1. After making sure breaker point gap is properly set, connect timing light to #1 cylinder then start engine.

2. Aim timing light into pointer area on bell housing. SPK mark should be even with the pointer just as the light flashes. If it is not, proceed with Step 3.

3. To adjust timing, loosen (do not remove) the two magneto mounting capscrews--shift position of magneto (top flange eccentric) until SPK mark is exactly centered. After proper timing is attained, retighten mounting capscrews.

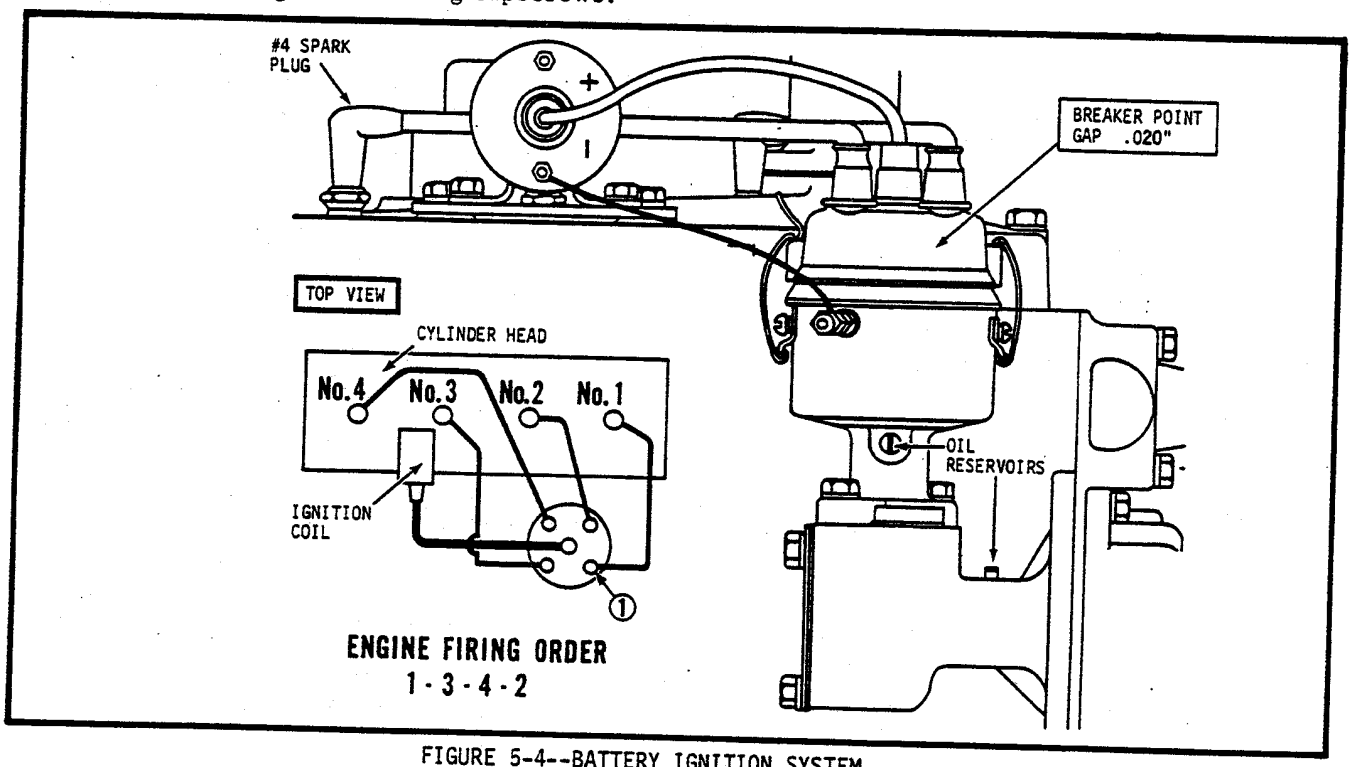


FIGURE 5-4--BATTERY IGNITION SYSTEM

BATTERY (DISTRIBUTOR) IGNITION

DISTRIBUTOR SERVICE: After each 500 hours of operation, remove distributor cap and check condition of the breaker points. If points are dirty, clean with lacquer thinner and a coarse (lint free) cloth. Replace points if badly worn or pitted. To adjust point gap, turn engine over until point opening is a maximum--point gap should be set at .020". Check and adjust gap after servicing or replacing points.

Every 500 hours, remove the plug on the distributor housing and the plug on the drive housing as shown--fill reservoirs with SAE 20 weight oil. Reinstall plugs after servicing. Distributor rotor turns in clockwise direction when viewed from the top. The number 1 terminal is indicated above--connect spark plug leads as shown for proper firing sequence. Use the following procedure if distributor retiming becomes necessary.

STEP 1: To establish firing position of #1 cylinder, rotate engine by hand until timing mark on generator fan (SPK) lines up with timing mark (line) on generator housing and compression is felt in #1 cylinder (place thumb over spark plug hole).

STEP 2: With distributor removed from engine, remove distributor cap, rotor and cover. Reinstall rotor and rotate drive gear until ignition points just begin to open when rotor is positioned to fire #1 spark plug.

STEP 3: Install distributor on engine. Reassemble cover, rotor and cap in proper position. Connect spark plug leads as indicated, use timing light for precision timing of the ignition.

COOLING SYSTEMS

RADIATOR SYSTEMS

Coolant is circulated through the engine and radiator by a belt driven water pump. When the engine is cold, the thermostat (in housing on top of cylinder head) remains closed to cause coolant to by-pass the radiator thus resulting in rapid warm-up. As the engine warms, the thermostat opens to allow water to circulate into and through the radiator core. Heated water enters at the top of the radiator, is cooled, then flows out at bottom to recirculate back into and through the engine water jacket. A pusher type fan pulls cooling air across the generator and engine, forces the air through the radiator core and expels it as heated air through the front of the radiator.

RADIATOR CAPACITIES: There are several styles of radiators in use. All are for pressure systems, so make sure the correct pressure type cap is used. Radiator type cooling system capacity is about 7 quarts of liquid. When operating in climates subject to freezing temperatures, make sure a sufficient amount of anti-freeze solution is added to prevent freeze up of the system. On the type of radiator shown below, a petcock is provided on the underside of the radiator to drain the system. On other types the petcock is on the inlet elbow to the crankcase. When draining coolant system, remove the radiator cap and open the drain valve on crankcase near the oil filler cap to prevent air pockets from forming and blocking water in passages in the block. Check coolant level frequently and add water or anti-freeze as needed to maintain correct level.

ANTI-FREEZE PROTECTION

Closed system such as the radiator and the heat exchanger type cooling systems can be protected with anti-freeze. Direct type marine and many city water cooling systems are "open circuit" systems and cannot therefore be protected with anti-freeze. Before adding anti-freeze, drain the coolant system completely to assure correct proportions of anti-freeze to water. Radiator systems hold about 7 quarts of liquid while the marine type heat exchanger system (page 6.3) holds about 5 quarts. If, for example, you want to protect a 7 quart capacity radiator system down to 11° below zero with ethylene glycol, use a 40% solution per the chart below--this is figured as .40 x 7 = 2.80 or rounded off, 3 quarts anti-freeze to 4 quarts of water. For maximum protection always use a solution which will remain liquid well below the lowest anticipated temperature.

ANTI-FREEZE PROTECTION CHART

ANTI-FREEZE	10%	20%	30%	40%	50%
ETHYLENE GLYCOL	--	+16°	+3°	-11°	-31°
GLYCERINE TYPE	+29°	+21°	+12°	0°	-15°

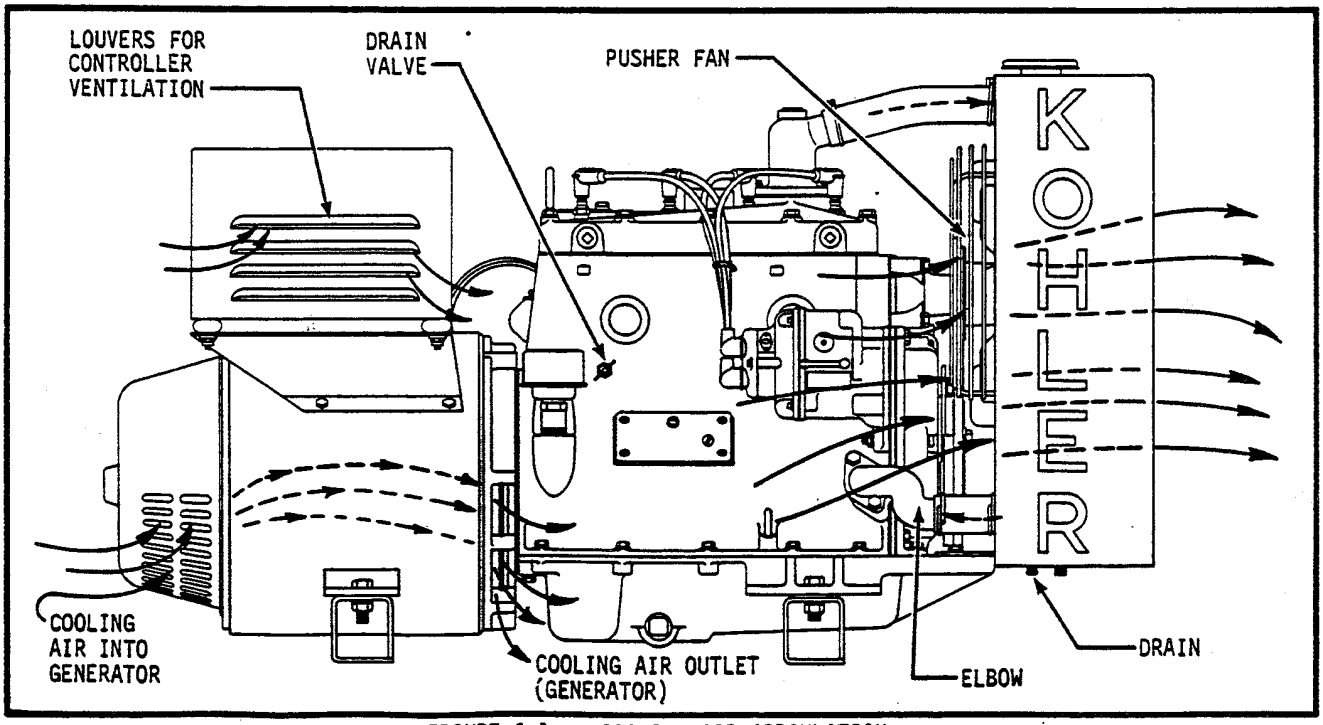


FIGURE 6-1 -- COOLING AIR CIRCULATION

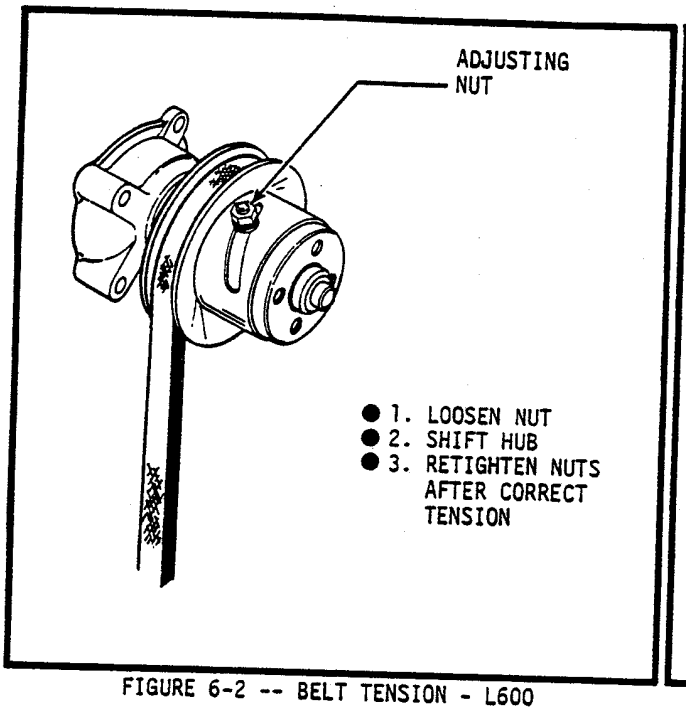


FIGURE 6-2 -- BELT TENSION - L600

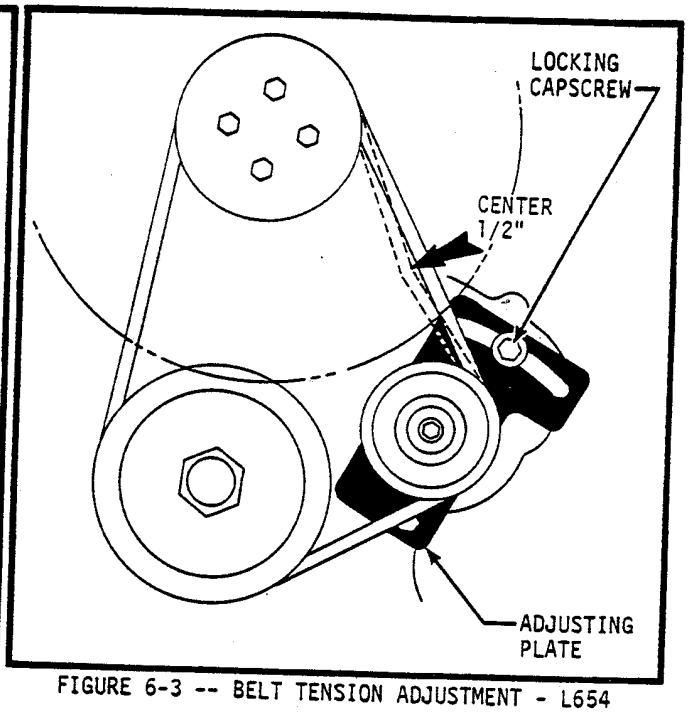


FIGURE 6-3 -- BELT TENSION ADJUSTMENT - L654

BELT TENSION, BELT REPLACEMENT

On radiator cooled models, belt tension should be adjusted so that the belt can be depressed about 1/2 to 1" in the center of the longest span between pulleys. The adjustment and replacement procedure differs between the L600 and L654 models. It is also different on marine models--refer to page 6.4 for marine models. On L600 models with the adjustable pulley as shown in Figure 6-2, loosen nuts on pulley hub, move hub in closer to the inner face to increase tension or away to decrease tension. Retighten nuts after proper tension is achieved. To replace belt on L600, remove belt guard, loosen pulley hub until belt can be slipped off the pulleys.

L-654 radiator equipped models have an arrangement shown in Figure 6-3. On these, loosen the two mounting capscrews and shift plate out to increase tension or in to decrease tension. Move plate all the way in to allow removal of a bad belt over the pulleys. Retighten capscrews after proper tension is attained.

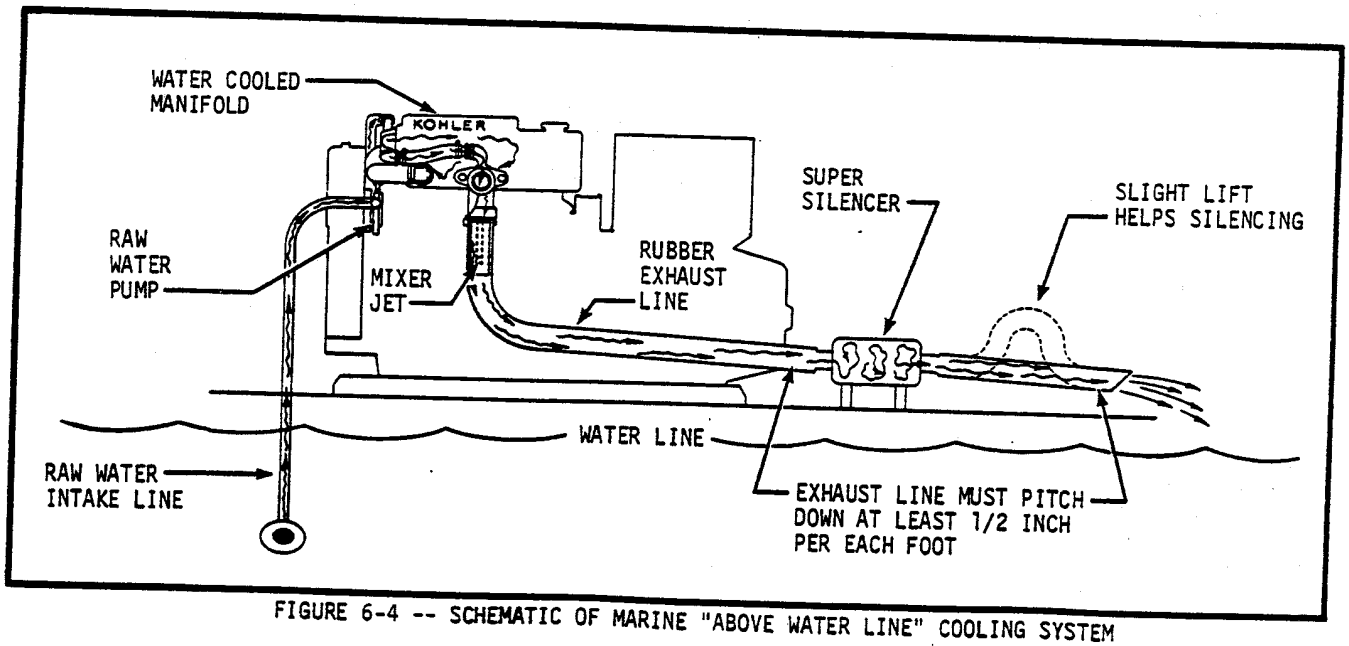


FIGURE 6-4 -- SCHEMATIC OF MARINE "ABOVE WATER LINE" COOLING SYSTEM

MARINE COOLING SYSTEMS

Marine electric plants use heat exchanger and direct type cooling systems. The only outward difference between the two systems (new design - see illustration) is in the type of cap used on the water-cooled exhaust manifold. The heat exchanger system utilizes a pressure cap (with filler neck and overflow tube) while the direct type uses a solid, non-pressure type cap. To further identify the systems, the tubes of the heat exchanger can be seen or felt when the cap is removed from the manifold. To drain systems, turn petcock located on lower right front side of crankcase or if this is not provided, loosen cover plate.

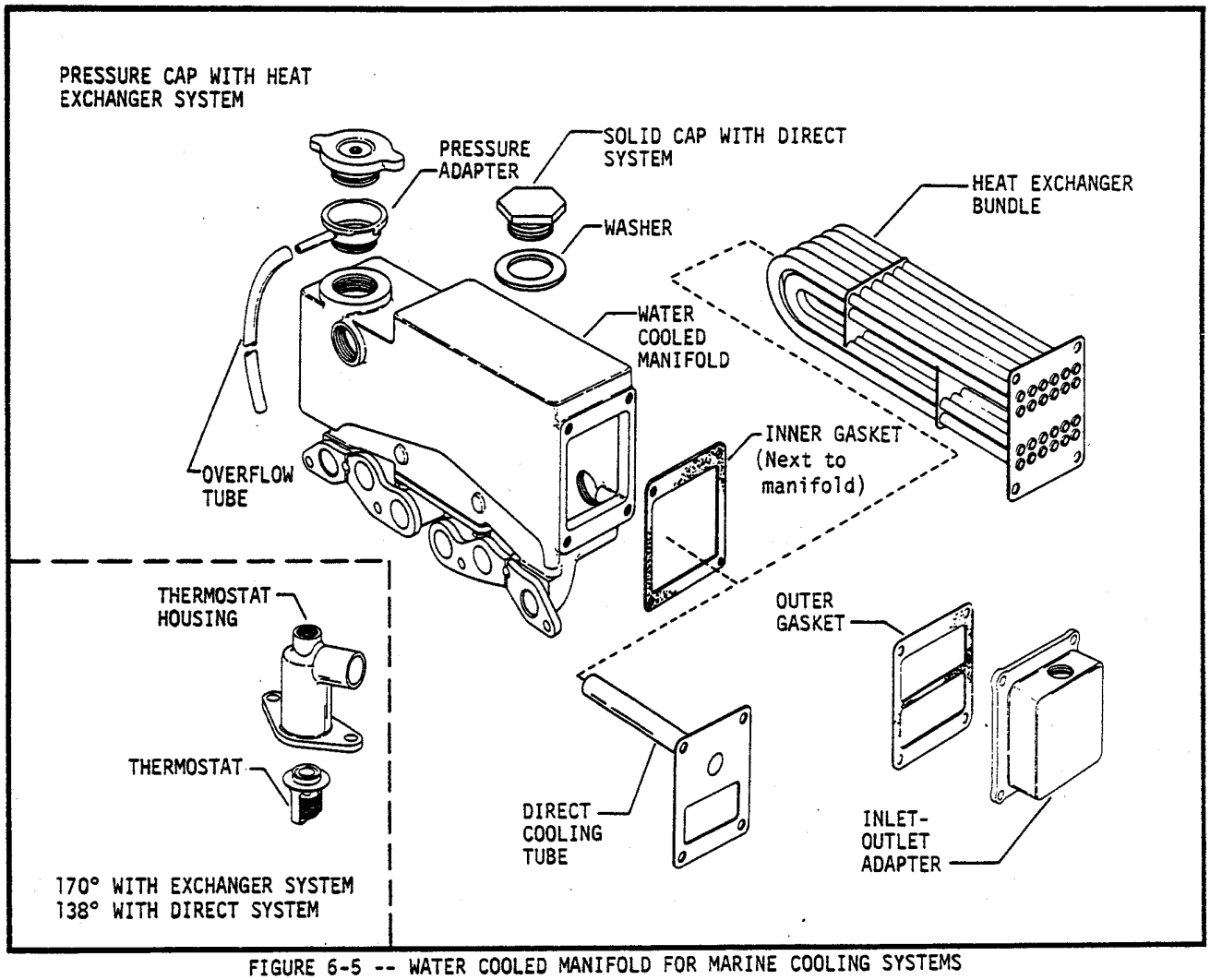


FIGURE 6-5 -- WATER COOLED MANIFOLD FOR MARINE COOLING SYSTEMS

Heat Exchanger System: The heat exchanger system is comprised of two circuits--a closed engine circuit and the raw or sea water circuit. In the closed circuit, coolant is circulated by the engine water pump through the water jacket, manifold and returned to the pump for recirculation. Since this is a closed circuit, antifreeze can be added if required--the circuit holds 5 to 5-1/2 quarts of liquid. In the raw water circuit, the belt driven sea water pump picks up sea water and circulates it through the tube bundle where it absorbs and carries away heat of the closed circuit which is being circulated around the tubes. The heated water is sprayed into and mixed with the exhaust which is in turn ejected through the wet type silencer and finally is expelled through the exhaust outlet.

Direct Type System: On the direct system, the sea water pump introduces sea water directly into the manifold where it is circulated throughout the engine by the engine water pump. The heated water is forced away and injected into the exhaust in the same way as in the heat exchanger system. Since the direct system is of the non-pressure type, the solid cap must be used. This system cannot be protected with antifreeze since it is an open circuit. A 138° thermostat is required with the direct system.

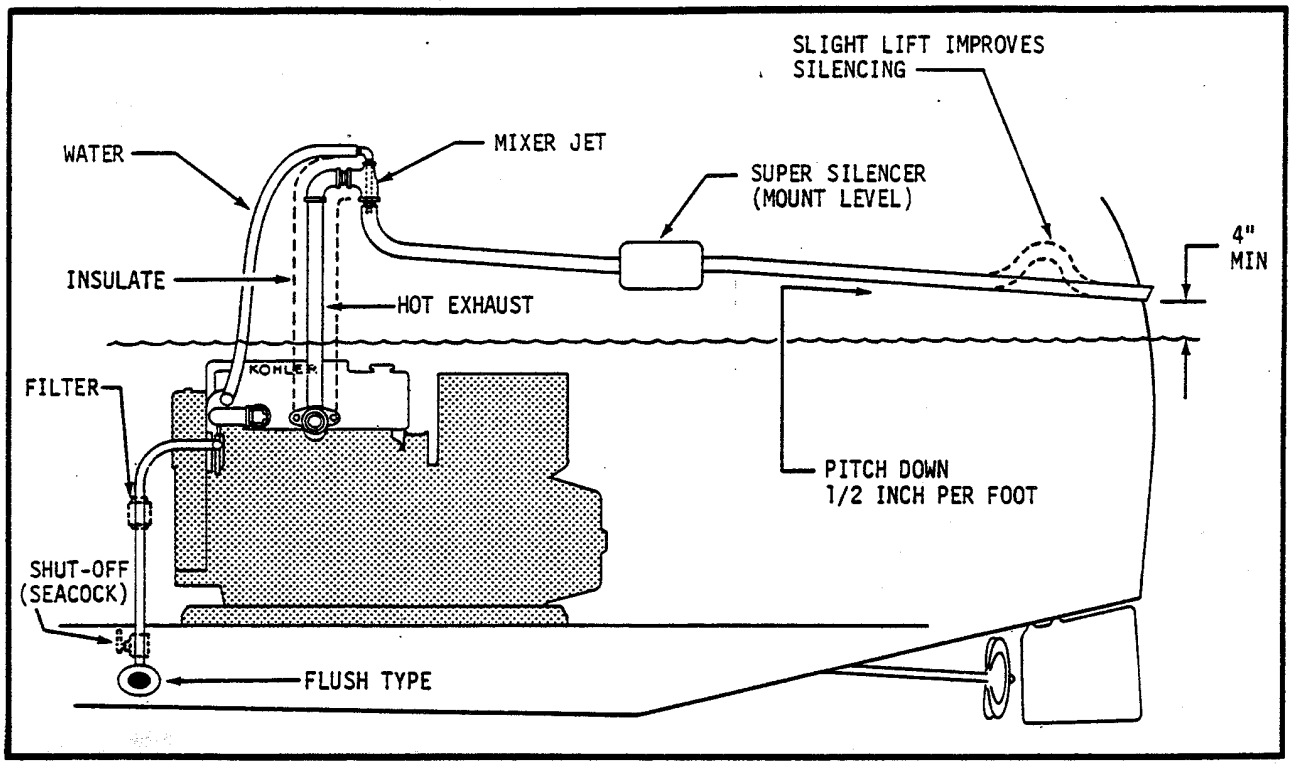


FIGURE 6-6 -- SCHEMATIC SHOWING TYPICAL "BELOW WATER" MARINE COOLING SYSTEM

Belt Tension: On marine models, the belt should be adjusted so that it can be depressed about 1/2" as shown in accompanying illustration. To adjust, remove belt guard, loosen adjusting plate capscrews then shift plate until proper tension is obtained--retightening plate at new setting then replace belt guard.

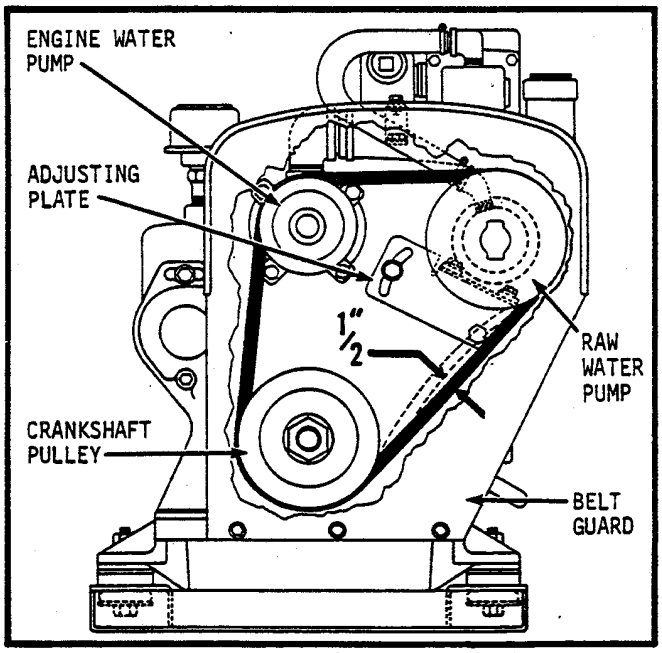


FIGURE 6-7 -- BELT ADJUSTMENT - MARINE

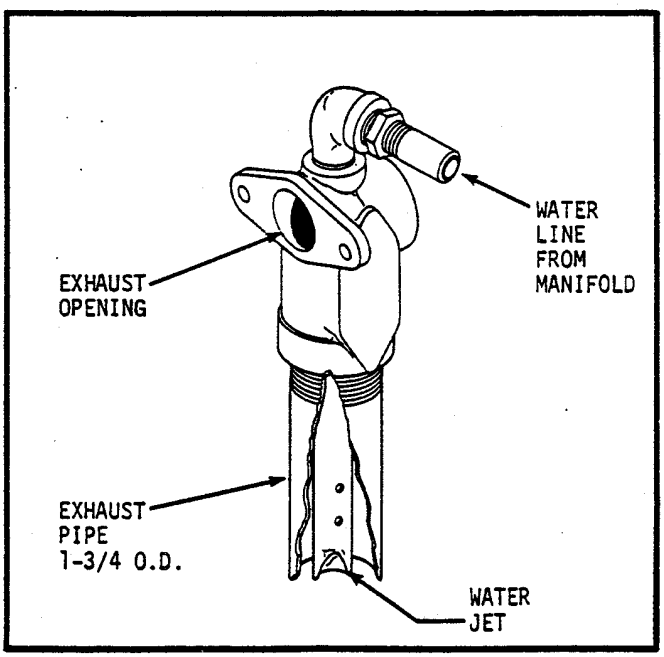


FIGURE 6-8 -- EXHAUST MIXER - MARINE MODELS

GOVERNOR

Standard equipment is an externally mounted, centrifugal flyweight type mechanical governor. The governor is flange mounted on the front support plate and is driven off the camgear. Lubrication is provided by an external oil line which connects the engine lube system to the governor. No regular service is required on the unit. The governor is adjusted during run-in at the factory and further adjustment should not be needed unless greatly varying load conditions are encountered or if poor governor control develops after extended usage.

GOVERNOR ADJUSTMENT

If governor setting is too sensitive, hunting or speed surging will occur with changing load. If a considerable drop in speed is experienced when normal load is applied, the governor should be adjusted for greater sensitivity.

If one of the governor settings is readjusted, the other should also be readjusted since each has an effect on the other. With plant running at full load, governed speed, readjust governor as follows:

1. Speed Range: Check speed with hand tachometer or by frequency meter if plant is so equipped. Loosen locking nut on speed adjusting screw, turn screw in clockwise direction to increase speed (and frequency) or in counterclockwise direction to decrease speed. Lock nut at new setting. Follow this adjustment with Step 2.

2. Sensitivity (Droop) Adjustment: Test under normal load conditions. If readjustment is needed, proceed as follows. To make governor control more sensitive, loosen the nut at bottom of adjusting eye bolt and tighten the top nut thereby drawing the head of the eye bolt closer to the governor arm pivot point. To make governor control less sensitive, loosen the top nut and tighten the bottom nut to move the head of the eye bolt away from the pivot point. After sensitivity is correct, tighten the nut that was previously loosened to lock the eye bolt at the new setting. Recheck speed after sensitivity adjustment since changing this will also affect speed.

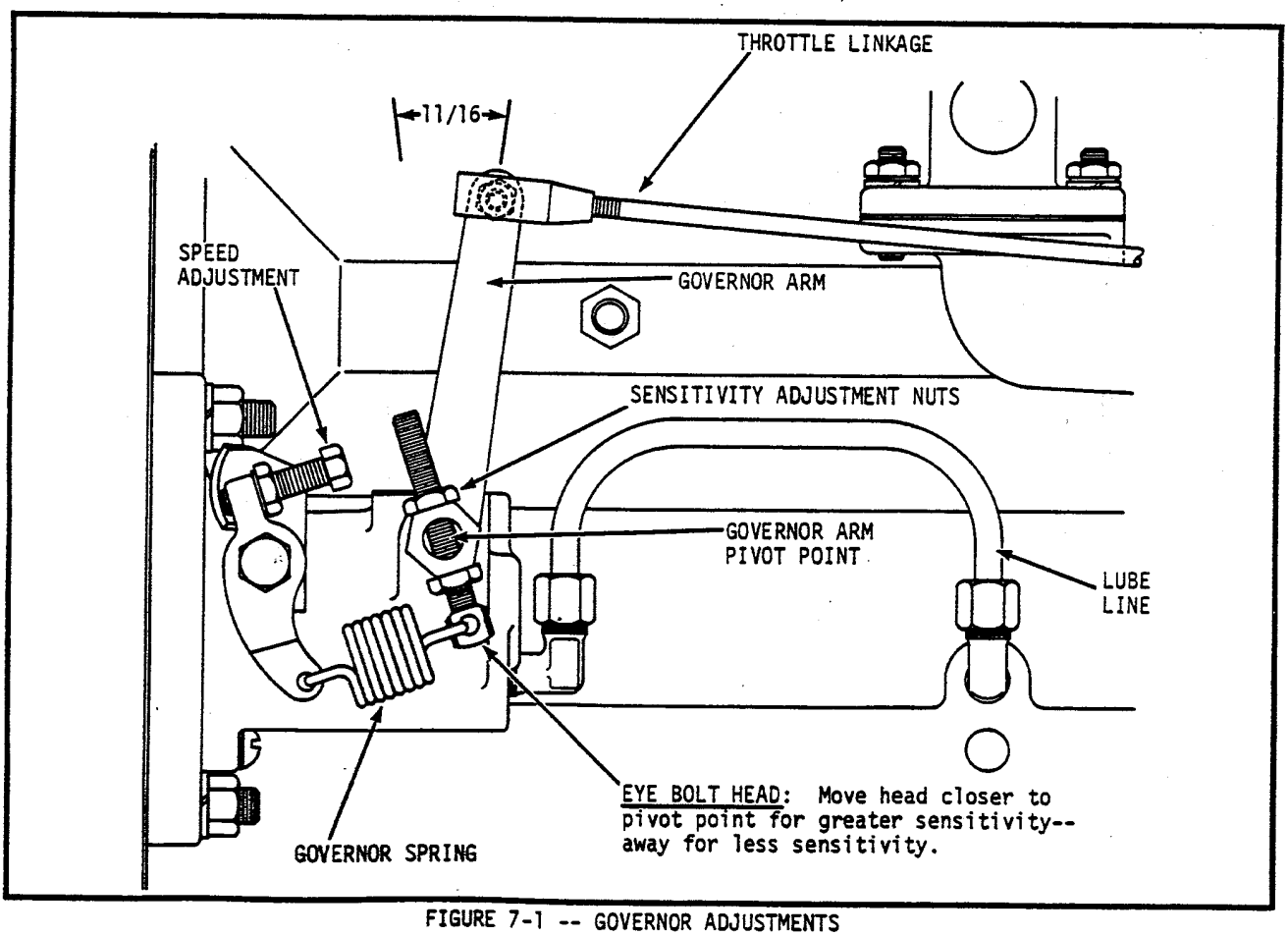


FIGURE 7-1 -- GOVERNOR ADJUSTMENTS

ENGINE - GENERAL SERVICES

CYLINDER HEAD SERVICE

After each 500 hours of operation, the cylinder head should be taken off the engine and serviced. Remove carbon deposits from combustion chamber in head. Scrape and remove carbon with a sharp piece of wood--wood or similar material is suggested to avoid scratching machined surfaces of head. Always use new cylinder head gaskets, make sure head bolts are tightened in the proper sequence and to the torque value stated in the Specification Section. Before reinstalling the serviced heads, check and adjust valve-tappet clearance per the following instructions.

VALVE ADJUSTMENT

Valve - Tappet Clearance: Poppet type valve mechanism is used on these engines. With this type, each valve is spring held in the closed position until forced open by the action of the tappet which rides on a cam of the camshaft. Tappets have self-locking setscrews for adjusting the valve stem to tappet clearance.

Every 200 hours, remove valve cover and check valve-tappet clearance. Cold (engine cold) clearance should be .008" on intake and .011" on exhaust valves. To check and adjust clearance (cold) proceed as follows:

1. Remove spark plugs then turn engine over until #1 piston is at Top Dead Center (observe through spark plug hole) on compression stroke. Both intake and exhaust valves will be closed at this point.

2. Insert feeler gauge between tappet and the end of the exhaust valve. If necessary, adjust clearance by moving tappet setscrew so that very slight drag is felt on the feeler gauge as it is withdrawn. Repeat procedure on intake valve on #1 cylinder.

3. Turn engine over until next piston is at TDC compression and repeat procedure in turn on each cylinder until all valves are properly adjusted.

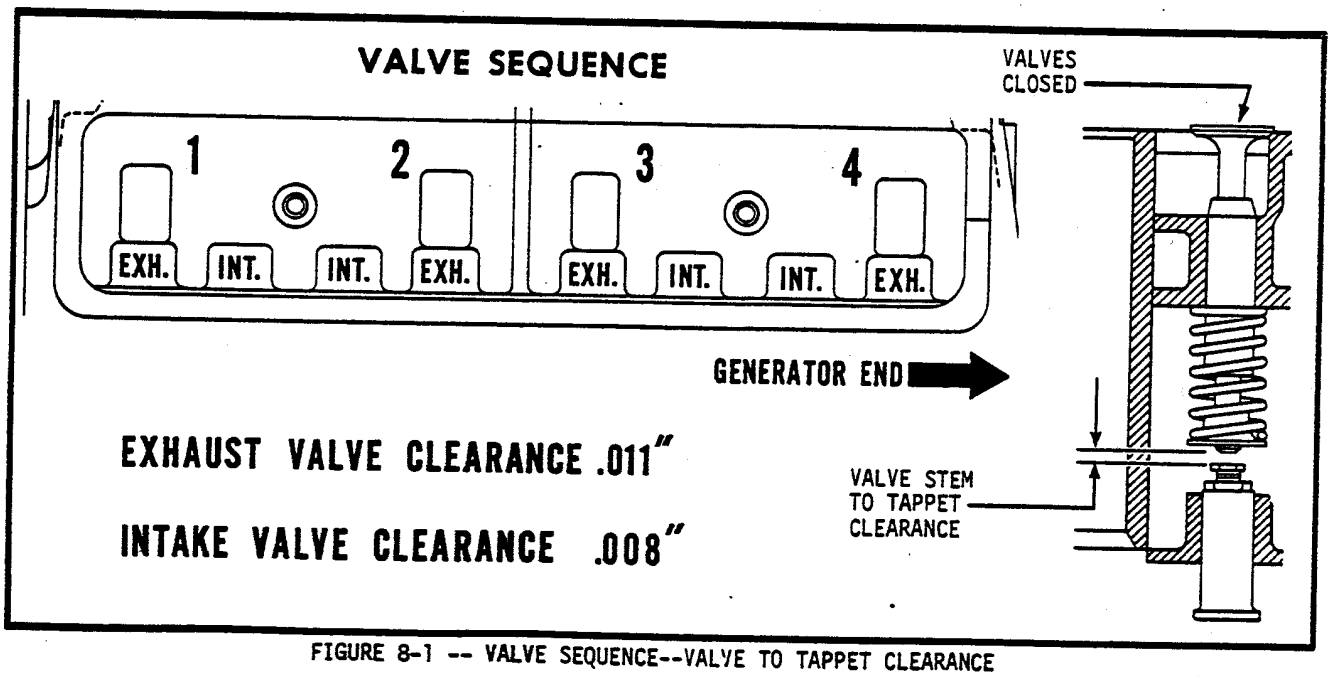


FIGURE 8-1 -- VALVE SEQUENCE--VALVE TO TAPPET CLEARANCE

COMPRESSION TEST

The results of a compression check can be used to determine if an engine is in good operating condition or if reconditioning is needed. Low readings can indicate several conditions or a combination of different conditions:

LOW COMPRESSION	
POSSIBLE CAUSE	REMEDY
A. Cylinder head gasket blown.	A. Remove head, replace gasket, reinstall head, recheck compression.
B. Cylinder head warped or loose.	B. Remove head, check for flatness (see cylinder head service), reinstall and secure in proper sequence to specified torque value.
C. Piston rings worn--blowby occurring.	C. Recondition engine.
D. Valves leaking or too tight tappet clearance.	D. Recondition valves and seats and adjust tappets.

Higher than normal compression can indicate that excessive carbon deposits have built up in the combustion chamber. Be sure air cleaner is clean and exhaust is not restricted before checking compression. Insert gauge in spark plug hole and take several readings on each cylinder. Consistant readings in the 110 to 120 psi range indicate good compression. Reconditioning is indicated if readings fall below 100 psi or if readings between any cylinders are far apart.

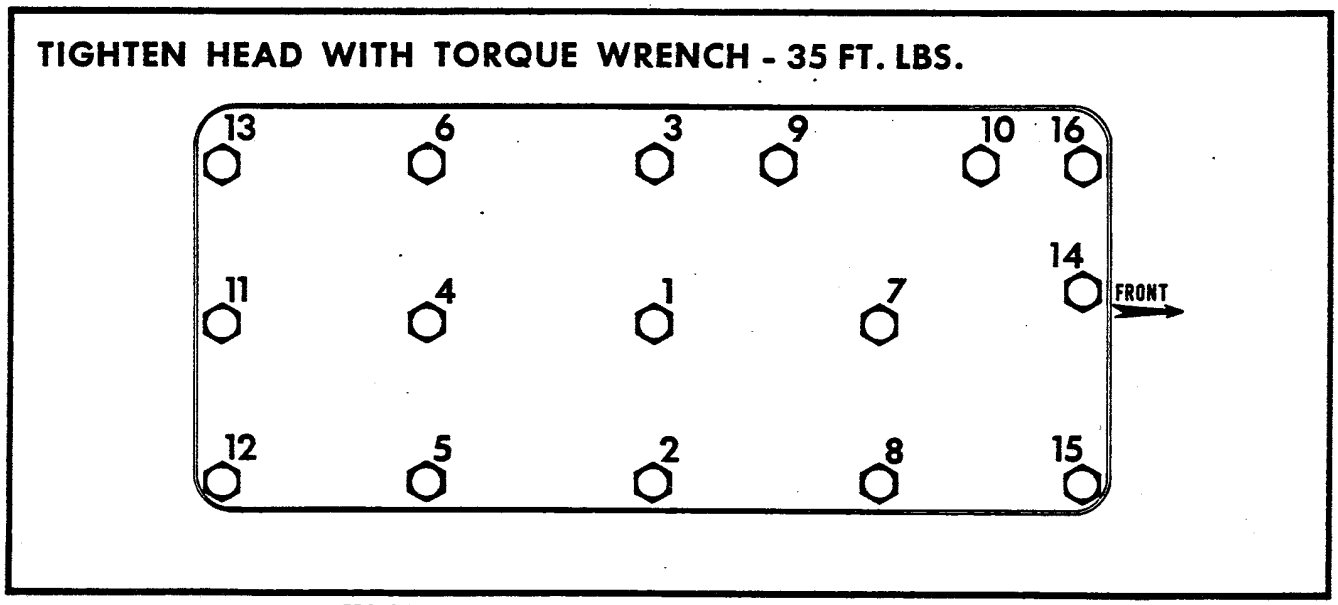


FIGURE 8-2 -- CYLINDER HEAD BOLT TIGHTENING SEQUENCE

ENGINE RECONDITIONING

WORK AREA

Before starting disassembly of an engine, make sure work area is in clean, neat condition and that adequate tools are on hand. Certain special tools are required to satisfactorily install oil seals, "O" rings, etc. Good lighting is also essential for proper inspection and reconditioning. Observe all rules of safety when working on an engine. Make sure cleaning solvents and other flammable liquids are properly identified and stored in covered containers safely away from danger of combustion from open flames, sparks, etc. The best protection against accidents in all situations is provided mainly through the use of good common sense.

INSPECTION

When disassembling an engine, carefully inspect and note the physical appearance of each of the components. Often the appearance of parts will indicate operation under other than ideal conditions. In observing these indicators, you may be able to suggest improved service and operating techniques which will result in prolonged engine service life. Some of the things to look for are:

1. Excessive sludge and varnish formation.
2. Scoring of the cylinder walls.
3. Severe piston damage.
4. Evidence of external oil leakage.

These are just a few of the more common indicators. Numerous others exist and are obvious to the experienced mechanic. Often the cause will become apparent in view of the particular condition of the part. Always look for these signs when disassembling an engine prior to reconditioning.

Excessive Sludge: This is a natural by-product of combustion and a small accumulation is normal. Excessive sludge formation could indicate several things. The most common cause is perhaps too infrequent oil and oil filter changes. It can also indicate operation with improper ignition timing or overrich carburetor adjustment or a poorly serviced clogged air cleaner which restricts air intake and also results in an overrich mixture.

Scoring of the Cylinder Wall: Unburnt fuel not only adds to sludge formation but can, in severe cases, cause scuffing and scoring of the cylinder walls. As raw fuel seeps down the cylinder walls, it washes the necessary lubricating oils off the piston and cylinder walls so that the piston rings make metal to metal contact with the walls. Scoring of the cylinder walls can also be caused by localized hot spots resulting from blocked cooling passages or from inadequate or contaminated lubrication.

Severe Piston Damage: Major damage to pistons and rings can take various forms. The top of the piston ring may be burned through or the top groove may be excessively worn and the ring broken or stuck in the groove. This can be attributed to abnormal combustion. If ignition timing is overadvanced, ignition will occur while the piston still has a long distance to travel on its compression stroke. As a result, the combined heat of compression plus the heat of pre-ignited fuel raises temperatures to values comparable to that of an acetylene torch. This, of course, acts mainly on the top land and top ring of the piston and results in early failure.

Evidence of External Oil Leakage: If excessive oil leakage is evident, this may indicate improperly serviced breather systems. Normally, an engine operates internally at pressures under atmospheric or, in other words, with a negative crankcase pressure. If positive pressures build up within the crankcase from a clogged breather or from piston blowby, oil will be forced out of an engine at oil seals, gaskets, or any other available spot.

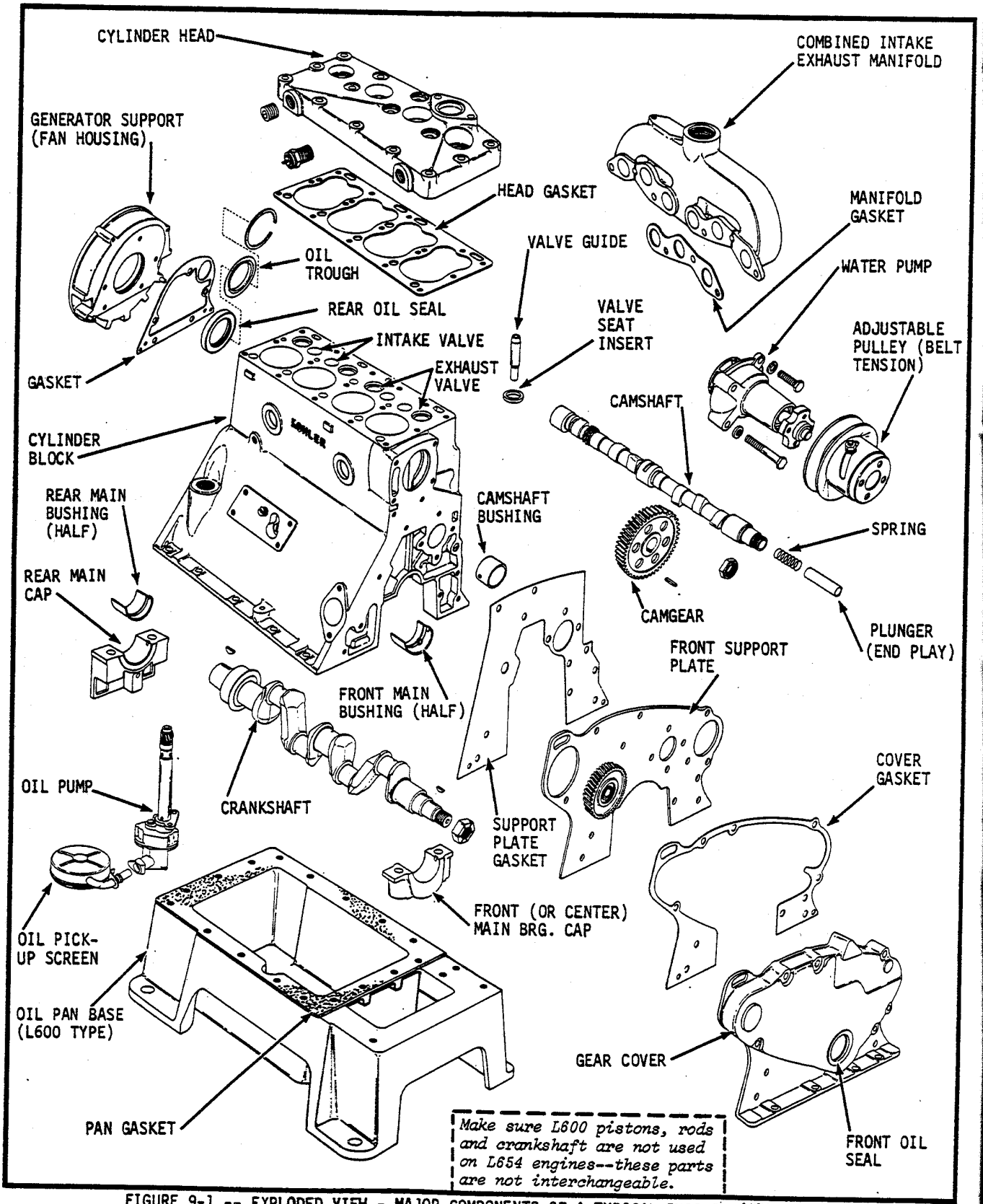


FIGURE 9-1 -- EXPLODED VIEW - MAJOR COMPONENTS OF A TYPICAL ENGINE

DISASSEMBLY PROCEDURE

The following is intended as a guide to disassembly. The procedure may have to be varied to facilitate removal of special equipment or accessory items such as gas fuel system components, etc.

Prior to disassembly, remove drain plugs and allow ample time for complete drainage of fuel, coolant, and lubricating oil. It is good practice to do this outside or at a location away from the work bench to keep this area in clean condition. If engine is dirty externally, it should be steam cleaned or thoroughly cleaned in some other manner before being moved to the work bench. Keep the work area in cleanest possible condition at all times.

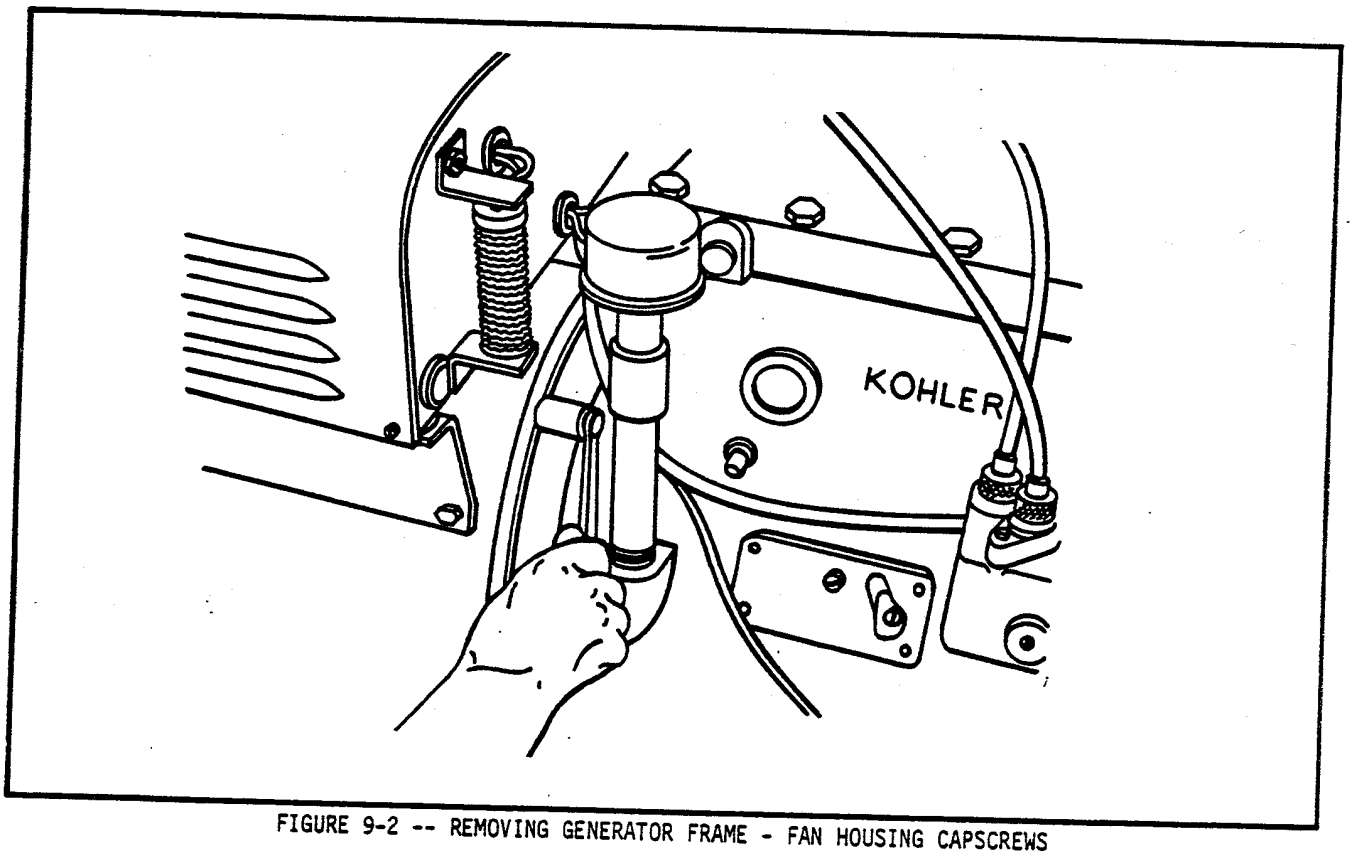


FIGURE 9-2 -- REMOVING GENERATOR FRAME - FAN HOUSING CAPSCREWS

GENERATOR REMOVAL

Before detaching generator from the engine, place blocks of wood under the oil pan on marine models or under the generator frame on other models. The Controller can remain installed on generator, however, disconnect leads from engine to Controller before detaching generator. Use the following procedure to remove generator:

1. Remove generator end cover then lift AC and DC brushes off slip rings and commutator.
2. Remove four capscrews which hold generator frame to the fan housing on the engine.
3. Remove armature thru bolt then install standard puller and remove generator frame and end bracket as a unit.
4. To remove armature from tapered portion of engine crankshaft, reinstall thru bolt--turn into shaft about halfway then block or hold armature to prevent it from falling and tap end of this bolt sharply with steel hammer--this "bumps" the crankshaft sufficiently to detach armature from the taper.

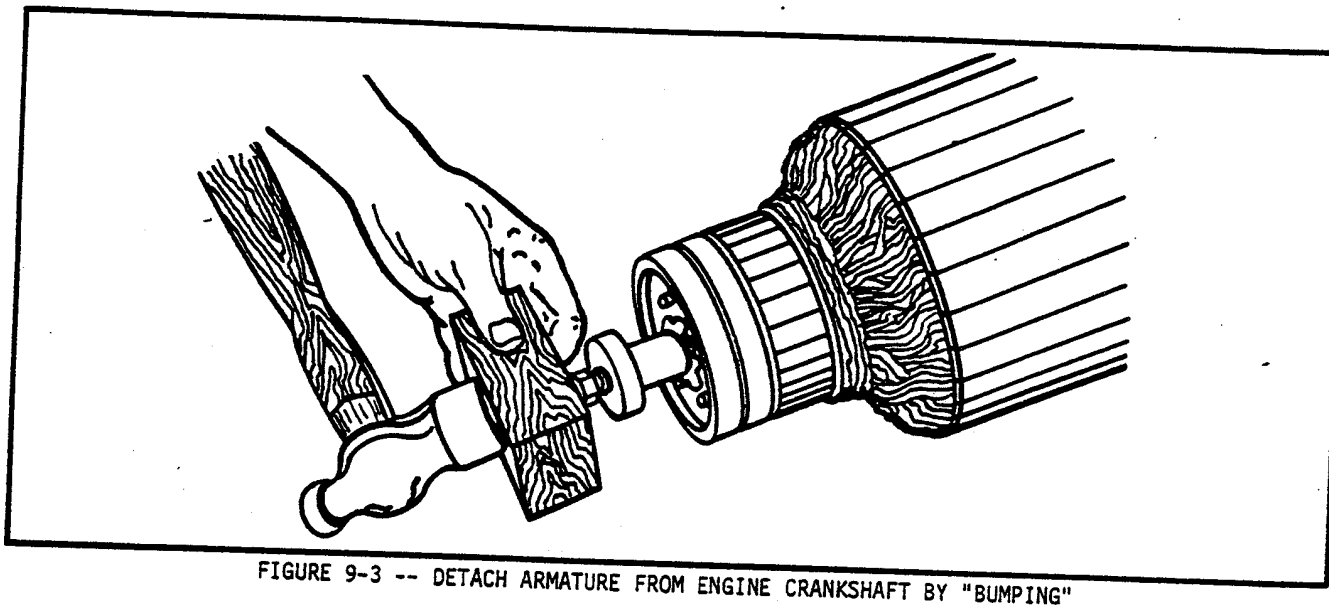


FIGURE 9-3 -- DETACH ARMATURE FROM ENGINE CRANKSHAFT BY "BUMPING"

RADIATOR: After draining cooling system, disconnect outlet hose, inlet hose, belt guard then remove two mounting bolts and detach radiator from frame or oil pan base.

GOVERNOR: Disconnect linkage at carburetor, remove two capscrews, slip governor out toward rear of engine.

CARBURETOR - AIR CLEANER: Disconnect automatic choke linkage and hose from valve cover then detach carburetor (with air cleaner attached) from flange on intake manifold.

FUEL PUMP: Disconnect fuel lines, fuel filter (if used) then detach fuel pump from crankcase.

MAGNETO: Remove high tension leads at spark plugs, remove two flange mounting capscrews then remove magneto.

OIL FILLER AND FILTER: Remove filler cap and disconnect oil filter and bracket (when used) from right side of crankcase. Remove dipstick, filler tube and oil gauge.

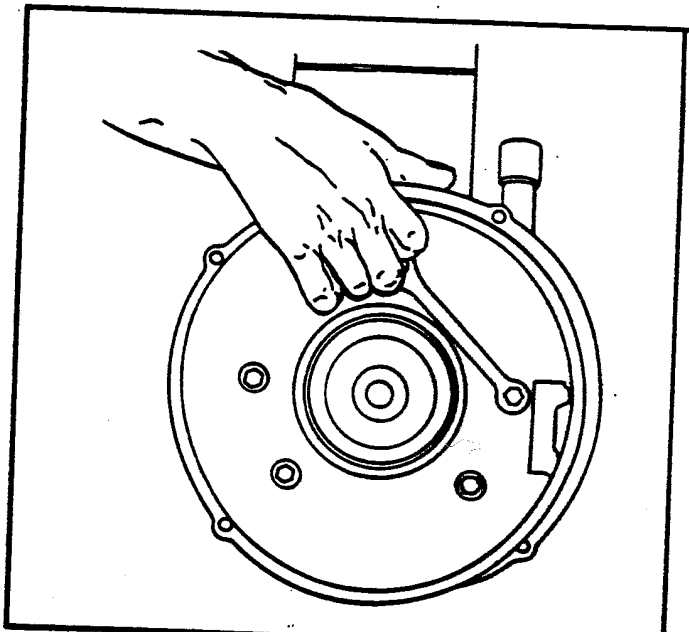


FIGURE 9-4 -- REMOVING GENERATOR SUPPORT (FAN HOUSING)

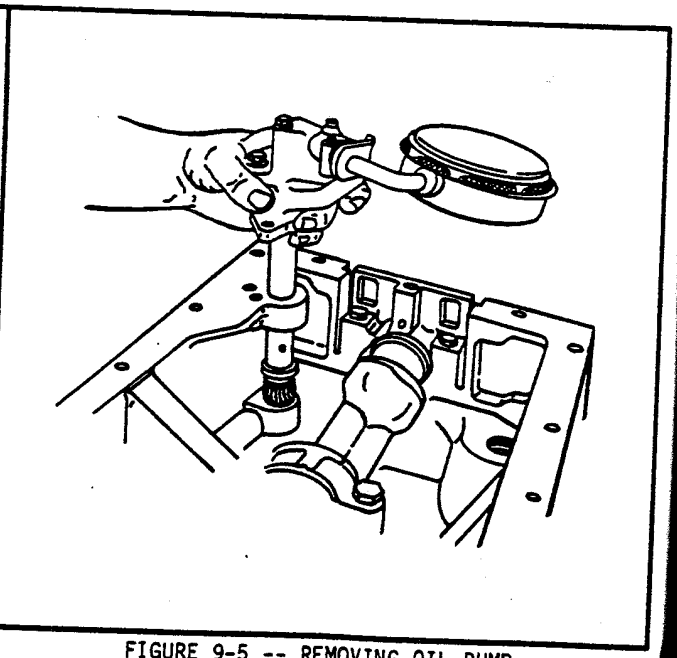


FIGURE 9-5 -- REMOVING OIL PUMP

MANIFOLDS: Detach automatic choke if manifold mounted type then remove exhaust manifold and intake manifold.

CYLINDER HEAD: Remove thermostat housing, thermostat, spark plugs then remove cylinder head bolts and head. Discard head gasket.

VALVES: Remove valve cover, then using spring compressor tool, compress springs to remove keepers then remove valve springs and valves--tag valves with cylinder number and do not mix valve parts as they are removed. If re-usable, these parts should be reinstalled in the same place as removed. Tappets cannot be removed until after the camshaft is removed.

GENERATOR SUPPORT: Remove five capscrews securing support to crankcase. Rear oil seal and retainer or trough will be removed along with generator support.

WATER PUMP: Remove four capscrews and detach water pump (with fan attached) from flange at front of crankcase.

GEAR COVER - GEARS: After removing crankjaw and belt drive pulley, remove capscrews around outer edges and on bottom flange of gear cover then separate cover from front support plate. Discard gasket. Slide front oil slinger off crankshaft then place block of wood between gear teeth to hold gears while the camshaft nut and cam gear are removed. The crank gear does not have to be removed in order to remove front support plate.

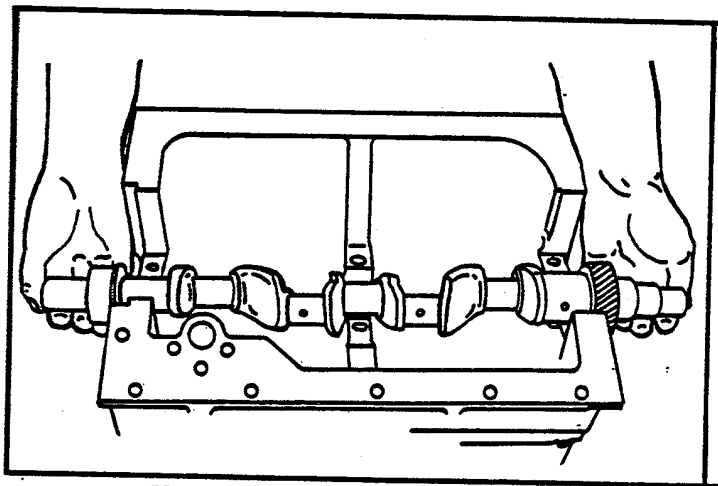


FIGURE 9-6 -- REMOVING CRANKSHAFT

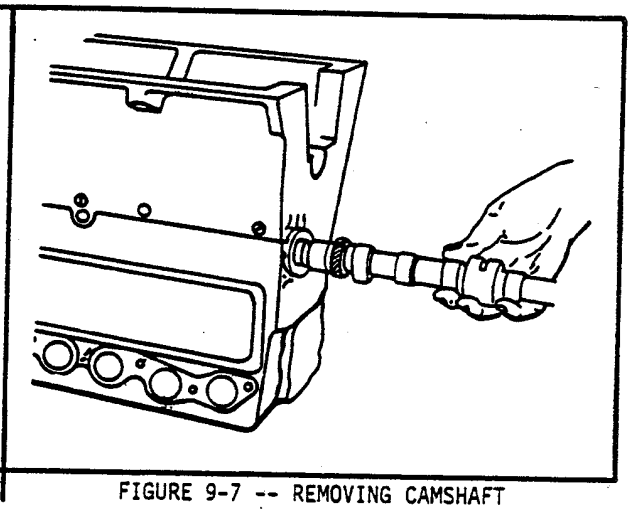


FIGURE 9-7 -- REMOVING CAMSHAFT

The idler gear rides on an anti-friction bearing which is, in turn, press fitted on a stub shaft in the gear cover. If the gear spins freely without any evidence of binding, etc., the ball bearing does not have to be replaced. To replace bearing, remove snap ring then slip gear off. Bearing is press fitted on shaft. Use press to remove and to reinstall new bearing.

CRANKCASE - OIL PAN BASE: Remove all oil pan to crankcase capscrews then carefully separate crankcase from base--tilt crankcase sideways off base to avoid damaging oil pick up screen.

OIL PUMP: Remove capscrews securing flanged portion of oil pump to the pad inside crankcase. Turn pump body from side to side as the gear extension is pulled free of bored alignment holes as these are closely fitted.

CRANKSHAFT: Remove safety wiring, remove capscrews then disconnect main and rod bearing caps from journals and crankpins--temporarily reinstall each rod cap on the connecting rod from which it was removed. Carefully lift crankshaft out of crankcase.

PISTONS - CONNECTING RODS: After crankshaft is removed, the piston - rod assemblies can be removed through bottom of cylinder bore in crankcase. If taken out through the top, a ridge reamer may have to be used to remove ridge created at the top of the cylinder.

CAMSHAFT: If cam gear is not worn or damaged, it does not have to be removed from camshaft. Push tappets away from camshaft then carefully guide camshaft out through front or gear end of block. Remove tappets through inside of crankcase after camshaft is removed--tag or mark tappets according to cylinder number.

RECONDITIONING PROCEDURE

All parts should be thoroughly cleaned--dirty parts cannot be accurately gauged or properly inspected for wear or damage. There are many commercial cleaners available that quickly remove grease, oil and grime accumulation from engine parts. If such a cleaner is used, make sure that all trace of the cleaner is removed before the engine is reassembled and placed in operation. Even small amounts of these cleaners quickly break down the lubricating properties of engine oils.

CYLINDER BLOCK

1. INSPECTION

A. Gasket Surfaces - Check all surfaces to make sure that they are free of gasket fragments. Surfaces must also be free of deep scratches or nicks.

B. Bearings - Whenever an engine is completely disassembled for overhaul, it is good practice to replace main and connecting rod bearings regardless of condition of old bearings. Service bearings are available in standard size plus .002", .010", .020", and .030" oversize sets. Select bearings according to the accompanying chart.

SERVICE BEARING SET	MAIN BEARING JOURNAL DIA.	CRANKPIN DIAMETER
Standard	1.998 - 1.999"	1.340 - 1.341"
.002"	1.996 - 1.997"	1.338 - 1.339"
.010"	1.988 - 1.989"	1.330 - 1.331"
.020"	1.978 - 1.979"	1.320 - 1.321"
.030"	1.968 - 1.969"	1.310 - 1.311"
Running Clearance	.001 - .0035"	.0004 - .0025"

Refer to Parts Manual for bearing number. Front and center main bearings are the same--rear main is not interchangeable with the others.

C. Bushings (Camshaft) - Check bushings for signs of scuffing, scoring and excessive wear. See Clearance Section for wear limits. Precision type bushings, which do not require line reaming, are available if replacement is necessary.

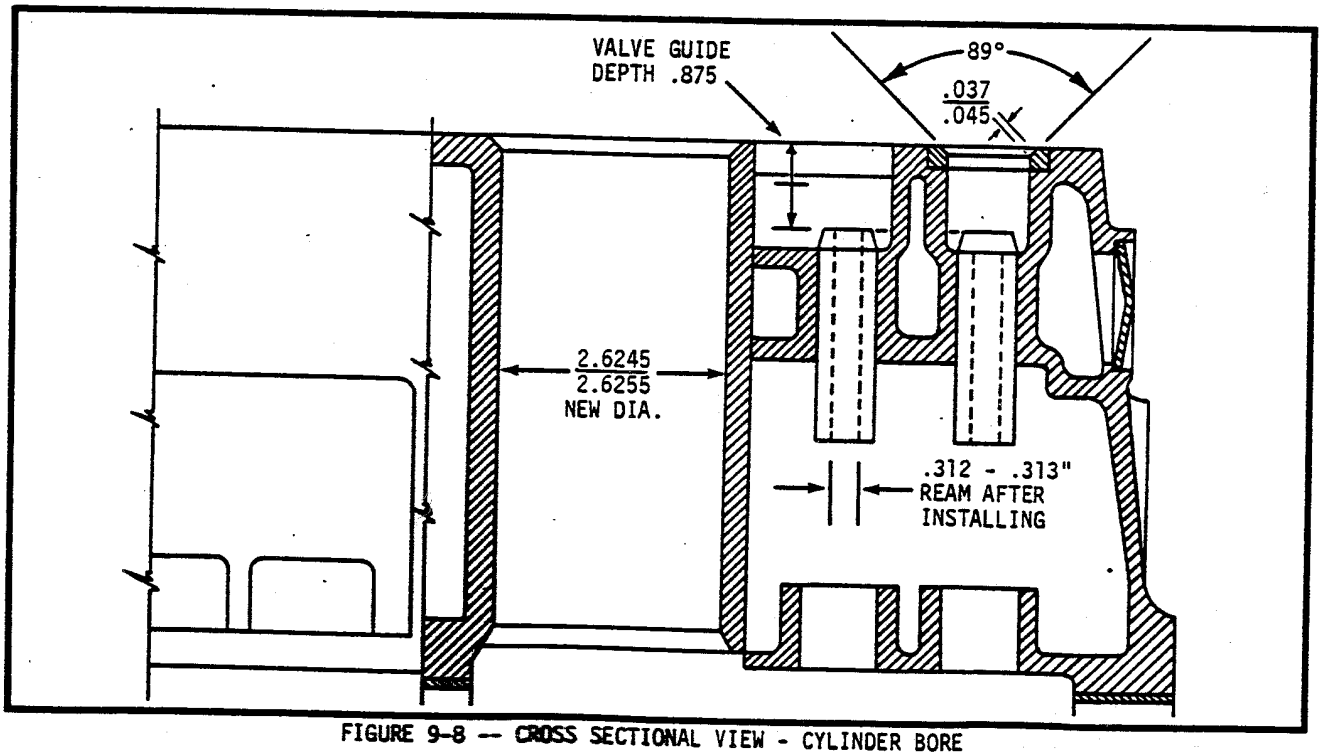


FIGURE 9-8 -- CROSS SECTIONAL VIEW - CYLINDER BORE

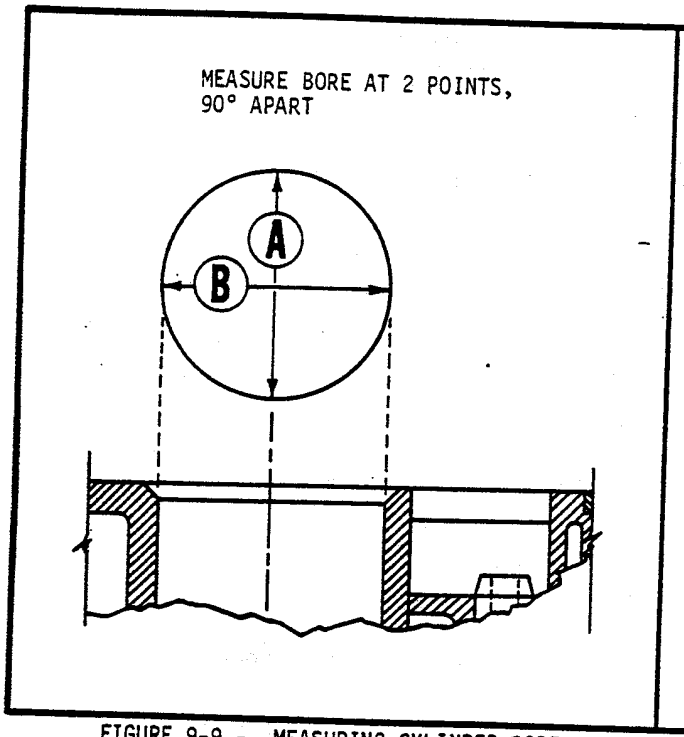


FIGURE 9-9 -- MEASURING CYLINDER BORE

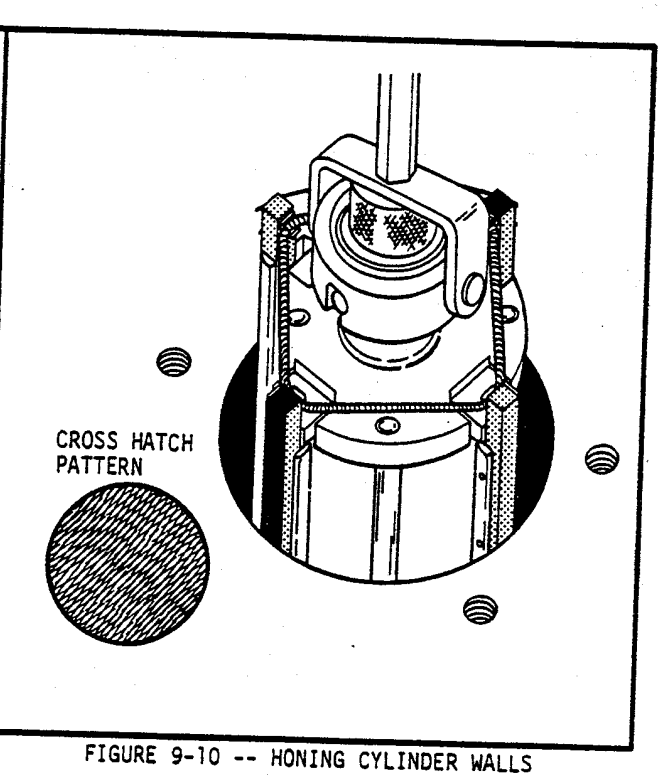


FIGURE 9-10 -- HONING CYLINDER WALLS

D. Cylinder Bore - If badly scored, excessively worn or tapered or out of round more than .005", reboring is necessary. Use an inside micrometer to determine amount of wear (See Fits and Clearance Section). If cylinder bore is not damaged and is within tolerances, only light deglazing may be necessary.

2. REBORING PROCEDURE - See Clearance Section for original cylinder bore size. Use an inside micrometer to measure wear then select nearest suitable oversize of either .010, .020 or .030". Reboring to one of these oversizes will allow usage of the available oversize piston and ring assemblies. While most commercially available cylinder hones can be used with either portable drills or drill presses, the use of a low speed drill press is preferred as this facilitates more accurate alignment of the bore in relation to the crankshaft crossbore. Reboring is best accomplished at drill speed of about 600 RPM. After installing coarse stones in hone, proceed as follows:

A. Lower hone into bore and after centering, adjust so that stones are in firm contact with walls. Diesel fuel oil or kerosene can be applied to the stones as a cutting-cooling agent.

B. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and begin honing process. Move hone up and down while reboring to prevent formation of cutting ridges. Check size frequently.

C. When bore is within .0025" of desired size, remove coarse stones and replace with burnishing stones. Continue with burnishing stones until within .0005" of desired size then use finish stones and polish to final size.

D. After reboring, carefully clean cylinder wall with soap and water, then after drying thoroughly, apply light coat of SAE 10 oil to prevent formation of rust.

CRANKSHAFT

Carefully inspect crankshaft for signs of excessive wear or damage. Look for metallic pickup or score marks on crankpin and main bearing journals. If keyways are badly worn or chipped, the crankshaft may have to be replaced. If journals and/or crankpins are worn beyond .002", regrind to the nearest undersize of .010, .020 or .030". Regrind .010" under on L654 and use .010" undersize rod. Use corresponding Service type main and connecting rod bushings on L600 or rod on L654 to attain correct running clearance.

PISTON - PISTON RINGS

Check pistons to see if they are within wear limits. Measure at thrust face and top of skirt. The thrust face is just below the oil control ring groove and is measured at right angles to the piston pin bore. Pistons may be reused if within limits (See Clearance Section) and there are no scuff or score marks. DO NOT reuse old rings--always replace with new set. Use the following procedure to replace rings:

STEP 1 - Use ring expander and remove old rings. Break old ring and use edge to clean up grooves--be careful not to scrape edges of grooves.

STEP 2 - Place each new ring in its approximate running area in cylinder (push down to proper depth with piston) then check end clearance.

STEP 3 - Install new rings on piston with ring expander. Position slotted oil control ring first, dull or black finish ring in middle groove and lighter or shiny ring in top groove. Check side clearance of rings in groove--replace rings if necessary only in a set, not individually.

PISTON - ROD ASSEMBLIES

Normally, very little wear takes place in the piston boss-piston area. If the original piston and connecting rod can be reused after reconditioning, the pin will usually not have to be replaced.

If the piston boss or connecting rod small end is worn beyond limits, use new piston-rod assembly rather than rework the old piston boss and connecting rod. A new piston pin should be used whenever a new connecting rod is used with the original piston. After checking pin, rod and piston boss to make sure proper clearances are available, assemble piston to rod with pin (light interference to loose fit) and lock pin with new retainers--make sure retainers are fully engaged in grooves.

CAMSHAFT - CAMSHAFT BUSHINGS

Inspect camshaft for evidence of excessive wear or damage. Replace camshaft if cams, bearing areas are grooved or worn beyond limits or if gear teeth (water pump drive) are chipped or damaged. Also check keyway for cam gear--replace camshaft if keyway is damaged. Position new key on camshaft and install cam gear--replace if looseness is detected.

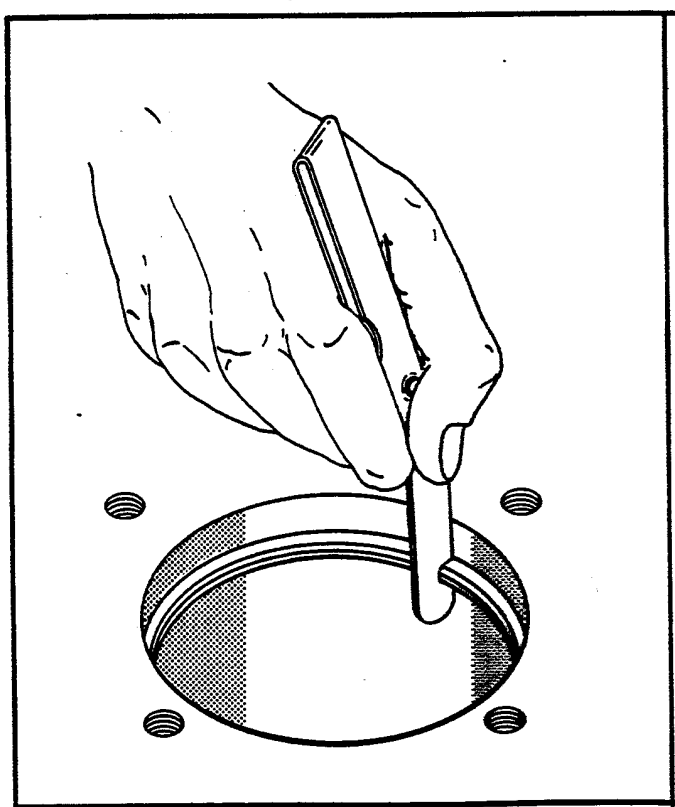


FIGURE 9-11 -- CHECKING RING END GAP

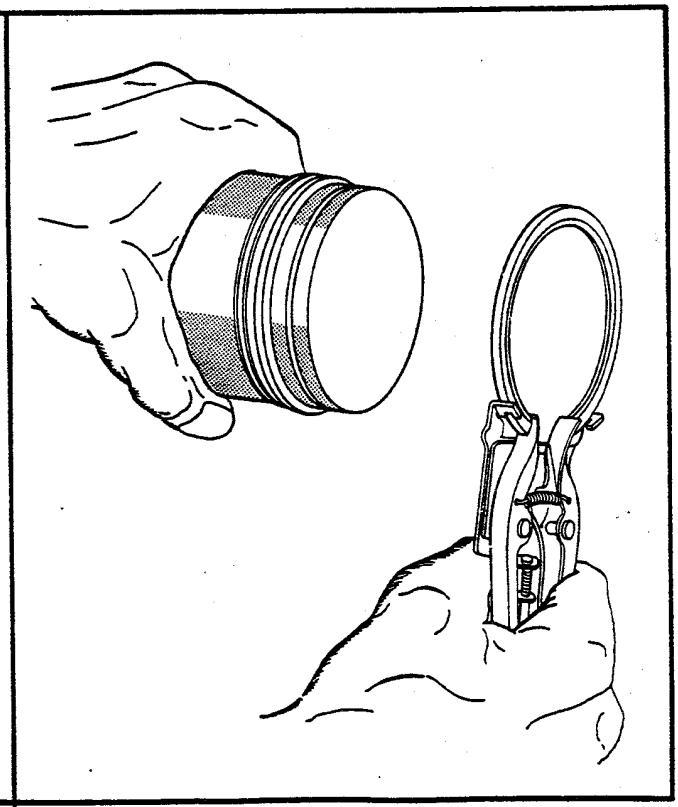


FIGURE 9-12 -- RING INSTALLATION SEQUENCE

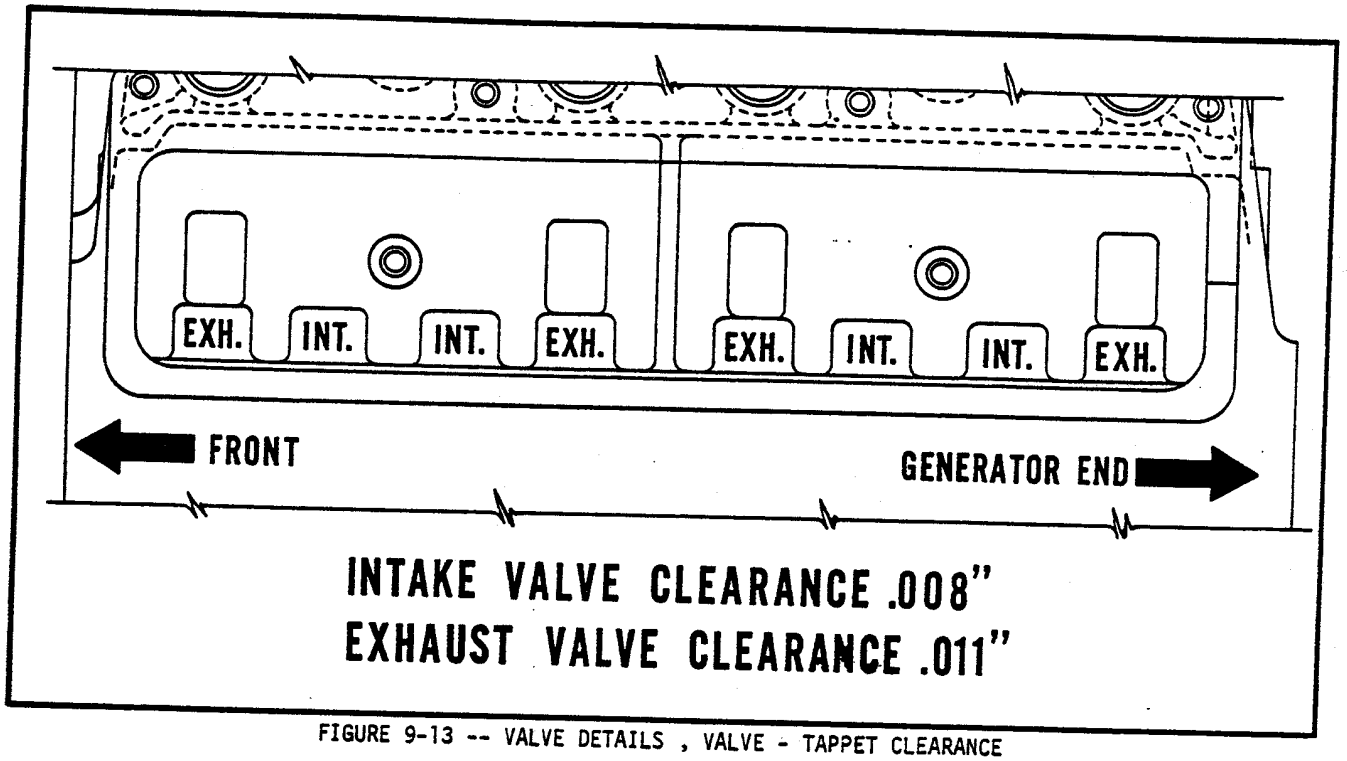


FIGURE 9-13 -- VALVE DETAILS , VALVE - TAPPET CLEARANCE

If bushings are grooved or worn beyond limits, replace with Service type bushings which do not have to be line reamed. Replace complete set of three. Rear and center bushings are identical--front bushing is not interchangeable with the others. Make sure oil holes line up after bushings are pressed into crankcase. Camshaft to bushing running clearance must be .0005 to .003".

VALVES - VALVE MECHANISM

Check valves, valve seats or inserts for signs of pitting, cracks or distortion. Also check condition of guides and clearance of valve stem to guides. Use the following procedure:

Guide: To remove worn or damaged guide, use rod with slightly smaller diameter and press guide down in to chamber until it falls free of the crankcase. Use Service guide for replacement. Service guides have larger OD to allow for metal scraped from crankcase when old guide is removed. Guides are originally reamed to .306" - .308" but must be re-reamed to .312" - .313" after they are installed in crankcase. Press guides to depth shown on accompanying valve detail drawings.

Valve and Valve Seats: Consult parts manual for correct valve numbers when replacing valves. Exhaust valves are hard faced. Intake valve seats are machined into block and exhaust valves on hardened seat inserts.

If valve seat insert is badly worn, warped, damaged or if seating surface is badly pitted, the insert must be replaced. Inserts are a tight press fit in the crankcase. A commercial valve seat removal tool is recommended for this job. Since removal causes loss of metal in the insert bore area, use only Kohler service replacement inserts for proper retention. Make sure service inserts are properly started and pressed evenly into bore to prevent cocking of the insert.

Seating surfaces should be held as close as possible to 1/32" width. Seats worn to more than 1/16" width must be reconditioned with 45° and 15° cutters to obtain proper width. Reground or new valves must be lapped in to provide proper fit. Use a hand valve grinder with suction cup for final lapping. Lightly coat valve face with "fine" grade of grinding compound then rotate valve on seat with grinder. Continue grinding until smooth surface is obtained on seat and on valve face.

Valve Clearance: Valve clearance must be checked after resurfacing and lapping in. Install valves in guides, rotate camshaft to position where cam has no effect on tappet. Clearance (cold) is shown above for intake and exhaust valves. Loosen adjusting screw, turn in or out until proper clearance is attained.

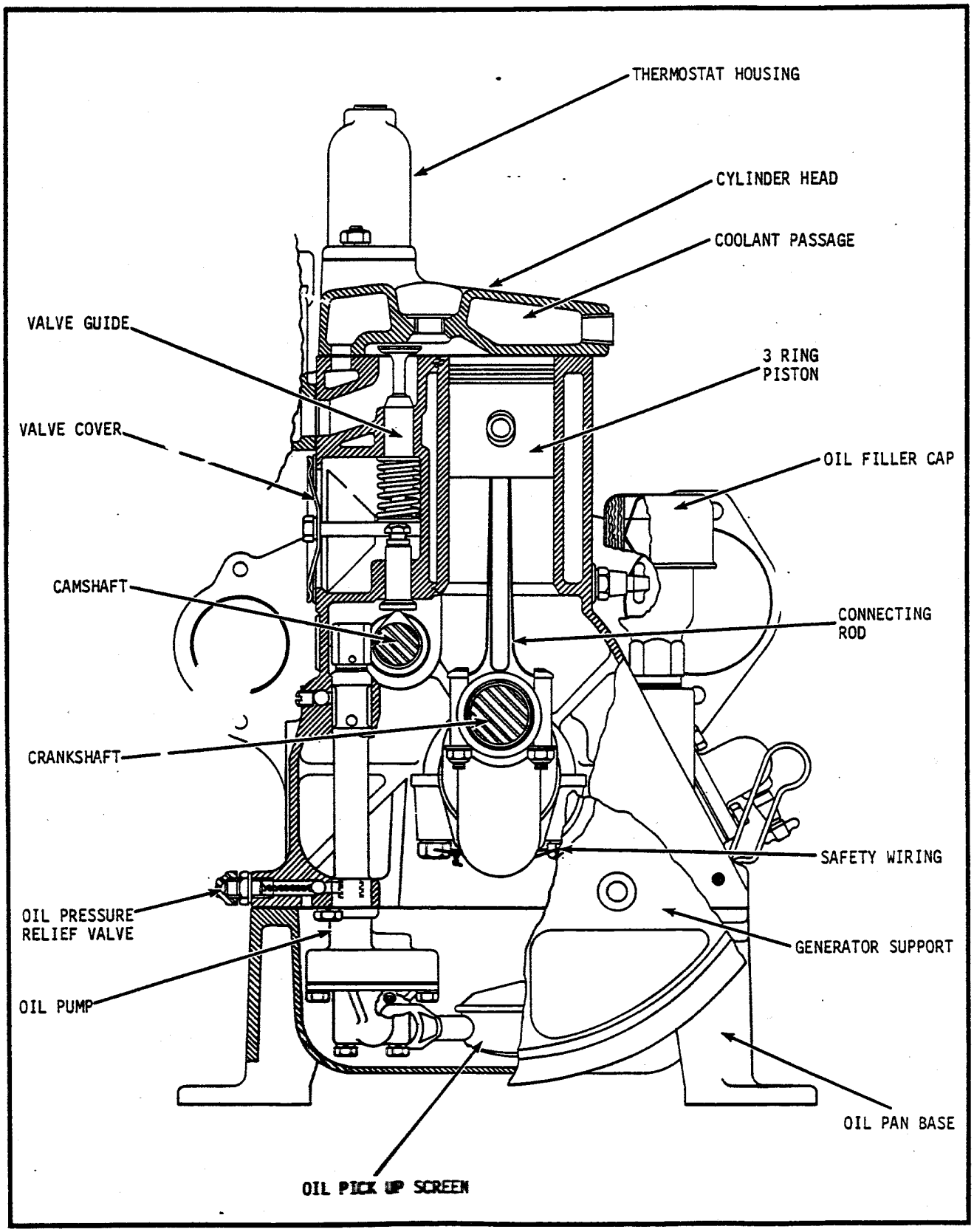


FIGURE 9-14 -- CROSS SECTIONAL VIEW OF ENGINE FROM GENERATOR END

REASSEMBLY

The following sequence is suggested for reassembling engine after components have been reconditioned and sub-assembly work, such as reinstalling bearings, guides, bushings, etc., has been completed. The procedure may be varied slightly to accommodate special equipment used on certain applications.

TAPPETS: Place crankcase on one side or upside down so that tappets will not fall then coat tappets with oil and insert each in tappet bore inside crankcase.

FRONT SUPPORT PLATE: Position new gasket then secure front support plate to crankcase with four capscrews around the camshaft opening.

CAMSHAFT: Oil camshaft then carefully guide camshaft through bushings and into position in crankcase. Camshaft end play is taken by a spring loaded plunger which is inserted in the hollow end of camshaft and rides against the inside of the gear cover. The spring and plunger are inserted just before the gear cover is reinstalled.

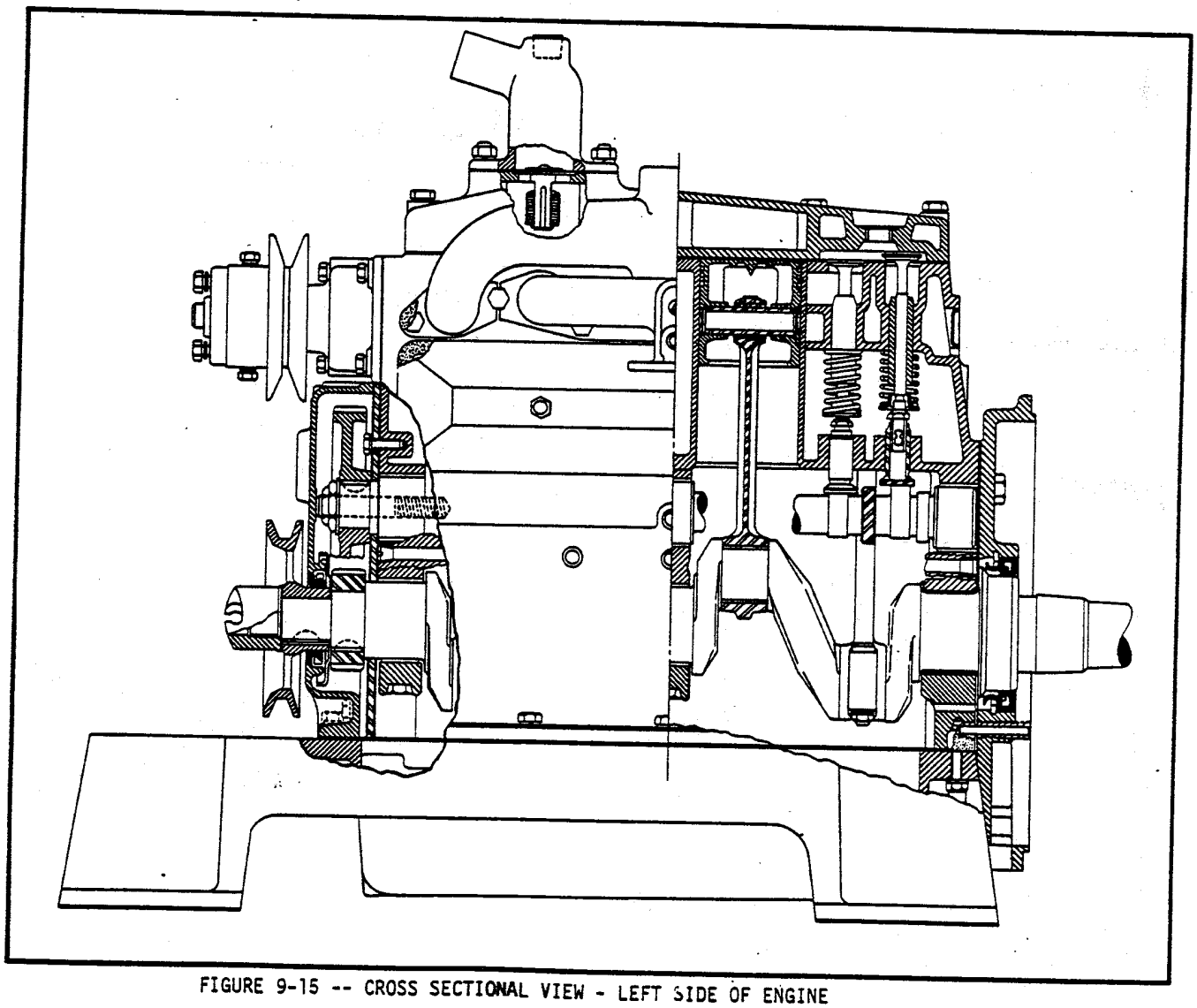


FIGURE 9-15 -- CROSS SECTIONAL VIEW - LEFT SIDE OF ENGINE

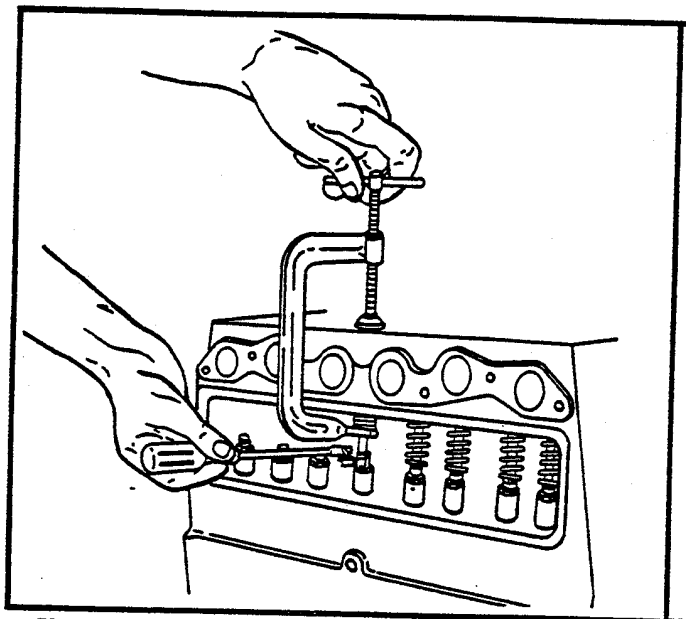


FIGURE 9-16 -- INSTALLING VALVES WITH COMPRESSOR

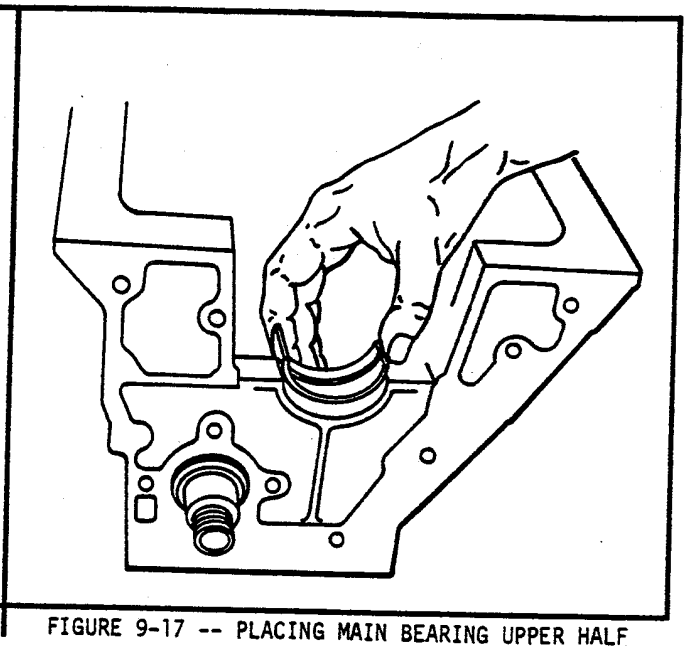


FIGURE 9-17 -- PLACING MAIN BEARING UPPER HALF

VALVES: Reinstall each valve to the seat to which it has been lapped in then place spring and spring guide and compress with spring compressor tool. Install taper lock then release compressor. Make sure intake and exhaust valves and springs are not mixed. Intake and exhaust valves are almost identical on the L600 although the exhaust valve head is slightly smaller in diameter. The valves are normally identified by IN or EX marking on the lower side of the valve head. Valve springs must remain tagged until installation to avoid mix up. Reinstall valve rotators in place of spring guides if these are used on exhaust valves. Stainless steel springs and rotators are generally used on marine plants.

CRANKSHAFT: Position main bearing upper halves in crankcase. Front and center main bearings are identical, make sure correct bearing is used for rear main. Align timing marks on cam and crankgears then carefully guide crankshaft into position on bearing in crankcase. Position bearing lower halves in caps and reinstall main bearing caps to crankcase. Tighten capscrews to 50 lbs. torque value then safety lock screws together with wire. Crankshaft end play is permanently established by thrust surfaces on main bearing caps and journals--adjustment is not required. Install cork gaskets on main bearing cap.

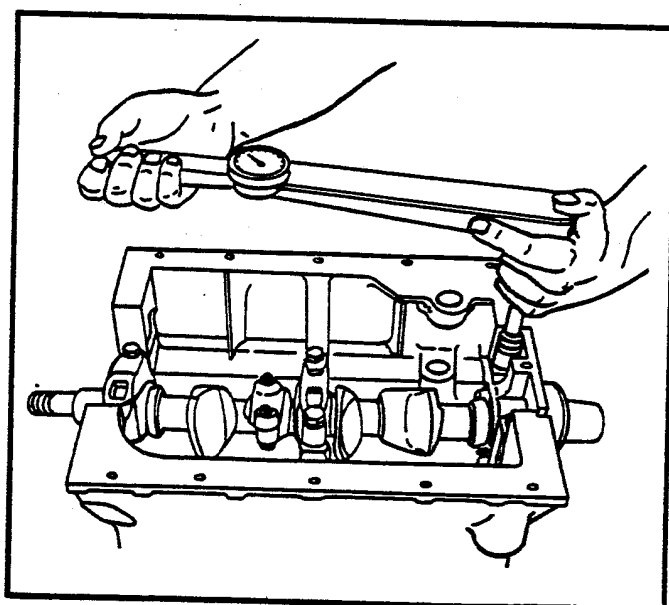


FIGURE 9-18 -- TIGHTEN BEARINGS TO PROPER TORQUE

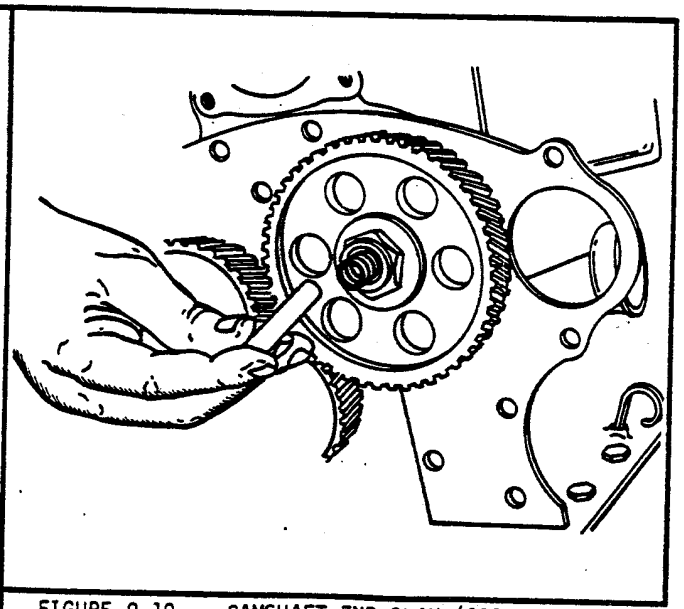


FIGURE 9-19 -- CAMSHAFT END PLAY (SPRING LOADED)

PISTON - ROD ASSEMBLIES: Separate rod caps from each assembly just before installing--be careful not to mix caps. Lightly oil cylinder bore, crankpins, bearings and piston rings. Rotate rings so that gaps are not in line. NOTE: When installing rods on L654 engine, make sure that the locating tabs, as shown below, are positioned on the side opposite the camshaft. Use ring compressor and install assemblies into cylinder bores--gently push each piston into bore with hammer handle--do not pound or force into position. Position rod bearings, turn crankshaft until bearing cap can be installed over crankpin then install cap (make sure match marks are aligned). Lubricate connecting rod bolts then install castle nuts and tighten each to 215 in. lbs. torque value. Repeat procedure until every piston assembly has been installed. Check crankshaft for freedom of rotation after all piston - rod assemblies have been installed.

OIL PUMP: With oil screen installed as shown in the accompanying illustration, lubricate oil pump shaft then twist pump slightly as it is installed through aligning holes in crankcase. Carefully guide oil pump gear into mesh with drive gear on camshaft then secure oil pump body to crankcase with two capscrews.

OIL PAN - GEAR COVER: Position new oil pan gasket then install and secure oil pan to crankcase. Before installing gear cover, insert end play spring and thrust plunger into hollow portion of camshaft.

Install oil slinger over crankshaft, position new cover gasket next to support plate then install gear cover. Carefully place cover over end of crankshaft to avoid damaging oil seal which is press-fitted into cover. After gear cover is secured, install pulley on crankshaft and secure with crankjaw or crankshaft retaining nut. Hold pulley with strap wrench while tightening nut.

GENERATOR SUPPORT: Place new gasket against crankcase then reinstall and secure generator support to crankcase. Carefully guide rear oil seal over crankshaft when installing generator support.

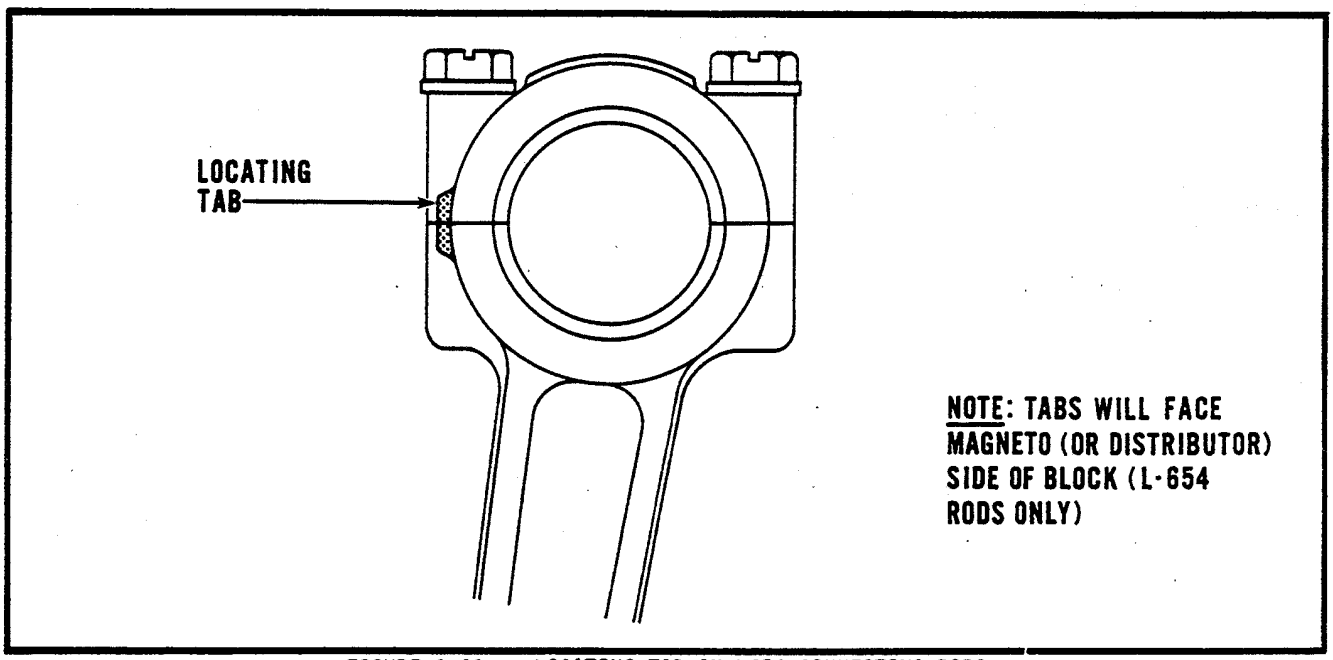


FIGURE 9-20 -- LOCATING TAB ON L654 CONNECTING RODS

CYLINDER HEAD - THERMOSTAT: With new head gasket properly positioned on crankcase, install cylinder head. Tighten capscrews in sequence and to the torque value shown on the accompanying cylinder head illustration. Reinstall new (or tested) thermostat, new gasket then secure thermostat housing.

ENGINE SYSTEM EQUIPMENT: At this time, reinstall and/or reconnect engine system equipment such as fuel pump, carburetor, oil filter (if used), magneto, governor radiator, etc. Refer to Service Section for installation adjustment and timing procedure wherever applicable. Reinstall generator and controller after other items have been reassembled.

RUN-IN RECOMMENDATIONS: After set is completely reassembled and initial adjustments are made, fill crankcase to proper level with a non-detergent type SAE 30 weight oil. Using non-detergent (or break-in oil if available) during the first five hours of operation will help seat piston rings on a rebuilt engine. Also place the engine under load from the very start as this will speed run-in process. Drain the non-detergent oil after the first five hours and replenish with Service MS oils of proper grade. Do not continue using non-detergent oil.

SPECIFICATIONS

FITS AND CLEARANCES

	L600	L654
COMPRESSION RATIO	6.5 to 1	6.5 to 1
CYLINDER BORE DIAMETER - NEW	2.6245-2.6255	2.6245-2.6255
CRANKSHAFT END PLAY	.002-.010	.002-.010
CRANKSHAFT - MAIN BEARING JOURNAL DIAMETER	1.998-1.999*	1.998-1.999
CRANKSHAFT - MAIN BEARING RUNNING CLEARANCE	.001-.0035	.001-.0035
CRANKSHAFT - MAIN BEARING THRUST CLEARANCE	.003	.003
CRANKSHAFT - CONNECTING ROD (CRANKPIN) JOURNAL DIAMETER	1.340-1.341**	1.340-1.341
CRANKSHAFT - CONNECTING ROD RUNNING CLEARANCE	.004-.0025	.001-.0025
CONNECTING ROD SIDE PLAY	.004-.010	.007-.016
CONNECTING ROD SMALL END DIAMETER (BUSHING IN PLACE)	.6877-.6880	Not Applicable
CONNECTING ROD - PISTON PIN FIT	.0003-.0008	.0005-.001
PISTON PIN TO PISTON FIT (INTERFERENCE TO LOOSE)	.0001 to .0003	Push Fit
PISTON CLEARANCE (THRUST FACE AND TOP OF SKIRT)	.002-.0035	.0013-.0038
PISTON RING SIDE CLEARANCE - TOP RING	.0015-.003	.002-.004
PISTON RING SIDE CLEARANCE - MIDDLE RING	.0015-.003	.002-.004
PISTON RING SIDE CLEARANCE - OIL RING	.001-.0025	.001-.003
PISTON RING END GAP	.007-.017	.007-.017
CAMSHAFT JOURNAL DIAMETER (ALL)	1.5775-1.5785	1.5775-1.5785
CAMSHAFT - CAMSHAFT BUSHING RUNNING CLEARANCE	.0005-.003	.0005-.003
CAMSHAFT END PLAY (SPRING LOADED - NOT MEASURABLE)	.000	.000
VALVE CLEARANCE - INTAKE (COLD)	.008	.008
VALVE CLEARANCE - EXHAUST (COLD)	.011	.011
VALVE STEM CLEARANCE IN GUIDE (INTAKE)	.001-.0025	.001-.0025
VALVE STEM CLEARANCE IN GUIDE (EXHAUST)	.0025-.004	.0025-.004
VALVE TAPPET CLEARANCE IN BLOCK	.0012-.0023	.0012-.0023
VALVE GUIDE - PRESS FIT IN BLOCK	.0005-.002	.0005-.002
VALVE SEAT INSERT (EXHAUST) PRESS FIT	.002-.004	.002-.004

* *Turning crankshaft mains to size "A" and using corresponding bearing will give running clearance of .001" to .0035".*

UNDER SIZE	(A) MAIN BEARING JOURNAL DIAMETER
Standard	1.998" to 1.999"
.002	1.996" to 1.997"
.010	1.988" to 1.989"
.020	1.978" to 1.979"
.030	1.968" to 1.969"

** *Turning crankpins to size "B" and using corresponding bearing will give running clearance of .0004" to .0025"*

UNDER SIZE	(B) CONN. ROD JOURNAL DIAMETER
Standard	1.340" to 1.341"
.002	1.338" to 1.339"
.010	1.330" to 1.331"
.020	1.320" to 1.321"
.030	1.310" to 1.311"

NOTE: Bearing undersizes shown for L600 only--on L654 use undersize connecting rod assembly. (.010 undersize available at present.)

GENERAL

ENGINE FIRING ORDER 1, 3, 4, 2

MAGNETO BREAKER POINT GAP (NOMINAL .015) .....013" - .017"

IGNITION TIMING ..... 16° BTDC

SPARK PLUG SIZE (STANDARD TYPE J8) ..... 14 mm

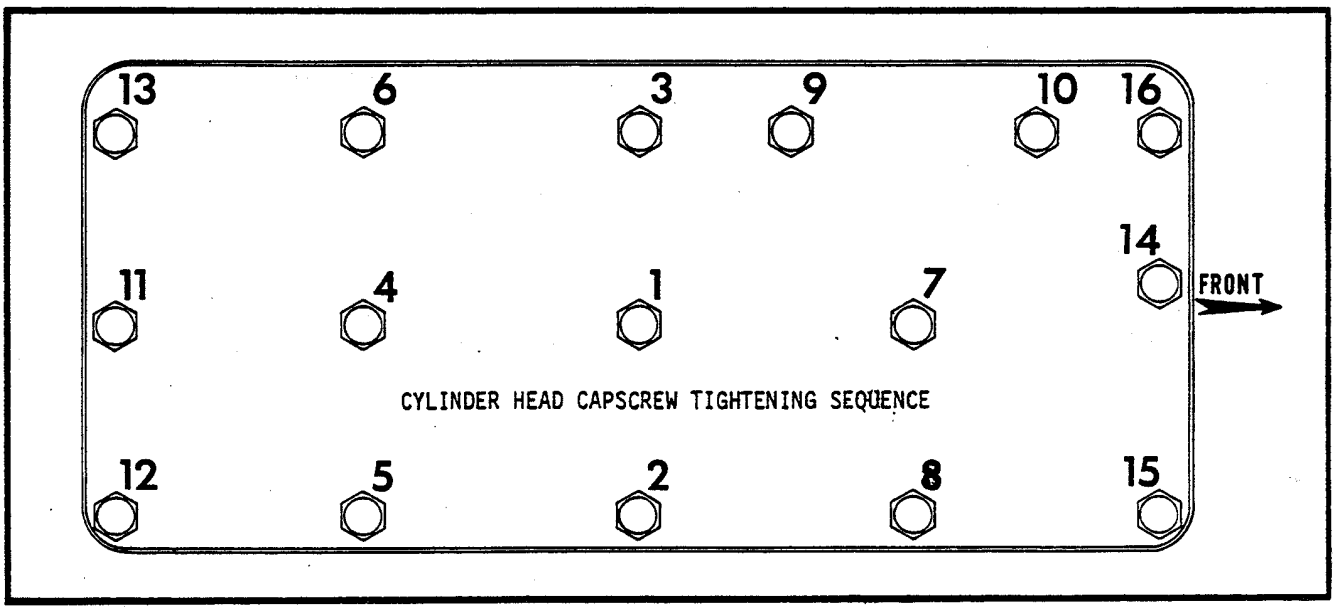
SPARK PLUG GAP - STANDARD, (GASOLINE) ..... .025"

SPARK PLUG GAP - (GASEOUS FUELS & SHIELDED) ..... .018"

TORQUE SPECIFICATIONS

ITEM	SIZE	TIGHTENING TORQUE
*SCREW, CONN. ROD	5/16	215 in. lbs.
*SCREW, CYL. HEAD	3/8	35 ft. lbs.
SCREW, MAIN BEARING	7/16	50 ft. lbs.
NUT, CAMSHAFT	7/8	40 ft. lbs.

* *Lubricate with oil at assembly.*



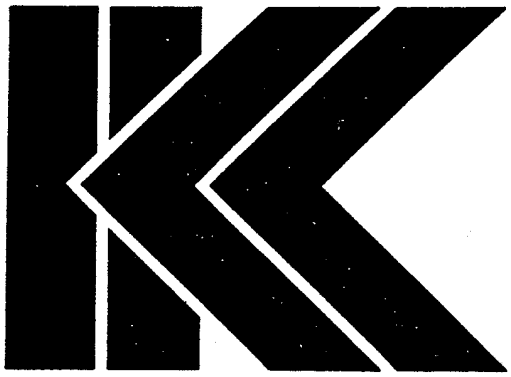
CYLINDER HEAD CAPSCREW TIGHTENING SEQUENCE

TORQUE VALUES -- STANDARD HARDWARE ITEMS

SIZE	TORQUE	SIZE	TORQUE
1/4 - 20	70 in. lbs.	1/2 - 13	50 ft. lbs.
1/4 - 28	85 in. lbs.	1/2 - 20	70 ft. lbs.
5/16 - 18	150 in. lbs.	9/16 - 12	75 ft. lbs.
5/16 - 24	165 in. lbs.	9/16 - 18	100 ft. lbs.
3/8 - 16	260 in. lbs.	5/8 - 11	110 ft. lbs.
3/8 - 24	300 in . lbs.	5/8 - 18	140 ft. lbs.
7/16 - 14	35 ft. lbs.	3/4 - 10	150 ft. lbs.
7/16 - 20	45 ft. lbs.	3/4 - 16	200 ft. lbs.

TORQUE VALUE -- CONVERSION TABLE (IN. LBS. - FT. LBS.)

FOOT LBS.	5	10	15	20	25	30	35	40	45	50
INCH LBS.	60	120	180	240	300	360	420	480	540	600



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