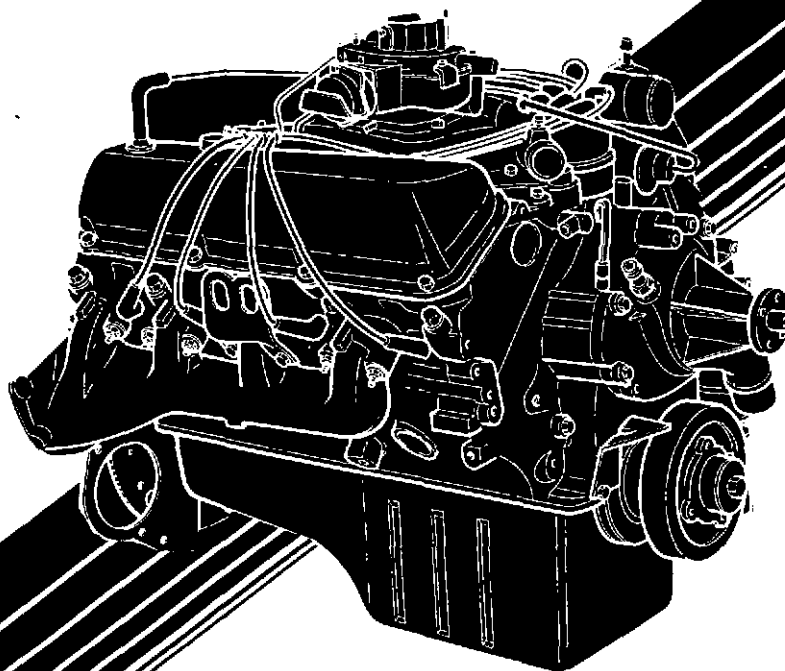


The Ford logo, featuring the word "Ford" in a stylized script font inside an oval.

**Power  
Products**

**7.5 LITER  
(460 CID)**



**INDUSTRIAL, MARINE  
AND IRRIGATION  
SERVICE MANUAL**

## Introduction

This Service Manual provides the Service technician with information for the proper servicing of the Ford 460 CID Industrial and Marine and Irrigation Engines.

In general, this manual covers the servicing of the engine and associated standard equipment. In many cases, engines are supplied with accessories and equipment that are unique to the application. If service information is ever required on such unique accessories or equipment it is suggested that the Industrial Engine Operations of Ford Motor Company be contacted. The proper information will either be forwarded or the Service Technician will be advised where it can be obtained.

The information in this manual is grouped in sections according to the type of work being performed. The various sections are indicated in the Index. In addition, each section is subdivided to include topics such as diagnosis and testing, cleaning and inspection, overhaul, removal and installation procedures, disassembly and assembly procedures, and service specifications.

FORD MOTOR COMPANY  
INDUSTRIAL ENGINE OPERATIONS  
FORD PARTS AND SERVICE DIVISION  
300 RENAISSANCE CENTER  
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DETROIT, MICHIGAN 48243

*The descriptions and specifications contained in this manual were in effect at the time the book was released for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design, without notice and without incurring obligation.*

## 460 CID INDUSTRIAL AND MARINE ENGINES

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### Part 1 Basic Engine

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### INDUSTRIAL AND IRRIGATION IDENTIFICATION

An Identification Decal (Figure 1) is affixed to each engine. The decal contains the engine serial number which identifies this unit from all others. Next is the engine displacement which determines the engine specifications, then the model number and S.O. or special options which determines the parts or components required on this unit. Use all the numbers when seeking information or ordering replacement parts for this engine.

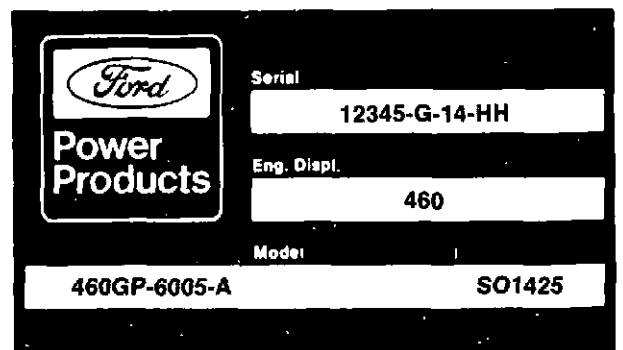


FIG. 1 Identification Decal-Industrial and Irrigation — Typical

### MARINE IDENTIFICATION

All Marine Engines have a white tape engine code label located on the front of the left rocker arm cover. A typical label and an explanation of the codes are shown in Figure 2.

If this tag is destroyed or painted over, it will be very

difficult to distinguish between the various levels of engines; that is, for example, to distinguish between the 460 standard output and low output or even standard rotation versus reverse rotation.

#### DENOTES PLANT SOURCED TO PRODUCE ENGINES

- D — DEARBORN ENGINE PLANT
- L — LIMA ENGINE PLANT
- C1 — CLEVELAND ENGINE PLT 1
- C2 — CLEVELAND ENGINE PLT 2
- W1 — WINDSOR ENGINE PLT 1
- W2 — WINDSOR ENGINE PLT 2
- C — OHIO TURBINE PLANT

#### BASIC MARINE ENGINE CODE NUMBER

- 1973**
- J880A 460-4V (STD.)
- J891A 460-4V (REV.)
- J880B-61 460-4V (STD.) SKI-BOAT
- 1974**
- 4C525LO 460-4V (STD.)
- 4C524LO 460-4V (REV.)
- 4C523BLO 460-4V (STD.) SKI-BOAT
- 1975**
- 5C525AA 460-4V (STD.)
- 5C524AA 460-4V (REV.)
- 5C523BAA 460-4V (STD.) SKI-BOAT
- 1976**
- 6C525AA 460-4V (STD.)
- 6C524AA 460-4V (REV.)
- 6C523BAA 460-4V (STD.) SKI-BOAT
- 1977**
- 7C525AA 460-4V (STD.)
- 7C524AA 460-4V (REV.)
- 7C523BAA 460-4V (STD.) SKI-BOAT



ENGINE BUILD DATE

"A TO M" MONTH — A IS JANUARY AND M IS DECEMBER.  
 SECOND LINE 123 IS TEN DIGIT OF DAY OF MONTH  
 THIRD LINE 1 TO 0 IS ONE DIGIT OF DAY OF MONTH  
 CORRECT LETTER OR DIGIT IS "MARKED-OUT":  
 TO INDICATE BUILD DATE

SERVICE LEVEL  
 (CHANGES WHEN COMPONENTS  
 ARE CHANGED WHICH AFFECT  
 INTERCHANGEABILITY.)

FIG. 2 Marine Identification Decal — Typical

## DESCRIPTION AND OPERATION

The 460 V-8 engine is a lightweight cast iron design with a bore of 4.36 inches and a stroke of 3.85 inches. Piston displacement is 460 cubic inches and the compression ratio is 8.5 to 1.

### MANIFOLDS

The cast iron intake manifold is an exhaust gas heated design with eight mounting bolts per side. Coolant is discharged from the engine through the outlet housing at the right front of the intake manifold.

The intake manifold contains two sets of air-fuel mixture passages which have round ports. All passages are of nearly equal length to assure more even mixture distribution to the cylinders. The upper set of passages feeds cylinders 1, 4, 6 and 7 from the right primary and secondary bores of the carburetor. Exhaust gases flow through the crossover passage below the carburetor mounting pad to provide the initial heat for vaporization of the air-fuel mixture.

Filtered air for use in automatic choke is heated in a heat chamber at the crossover passage of the intake manifold. This air is drawn from the air cleaner through the air inlet tube, and is directed to the automatic choke through the air outlet tube.

The cast iron exhaust manifolds are the conventional runner type. The hot and cold air intake shroud is mounted on the right exhaust manifold. Two engine lifting brackets are incorporated with the exhaust manifolds.

### CYLINDER HEADS

Cylinder head assemblies have rail type rocker arms individually mounted on threaded studs. Combustion chambers are cast in an advanced wedge (quench) design with more rounded contours. Valves are canted at angles so their heads will conform to these contours. Intake and exhaust ports are round in cross section. The valve arrangement from front to rear is E-I-E-I-E-I-E-I for the left cylinder head, and I-E-I-E-I-E-I-E for the right cylinder head.

The cylinder head gasket used on all marine engines is the asbestos binder-type with a stainless steel core and should be installed dry, that is, without any sealer.

### CYLINDER BLOCK

The cast iron cylinder block is a skirtless design with five main bearings. All oil passages are closed with pipe plugs. Main bearings are of intermediate copper-lead material with an oil groove only in the upper half. Crankshaft end thrust is controlled by the flanges of the center main bearing.

Cylinders are numbered from front to rear with 1 through 4 on the right bank and 5 through 8 on the left bank. Firing order is 1-5-4-2-6-3-7-8. Each slipper skirt autothermic piston has two compression rings and an oil control ring. The upper compression ring has a moly-filled groove and the lower compression ring has a scraper groove. The oil control ring assembly consists of a stainless steel expander spacer separating chrome-plated steel rails. Pressed-in piston pins and strap-type caps with overplated copper-lead alloy bearings are used with the connecting rods.

All 460 marine engines are available in either standard or reverse rotation, except for the "Ski Boat." The 460 Ski Boat engine is standard rotation only. The firing order is different between reverse and standard rotation. Standard rotation is 1-5-4-2-6-3-7-8. Reverse rotation is 1-8-7-3-6-2-4-5.

Two crankshaft assemblies are used on marine engines depending upon whether the engine is standard or reverse rotation. The knurling must throw oil toward the slinger.

A two-piece split lip-type rear oil seal is used for service on marine engines. They are color coded, yellow for use with a standard rotation crankshaft and red for use with a reverse rotation crankshaft.

The 460 engines have cast pistons with the notch, for assembly.

The cylinder front cover is die cast aluminum. The standard marine 460 engines use a cast iron front cover while the "Ski Boat" engines use the aluminum front cover. Mounted on it are the water pump (all marine engines except the 460 "Ski Boat" engine use a marine bi-rotational water pump with a stainless steel external bypass tube, left hand water inlet, and no heater inlet. The "Ski Boat" engine uses a standard automotive water pump) with bonded ceramic seal contact face. The oil pump is mounted at the lower left front of the block and is driven by the distributor through an intermediate 5/16 inch hex driveshaft.

### VALVE TRAIN

The camshaft is supported by five bearings pressed into the block. It is driven at one-half crankshaft speed by the timing chain and sprockets. The camshaft sprocket is positioned by a dowel in the forward face of the front camshaft bearing journal. Camshaft end play is controlled by a thrust plate attached to the front of the cylinder block. An eccentric cam for fuel pump actuation is attached to the front face of the sprocket. A helical accessory drive gear is machined in the camshaft directly behind the front journal to drive the distributor and oil pump. (There are two camshafts available for the 460 marine engines depending upon whether the engine is standard rotation or reverse rotation. The camshaft for the standard rotation engine can be identified by a white color band painted on the body diameter between the gear and the number one intake cam lobe. There is no color code used on the reverse-rotation camshaft.)

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which actuate the valve train. Two types of hydraulic valve lifters are used in the 460 V-8 engines. Although both types may be used interchangeably in an engine, their component parts are not interchangeable. Type II hydraulic valve lifters have three circumferential ribs on the barrel near the oil hole, while Type I hydraulic valve lifters have no ribs in that area. In a Type II lifter, an upper metering valve retainer with a tensioning finger is used. The metering valve in a Type I lifter is flat.

When a valve is closed, the related push rod is in its lowest position and the lifter assembly is on the base circle of the cam lobe. The valve lifter plunger spring expands, forcing the plunger upward. This force is transmitted to the rocker arm through the push rod, causing solid contact between the valve end of the rocker arm and the valve stem.

As the valve lifter plunger spring expands to move the plunger upward, the volume of the compression chamber in the bottom of the lifter body is increased. Oil, supplied at full lubrication system pressure through the oil gallery passages in the cylinder block unseats the disc type check valve in the bottom of the lifter and enters the compression chamber to fill the increased volume. The check valve closes when the chamber is filled.

As the camshaft rotates, the lifter body is raised by the cam lobe. The oil in the compression chamber, being incompressible, acts as a solid member and transfers the lifting force to the plunger and push rod. Because of the load imposed on the plunger by the push rod, the oil in the compression chamber is subjected to increased pressure. This causes a slight leakage out of the chamber past the walls of the plunger. The leakage flow is known as the calibrated

leak-down rate and is controlled by precise matching of valve body and plunger during original assembly of the valve lifter. Consequently, individual hydraulic valve lifter components are not interchangeable.

When the high point of the cam rotates past the foot of the valve lifter body, the lifter is forced downward by the push rod as the valve (intake or exhaust) returns to its seat in the cylinder head. This reduces the force on the lifter plunger and allows the plunger to be raised once again by the plunger spring. Engine oil is forced into the compression chamber to replace that which leaked out, priming the lifter for its next operating cycle.

Hydraulic force and plunger spring action in the valve lifter take up all clearances in the valve train mechanism to maintain zero valve lash.

The push rods are tubular steel with ball ends. Each push rod receives oil from a disc-type metering valve in the push rod cup at the top of the valve lifter. The oil enters and leaves the push rod through holes in both ball ends to independently lubricate each rocker arm.

The rail type rocker arms each have a hole in their push rod end for lubrication. Each rocker arm is individually mounted on a stud that is threaded into the cylinder head. The rocker arm pivots on a spherical fulcrum seat on the stud. A nut retains the rocker arm and fulcrum seat on the stud, and provides a means of adjusting valve clearance.

Intake valves are of forged alloy steel. Exhaust valves are of cast austenitic steel. (Marine engines use heavy duty valves with chrome plated stems. Both intake and exhaust valves are the free turning type. The valves of all engines except the low output version use valve spring dampers. Valves with oversize stems are available for all marine engines.) All valves have chromed stems and tips. Because the valves are canted, they open obliquely into the combustion chambers, in the direction of gas flow, to improve engine breathing. Pockets are cast in the piston heads to provide clearance at top dead center for full valve opening.

## LUBRICATION SYSTEM

Oil from the bottom of the sump in the front of the oil pan is drawn into the oil pump through the pump inlet tube and screen assembly. The positive displacement rotor type oil pump is driven by an intermediate drive shaft from the distributor. The pump forces the oil through the engine's lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure, returning any excess oil flow to the intake side of the pump.

The pressurized oil flow from the pump passes through a Motorcraft full-flow, two-stage oil filter before it enters the engine lubrication galleries. A relief valve in the filter permits oil to bypass the filter if the high capacity element becomes clogged.

From the filter, the oil flows through a passage to the right main oil gallery. Before reaching the right main oil gallery, some oil is diverted into a narrower vertical cross passage leading up to the No. 1 camshaft bearing and down to the No. 1 main bearing. Oil from the top of the cross passage flows through the oil hole in the camshaft bearing to lubricate the bearing surfaces. Some oil is conveyed through a groove in the bearing to a passage that lubricates the distributor shaft pilot bearing. The rest of the oil is squeezed out between the front and rear edges of the camshaft bearing and journal. Oil from the front of the bearing is directed through slots in the hub of the camshaft sprocket and drips onto the timing chain and fuel pump eccentric cam for lubrication. It then drains into the forward end of the oil pan.

Oil reaching the No. 1 main bearing from the lower end of the vertical cross passage lubricates the front crankshaft journal. A groove in the upper bearing half conveys oil to a lengthwise notch formed in the ends of the bearing shell, from where the oil is discharged. Oil coming out of the front of this notch drips onto the crankshaft sprocket and timing chain for lubrication, then drains into the forward end of the oil pan.

Oil in the right main oil gallery is routed to the main bearings, the hydraulic valve lifters for the right cylinder bank of the engine, and through a crossover passage to the left main oil gallery which supplies the hydraulic valve lifters for the left cylinder bank of the engine. A passage at the rear of the right main oil gallery leads to the sending unit for the low oil pressure warning light on the instrument panel.

Oil passages are drilled in the cylinder block from each main bearing to the camshaft bearing above it. After lubricating the camshaft bearings, the oil drains into the oil pan.

In addition to supplying oil for the camshaft bearings, the main bearing lubrication system also lubricates the connecting rod bearings through grooves in the upper halves of the main bearings and passages drilled in the crankshaft.

Oil enters each hydraulic valve lifter when the valve is closed and the oil hole in the lifter is exposed to the oil gallery passage. The oil is then metered through the disc valve in the head of the lifter and into the tubular push rod. From the upper end of the push rod, the oil is discharged into a hole drilled in the rocker arm to lubricate the upper valve train bearing areas. The oil returns to the oil pan through drain back holes at each end of the cylinder heads and cylinder block. A reservoir in each valve lifter bore retains oil for immediate valve lifter lubrication as the engine is started.

The level of the engine oil in the crankcase is indicated on a dipstick inserted in a tube extending downward and slightly rearward from the top right side of the cylinder front cover. The lower portion of the dipstick enters the surface of the oil supply near the right front corner of the oil pan.

## POSITIVE CRANKCASE VENTILATION SYSTEM

The 460 V-8 engine has a closed type, positive ventilation system. This system draws blow-by vapors from the crankcase and discharges them into the intake manifold to be burned in the combustion chambers of the engine, eliminating a major source of engine oil contamination. The closed positive crankcase ventilation system also prevents the discharge of any crankcase fumes to the atmosphere, as an air pollution control measure.

Ventilating air, taken from the carburetor air cleaner, flows through a hose to the oil filler cap on the front of the left valve rocker arm cover. The oil filler cap contains a filtering element which cleans the incoming air. The filter element and the narrow hose fittings slightly restrict air flow to help maintain a small vacuum in the crankcase when the engine is operating. The oil filler cap is sealed at the filler opening to prevent the entrance of atmospheric air.

From the oil filler cap, the air enters the left rocker arm chamber. Then it moves down past the push rods into the crankcase and also into the timing chain chamber. From these spaces, the ventilating air flows to the rear of the crankcase and up to the rear section of the right valve rocker arm cover, sweeping any combustion by-product fumes along with it. The vapor-laden air enters a spring-loaded regulator valve in the top rear portion of the right valve rocker arm cover. This "jiggle pin" valve regulates the amount of airflow to meet changing operating conditions. The air is then drawn to the intake manifold through the crankcase vent hose and the carburetor spacer passage.

The regulator valve operates by sensing intake manifold vacuum through the carburetor spacer passage and crankcase vent hose. At idle, intake manifold vacuum is high, overcoming the pressure of the valve spring. The valve "jiggle pin" moves to the low-speed operation position where only a minimum of ventilating airflow passes between the valve pin and outlet port in the valve body. As manifold vacuum decreases with an increase in engine speed and/or power output, the spring forces the pin to the full open position to increase the flow of ventilating air.

### CARBURETORS

The 460 engines use either a Holley Model 4150 or Model 4160 carburetor. (The 460 low output marine engines use a

Holley Marine Model 4160 carburetor while the 460 Standard Marine and "Ski Boat" engines use a Holley Marine Model 4150C carburetor with a center pivot float bowl design.)

### DISTRIBUTORS

The 460 Industrial engines use a dual advance distributor. All 460 marine and irrigation engines use a Prestolite centrifugal advance distributor.

## DIAGNOSIS AND TESTING

### CAMSHAFT LOBE LIFT

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove the air cleaner. Remove valve rocker arm cover.
2. Remove the valve rocker arm shaft assembly(ies) and install a solid, tappet-type push rod in the push rod bore of the camshaft lobe to be checked or use the adapter for ball end push rods shown in Figure 3.
3. Make sure the push rod is in the valve lifter socket. Install a dial indicator so that the actuating point of the indicator is in the push rod socket (or the indicator ball socket adapter is on the end of the push rod) and in the same plane as the push rod movement.
4. Connect an auxiliary starter switch in the starting circuit. Crank the engine with the ignition switch OFF. Bump the crankshaft over until the tappet or lifter is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position.
5. Zero the dial indicator. Continue to rotate the crankshaft slowly until the push rod is in the fully raised position.
6. Compare the total lift recorded on the indicator with specifications.
7. To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. **If the lift on any lobe is below specified wear limits, the camshaft and the valve lifters operating on the worn lobe(s) must be replaced.**
8. Remove the dial indicator and auxiliary starter switch.
9. Install the rocker arm shaft assembly as detailed under Removal and Installation.
10. Install the valve rocker arm cover and the air cleaner.

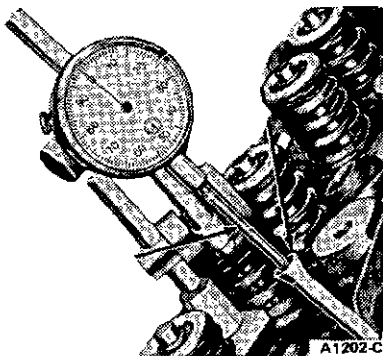


FIG. 3 Typical Camshaft Lobe Lift Hydraulic Valve Lifters — V-8 Engines

### COMPRESSION TEST

#### COMPRESSION GAUGE CHECK

1. Be sure the crankcase oil is of the correct viscosity and make sure that the battery is properly charged. Operate the engine for a minimum of 30 minutes at 1200 rpm, or until the engine is at normal operating temperature. Turn the ignition switch off; then remove all the spark plugs.
2. Set the carburetor throttle plates in the **wide open position**.
3. Install a compression gauge in No. 1 cylinder.
4. Install an auxiliary starter switch in the starting circuit. Using the auxiliary starter switch, crank the engine (with the ignition switch OFF) at least five compression strokes and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat the test on each cylinder as was required to obtain the highest reading on the No. 1 cylinder.

#### TEST CONCLUSION

The indicated compression pressures are considered normal if the lowest reading cylinder is within 75% of the highest. Refer to the following example and Figure 4.

Seventy-five percent of 140, the highest cylinder reading, is 105. Therefore, cylinder No. 7 being less than 75% of cylinder No. 3 indicates an improperly seated valve or worn or broken piston rings.

If one or more cylinders read low, squirt approximately one (1) tablespoon of engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, the piston rings are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on the pistons does not increase the compression, the cause may be a cylinder head gasket leak between the cylinders. Engine oil and/or coolant in the cylinders could result from this problem.

It is recommended that the following quick reference chart be used when checking cylinder compression pressures. The chart has been calculated so that the lowest reading number is 75% of the highest reading.

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	174	131	214	160
136	102	176	132	216	162
138	104	178	133	218	163
140	105	180	135	220	165
142	107	182	136	222	166
144	108	184	138	224	168
146	110	186	140	226	169
148	111	188	141	228	171
150	113	190	142	230	172
152	114	192	144	232	174
154	115	194	145	234	175
156	117	196	147	236	177
158	118	198	148	238	178
160	120	200	150	240	180
162	121	202	151	242	181
164	123	204	153	244	183
166	124	206	154	246	184
168	126	208	156	248	186
170	127	210	157	250	187
172	129	212	158		

CA1005-A

FIG. 4 Quick Reference Compression Pressure Limit Chart

**EXAMPLE**

After checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi. The lowest pressure reading was 155 psi. The engine is within specifications and the compression is considered satisfactory.

**HYDRAULIC VALVE LIFTER**

Dirt, deposits of gum and varnish and air bubbles in the lubricating oil can cause hydraulic valve lifter failure or malfunction.

**Dirt, gum and varnish can keep a check valve from seating and cause a loss of hydraulic pressure.** An open valve disc will cause the plunger to force oil back into the valve lifter reservoir during the time the push rod is being lifted to force the valve from its seat.

Air bubbles in the lubricating system can be caused by too much oil in the system or too low an oil level. Air may also be drawn into the lubricating system through an opening in a damaged oil pick-up tube. Air in the hydraulic system can cause a loss of hydraulic pressure.

Assembled valve lifters can be tested with Tool 6500-E to check the leak-down rate. The leak-down rate specification is the time in seconds for the plunger to move the length of its travel while under a 50 lb. load. Test the valve lifters as follows:

1. Disassemble and clean the lifter to remove all traces of engine oil. Lifters cannot be checked with engine oil in them. Only the testing fluid can be used.
2. Place the valve lifter in the tester with the plunger facing upward. Pour hydraulic tester fluid into the cup to a level that will cover the valve lifter assembly. The fluid can be purchased from the manufacturer of the tester. Do not use kerosene, for it will not provide an accurate test.
3. Place a 5/16 inch steel ball in the plunger cup (Figure 5).
4. Adjust the length of the ram so that the pointer is 1/16 inch below the starting mark when the ram contacts the valve lifter plunger (Figure 6) to facilitate timing as the pointer passes the start timing mark.

Use the center mark on the pointer scale as the stop timing point instead of the original stop timing mark at the top of the scale.

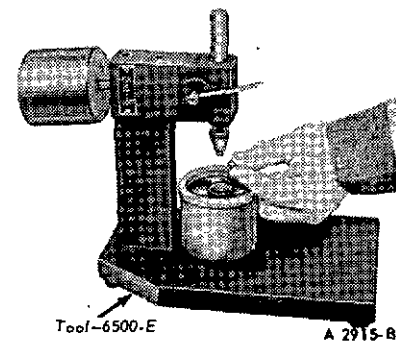


FIG. 5 Placing Steel Ball in Valve Lifter Plunger

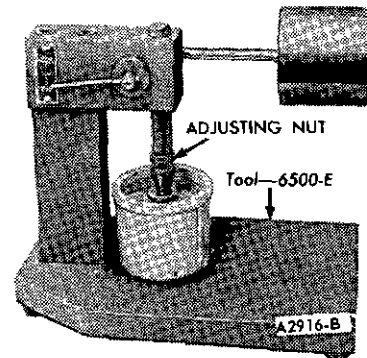


FIG. 6 Adjusting Ram Length

5. Work the valve lifter plunger up and down until the lifter fills with fluid and all traces of air bubbles have disappeared.
6. Allow the ram and weight to force the valve lifter plunger downward. Measure the exact time it takes for the pointer to travel from the start timing to the stop timing marks on the tester.
7. A valve lifter that is satisfactory must have a leak-down rate (time in seconds) within the minimum and maximum limits specified.
8. If the valve lifter is not within specifications, replace it with a new lifter. It is not necessary to test a new lifter before installing it in the engine.

## POSITIVE CLOSED-TYPE VENTILATION SYSTEM

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making carburetor adjustments. **The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life.** To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, perform either of the following tests.

### AIR INTAKE TEST

This test is performed with the crankcase ventilation tester C8AZ-6B627-A (Figure 7) which is operated by the engine vacuum through the oil fill opening. Follow the procedures described below to install the tester and check the crankcase ventilation system for faulty operation.

1. With the engine at **normal operating temperature**, remove the oil filler cap.
2. Hold the tester C8AZ-6B627-A over the opening in the valve cover. Make sure the surface is flat to form a seal between the cover and tester. If the cover is distorted, shape it as required to make an air tight seal. An air leak between the cover and tester will render the tester inoperative.
3. Start the engine and allow it to operate at the recommended idle speed.
4. Hold the tester over the oil filler cap opening making sure that there is a positive seal between the tester and cover.
5. If the ball settles in the **GOOD** (green) area, the system is functioning properly. If the ball settles in the **REPAIR** (red) area, clean or replace the malfunctioning components as required.
6. Repeat the test **AFTER** repairs are made to make sure that the crankcase ventilation system is operating satisfactorily.

Clean and replace the malfunctioning components as required. Repeat the test to ensure that the crankcase ventilation system is operating satisfactorily.

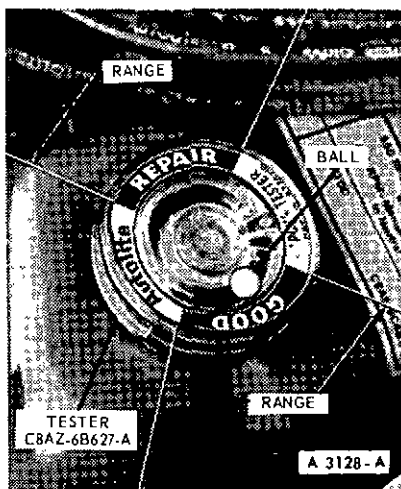


FIG. 7 Crankshaft Ventilation System Tester

## CRANKCASE VENTILATION REGULATOR VALVE TEST

Install a known good regulator valve (PCV) in the crankcase ventilation system.

Start the engine and compare the engine idle condition to the prior idle condition.

If the idle condition is found to be satisfactory, use the new regulator valve and clean the hoses, fittings, etc.

If the loping or rough idle condition remains when the good regulator valve is installed, the crankcase ventilation regulator valve is not at fault. Check the crankcase ventilation system for restriction at the intake manifold or carburetor spacer. If the system is not restricted, further engine component diagnosis will have to be conducted to find the malfunction.

## CRANKSHAFT END PLAY

1. Force the crankshaft toward the rear of the engine.
2. Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Figure 8).
3. Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.
4. If the end play exceeds the wear limit, replace the thrust washers. If the end play is less than the minimum limit inspect the thrust bearing faces for scratches, burrs, nicks, or dirt.

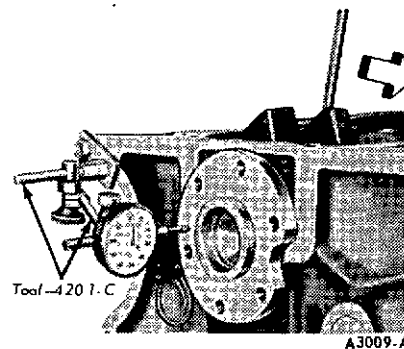


FIG. 8 Checking Crankshaft End Play

## FLYWHEEL FACE RUNOUT

Install a dial indicator so that the indicator point bears against the flywheel face. Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the clutch face runout exceeds specifications, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face sufficiently to true up the surface if the mounting flange runout exceeds specifications. Replace it or reinstall it on the flywheel.

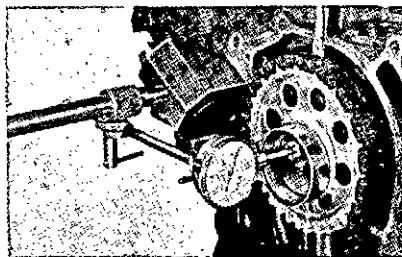
### CAMSHAFT END PLAY

Prying against the aluminum-nylon camshaft sprocket, with the valve train load on the camshaft, can break or damage the sprocket. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket attaching screw (Figure 9). Zero the dial indicator. Position a large screwdriver between the camshaft gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with specifications.

If the end play is excessive, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate.

Remove the dial indicator.



1. PUSH CAM TO REAR OF ENGINE
2. SET Dial ON ZERO
3. PULL CAM FORWARD AND RELEASE

A3010-A

FIG. 9 Checking Camshaft End Play

### TIMING CHAIN DEFLECTION

1. Rotate the crankshaft in a counterclockwise position (as viewed from the front) to take up the slack on the left side of the chain.

### CLEANING AND INSPECTION

The cleaning and inspection procedures are for a complete engine overhaul; therefore, for partial engine overhaul or parts replacement, follow the pertinent cleaning or inspection procedure.

#### INTAKE MANIFOLD

##### Cleaning

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

##### Inspection

Inspect the manifold for cracks, damaged gasket surfaces, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. **Remove all filings and foreign matter that may have entered the manifold as a result of repairs.**

#### EXHAUST MANIFOLDS

##### Cleaning

Remove all gasket material from the manifolds.

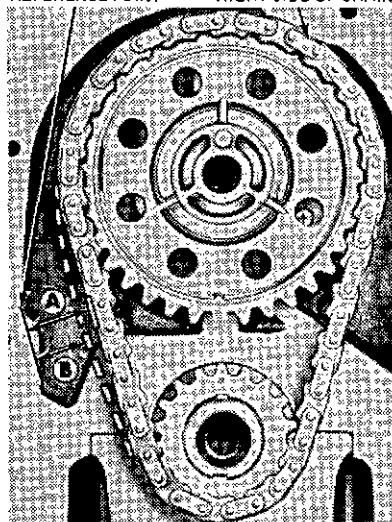
##### Inspection

Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.

Inspect the manifolds for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service.

2. Establish a reference point on the block and measure from this point to the chain.
3. Rotate the crankshaft in the opposite direction to take up the slack on the right of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements. If the deflection exceeds specifications, replace the timing chain and sprockets.

REFERENCE POINT      RIGHT SIDE OF CHAIN



TAKE UP SLACK ON LEFT SIDE, ESTABLISH REFERENCE POINT. MEASURE DISTANCE A. TAKE UP SLACK ON RIGHT SIDE. FORCE LEFT SIDE OUT, MEASURE DISTANCE B. DEFLECTION IS A MINUS B.

A2906-A

FIG. 10 Checking Timing Chain Deflection

### VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY

#### Cleaning

Clean all the parts thoroughly. Make sure all oil passages are open.

Make sure the oil passage in the push rod end of the rocker arm is open.

#### Inspection

On rocker arm shaft assemblies, check the clearance between each rocker arm and the shaft by checking the ID of the rocker arm bore and the OD of the shaft. If the clearance between any rocker arm and the shaft exceeds the wear limit, replace the shaft and/or the rocker arm. Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs.

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. **Do not attempt to true this surface by grinding.**

Check the rocker arm adjusting screws and the push rod end of the rocker arms for stripped or broken threads, and the ball end of the adjusting screw for nicks, scratches or excessive wear.

#### PUSH RODS

##### Cleaning

Clean the push rods in a suitable solvent.

### Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator (Figure 11).

If the push rod is visibly bent, it should be replaced.

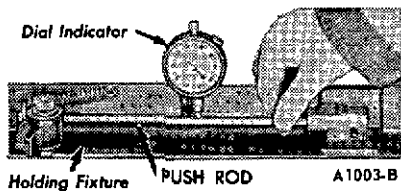


FIG. 11 Checking Push Rod Runout

## CYLINDER HEADS

### Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes; be sure the oil transfer passage is clean. Remove all deposits from the valves with a fine wire brush or buffing wheel.

### Inspection

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Figure 12) for conformance to specifications. If necessary to refinish the cylinder head gasket surface, do not plane or grind off more than 0.010 inch.

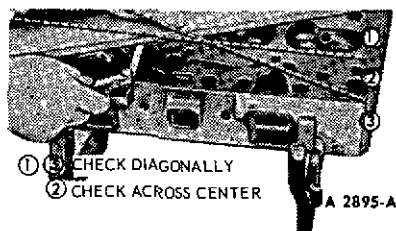


FIG. 12 Typical Cylinder Head Flatness

Check the valve seat runout with an accurate gauge (Figure 13). Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. Measure the valve seat width (Figure 27). Reface any valve seat whose width is not within specifications.

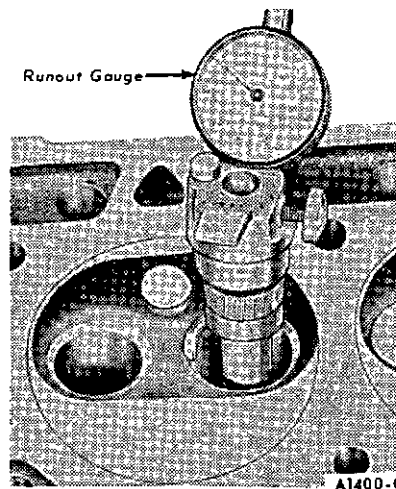


FIG. 13 Checking Valve Seat Runout

Inspect the valve face and the edge of the valve head for pits, grooves, scores or other damage. Inspect the stem for a bent condition and the end of the valve head for pits, grooves, scores or other wear. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for signs of burning, erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged. Do not discard sodium-cooled valves with other scrap metal in scrap bins. If a sodium-cooled valve is accidentally broken and the sodium exposed, it will react violently upon contact with water resulting in fire and explosion due to chemical action. Therefore, these valves should be handled with care and disposed of by being buried in the ground in an area not subjected to excavation.

Inspect the valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any visually damaged parts.

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Figure 14 or its equivalent. Use a flat end indicator point.

Install the tool on the valve stem until it is fully seated, and tighten the knurled set screw firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.

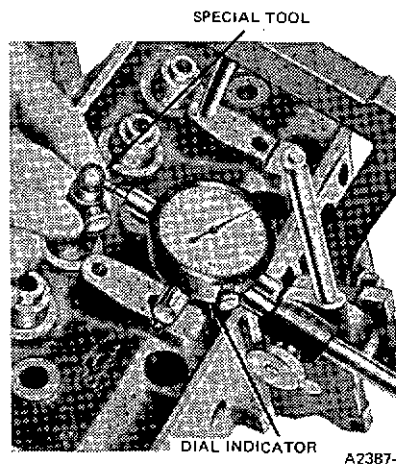


FIG. 14 Checking Valve Stem Clearance

Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool.

Check the springs for proper pressure (Figure 15) at the specified spring lengths (Tool 6513-DD). **Manually rotating the valve spring assemblies while installed in the engine must not be used to determine good and/or bad valve springs.** Weak valve springs cause poor engine performance. Replace any spring not within specifications.

Check each spring for squareness using a steel square and a flat surface (Figure 16). Stand the spring and square on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. The out-of-square limits are  $5/64$  inch.

Follow the same procedure to check new valve springs before installation. **Make certain the proper spring (color coded) is installed.**

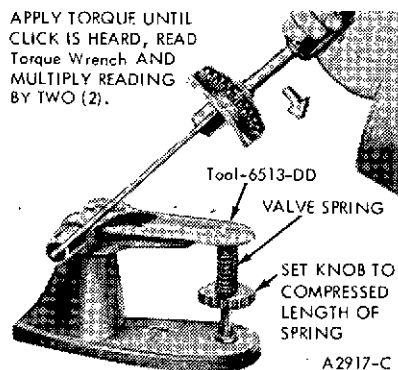


FIG. 15 Checking Valve Spring Pressure

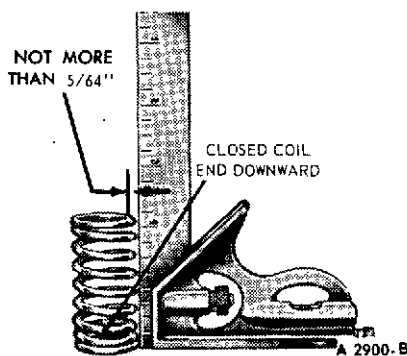


FIG. 16 Checking Valve Spring Squareness

## HYDRAULIC VALVE LIFTERS

The valve lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately so as not to intermix the internal parts. **If any part of the lifter assembly needs replacing, replace the entire assembly.**

### Cleaning

Thoroughly clean all the parts in cleaning solvent and wipe them with a clean, lint-free cloth.

## Inspection

Inspect the parts and discard the entire lifter assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the lifter assembly and check for freeness of operation by pressing down on the push rod cup. The lifters can also be checked with a hydraulic tester to test the leak-down rate. Follow the instructions of the test unit manufacturer.

## CRANKSHAFT VIBRATION DAMPER AND SLEEVE

### Cleaning

Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage the oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that the seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.**

### Inspection

Inspect the crankshaft damper or sleeve oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

## TIMING CHAIN AND SPROCKETS

### Cleaning

Clean all parts in solvent and dry them with compressed air.

Lubricate the timing chain with engine oil before installing it on the engine.

### Inspection

Inspect the chain for broken links. Inspect the sprockets for cracks and worn or damaged teeth. Replace all the components of the timing chain and sprocket assembly if any one item needs replacement.

Inspect the fuel pump drive eccentric for scores, nicks and excessive wear. If the eccentric is scored, replace it.

## TIMING GEARS

### Cleaning

Clean the gears in solvent and dry them with compressed air.

### Inspection

Inspect the gear teeth for scores, nicks, etc. Note the condition of the teeth contact pattern. If the teeth are scored, replace the gears.

## CAMSHAFT

### Cleaning and Inspection

Clean the camshaft in solvent and wipe it dry. Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded 0.005 inch.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

Check the distributor drive gear for broken or chipped teeth. Replace the camshaft if this condition exists.

## CRANKSHAFT

### Cleaning

Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces. Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

### Inspection

Inspect the main and connecting rod journals for cracks, scratches, grooves or scores. Inspect the crankshaft oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition (Figure 17).

Check the fit of the clutch pilot bushing in the bore of the crankshaft. The bushing is pressed into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the ID of the bushing (Figure 18). Replace the bushing if it is worn or damaged or the ID is not within specifications.

Inspect the pilot bearing (ball bearing) when so equipped, for roughness, evidence of overheating or loss of lubricant. Replace it if any of these conditions are found.

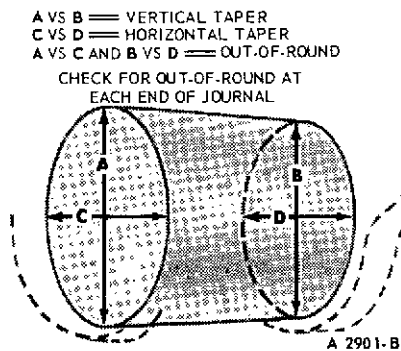


FIG. 17 Crankshaft Journal Measurement

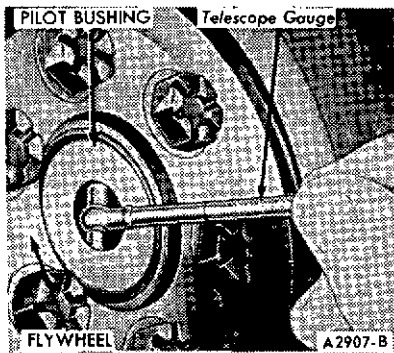


FIG. 18 Checking Clutch Pilot Bushing Wear

## FLYWHEEL

### Inspection

Inspect the flywheel for cracks, heat check, or other damage that would make it unfit for further service. Machine the friction surface of the flywheel if it is scored or worn. If it is necessary to remove more than 0.045 inch of stock from the original thickness, replace the flywheel.

Inspect the ring gear for worn, chipped, or cracked teeth. If the teeth are damaged, replace the ring gear.

With the flywheel installed on the crankshaft, check the flywheel face runout, following the procedure under Diagnosis and Testing.

## CONNECTING RODS

### Cleaning

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

### Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced. Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specifications, install a 0.002 inch oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston. Then, assemble the piston, piston pin and connecting rod following the procedures for assembly. **It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts. Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specifications, the connecting rod must be straightened or replaced.**

## PISTONS, PINS AND RINGS

### Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.**

Clean the ring grooves with a ring groove cleaner (Figure 19). Make sure the oil ring slots (or holes) are clean.

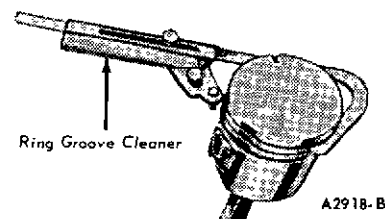


FIG. 19 Cleaning Piston Ring Grooves

### Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves has a high step, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition.

Check the piston to cylinder bore clearance by measuring the piston and bore diameters. Refer to the specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurement procedure. **Measure the OD of the piston with micrometers approximately 2¼ inches below the dome and at 90 degrees to the piston pin bore.** Check the ring side clearance following the procedure under Fitting Piston Rings in this section.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to Piston and Connecting Rod Assembly.

Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications.

Replace all rings. Check the end gap and side clearance. **Rings should not be transferred from one piston to another regardless of mileage or hours.**

## MAIN AND CONNECTING ROD BEARINGS

### Cleaning

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. **Do not scrape gum or varnish deposits from the bearing shells.**

### Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in Figure 20. The copper-lead bearing base may be visible through the bearing overlay. This does not mean that the bearing is worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as detailed under Main and Connecting Rod Bearings.

## CYLINDER BLOCK

### Cleaning

After any cylinder bore repair operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally, wipe the bore(s) with a clean cloth dipped in engine oil. If these procedures are not followed, rusting of the cylinder bore(s) may occur.

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. Blow out all passages, bolt holes, etc., with compressed air. Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true up threads and to remove any deposits. Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

### Inspection

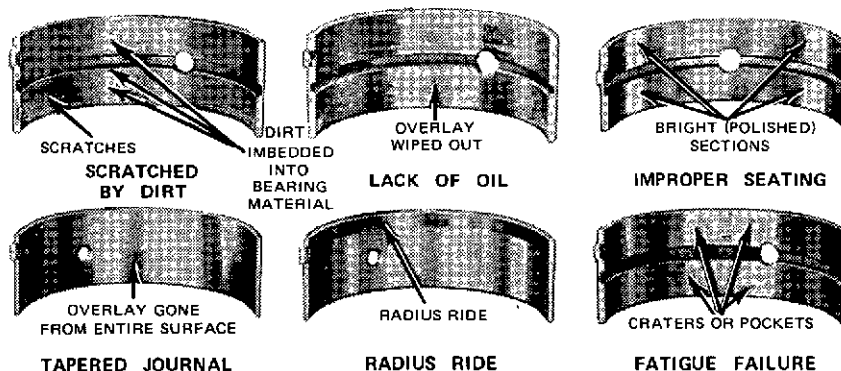
After the block has been thoroughly cleaned, check it for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

Replace all expansion-type plugs that show evidence of leakage.

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Figure 21). **Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.**

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed the wear limits. If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits.



A2903-A

FIG. 20 Typical Bearing Failures

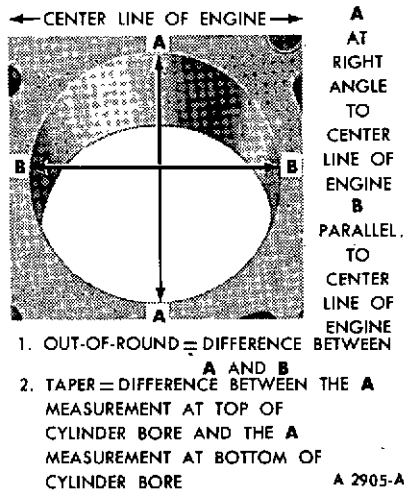


FIG. 21 Cylinder Bore Out-of-Round and Taper

## OIL PAN

### Cleaning

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Be sure all foreign particles are removed from below the baffle plate.

### Inspection

Check the pan for cracks, holes, damaged drain plug threads, and a loose baffle or a damaged gasket surface.

Inspect for damage (uneven surface) at the bolt holes caused by over-torquing the bolts. Straighten surfaces as required. Repair any damage, or replace the pan if repairs cannot be made satisfactorily.

## OIL PUMP

### Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal particles are removed.

### Inspection

Refer to the specifications for clearances and wear limits.

Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. If the cover mating surface is worn, scored or grooved, replace the cover.

Measure the outer race to housing clearance (Figure 22). Then check the clearance between the outer race and the rotor lobes.

With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straight edge and the rotor and outer race (Figure 23). The outer race, shaft and rotor are replaceable only as an assembly. Check the drive shaft to housing bearing clearance by measuring the OD of the shaft and the ID of the housing bearing. Inspect the relief valve spring for a collapsed or worn condition. Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is worn or damaged, replace the spring. Check the relief valve piston for scores and free operation in the bore.

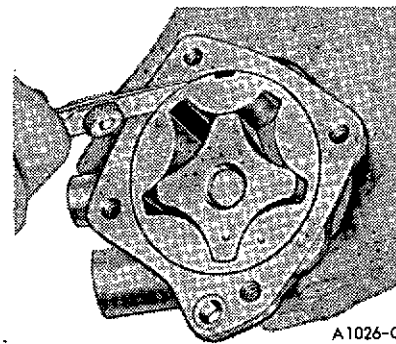


FIG. 22 Checking Outer Race to Housing Clearance

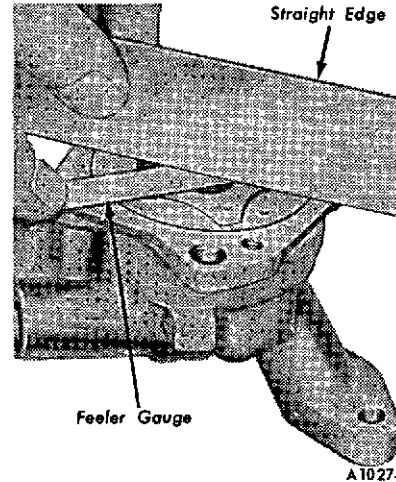


FIG. 23 Checking Rotor End Play

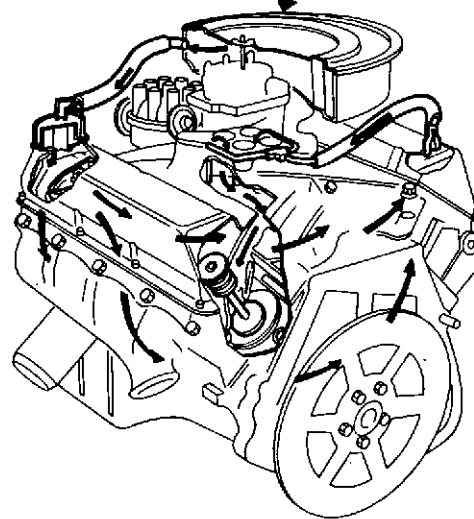


FIG. 24 Crankcase Ventilation System Regulator Valve Installed

## POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

### Cleaning

Do not attempt to clean the crankcase ventilation regulator valve; it should be replaced at the specified maintenance interval. The oil filler cap and oil separator should be cleaned at the proper maintenance interval. Remove the cap and the oil separator and wash them in a low-volatility, petroleum-base solvent. Shake the cap dry and install them. Clean the crankcase ventilation system connection(s) on the intake manifold by probing with a flexible wire or bottle brush. Clean the hoses, fittings, tubes and associated hardware with a low-volatility, petroleum-base solvent and dry with compressed air.

## OVERHAUL CYLINDER HEAD

Replace the head if it is cracked. Do not plane or grind more than 0.010 inch from the cylinder head gasket surface. Remove all burrs or scratches with an oil stone.

### REAMING VALVE GUIDES

If it becomes necessary to ream a valve guide (Figure 25) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: a 0.003-inch OS reamer with a standard diameter pilot, a 0.015-inch OS reamer with a 0.003-inch OS pilot, and a 0.030-inch reamer with a 0.015-inch OS pilot.

When going from a standard size valve to an oversize valve always use the reamer in sequence. Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

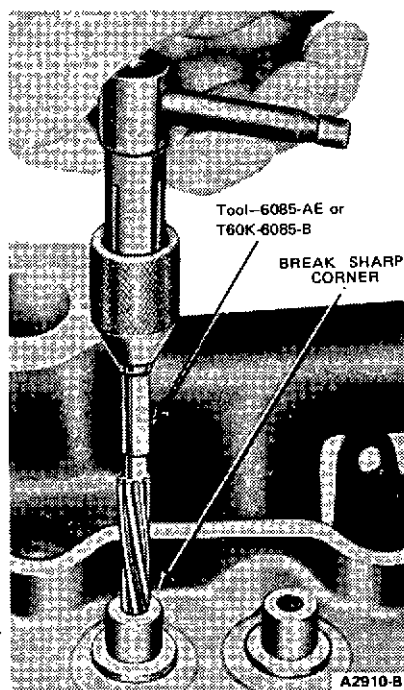


FIG. 25 Reaming Valve Guides

### REFACING VALVE SEATS

Refacing the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference fit will be maintained. This is important so that the valve and seat will have a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle (Figure 26). Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width (Figure 27). Narrow the seat, if necessary, to bring it within specifications, and center it on the valve face.

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications, and center.

On the valve seats of all engines, use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats) and use a 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

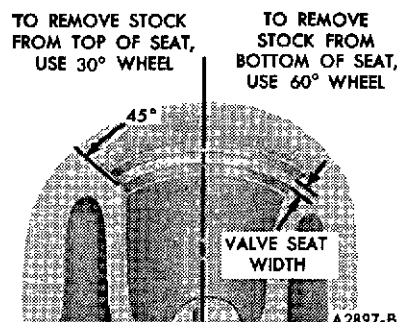


FIG. 26 Refacing Valve Seat

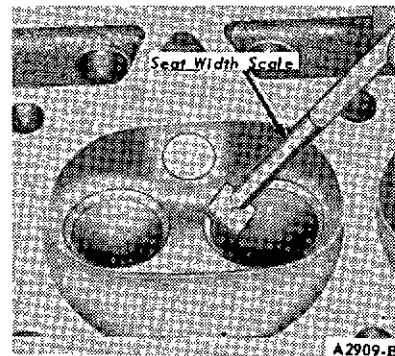


FIG. 27 Checking Valve Seat Width

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

### VALVES

Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if the face runout cannot be corrected by refinishing or stem clearance exceeds specifications. Discard any excessively worn or damaged valve train parts.

### REFACING VALVES

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and of the valve seat will be to specifications and provide a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

Under no circumstances should the faces of aluminized intake valves be ground or the valves lapped in as this will remove the diffused aluminum coating and reduce the valve's wear and heat resistant properties. If the valve faces are worn or pitted it will be necessary to install new valves and to resurface the valve seats or, alternatively, lap the seats using dummy valves. The exhaust valves may be lapped in or the faces ground if required.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 1/32 inch thick after grinding (Figure 28), replace the valve as the valve will run too hot in the engine. The interference fit of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.010 inch from the end of the valve stem.

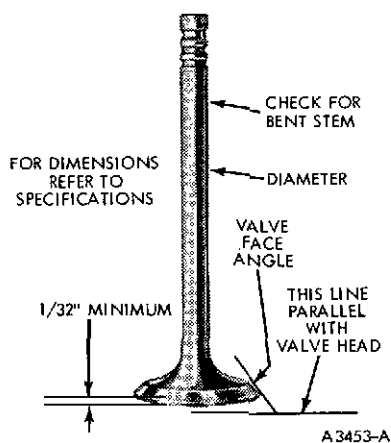


FIG. 28 Critical Valve Dimensions

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

### SELECT FITTING VALVES

If the valve stem to valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.003, 0.015 and 0.030 inch are available for service. Always reface the valve seat after the valve guide has been reamed. Refer to Reaming Valve Guides.

### CAMSHAFT REPAIR

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

### CRANKSHAFT

Dress minor scores with an oil stone. If the journals are severely marred or exceed the wear limit, they should be refinished to size for the next undersize bearing.

### REFINISHING JOURNALS

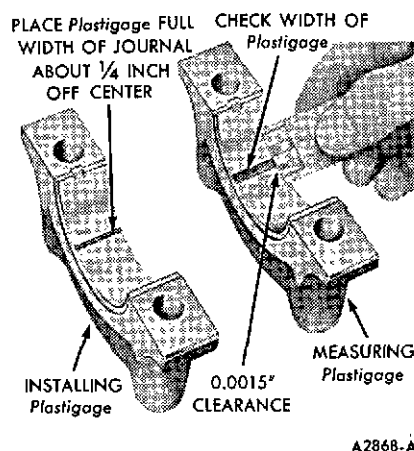
Refinish the journals to give the proper clearance with the next undersize bearing. If the journal will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes; then polish the journal with a No. 320 grit polishing cloth and engine oil. Crocus cloth may also be used as a polishing agent.

### FITTING MAIN OR CONNECTING ROD BEARINGS WITH PLASTIGAGE

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. If the desired clearance cannot be obtained with a standard bearing, try a 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.
2. If fitting a main bearing in the chassis, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.



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FIG. 29 Installing and Measuring Plastigage

3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center (Figure 29).
4. Install cap and torque bolts to specifications. Do not turn crankshaft while Plastigage is in place.
5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.
6. If clearance exceeds specified limits, on the connecting rod bearings, try a 0.002 inch undersize bearing in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 inch undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.
7. After bearing has been fitted, remove Plastigage and apply light coat of engine oil to journal and bearings. Install bearing cap. Torque cap bolts to specifications.
8. Repeat procedure for remaining bearings that require replacement.

### PISTONS, PINS AND RINGS

#### FITTING PISTONS

Pistons are available for service in standard sizes and the oversizes shown in the parts book.

The standard size pistons are color coded red or blue, or have .0025 O.S. stamped on the dome. Refer to the Specifications for standard size piston dimensions.

Measure the cylinder bore and select the piston to assure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third a blue piston should be used. When the bore diameter is in the upper one-third, the 0.0025 O.S. piston should be used.

Measure the piston diameter to ensure that the specified clearance is obtained. It may be necessary periodically to use another piston (red or blue) that is either slightly larger or smaller to achieve the specified clearance. **If none can be fitted, refinish the cylinder to provide the proper clearance for the piston. When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted. If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze (refer to Cylinder Block, Refinishing Cylinder Walls). Be sure to clean the cylinder bore thoroughly.**

1. Calculate the size piston to be used by taking a cylinder bore check. Follow the procedures outlined under Cleaning and Inspection.

2. Select the proper size piston to provide the desired clearance (refer to the specifications). The piston should be measured  $2\frac{1}{4}$  inches below the dome and at  $90^\circ$  to the piston pin bore.
3. Make sure the piston and cylinder block are at room temperature (70 degrees F.). After any refinishing operation allow the cylinder bore to cool, and make sure the piston and bore are clean and dry before the piston fit is checked.

#### FITTING PISTON RINGS

1. Select the proper ring set for the size cylinder bore.
2. Position the ring in the cylinder bore in which it is going to be used.
3. Push the ring down into the bore area where normal ring wear is not encountered.
4. Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. Use caution to avoid damage to the ring or cylinder bore.
5. Measure the gap between the ends of the ring with a feeler gauge (Figure 30). If the ring gap is less or greater than the specified limits, try another ring set.
6. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Figure 31). The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower land have high steps, the piston should be replaced.

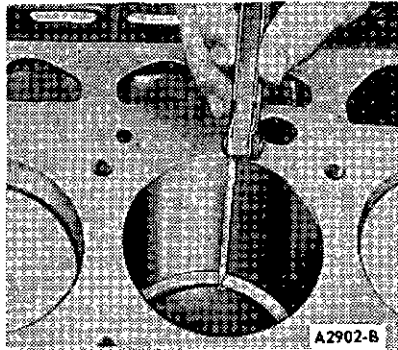


FIG. 30 Checking Piston Ring Gap

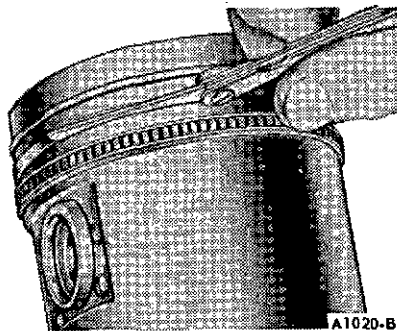


FIG. 31 Checking Piston Ring Clearance

#### FITTING PISTON PINS

The piston pins are selected to give the correct fit in the piston pin bore and bushing in the connecting rod. Pistons are only supplied in service complete with the piston pin, to ensure the correct fit. The piston pins should not be interchanged.

#### VALVE ROCKER ARM

If the pad at the valve end of the rocker arm has a grooved radius, replace the rocker arm. Do not attempt to true this surface by grinding.

#### PUSH RODS

Following the procedures under Push Rod Inspection, check the push rods for straightness.

If the runout exceeds the maximum limit at any point, discard the rod. Do not attempt to straighten push rods.

#### CYLINDER BLOCK

##### REFINISHING CYLINDER WALLS

Honing is recommended for refinishing cylinder walls only when the walls have minor scuffs or scratches, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance.

Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.0015 inch of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained.

For the proper use of the refinishing equipment, follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work.

Use a motor-driven, spring pressure-type hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 15/32 RMS. When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean and oil the cylinder walls. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

### REPAIRING SAND HOLES OR POROUS ENGINE CASTINGS

Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes. A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), repairs can be made with metallic plastic (Part No. C6AZ-19554-A). **Do not repair cracks with this material.** Repairs with this metallic plastic must be confined to those cast iron engine component surfaces where the inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:

1. Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket but not including machined areas.
2. Lower rear face of the cylinder block.
3. Intake manifold casting.
4. Cylinder head, along the rocker arm cover gasket surface.

The following procedure should be used to repair porous areas or sand holes in cast iron:

- a. Clean the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 1/4 inch should not be repaired using metallic plastic. Openings in excess of 1/4 inch can be drilled, tapped and plugged using common tools. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.
- b. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.
- c. Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing the epoxy into the hole or porosity.
- d. Allow the repair mixture to harden. This can be accomplished by two methods: heat cure with a 250 degree watt lamp placed 10 inches from the repaired surface, or air dry for 10-12 hours at temperatures above 50 degrees F.
- e. Sand or grind the repaired area to blend with the general contour of the surrounding surface.
- f. Paint the surface to match the rest of the block.

### ADJUSTMENTS VALVE CLEARANCE

The valve arrangement on the left bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that, if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

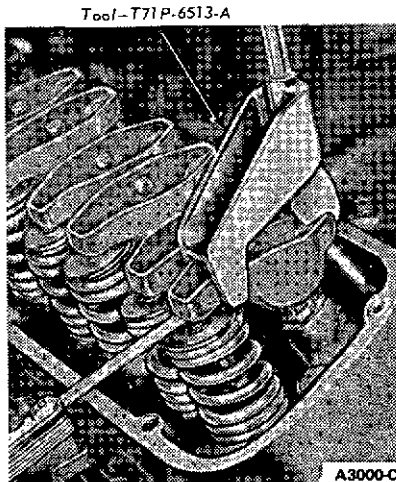
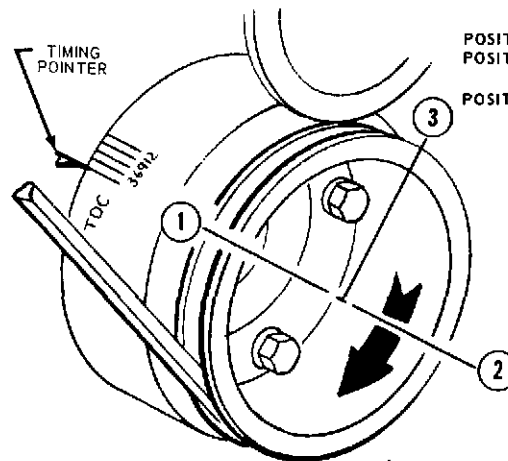


FIG. 32 Checking Valve Clearance

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. Install an auxiliary starter switch. **Crank the engine with the ignition switch OFF until the No. 1 piston is on TDC after the compression stroke.**
2. With the crankshaft in the positions designated in Steps 3, 4 and 5, position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Figure 32). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge. If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.
3. With the No. 1 piston on TDC at the end of the compression stroke as shown in Position No. 1, Figure 33, check the following valves:
  - No. 1 Intake, No. 1 Exhaust
  - No. 7 Intake, No. 5 Exhaust
  - No. 8 Intake, No. 4 Exhaust
4. After checking the spacing on these valves, rotate the crankshaft to Position No. 2 as shown in Figure 33, then check the following valves:
  - No. 4 Intake, No. 2 Exhaust
  - No. 5 Intake, No. 6 Exhaust
5. After checking the spacing on these valves, rotate the crankshaft to Position No. 3 as shown in Figure 33 and check the following valves:
  - No. 2 Intake, No. 3 Exhaust
  - No. 3 Intake, No. 7 Exhaust
  - No. 6 Intake, No. 8 Exhaust

With No. 1 at TDC at end of compression stroke make a chalk mark at points 2 and 3 approximately 90 degrees apart.



- POSITION 1** - No. 1 at TDC at end of compression stroke.  
**POSITION 2** - Rotate the crankshaft 180 degrees (one half revolution) clockwise from POSITION 1.  
**POSITION 3** - Rotate the crankshaft 270 degrees (three quarter revolution) clockwise from POSITION 2.

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FIG. 33 Positioning Crankshaft for Checking Valve Clearance and Installing Rocker Arms

## REMOVAL AND INSTALLATION CRANKCASE VENTILATION SYSTEM

### Removal

1. Remove ventilation system air intake hose from air cleaner. Remove the hose, elbow and grommet from the left rocker arm cover.
2. Remove air cleaner and intake duct assembly.
3. Disconnect the inlet vent hose from the bracket and carburetor spacer.  
Unlock the oil filler cap from the left rocker arm cover and remove the inlet hose, PCV valve and oil filler cap as an assembly. Disassemble for cleaning.
4. Pull PCV valve out of mounting grommet in right valve rocker arm cover.

### Installation

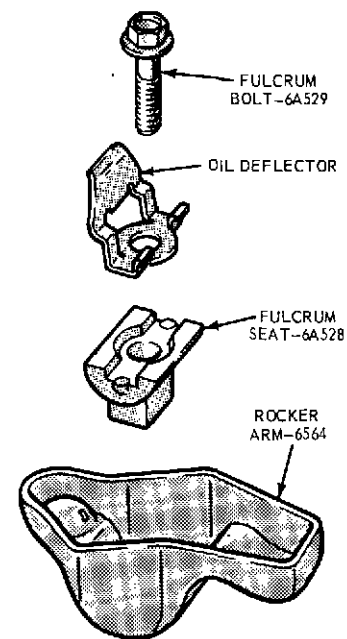
1. Install the oil filler cap and insert PCV valve into mounting grommet.
2. Position the inlet vent hose in the bracket and connect carburetor spacer and PCV valve.
3. Install air cleaner and intake duct assembly.
4. Install ventilation system air intake hose and elbow to air cleaner and right rocker arm cover grommet.

## VALVE ROCKER ARM COVER AND ROCKER ARM

The valve rocker arm is shown in Figure 34.

### Removal

1. Remove the air cleaner.  
If a right cylinder head rocker arm is to be removed, remove the crankcase ventilation PCV valve from the valve rocker arm cover.
2. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap only. Remove the wires from the bracket on the valve rocker arm cover(s) and position the wires out of the way.
3. Remove the valve rocker arm cover(s).
4. Remove the valve rocker arm bolt, oil deflector, fulcrum seat and rocker arm.



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FIG. 34 Rocker Arm and Related Parts

### Installation

1. Apply Lubriplate or equivalent to the top of the valve stems, the rocker arm and fulcrum seats.
2. Position the No. 1 piston on TDC at the end of the compression stroke, Position 1 in Figure 33, and install the rocker arm, fulcrum seat, oil deflector and bolt on the following valves:  
 No. 1 Intake, No. 1 Exhaust  
 No. 7 Intake, No. 5 Exhaust  
 No. 8 Intake, No. 4 Exhaust  
 Position the crankshaft in Position 2 in Figure 33 and install the rocker arm, fulcrum seat, oil deflector and bolt on the following valves:  
 No. 4 Intake, No. 2 Exhaust  
 No. 5 Intake, No. 6 Exhaust  
 Position the crankshaft in Position 3 in Figure 33 and install the rocker arm, fulcrum seat, oil deflector and bolt on the following valves:  
 No. 2 Intake, No. 3 Exhaust  
 No. 3 Intake, No. 7 Exhaust  
 No. 6 Intake, No. 8 Exhaust

Be sure that the fulcrum seat base is inserted in its slot on the cylinder head before tightening the fulcrum bolts. Tighten the fulcrum bolt to specification. Check the valve clearance following the procedures under Valve Clearance Checking Procedure.

- Clean the valve rocker arm cover(s) and the cylinder head gasket surface(s). Position the gasket in the cover, making sure that the gasket tangs are secured in the notches in the cover.
- Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Tighten the bolts to specifications. Two minutes later, tighten the bolts to the same specifications.

If the right cover was removed, install PCV valve.

Install the air cleaner and intake duct assembly.

- Install the spark plug wires in the bracket on the valve rocker arm cover(s). Connect the spark plug wires.
- Start the engine and check for leaks.

### VALVE SPRING, RETAINER AND STEM SEAL

Broken valve springs or defective valve stem seals or retainers may be replaced without removing the cylinder head if valve or valve seat is not damaged.

#### Removal

- If defective spring, retainer, or seal is on right side of engine, remove air cleaner and intake duct assembly. Remove PCV valve and hose from right valve rocker arm cover.

If defective spring, retainer, or seal is on left side of engine, remove oil filler cap and ventilation hose from left valve rocker arm cover and position out of way.

- Remove valve rocker arm cover(s) and applicable spark plug(s).
- Remove valve rocker arm bolts, oil deflectors, fulcrum seats, rocker arms, and push rods from affected cylinder(s).
- Install air line with adapter in spark plug hole. Turn on air supply to hold valves closed.
- Install Tool T70P-6049-A (Figure 35) and compress valve spring. Remove retainer locks, spring retainer, and spring. Remove and discard valve stem seal (Figure 36). If air pressure fails to hold valve in closed position, valve damage affecting sealing is indicated. Remove and inspect cylinder head assembly.

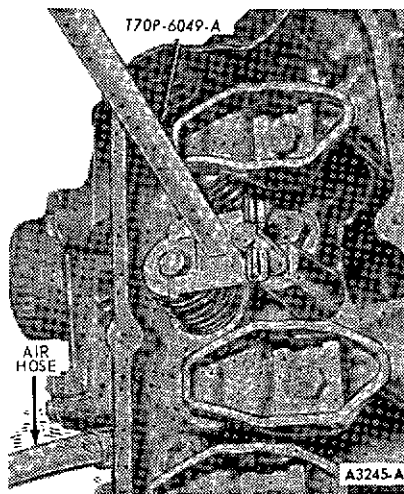


FIG. 35 Compressing Valve Spring-In Chassis

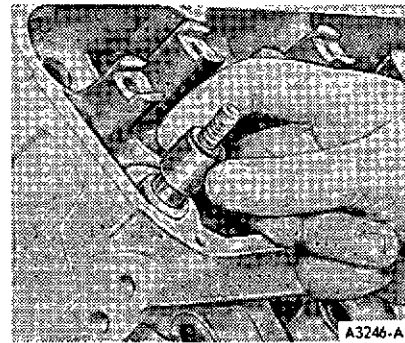


FIG. 36 Removing or Installing Valve Stem

- Wrap rubber band, tape or string around end of valve stem to prevent valve from dropping into cylinder when air pressure in cylinder is shut off if piston is at bottom of cylinder. Shut off air pressure.
- Inspect valve stem for damage. Rotate valve, checking tip for eccentric movement. Move valve up and down through normal travel in valve guide and check for binding. If valve is damaged, cylinder head must be removed for repairs.

#### Installation

- If valve proves satisfactory, hold valve closed and turn on air pressure in cylinder.
- Lubricate the valve stems with heavy engine oil SE. Install new valve stem seal (Figure 36). Set spring and retainer over valve stem. Compress valve spring (Figure 35) and install retainer locks. Release spring and remove tool.
- Shut off air pressure and remove air line and adapter. Install spark plug.
- Apply Lubriplate to tip of valve stem and each end of push rod. Install push rod. Be sure lower end of push rod is seated in valve lifter.
- Lubricate fulcrum seats and sockets with Lubriplate or equivalent.
- Lubricate the push rod socket, fulcrum seat and the valve pad of the rocker arm with heavy engine oil SE.
- Install the rocker arms and rocker arm covers using the procedure and sequence given under Rocker Arm Installation. If the right cover was removed, install PCV valve.
- Install the spark plug and connect the spark plug wires.
- Install the air cleaner and intake duct assembly.
- Connect the automatic choke heat chamber air inlet hose.

### INTAKE MANIFOLD

#### Removal

- Drain cooling system. Remove air cleaner.
- Disconnect radiator upper hose at engine.
- Loosen water pump by-pass hose clamp at intake manifold.
- Disconnect PCV valve and hose at right valve rocker arm cover.
- Disconnect wires at spark plugs by twisting and pulling moulded caps. Remove wires from brackets on valve rocker arm covers. Disconnect coil high tension lead at coil and remove distributor cap and wires as an assembly.

6. Disconnect all distributor vacuum line at carburetor. Remove distributor and vacuum lines as an assembly.
7. Disconnect throttle linkage at carburetor. Remove bolts holding throttle linkage bell crank, remove linkage springs, and position linkage out of way.
8. Disconnect fuel line at carburetor.
9. Disconnect wiring harness at coil battery terminal, engine temperature sending unit, oil pressure sending unit, and other connections as necessary. Disengage wiring harness from three clips at left valve rocker arm cover bolts, and position wiring harness out of way.
10. Remove coil and bracket assembly.
11. Remove attaching bolts and nuts and remove intake manifold and carburetor as an assembly (Figure 37). If necessary to pry manifold away from cylinder heads, do not damage gasket sealing surfaces.
12. Remove and discard intake manifold gaskets and seals.
13. If manifold is to be further disassembled (Figure 39), remove coolant outlet housing, gasket, and thermostat. Remove automatic choke heat tubes, carburetor, spacer, and gaskets. Remove engine temperature sending unit. Discard all gaskets.

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspect the manifold for cracks, damaged gasket surfaces, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Remove all filings and foreign matter that may have entered the manifold as a result of repairs.

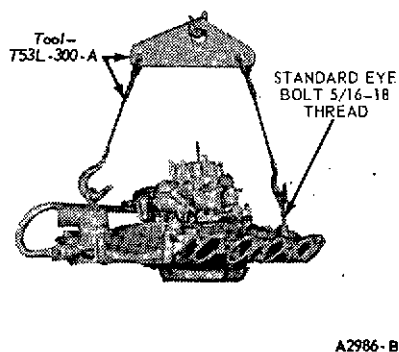


FIG. 37 Removing or Installing Intake Manifold

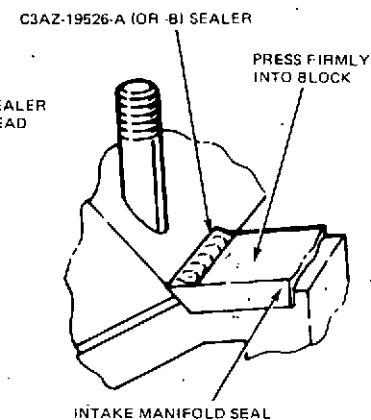
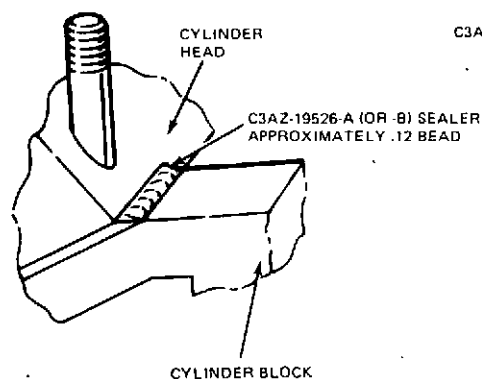


FIG. 38 Sealing Intake Manifold with RTV Sealer

### Installation

1. If intake manifold assembly was disassembled, install coolant outlet housing, new gasket, and thermostat. Install carburetor, spacer, new gaskets, automatic choke heat tubes. Coat threads with electrical conductive sealer and install water temperature sending unit.
2. Clean mating surfaces of intake manifold, cylinder heads, and cylinder block. Use a solvent such as Ford Spot Remover (B7A-19521-A) or similar degreasing agent.
3. Apply a 1/8 inch diameter bead of silicone rubber sealer (C3AZ-19562-A or B) in and along the joint, the full width of the cylinder block seal mounting surface (4 corners) as shown in Figure 38.
4. Install the cylinder head to manifold gaskets and the front and rear intake manifold to cylinder block seals. Apply a 1/16 inch bead of sealer at the outer-end of each intake manifold seal for the full width of the seal (Figure 38).

**NOTE: This sealer sets up within 15 minutes after application, so assembly should proceed promptly.**

5. Carefully lower intake manifold into position over four studs in ends of cylinder heads. When intake manifold is in place, run finger around seal area to be sure seals are in place. If seals have shifted, remove manifold and reposition seals.
6. Be sure intake manifold gaskets are properly aligned. Then install attaching bolts and nuts snugly to manifold. Tighten bolts and nuts in sequence (Figure 40) to specifications to compress gaskets and seals. Then repeat sequence, tightening bolts and nuts to same specifications.
7. Install water pump by-pass hose to intake manifold fitting.
8. Connect radiator upper hose to coolant outlet housing.
9. Rotate crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Position distributor in block with rotor at No. 1 firing position and points open. Install hold down clamp.
10. Connect PCV valve and hose to right valve rocker arm cover.
11. Connect fuel line to carburetor.
12. Install coil and bracket assembly to intake manifold.
13. Fit wiring harness into three clips at inboard edge of left valve rocker arm cover and connect to all terminals.
14. Position throttle linkage on manifold. Attach throttle linkage bell crank. Install linkage springs and connect linkage to carburetor.

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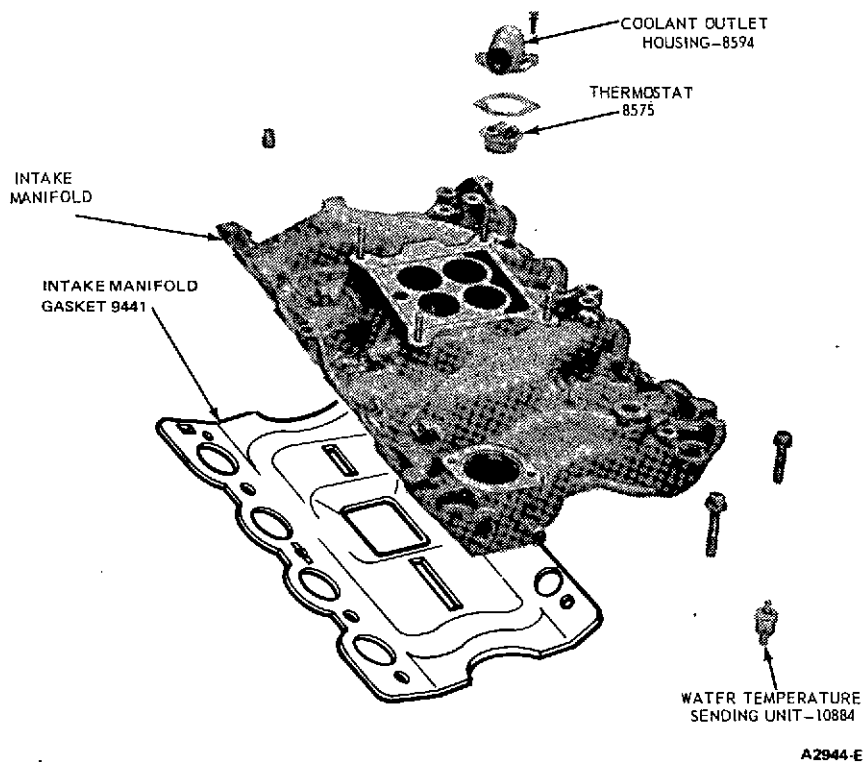


FIG. 39 Intake Manifold Disassembled

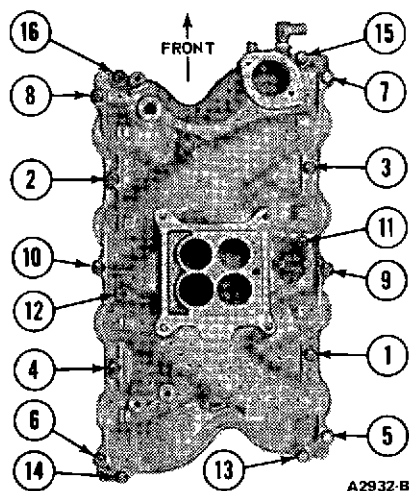


FIG. 40 Intake Manifold Torque Sequence

15. Secure distributor cap to distributor. Connect spark plug wires to spark plugs and fit wires into brackets on valve rocker arm covers. Connect coil high tension lead to coil.
16. Fill the cooling system.
17. Start engine. Check and adjust ignition timing. Connect distributor vacuum line.
18. Operate engine at fast idle and check for coolant leaks. Re-check coolant level and refill as necessary.
19. Start the engine and allow it to reach normal operating temperature, then re-tighten the manifold attaching nuts and bolts to specifications.
20. Check and adjust carburetor idle speed and mixture as required. Install air cleaner and intake duct assembly.

## VALVE LIFTER

The following procedure is applicable for removing one or all of the valve lifters. Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improper valve clearance or by worn rocker arms and/or push rods.

### Removal

1. Remove intake manifold and carburetor as an assembly, following instructions under Intake Manifold.
2. Remove the valve rocker arm covers. Loosen the rocker arm bolts and turn rocker arms to one side.
3. Remove the push rods in sequence.
4. Remove the valve lifters with a magnet. Place them in a rack in sequence. If the lifters are stuck in bores, use plier-type Tool (T52T-6500-DJD) to remove them. Rotate lifter back and forth to loosen them from gum or varnish deposits. Refer to cleaning, inspection and testing procedures earlier in this section. If necessary to disassemble lifter(s), refer to Valve Lifter Disassembly and Assembly.

### Installation

1. Clean the outside of valve lifters. Lifters and bores are to be lubricated with heavy oil SE before installation. Install the lifters in their original bores. Check any new lifter for free fit in bore to which it is to be installed.
2. Install push rods in original positions. Apply Lubriplate or equivalent to valve stem tips and push rod ends.
3. Position the rocker arms over the push rods and tighten the bolts following the procedure under Valve Rocker Arm Installation. Adjust valve clearance.
4. Install rocker arm covers following procedure under Rocker Arm and Cover Installation.
5. Install intake manifold and carburetor, following the instructions under Intake Manifold.

## CYLINDER HEADS

### Removal

1. Remove intake manifold and carburetor as an assembly, following procedure under Intake Manifold Removal.
2. Loosen alternator attaching bolts and remove bolt attaching alternator bracket to right cylinder head.
3. Remove valve rocker arm covers. Remove rocker arm bolts, rocker arms, oil deflectors, fulcrums and push rods in sequence (Figure 41) so they can be installed in their original positions.
4. Remove cylinder head attaching bolts. Lift cylinder heads and exhaust manifolds as assemblies from cylinder block with a hoist. **If necessary to loosen cylinder head gasket seal, pry at forward corners of cylinder heads against casting bosses provided on cylinder block. Do not damage machined surfaces of head or block. Discard cylinder head gasket.**
5. If disassembly or machining of cylinder head is required, remove exhaust manifold.

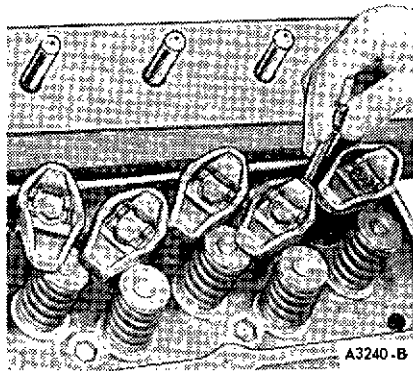


FIG. 41 Removing Valve Push Rod

### Installation

1. Clean cylinder head, intake manifold, valve rocker arm cover, and cylinder block gasket surfaces. If cylinder head was removed for cylinder head gasket replacement, check flatness of cylinder head and block gasket surfaces. If exhaust manifold was removed, coat cylinder head and manifold port areas with film of graphite grease and install manifold and gasket to cylinder head.
2. Position new cylinder head gaskets on block over dowels. Do not apply sealer to head gasket surfaces. Place cylinder heads on block and install attaching bolts (longer bolts in lower row of bolt holes). Tighten all cylinder head attaching bolts in sequence (Figure 42) in three steps: first to 75 ft-lb, then to 105 ft-lb, and finally to specifications. **When this procedure is used, it is not necessary to re-tighten bolts after extended operation.**
3. Clean and inspect push rods, one at a time. Clean the oil passage in the push rods with a suitable solvent, and blow out with compressed air.
4. Install push rods in original positions. Apply Lubriplate or equivalent to valve stem tips and push rod ends.
5. Lubricate and install the rocker arms following the procedure under Valve Rocker Arm Installation. **Be sure lower ends of push rods remain seated in valve lifters.**

6. Install intake manifold and carburetor assembly, following procedure under Intake Manifold Installation.
7. Perform valve clearance adjustment, as detailed under Valve Clearance Adjustment, only if necessary.
8. Apply oil-resistant sealer to one side of new valve rocker arm cover gaskets. Lay cemented side of gaskets in place in covers. Install covers.
9. Install bolt attaching alternator bracket to right cylinder head. Adjust alternator drive belt tension to specifications and tighten alternator attaching bolts.
10. Fill cooling system as necessary.
11. Start engine and check for leaks.
12. Check and adjust carburetor idle speed and mixture as required.
13. required.

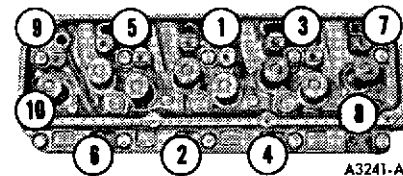


FIG. 42 Cylinder Head Bolt Torque Sequence

## EXHAUST MANIFOLD

### Removal

1. Remove attaching bolts and washers, and remove exhaust manifold(s), lifting bracket(s) and spark plug wire heat shields.
  - Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.
  - Inspect the manifold(s) for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service.

### Installation

1. Clean mating surfaces of exhaust manifold(s) and cylinder head(s). Apply light film of graphite grease to exhaust manifold(s).
2. Position spark plug wire heat shields and exhaust manifold(s) on cylinder heads. Install attaching bolts and washers, starting at fourth bolt hole from front of each manifold. Position lifting bracket under bolts at third exhaust port from front of engine. Tighten bolts to specifications, working from center of manifold to both ends.
3. Place new gasket(s) on inlet pipe(s). Position inlet pipe(s) to manifold(s). Install attaching nuts and tighten to specifications.
4. Start engine and check for exhaust leaks.

## WATER PUMP

### Removal

1. Drain cooling system.
2. Remove bolts attaching fan assembly to water pump and remove fan.
3. Loosen the alternator pivot bolt. Remove the two attaching bolts and spacer. Remove the belt, then rotate the bracket out of the way.
4. Disconnect the lower hose.
5. Loosen the by-pass hose clamp at the pump.
6. Remove remaining water pump attaching bolts and remove water pump from cylinder front cover. Remove separator plate from water pump. Discard gaskets.

### Installation

1. Remove any gasket material from water pump, cylinder front cover and separator plate mating surfaces.
2. Position new gaskets coated on both sides with water-resistant sealer.
3. Position water pump on cylinder front cover and install only those bolts not used to attach alternator bracket to water pump. Tighten bolts to specifications.
4. Connect lower hose and by-pass hose to water pump.
5. Place the water pump pulley on the pump.
6. Lower the fan into position. Install the fan attaching bolts and the shroud attaching bolts. Tighten the bolts to specifications.
7. Rotate the alternator bracket into position and install the two attaching bolts and spacer. Adjust the belt tension and tighten the attaching bolts to specification.
8. Fill the cooling system.
9. Start the engine and check for leaks.

## CYLINDER FRONT COVER AND TIMING CHAIN

### Removal

Cylinder front cover oil seal replacement is recommended whenever the cover has been removed.

1. Drain cooling system and crankcase.
2. Remove bolts attaching fan to water pump shaft. Remove fan.
3. Disconnect upper and lower hoses at engine.
4. Remove radiator.
5. Loosen alternator attaching bolts to relieve tension on drive belt. Remove drive belts with water pump pulley.
6. Remove the crankshaft pulley from the vibration damper.
7. Remove bolt and washer attaching crankshaft damper. Remove crankshaft damper with a puller (Figure 43). Remove Woodruff key from crankshaft.

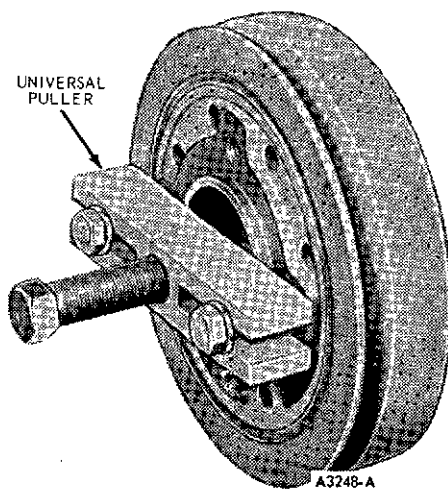


FIG. 43 Removing Crankshaft Vibration Damper

8. Loosen by-pass hose at water pump.
9. Disconnect and plug fuel inlet line at fuel pump. Disconnect fuel line to carburetor at fuel pump. Remove fuel pump.
10. Remove bolts attaching cylinder front cover to cylinder block. Using a thin-bladed knife, cut the oil pan seal flush with cylinder block face prior to separating the cover from the cylinder block. Remove cylinder front cover and water pump as an assembly. Discard cylinder front cover gasket and oil pan seal.

11. If new cylinder front cover is to be installed, remove water pump and install it and a new gasket on the new front cover.
12. Check timing chain deflection by rotating the crankshaft in a counterclockwise direction to take up the slack on the left side of the chain. (All directions are as viewed from the front of the engine.)

Establish a reference point on the block and measure from this point to the left side of the chain as shown in Figure 44.

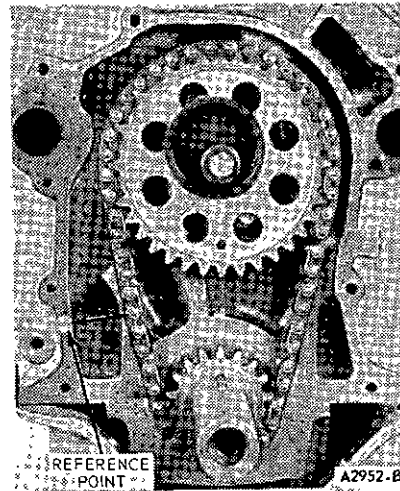


FIG. 44 Timing Chain Deflection

Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

If the deflection exceeds specifications, replace the timing chain and sprockets.

13. If the timing chain and sprocket are to be removed, crank the engine until timing marks on sprockets are as shown in Figure 45.
14. Remove camshaft sprocket cap screw, washer, two-piece fuel pump eccentric and front oil slinger. Slide timing chain and sprockets forward, and remove as an assembly (Figure 46).

Refer to Page 1-10 for cleaning and inspection procedures.

### Installation

1. Assemble the timing chain and sprockets so sprocket timing marks point directly toward each other as shown in Figure 45. Install the chain and sprockets as an assembly to crankshaft and camshaft. Verify proper alignment of timing marks after installation. Install front oil slinger.
2. Install the fuel pump eccentric, camshaft sprocket cap screw and washer. Tighten cap screw to specifications. Lubricate timing chain with engine oil.
3. Coat the gasket surface of the oil pan with sealer. Cut and position the required sections of a new seal on the oil pan. Apply sealer at the corners.
4. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.
5. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible mislocation.

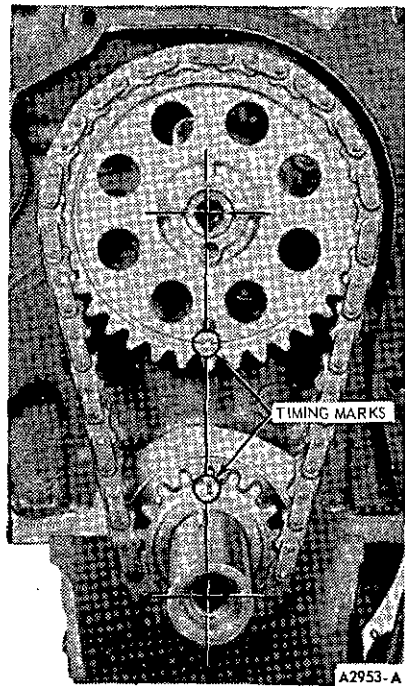


FIG. 45 Aligning Timing Marks

6. Install the cylinder front cover to seal alignment tool into proper position. It may be necessary to force the cover downward in a manner to slightly compress the pan seal. This operation can be facilitated by using a suitable tool at the attaching bolt hole locations.
7. Coat the threads of the attaching bolts with oil-resistant sealer and install the screws.
8. While pushing in on the alignment tool (Figure 47) tighten the oil pan to cover attaching bolts to specifications. Remove alignment tool. Tighten the cover to cylinder block attaching screws.
9. Apply white lead and oil mixture to front of crankshaft for damper installation.
10. Position crankshaft damper Woodruff key and install crankshaft damper (Figure 48). Install damper attaching screws and washer. Tighten to specification.
11. Install the crankshaft pulley.
12. Coat new fuel pump gasket with oil-resistant sealer and place on fuel pump. Install fuel pump. Connect fuel lines to fuel pump.
13. Install water pump pulley and all drive belts.
14. Position radiator and install attaching bolts. Connect radiator upper and lower hoses at engine. Connect oil cooler lines.
15. Position the fan on the water pump and install and tighten the attaching bolts.
16. Adjust belt tension to specifications. Tighten alternator attaching bolts.
17. If any of the coolant entered the oil pan when separating the cylinder front cover from the block, the crankcase should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.
18. Fill and bleed the cooling system. Fill the crankcase to the correct level with the recommended oil.
19. Run engine at fast idle and check for coolant and oil leaks. Adjust ignition timing and curb idle speed to specifications.

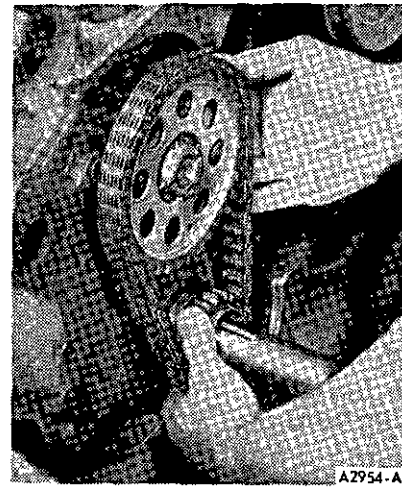


FIG. 46 Removing or Installing Timing Chain

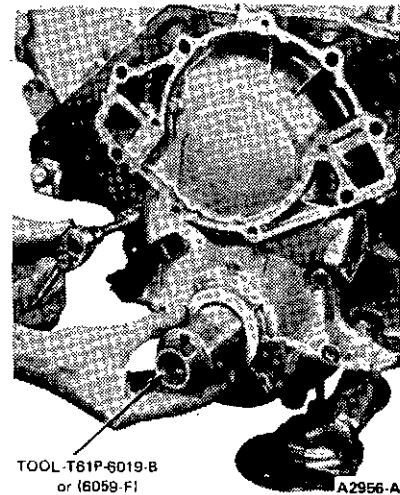


FIG. 47 Aligning Cylinder Front Cover

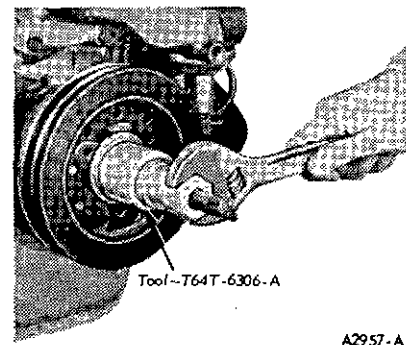


FIG. 48 Installing Crankshaft Vibration Damper

## CORE PLUGS

### Removal

To remove a large core plug, drill a 1/2 inch hole in the center of the plug and remove with a clutch pilot bearing puller (Tool T59L-100-B and T58L-101-A) or pry it out with a large drift punch. On a small core plug, drill a 1/4 inch hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

Coat the plug and/or bore lightly with an oil-resistant (oil galley) or water-resistant (cooling jacket) sealer and install it following the procedure for cup type or expansion type below:

### Installation

#### Cup Type

Cup-type core plugs (Figure 49) are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter at the outer (sealing) edge.

**It is imperative to pull the plug into the machined bore by using a properly designed tool.** Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blow out.

The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

**If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.**

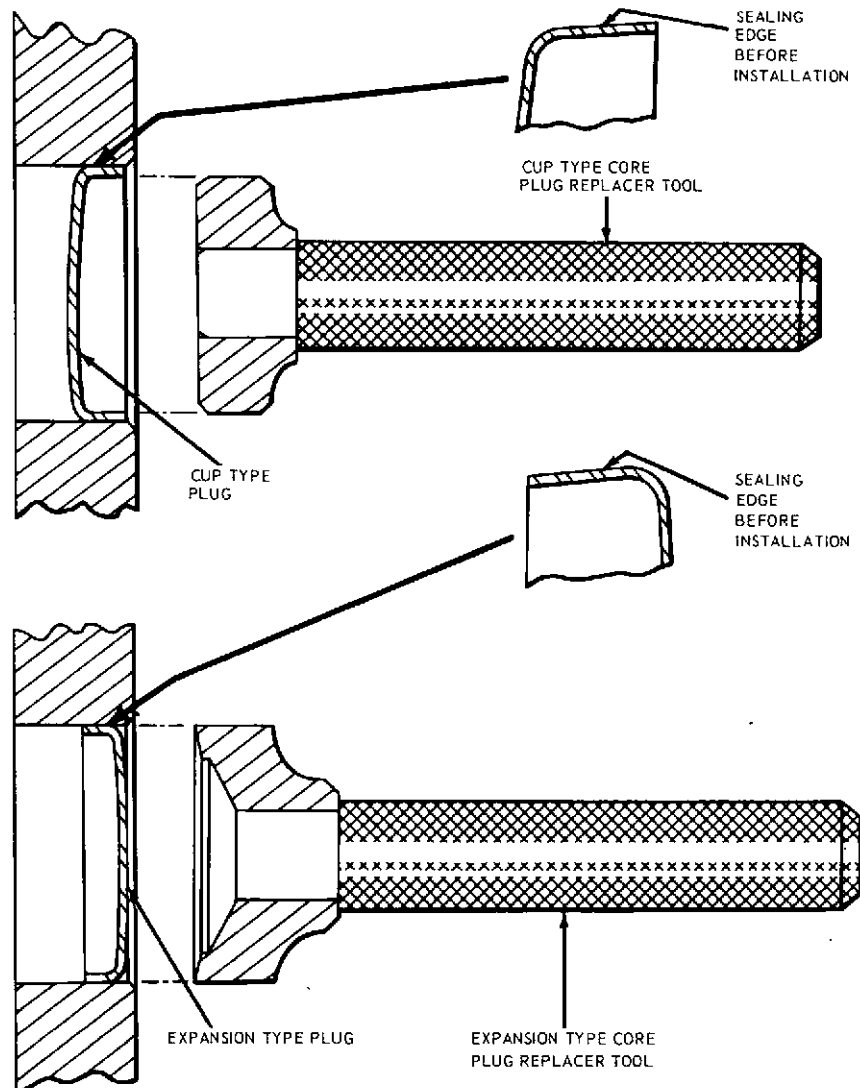
#### Expansion-Type

Expansion-type core plugs (Figure 49) are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

**It is imperative to push or drive the plug into the machined bore using a properly designed tool.** Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

When installed the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

**If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.**



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FIG. 49 Typical Core Plugs and Installation Tools

## FRONT OIL SEAL

### Removal

Replacement of the front oil seal is recommended whenever the cylinder front cover is removed.

1. Drive out the old seal with a pin punch. Clean the seal recess in the cylinder front cover.

### Installation

1. Coat a new seal with grease. Install the seal with Tool T68P-6700-A (Figure 50). After installation, be sure seal spring remains in proper position.

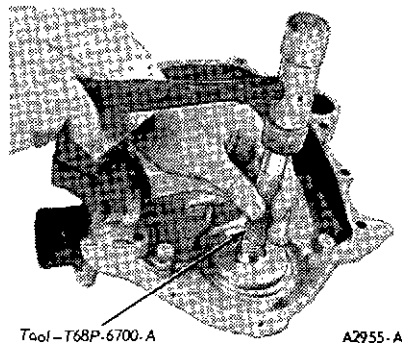


FIG. 50 Installing Front Oil Seal

## CAMSHAFT

The camshaft and related parts are shown in Figure 51.

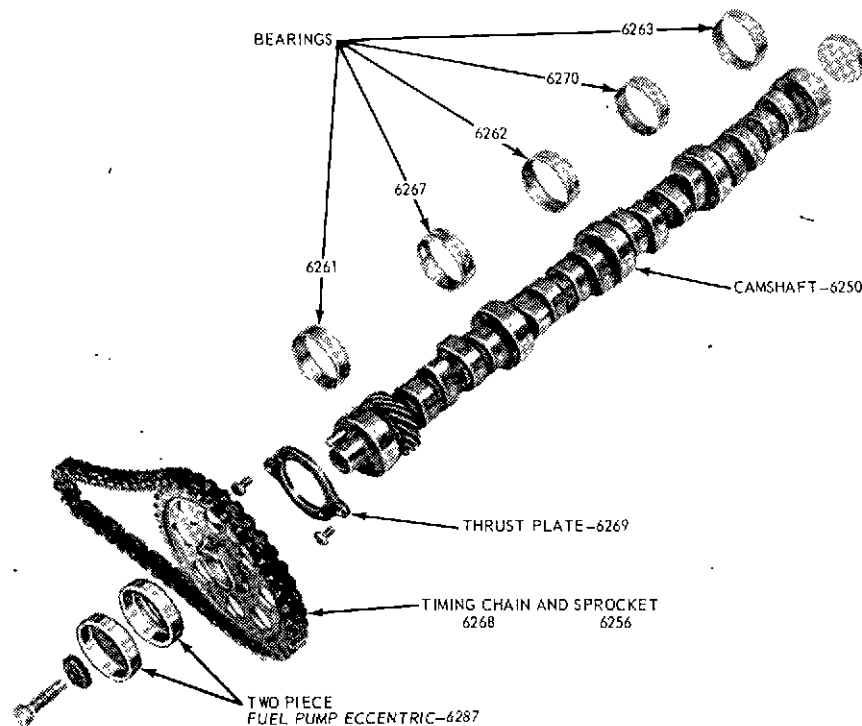
### Removal

1. Remove timing chain and sprockets, following procedure under Cylinder Front Cover and Timing Chain. Check timing chain deflection before removal.
2. Remove the intake manifold and carburetor as an assembly, following the instructions under Intake Manifold.

3. Remove valve rocker arm covers. Back off all rocker arm bolts, turn rocker arms sideways, and remove the push rods in sequence (Figure 41).
4. Remove the valve lifters with a magnet and place them in a rack in sequence. If the lifters are stuck in bores, use plier-type Tool (T52T-6500-DJD or 6500-D) to remove them. Rotate the lifter back and forth to loosen it from gum or varnish deposits.
5. Remove the camshaft thrust plate attaching bolts, and carefully remove the camshaft from the front of engine. **Do not damage the camshaft bearings.** Refer to Page 1-10 for cleaning and inspection procedures. Refer to Page 1-15 for repair procedure.

### Installation

1. Oil the camshaft journals and apply Lubriplate or equivalent to the cam lobes. Carefully slide the camshaft into position.
2. Install camshaft thrust plate. Check camshaft end play. If end play is excessive, replace the camshaft thrust plate.
3. Install timing chain, sprockets, oil slinger and cylinder front cover as detailed under Cylinder Front Cover and Timing Chain.
4. Clean the lifters externally. Lubricate the lifters and lifter bores with heavy oil SE before installing them. Lubricate the push rod ends with Lubriplate or equivalent. Install the valve lifters and push rods in their original positions.
5. Install intake manifold and carburetor, following the procedure under Intake Manifold.



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FIG. 51 Camshaft and Related Parts

6. Rotate the crankshaft damper until No. 1 piston is at TDC at the end of compression stroke. Position the distributor in the block with the rotor at No. 1 firing position and points just starting to open. Install the hold down clamp.
7. Apply Lubriplate or equivalent to valve stem tips. Position rocker arms over push rods and tighten bolts following the procedure under Valve Rocker Arm Installation. Adjust valve clearance if necessary.
8. Clean the valve rocker arm covers and cylinder head gasket surfaces. Apply oil-resistant sealer to one side of the new cover gaskets. Lay the cemented side of gaskets in place in the covers.
9. Position the covers on the cylinder heads and make sure that gaskets seat evenly. Install cover attaching bolts and tighten to specifications. Two minutes later, tighten bolts to same specifications.
10. Connect the radiator upper hose.
11. Connect the fuel line to the carburetor.
12. Install the coil and bracket assembly to intake manifold.
13. Install the throttle linkage.
14. Engage engine wiring harness in clips on left cylinder head and connect all wire terminals. Connect engine vacuum lines to their original outlets on the fitting at rear of the intake manifold. Connect PCV valve and hose to right valve rocker arm cover.
15. Install the distributor cap and connect the coil and spark plug wires.
16. Place the water pump pulley and drive belts in position. Position the fan assembly to water pump shaft and install and tighten the attaching screws to specification.
17. Adjust the tension of drive belts to specifications and tighten attaching screws.
18. Fill and bleed the cooling system. Run engine at fast idle and check for leaks.
19. Adjust the ignition timing and connect distributor vacuum line.
20. Check and adjust the carburetor idle speed and mixture as required after engine temperature has stabilized. Adjust transmission linkage, if necessary. Install the air cleaner and intake duct.

## OIL PAN

### Removal

1. Disconnect the battery ground cable.
2. Drain the crankcase.
3. Remove the oil filter.
4. Remove the oil pan attaching bolts and remove the pan. It may be necessary to rotate the crankshaft to provide clearance between the pan and crankshaft throws or counterweights.
5. Refer to cleaning and inspection procedures. Check the gasket surface for damage caused by over-tightened bolts. Straighten the surface as required to restore original flatness.

### Installation

1. Clean the gasket surfaces of the block and oil pan. Coat the block surface and the oil pan gasket surface with oil-resistant sealer. Position the oil pan gaskets on the cylinder block.
2. Position the oil pan front seal on the cylinder front cover. **Be sure that the tabs on the seal are over the oil pan gasket.**
3. Position the oil pan rear seal on the rear main bearing cap. **Be sure that the tabs on the seal are over the oil pan gasket.**
4. Hold the oil pan in place against the block and install a bolt, finger tight, on each side of the oil pan. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.

5. Install a new oil filter.
6. Connect the battery ground cable.
7. Fill the crankcase. Start the engine and check for leaks.

## OIL PUMP

### Removal

1. Remove the oil pan following the procedure under Oil Pan Removal.
2. Remove the oil pump mounting bolts and remove the pump from the cylinder block.

### Installation

1. Prime the oil pump by filling the inlet port with engine oil. Rotate the pump shaft to distribute oil within the pump body.
2. Install the distributor intermediate shaft in the oil pump rotor shaft.
3. Insert the intermediate shaft into the distributor shaft hex bore. Make certain that the intermediate shaft is properly seated. Do not force the pump into position if it will not seat readily. The intermediate shaft hex may be misaligned with distributor shaft. To align, rotate the intermediate shaft until it can be seated. Secure the oil pump to cylinder block and tighten the screws to specifications.
4. Install the oil pan and related parts following procedure under Oil Pan Installation.

## CRANKSHAFT REAR OIL SEAL

A split-lip type crankshaft rear oil seal is provided for servicing 460 engines. The complete seal is replaced without removing the crankshaft.

### Removal

1. Remove the oil pan and the oil pump (if required).
2. Loosen all the main bearing cap bolts, thereby lowering the crankshaft slightly but not to exceed 1/32 inch.
3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal use a seal removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. **Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.**
4. Remove the oil seal retaining pin from the bearing cap if so equipped. **The pin is not used with the split-lip seal.**

### Installation

1. Carefully clean the seal groove in the cap and block with a brush and solvent.
2. Dip the split lip-type seal halves in clean engine oil.
3. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Figure 52), by rotating it on the seal journal of the crankshaft until approximately 1/8 inch protrudes below the parting surface. **Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.**
4. Tighten the remaining bearing cap bolts and torque to specifications.
5. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Figure 52), allowing the seal to protrude approximately 1/8 inch above the parting surface to mate with the upper seal when the cap is installed.

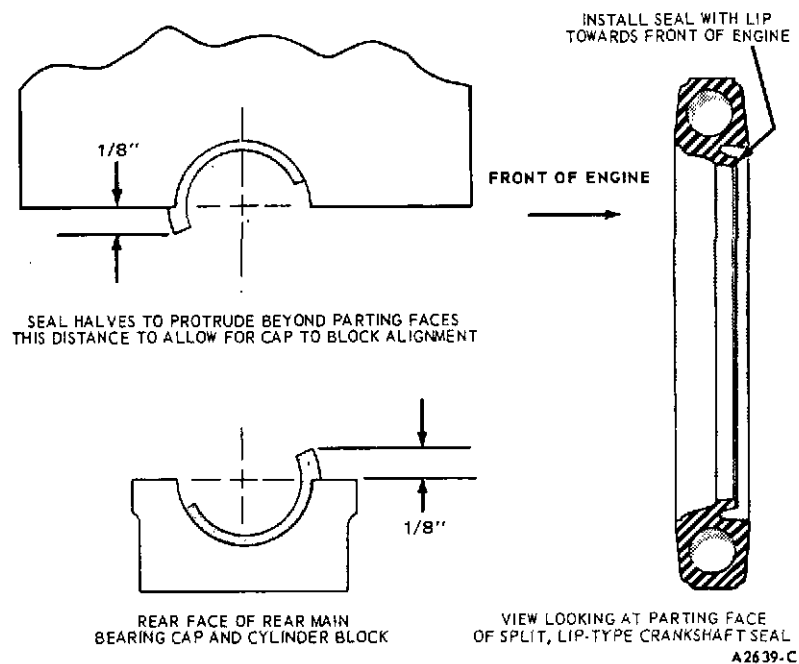


FIG. 52 Installing Crankshaft Rear Oil Seal

6. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. Do not apply sealer to the area forward of the side seal groove. Install the rear main bearing cap. Torque the cap bolts to specifications.
7. Install the oil pump and oil pan. Fill the crankcase with the proper amount and viscosity oil.
8. Operate the engine and check for oil leaks.

### MAIN BEARINGS

Main and connecting rod bearing inserts are selective fits.

Selective fit bearings are available for service in standard size, 0.001 and 0.002 inch undersize. Undersize bearings (0.010, 0.020, 0.030 and 0.040 inch), which are not selective fit, are available for use on crankshaft journals that have been refinished.

#### Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.
2. Remove the oil pump.
3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
4. Insert the upper bearing removal tool (Tool 6331) in the oil hole in the crankshaft (Figure 53).
5. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
6. Clean the crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.

#### Installation

1. To install upper main bearing, place plain end of bearing over shaft on locking tang side of block and partially install bearing so Tool 6331 can be inserted in oil hole in crankshaft. With Tool 6331 in oil hole, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

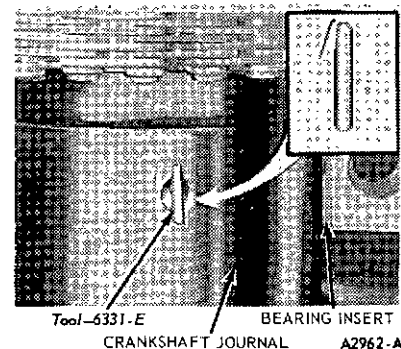


FIG. 53 Removing or Installing Upper Main Bearing Insert

2. Fit the main bearings as detailed on Page 1-15 under Fitting Bearings with Plastigage.
3. After the bearing has been fitted, apply light coat of engine oil to journal and bearings. Install the bearing cap. Tighten the cap bolts to specifications.
4. Repeat the procedure for remaining bearings that require replacement.
5. If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear oil seal.
6. Clean rear journal oil seal groove and mating surfaces of block and rear main bearing cap.
7. Install the new seal as shown in Figure 53.
8. Seal the rear main bearing cap. After sealing, install the rear main bearing cap and tighten cap bolts to specifications.
9. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of bearing (Figure 54). Hold the crankshaft forward and pry thrust bearing cap to rear. This aligns thrust surfaces of both halves of bearing. Retain forward pressure on crankshaft. Tighten cap bolts to specifications.

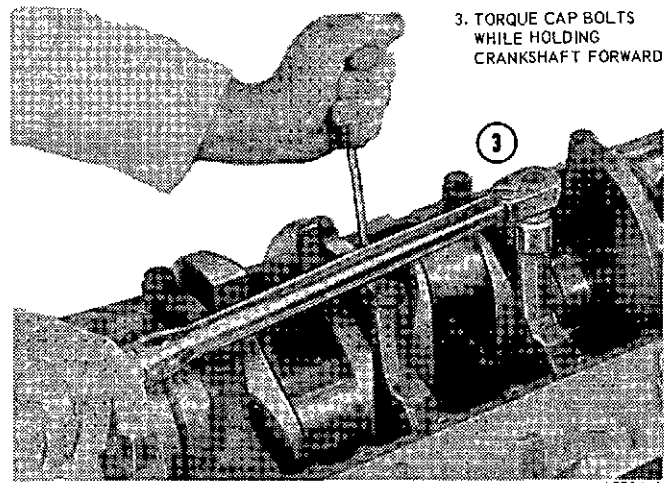
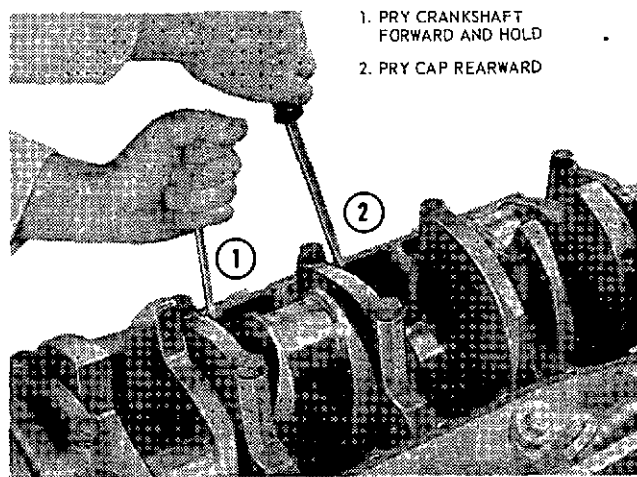


FIG. 54 Aligning Thrust Bearing

10. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump.
11. Install the oil pan following procedure under Oil Pan Installation.
12. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## CONNECTING ROD BEARING

### Removal

1. Follow steps 1 and 2 under Main Bearing Removal.
2. Turn the crankshaft until connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from rod and cap.
3. Be sure the bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure.
4. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.

### Installation

1. Fit connecting rod bearings as detailed on Page 1-15 under Fitting Bearings with Plastigage.
2. Install the bearing inserts in the connecting rod and cap with tangs in the slots provided.
3. Pull the connecting rod assembly down firmly on the crankshaft journal.
4. Apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap. Be sure the connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to specifications.
5. Repeat the procedure for the remaining connecting rods that require new bearings.
6. To complete installation, follow instructions under Main Bearing Installation.

Refer to Page 1-11 for cleaning and inspection procedures.

## PISTONS AND CONNECTING RODS

### Removal

1. Drain the cooling system and crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following procedures in this section.

2. Remove any ridge and/or deposits from upper end of cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at bottom of its travel. Place a cloth on top of the piston to collect cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. **Never cut into ring travel area in excess of 1/32 inch when removing ridges.** Repeat the procedure at the remaining cylinders.

3. Make sure that all connecting rod caps are marked so they can be installed in their original positions.
4. Turn the crankshaft until the connecting rod being removed is down.
5. Remove the connecting rod nuts and cap.
6. Push the connecting rod and piston assembly out through the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal and cylinder wall when removing the piston and rod.**
7. Remove the bearing inserts from the connecting rod and cap.
8. Install the cap on the connecting rod from which it was removed.

### Installation

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow instructions as detailed on Page 1-16.
2. Oil the piston rings, pistons and cylinder walls with light engine oil. **Be sure to install pistons in the same cylinders from which they were removed or to which they were fitted. Connecting rods and bearing caps are numbered from 1 to 4 in the right bank, and 5 to 8 in the left bank, beginning at the front of the engine. Numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**
3. Make sure that ring gaps are properly spaced around circumference of piston (Figure 55).
4. Install piston ring compressor on piston and push in with hammer handle until it is slightly below top of cylinder (Figure 56). Be sure to guide connecting rods while tapping them into position to avoid damaging crankshaft journals. **Install piston with indentation notch in piston head toward front of engine.**

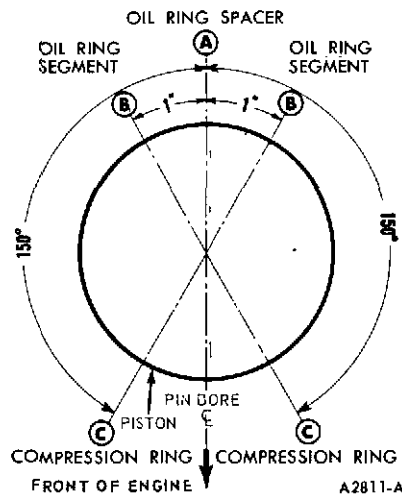


FIG. 55 Piston Ring Spacing

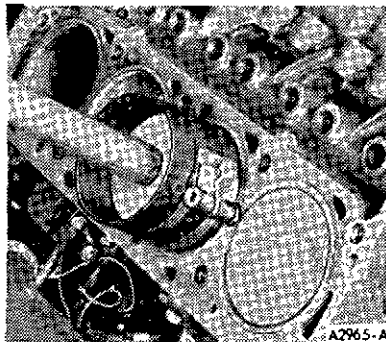


FIG. 56 Installing Piston Assy.

5. Check clearance of each bearing, following procedure under Fitting Connecting Rod Bearings.
6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
7. Turn the crankshaft throw to the bottom of the stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
8. Install the connecting rod cap. Be sure connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to specifications.
9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal.
10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen, and oil pan and the block gasket surfaces.
11. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump. Install the oil pan, following the procedure under Oil Pan Installation.
12. Install the cylinder heads, following instructions under Cylinder Head Installation.
13. Install the intake manifold, following instructions under Intake Manifold Installation.
14. Fill and bleed the cooling system: Fill the crankcase to the correct level with the specified engine oil.
15. Start the engine and adjust the ignition timing. Connect the distributor vacuum line.
16. Operate the engine at fast idle and check for oil and coolant leaks. With the engine temperatures stabilized, adjust the engine curb idle speed and mixture.
17. Install the air cleaner.

## CRANKSHAFT

To perform the following operation, it is necessary to install the engine on a work stand.

The crankshaft and related parts are shown in Figure 57.

### Removal

1. Disconnect the wires from the spark plugs. Remove the spark plugs to allow easy rotation of crankshaft.
2. Remove the fuel pump and the oil filter. Slide water pump by-pass hose clamp toward the water pump.
3. Remove the crankshaft pulley from the vibration damper.
4. Remove the cap screw and washer from the end of the crankshaft. Install a puller on the crankshaft vibration damper (Figure 47) and remove damper. Remove Woodruff key.
5. Remove the cylinder front cover and water pump as an assembly. Check the timing chain deflection. Remove the timing chain and sprockets.
6. Invert the engine on a work stand. Remove the flywheel and the engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.
7. Make sure that all bearing caps (main and connecting rod) are marked so they can be installed in their original locations.

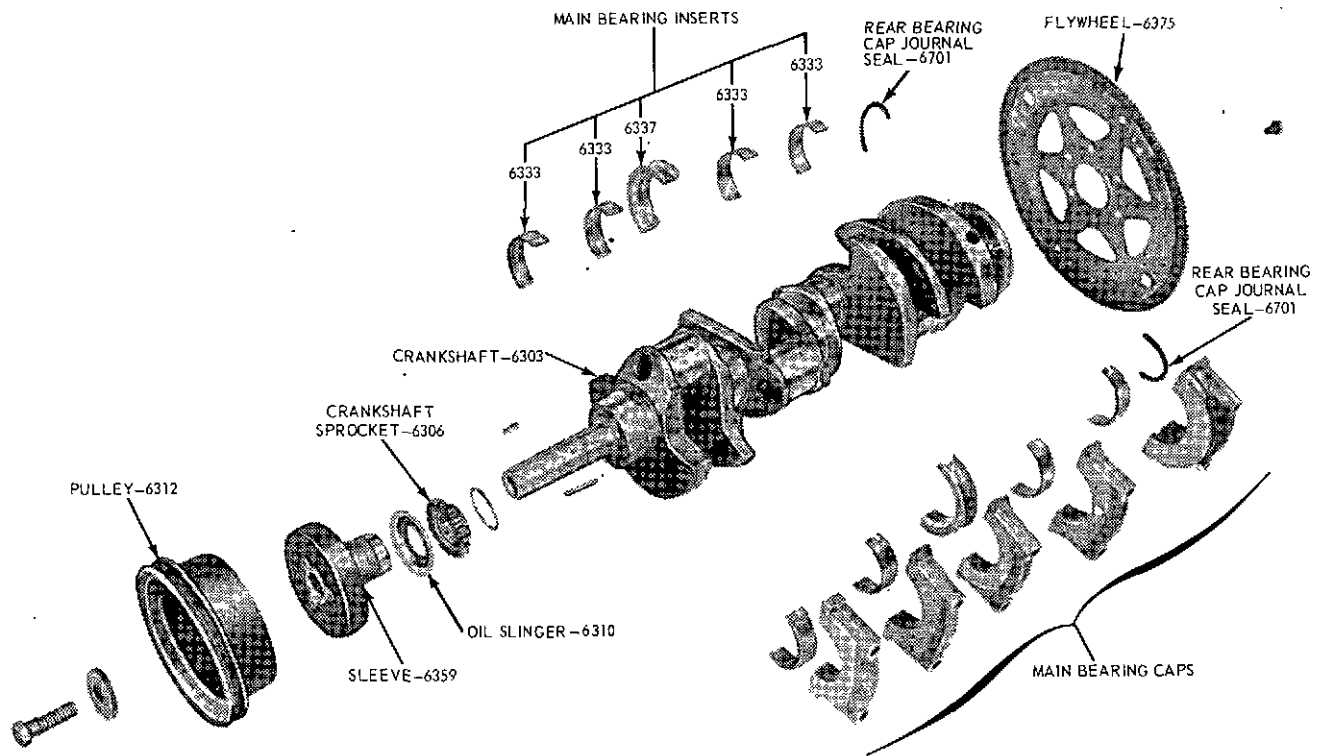
Turn the crankshaft until the connecting rod from which the cap is being removed is down, then remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.

8. Remove the main bearing caps.
9. Carefully lift the crankshaft out of the block so thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Refer to Page 1-11 for cleaning and inspection procedures. Clean the crankshaft damper.

### Installation

1. Remove the rear journal oil seal from the block and rear main bearing cap.
2. Remove the main bearing inserts from the block and bearing caps.
3. Remove the connecting rod bearing inserts from the connecting rods and caps.
4. If the crankshaft main bearing journals have been re-finished to a definite undersize, install the correct undersize bearing. Be sure that bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.
5. Place the upper main bearing inserts in the bores with tang in slot.
6. Install lower main bearing inserts in bearing caps.
7. Clean the rear journal oil seal grooves and mating surfaces of the block and rear main bearing cap.
8. Install a new rear main bearing oil seal in the block and cap.
9. Carefully lower the crankshaft into place. **Be careful not to damage bearing surfaces.**
10. Check the clearance of each main bearing.
11. After bearings have been fitted, apply a light coat of engine oil to journals and bearings. Install a new seal in the rear main bearing cap and install the rear main bearing cap. Install all bearing caps except thrust bearing cap (No 3 bearing). **Be sure that main bearing caps are installed in original locations.** Tighten the bearing cap bolts to specifications.
12. Install the thrust bearing cap with bolts finger-tight.
13. Pry the crankshaft forward against thrust surface of upper half of bearing (Figure 54).



A2970-D

FIG. 57 Crankshaft and Related Parts

14. Hold crankshaft forward and pry thrust bearing cap to rear. This aligns thrust surfaces of both halves of bearing.
15. Retain forward pressure on the crankshaft. Tighten cap bolts to specifications.
16. Force the crankshaft toward the rear of the engine.
17. Check the crankshaft end play.
18. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing.
19. After the connecting rod bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
20. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.
21. Install the connecting rod cap. Be sure that connecting rod bolt heads are properly seated in connecting rod. Tighten nuts to specifications.
22. After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each connecting rod crankshaft journal.
23. Install timing chain and sprockets, oil slinger, cylinder front cover, and crankshaft damper as detailed in Cylinder Front Cover and Timing Chain Installation.
24. Install the engine rear cover plate. Coat flywheel attaching bolt threads with oil-resistant sealer. Position flywheel on crankshaft flange. Install and tighten the bolts to specifications.
25. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling inlet port with engine oil and rotating pump shaft to distribute oil within housing. Install oil pump and oil pan by following procedures under Oil Pan and Oil Pump Installation.
26. Install the oil filter and fuel pump, and connect the fuel lines.
27. Install the spark plugs and connect the spark plug wires.

## CAMSHAFT BEARINGS

Camshaft bearings are available pre-finished to size for standard and undersize journal diameters.

### Removal

1. With engine removed and placed in a work stand, remove the camshaft, flywheel, and crankshaft, following the appropriate procedures in this part. Push pistons to top of cylinders.
2. Remove the camshaft rear bearing bore plug. Remove camshaft bearings (Figure 58).

### Installation

1. Select the proper size expanding collet and back-up nut and assemble on expanding mandrel. With the expanding collet collapsed, install the collet in the camshaft bearing and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.
2. Assemble the puller screw and extension (if necessary) as shown in Figure 58 and install on expanding mandrel. Wrap a cloth around threads of the puller screw to protect the front bearing or journal. Tighten pulling nut against the thrust bearing and pulling plate to remove camshaft bearing. Hold a wrench on the end of puller screw to prevent it from turning.
3. Repeat the procedure for each bearing. To remove the front bearing, install puller screw from rear of cylinder block.
4. Position new bearings at bearing bores, and press in place with the tool shown in Figure 58. Be sure to center the pulling plate and puller screw to avoid bearing damage.

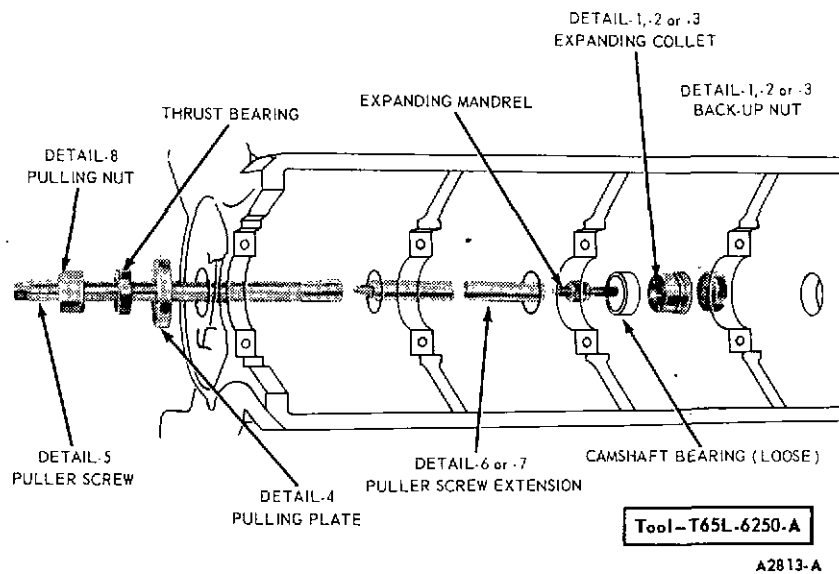


FIG. 58 Replacing Camshaft Bearing

**Failure to use correct expanding collet can cause severe bearing damage.** Align oil holes in bearings with oil holes in cylinder block before pressing them into block. Be sure front bearing is installed specified distance below front face of cylinder block (Figure 59).

5. Install core plug.
6. Install the camshaft, crankshaft, flywheel and related parts; following appropriate procedures in this part, except do not check connecting rod and main bearing clearances.

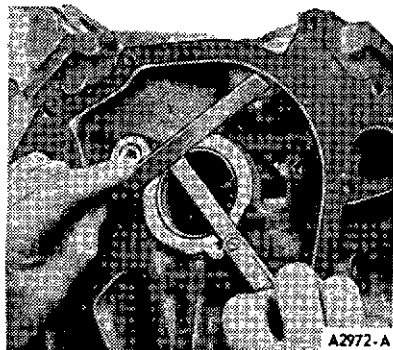


FIG. 59 Measuring Depth of Camshaft Front Bearing

## OIL FILTER

### Removal

The oil filter assembly is shown in Figure 60.

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting and clean the adapter recess. Clean the oil filter gasket surface.

### Installation

1. Coat the gasket on a new filter with oil. Place the filter on the adapter fitting. Hand tighten the filter until the gasket contacts the sealing surface, then tighten 1/2 turn more.
2. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase to the correct level.

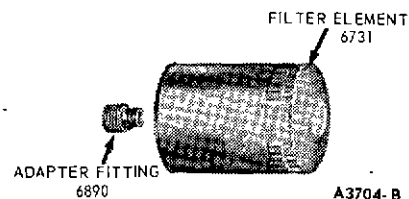


FIG. 60 Oil Filter

## DISASSEMBLY AND ASSEMBLY

When installing nuts or bolts that must be tightened refer to specifications. Oil the threads with light engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

### VALVE LIFTER

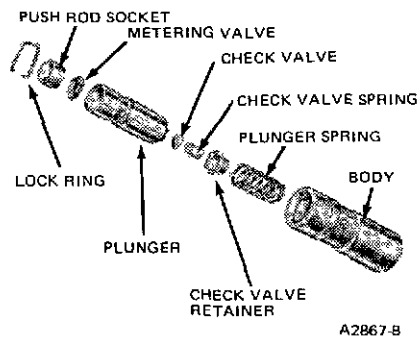
Each lifter is a matched assembly. If parts of one are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Valve lifters should be tested after assembly as described

on Page 1-06. Keep the lifter assemblies in proper sequence so they can be installed in their original bores.

### Disassembly

Hydraulic valve lifter assembly is shown in Figure 61.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.



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FIG. 61 Hydraulic Valve Lifters

2. Remove the push rod cup, metering valve (disc), plunger and spring.
3. Remove the plunger assembly and the plunger spring. Carefully remove the plunger spring, check valve retainer spring, check valve retainer and check valve disc from the plunger.

Refer to Page 1-10 for cleaning and inspection procedures.

#### Assembly

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring then push the retainer down into place on the plunger.
4. Place the plunger spring and the plunger (open end up) into lifter body.
5. Position the metering valve (disc) in the plunger, and place push rod seat in the plunger.
6. Depress the plunger and position the closed end of lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
7. Use a hydraulic valve lifter leak-down tester to fill the lifter with test fluid.

### CYLINDER HEAD

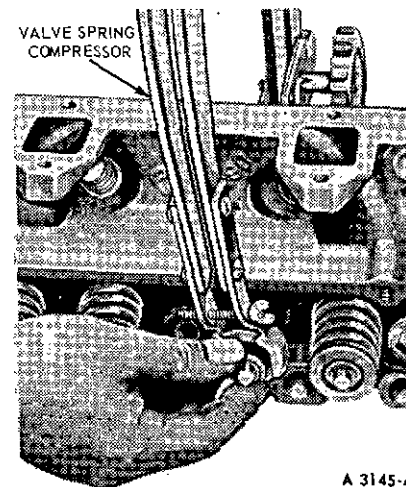
#### Disassembly

1. With cylinder head removed from engine, remove rocker arm bolts, oil deflectors, fulcrum seats, and rocker arms. Remove exhaust manifolds and spark plugs.
  2. Clean carbon from combustion chambers before removing valves.
  3. Compress valve springs (Figure 62). Remove spring retainer locks and release springs. Remove retainers, springs, stem seals, and valves. Discard stem seals.
- Clean and inspect cylinder head(s) and related components, using pertinent procedures in this section.

Refer to Page 1-14 for repair procedures for cylinder heads and valves.

#### Assembly

Lubricate all valves, valve stems and valve guides with heavy oil SE. The valve tips are to have Lubriplate or equivalent applied. The lubricant is to be applied before installation.



A 3145-A

FIG. 62 Compressing Valve Spring-On Bench

1. Install each valve in port from which it was removed or to which it was fitted. Install new stem seal on each valve.
2. Set valve spring and retainer over valve stem. Compress spring (Figure 62) and install retainer locks.
3. With dividers, measure assembled height of valve spring from surface of spring pad on cylinder head to underside of spring retainer (Figure 63). Check dividers with accurate scale. If assembled height exceeds specifications, install spacer(s) below spring to reduce height to recommended dimension. **Reducing assembled height below specifications can cause spring breakage and rapid wear of cam lobe.**
4. Coat the fulcrum seats and sockets with Lubriplate. Make certain that the rocker arm bolts are in a serviceable condition before installing them. Install rocker arms, fulcrum seats, oil deflectors and bolts as detailed under Valve Rocker Arm Installation.
5. Install exhaust manifolds and spark plugs.

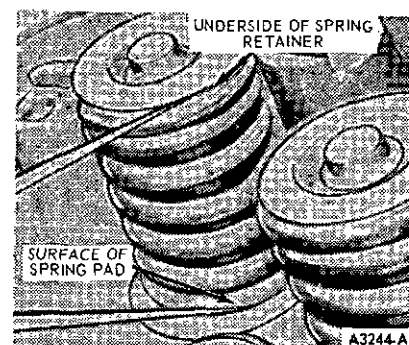
### PISTON AND CONNECTING ROD

#### Disassembly

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons to assure assembly with same rod and installation in the same cylinders from which they were removed.
3. Using an arbor press and the tool shown in Figure 64, press the piston pin from the piston and connecting rod. Remove the piston rings.

Refer to Page 1-11 for cleaning and inspection procedures.

Refer to Page 1-15 for repair procedures.



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FIG. 63 Measuring Valve Spring Assembled Height

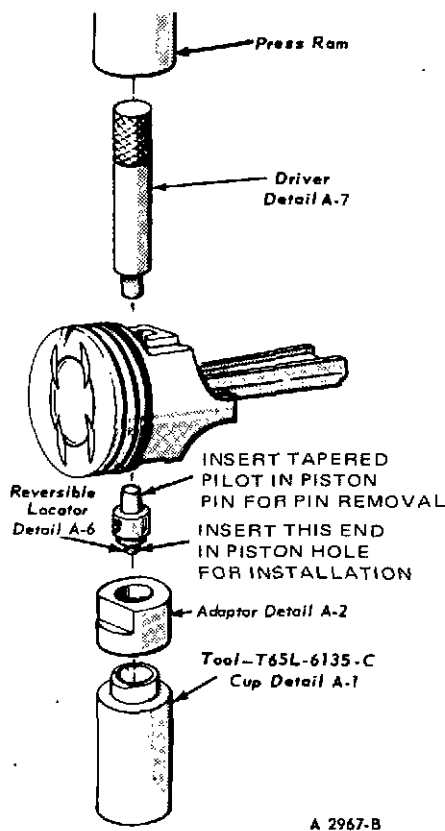


FIG. 64 Removing or Installing Piston Pin

### Assembly

Check the fit of a new piston in the cylinder bore before assembling piston and piston pin to connecting rod. Piston pin bore of connecting rod and diameter of piston pin must be within specifications.

1. Apply a light coat of engine oil to all parts. Assemble the piston to the connecting rod with the cylinder number side of the connecting rod and indentation notch in piston positioned as shown in Figure 65.

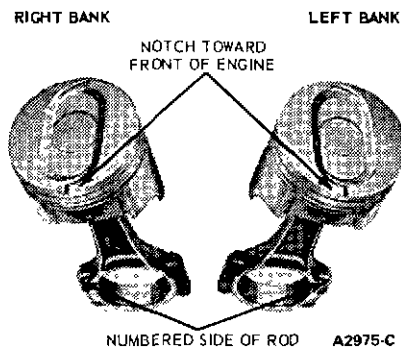


FIG. 65 Correct Piston and Rod Position

2. Start the piston pin in the piston and the connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the end of pin is 1/16 inch to 1/8 inch below chamfer of the pin bore in the piston.
3. Check the end gap of all piston rings. End gap must be within specifications. Follow the instructions contained on piston ring package and install the piston rings.

4. Check the ring side clearance of compression rings with a feeler gauge inserted between the ring and the lower land. Feeler gauge should slide freely around the ring circumference without binding. Any wear will form a step at the inner portion of the lower land. If the lower lands have high steps, replace the piston.
5. Be sure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

## OIL PUMP

### Disassembly

1. Remove the four screws and washers securing the oil pump cover to the oil pump.
2. Remove the oil pump outer rotor and rotor shaft assembly from the oil pump housing.
3. Remove the cotter pin that secures the relief valve plug in the oil pump housing. To remove the plug, drill a small hole and insert a self-tapping screw in the relief valve plug. Use pliers to remove plug from oil pump housing (Figure 66). Use care to prevent the loss of the relief valve spring.
4. Remove the spring and relief valve from the oil pump housing.

Refer to Page 1-13 for cleaning and inspection procedures.

### Assembly

1. Install the relief valve, spring and the relief valve plug in the oil pump housing. Press the plug inward until it seats; then, install the cotter pin.
2. Install the outer rotor and rotor shaft in the housing. Be sure that the identification mark on the outer rotor is on the same side as the identification mark on the inner rotor. These parts are matched sets and should only be replaced as an assembly. Fill the housing with engine oil for priming purposes.

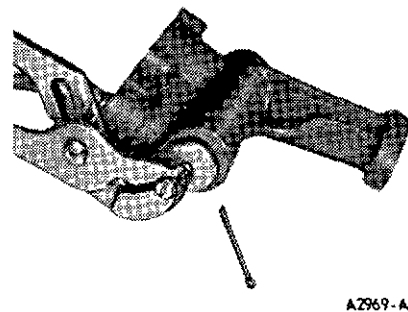


FIG. 66 Removing Oil Pump Relief Valve Plug

## CYLINDER ASSEMBLY

### Disassembly

1. Mount the old engine in a work stand and remove all the parts not furnished with the new cylinder assembly, following the procedures given under Removal and Installation.
2. Remove the four cylinder head locating dowels and the block drain plugs.
3. Remove the old cylinder assembly from the work stand.

**Assembly**

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly in a work stand and install the cylinder head locating dowels and block drain plugs.
3. Transfer all serviceable parts removed from the old cylinder assembly, following the procedures given under Removal and Installation.
4. Check all assembly clearances and correct as necessary.

**CYLINDER BLOCK**

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following the procedures given of Page 1-16.

**Disassembly**

1. Mount the old engine in a work stand and completely disassemble it, following the procedures given under Removal and Installation.
2. Remember to ridge-ream the cylinder bores before removing piston assemblies.
3. Remove the cylinder head locating dowels and the block drain plugs.

**Assembly**

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block in a work stand and install the cylinder head locating dowels and the block drain plugs.
3. Transfer all serviceable parts removed from the old cylinder block, following the procedures given under Removal and Installation.
4. Check all assembly clearances and correct as necessary.

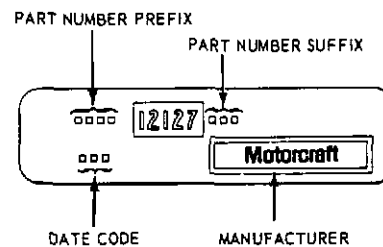
## Part 2 Ignition System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
IDENTIFICATION .....	2-01	Breaker Points and/or	
DESCRIPTION AND OPERATION .....	2-01	Condenser .....	2-08
DIAGNOSIS AND TESTING .....	2-02	Vacuum Advance Unit .....	2-08
Spark Intensity Tests .....	2-02	Spark Plug Wire .....	2-08
Ignition System Tests .....	2-03	Spark Plugs .....	2-08
Distributor Tests — On Vehicle .....	2-04	Distributor .....	2-09
Distributor Tests — Off Vehicle .....	2-04	Breaker Plate and Sub-Plate .....	2-10
ADJUSTMENTS (Industrial Engines) ...	2-05	CLEANING AND INSPECTION .....	2-10
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Dual-Advance Distributor .....	2-06	PRESTOLITE DISTRIBUTORS	
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Condenser .....	2-07	Description and Operation .....	2-12
REMOVAL AND INSTALLATION		Adjustments and Repairs .....	2-12
(Industrial Engines) .....	2-08	Major Repair Operations .....	2-13

### IDENTIFICATION

The distributor identification number is stamped on the distributor housing. The basic part number for distributors is 12127. To procure replacement parts, it is necessary to know the part number prefix and suffix (Figure 1).

Always refer to the Parts Catalog for parts usage and interchangeability before replacing a distributor or a component part for a distributor.



BS401-A

FIG. 1 Distributor Identification

### DESCRIPTION AND OPERATION

The 460 engines use a conventional ignition system.

The direction of distributor rotation is counterclockwise as viewed from the top of the distributor (on Marine reverse rotating engines, the distributor rotation is clockwise).

The spark plug wires are inserted in the distributor cap in the firing order of the engine, 1-5-4-2-6-3-7-8. (Marine engines are either standard rotation, 1-5-4-2-6-3-7-8 or reverse rotation, 1-8-7-3-6-2-4-5.) Number one socket is identified by the number one on the cap. The cylinders are numbered from front to rear — right bank, 1-2-3-4, left bank, 5-6-7-8.

The distributor used on the 460 Industrial engines is the dual advance type (Figure 2) with two independently operated spark advance systems. (Marine and Irrigation engines use a Prestolite distributor which is covered later in this section.)

use a Prestolite distributor which is covered later in this section.

A vacuum operated spark advance control diaphragm is located on the side of the distributor base. A centrifugal advance mechanism is located beneath the stationary sub-plate assembly.

The diaphragm is connected to the movable breaker plate by a link. An increase in vacuum will move the diaphragm against the advance diaphragm spring tension, causing the movable breaker plate to pivot opposite the distributor rotation. Thus, ignition timing is advanced, and this is calculated to occur during normal load operation, but not during deceleration or idle.

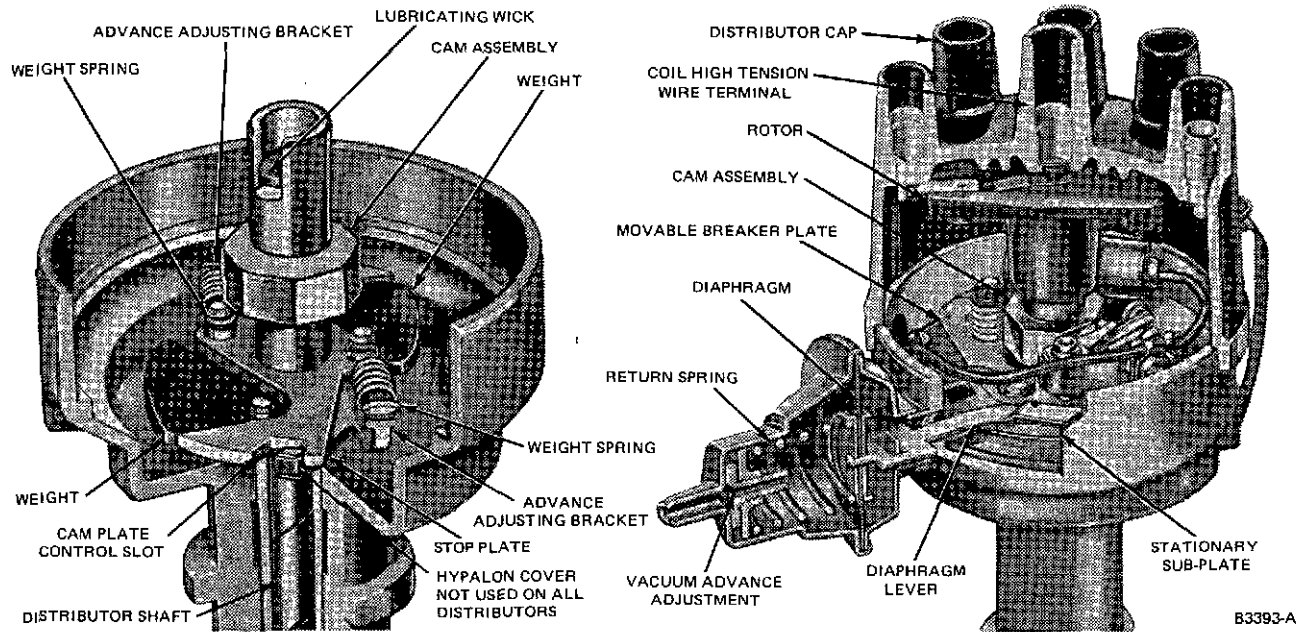


FIG. 2 Dual Advance Distributor

### CIRCUIT OPERATION

The ignition system consists of a primary (low voltage) and a secondary (high voltage) circuit (Figure 3).

The primary consists of the:

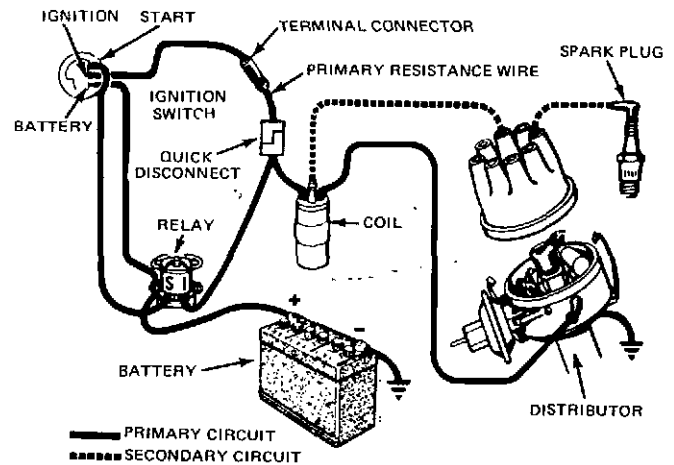
1. Battery.
2. Ignition switch.
3. Primary circuit resistor.
4. Primary windings of the ignition coil.
5. Breaker points.
6. Condenser.

The secondary circuit consists of the:

1. Secondary windings of the ignition coil.
2. Distributor rotor.
3. Distributor cap.
4. High tension (spark plug) wires.
5. Spark plugs.

When the breaker points are closed, current flows from the battery through the ignition switch to the primary windings in the coil, then to ground through the closed breaker points. When the breaker points open, the magnetic field built up in the primary windings of the coil moves through the secondary windings of the coil, producing high voltage.

**High voltage is produced each time the breaker points open.** The high voltage flows through the coil high tension lead to the distributor cap where the rotor distributes it to one of the spark plug terminals in the distributor cap. This process is repeated for every power stroke of the engine.



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FIG. 3 Typical Ignition System Circuits

## DIAGNOSIS AND TESTING

Ignition systems troubles are caused by a failure in the primary and/or the secondary circuit; incorrect ignition timing; or incorrect distributor advance. Circuit failures may be caused by shorts, corroded or dirty terminals, loose connections, defective wire insulation, cracked distributor cap or rotor, defective distributor points, fouled spark plugs, or by improper dwell angle.

If engine starting or operating trouble is attributed to the ignition system, start the engine and verify the complaint. On engines that will not start, be sure there is gasoline in the fuel tank and that fuel is reaching the carburetor. Then locate the ignition system problem by an oscilloscope test or by a spark intensity test.

## SPARK INTENSITY TESTS

### Trouble Isolation

1. Connect an auxiliary starter switch in the starting circuit.
2. Remove the coil high tension lead from the distributor cap.
3. Turn on the ignition switch.
4. While holding the high tension lead approximately 3/16 inch from the cylinder head or any other good ground, crank the engine with an auxiliary starter switch.

If the spark is good, the trouble lies in the secondary circuit.

If there is no spark or a weak spark, the trouble is in the primary circuit, coil to distributor high tension lead, or the coil.

### Primary Circuit

A breakdown or energy loss in the primary circuit can be caused by: defective primary wiring, or loose or corroded terminals; burned, shorted, sticking or improperly adjusted breaker points; an open or shorted coil; or condenser.

A complete test of the primary circuit consists of checking the circuit from the coil to ground, and the starting ignition circuit.

Excessive voltage drop in the primary circuit will reduce the secondary output of the ignition coil, resulting in hard starting and poor performance.

To isolate a trouble in the primary circuit, use a voltmeter and perform the following tests: Battery to Coil, Starting Ignition Circuit, Coil to Ground, or Breaker Points.

### Secondary Circuit

A breakdown or energy loss in the secondary circuit can be caused by: fouled or improperly adjusted spark plugs; defective high tension wiring or high tension leakage across the coil, distributor cap or rotor resulting from an accumulation of dirt.

To check the spark intensity at the spark plugs, thereby isolating an ignition problem to a particular cylinder, proceed as follows:

1. Disconnect a spark plug wire. **Check the spark intensity of one wire at a time.**
2. Install a terminal adapter in the terminal of the wire to be checked. Hold the adapter approximately 3/16 inch from the exhaust manifold and crank the engine, using an auxiliary starter switch. The spark should jump the gap regularly.
3. If the spark intensity of all the wires is satisfactory, the coil, condenser, rotor, distributor cap and the secondary wires are probably satisfactory.

If the spark is good at only some wires, check the resistance of those particular leads.

If the spark is equal at all wires, but weak or intermittent, check the coil, distributor cap and the coil to distributor high tension wire. The wire should be clean and bright on the conducting ends, and on the coil tower and distributor sockets. The wire should fit snugly and be bottomed in the sockets.

## IGNITION SYSTEM TESTS

### Battery to Coil Voltmeter Test

1. Connect the voltmeter leads as shown in Figure 4.
2. Connect a jumper wire to the distributor terminal of the coil and to a good ground on the distributor housing.
3. Turn the accessories off.
4. Turn the ignition switch on.
5. If the voltmeter reading is between 4.5 and 6.9 volts, the primary circuit from the battery to the coil is satisfactory.
6. If the voltmeter reading is greater than 6.9 volts, check the following:
  - The battery and cables for loose connections or corrosion
  - The resistance wire for damage
  - The primary insulation, broken strands, and loose or corroded terminals
  - The starter-relay-to-ignition switch for damage

If the voltmeter reading is less than 4.5 volts, the ignition resistor should be replaced.

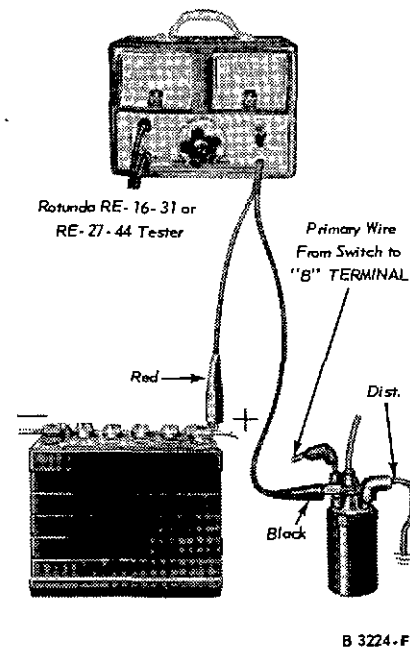


FIG. 4 Battery-to-Coil and Starting Ignition Circuit Test

### Starting Ignition Circuit Voltmeter Test

1. Connect the voltmeter leads as shown in Figure 4.
2. Disconnect and ground the coil to distributor high tension lead at the distributor.
3. With the ignition switch off, crank the engine with an auxiliary starter switch while observing the voltage drop.
4. If the voltage drop is 0.4 volt or less, the starting ignition circuit is satisfactory.
5. If the voltage drop is greater than 0.4 volt, clean and tighten the terminals in the circuit or replace the wiring as necessary.

### Coil to Ground Voltmeter Test

1. Connect the voltmeter leads as shown in Figure 5.
2. Close the breaker points.
3. Turn all lights and accessories off.
4. Turn the ignition switch on.
5. If the voltmeter reading is 0.25 volt or less, the primary circuit from coil to ground is satisfactory.
6. If the voltmeter reading is greater than 0.25 volt, test the voltage drop between each of the following:
  - The coil and the breaker point connections of the coil to distributor primary wire
  - The movable breaker point and the breaker plate
  - The breaker plate and the distributor housing
  - The distributor housing and engine ground.
7. Turn the ignition switch off. Disconnect the voltmeter leads.

### Breaker Points Check

Clean and inspect the breaker points by following the procedure under Cleaning and Inspection, page 2-10.

The breaker point dwell can be checked with a distributor tester or a dwell meter by following the procedure under Distributor Tests.

The breaker point resistance can be checked with a distributor tester by following the procedure under Distributor Tests on page 2-05.

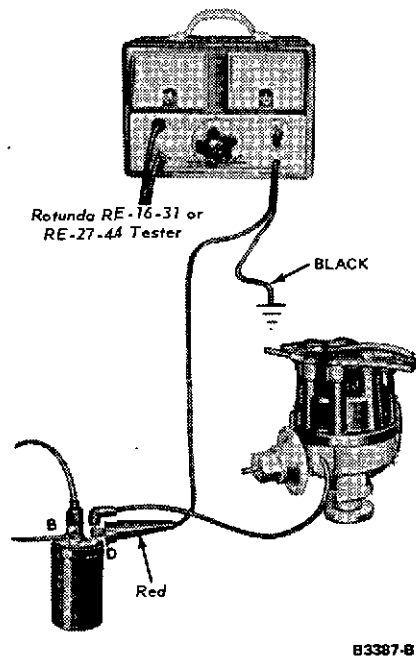


FIG. 5 Coil-to-Ground Test

### Coil Test

Check the coil on a coil tester following the manufacturer's instructions. Check for ohms resistance both primary and secondary. Also check the amperage draw both with the engine idling and stopped. These checks should all fall within specifications.

### Secondary (High Tension) Wires Resistance Test

The secondary wires include the wires connecting the distributor cap to the spark plugs and the wire connecting the center terminal of the distributor cap to the center terminal of the ignition coil.

These wires are the radio resistance-type which filter out the high frequency electrical impulses that are the source of ignition noise interference. The resistance of each wire should not exceed 5000 ohms per inch. **When checking the resistance of the wires or setting ignition timing, do not puncture the wires with a probe. The probe may cause a separation in the conductor.**

When removing the wires from the spark plugs, grasp and twist the moulded cap, then pull the cap off the spark plug by hand only. Do not pull on the wire because the wire connection inside the cap may become separated or the insulator may be damaged.

To check the spark intensity at the spark plugs, proceed as follows:

1. Disconnect a spark plug wire. **Check the spark intensity of one wire at a time.**
2. Install a terminal adapter in the terminal of the wire to be checked. Hold the adapter approximately 3/16 inch from the exhaust manifold and crank the engine, using an auxiliary starter switch. The spark should jump the gap regularly.
3. If the spark intensity of all the wires is satisfactory, the coil, condenser, rotor, distributor cap and the secondary wires are probably satisfactory.

If the spark is good at only some wires, check the resistance of those particular leads.

If the spark is equal at all wires, but weak or intermittent, check the coil, distributor cap and the coil to distributor secondary (high tension) wires.

### Spark Plug Test

Inspect, clean, file the electrodes and gap the plugs. After the proper gap is obtained, check the plugs on a testing machine. Compare the sparking efficiency of the cleaned and gapped plug with a new plug. Replace the plug if it fails to meet 70 percent of the new plug performance.

### DISTRIBUTOR TESTS — ON VEHICLE TEST CONNECTIONS

1. Disconnect the distributor primary wire at the coil. Connect a short jumper wire to the DIST terminal of the coil and the distributor primary wire. Connect the red lead to the jumper wire.
2. Connect the black lead to a good ground on the engine.

### Dwell Angle Check

1. Disconnect and plug the distributor vacuum line. Connect the tester.
2. Turn the test control knob to the set position.
3. Adjust the set control knob until the needle on the dwell meter lines up with the set line.
4. Start the engine and let it idle.
5. Turn the test control knob to the 8 CYL position.
6. Read the dwell angle on the dwell meter and compare the reading to specifications.
7. Turn off the engine.
8. If the dwell angle was below the specified amount, the breaker point gap is too wide. If the dwell angle was above the specified amount, the breaker point gap is too close.

If the dwell is to specifications, turn the test selector knob to the OFF position and disconnect the tester leads and jumper wire; then connect the distributor vacuum line.

### Dwell Angle Adjustment

If the dwell angle is not within specifications, proceed as follows:

1. Remove the coil high tension lead from the distributor and ground it.
2. Remove the distributor cap and place it out of the way. Remove the rotor.
3. Connect an auxiliary starter switch in the circuit.
4. Loosen the breaker point assembly retaining screw near the breaker point contacts.
5. With the ignition on, crank the engine with an auxiliary starter switch and adjust the gap to specifications.
6. Release the auxiliary starter switch and tighten the breaker point attaching screw.
7. Since the adjustment may have changed when the attaching screw was tightened, crank the engine again with the auxiliary starter switch and check the dwell. When the dwell is properly adjusted, remove the jumper wire, auxiliary starter switch and tester leads and install the rotor, distributor cap, coil high tension lead and starter relay wires. Connect the distributor vacuum line.

### DISTRIBUTOR TESTS — OFF VEHICLE

#### Distributor Shaft End Play

If the shaft end play is not to specifications, check the location of the collar on the distributor shaft.

1. Remove the distributor from the engine.
2. Place the distributor in the holding tool and clamp it in a vise.
3. Push the distributor shaft downward as far as it will go, and check the end play with a feeler gauge placed between the collar and the distributor base. The end play should be within the specified limits. If the shaft end play is not to specifications, check the location of the distributor shaft collar.

### General Principles for Testing

The following instructions indicate the general principles to be followed for testing the distributor on a tester. The method of testing, however, may vary for machines of different manufacture. For specific instructions refer to the equipment manufacturer's handbook.

1. Mount the distributor on the tester. Check that the distributor is free to rotate.
2. Make the necessary electrical connections and zero the instrument if required.
3. Tighten the drive chuck to the distributor drive shaft securely.
4. Rotate the drive chuck by hand to make sure the distributor shaft turns freely and then tighten the locking screw on the distributor support arm.
5. Connect the Synchograph test lead to the primary lead wire of the distributor.

### Breaker Point Resistance

1. Turn the test selector to the position for checking resistance.
2. Rotate the chuck by hand until the distributor breaker contacts are closed.
3. The pointer on the cam angle meter should read in the OK zone of the meter scale. If the meter pointer does not fall in the OK zone, there is excessive resistance caused by a faulty contact across the distributor points, a damaged primary lead, or a poorly grounded base plate. A faulty contact across the distributor points indicates improper spring or burned or pitted points.

### Insulation and Leakage

1. Turn the test selector to the cam angle position and rotate the chuck by hand until the distributor breaker contacts are open.
2. The cam angle meter should show a zero reading. If a zero reading is not obtained, a short circuit to ground exists.

A short could be caused by poor primary wire insulation, a shorted condenser or a short between the breaker arm and breaker plate.

### Mechanical Operation

1. Manually check the advance mechanism by turning the rotor in the direction of distributor rotation and then releasing it. The rotor will return to its original position if the mechanism has freedom of movement and the springs are in good condition.

2. Make the necessary connections for the stroboscopic timing light or sparking protractor. (Refer to equipment manufacturer's handbook).
3. Adjust the speed control to vary the distributor speed between 400 and 4000 engine rpm, or at the maximum speed of the engine on which the distributor is used. Erratic or faint flashes of light preceding the regular flashes as the speed of rotation is increased can be due to weak breaker arm spring tension or binding of the breaker arm on the pivot pin.
4. Operate the distributor at approximately 2500 engine rpm and move the protractor scale so that the zero degree mark on the scale is opposite one of the neon flashes. The balance of all the flashes should come within 1 degree, plus or minus, evenly around the protractor scale. A variation larger than 1 degree or erratic or wandering flashes may be caused by a worn cam or distributor shaft or a bent distributor shaft.

### Breaker Plate Wear

A worn breaker plate on the distributor will usually cause the breaker point gap and contact dwell to be erratic as engine speed and load conditions are varied.

Adjust the test set to 0 degree advance, 0 inches vacuum, and 1000 rpm. Adjust the dwell angle to 26 degrees. Apply vacuum to the distributor diaphragm and increase it very slowly while observing the indicated dwell angle. The maximum dwell angle variation should not exceed 4 degrees when going from zero to maximum vacuum at constant rpm. If the dwell angle variation exceeds this limit, there is excessive wear.

### Distributor Spark Advance Test

The spark advance is checked to determine if the ignition timing advances in proper relation to engine speed and load.

1. Check the contact dwell. If the contact dwell is not within specifications, adjust the breaker points.
2. Check the breaker arm spring tension and adjust it or replace the points as necessary.

The dual advance distributor has two independently operated spark advance systems. Each system is adjusted separately. **Adjust the centrifugal advance before adjusting the vacuum advance.**

## ADJUSTMENTS (INDUSTRIAL ENGINES)

Accurate ignition system adjustments are of great importance in the proper operation and performance of the engine.

After any adjustment of ignition timing and distributor point dwell, check the distributor automatic advance for proper operation.

Carburetor fuel mixture and idle speed adjustments should be checked after making ignition system adjustments. The crankcase ventilation system and vacuum system must also be in good operating condition.

## IGNITION TIMING TIMING MARK LOCATIONS

Each time the distributor points are replaced or adjusted, the ignition timing should be checked and adjusted as necessary. Proper adjustment of the ignition timing must be maintained to provide maximum engine power output and best possible fuel economy.

The timing marks are their locations and are illustrated in Figure 6.

For checking and adjusting the ignition timing with a scope refer to the scope manufacturer's instructions. To check and adjust the timing with a timing light, proceed as follows:

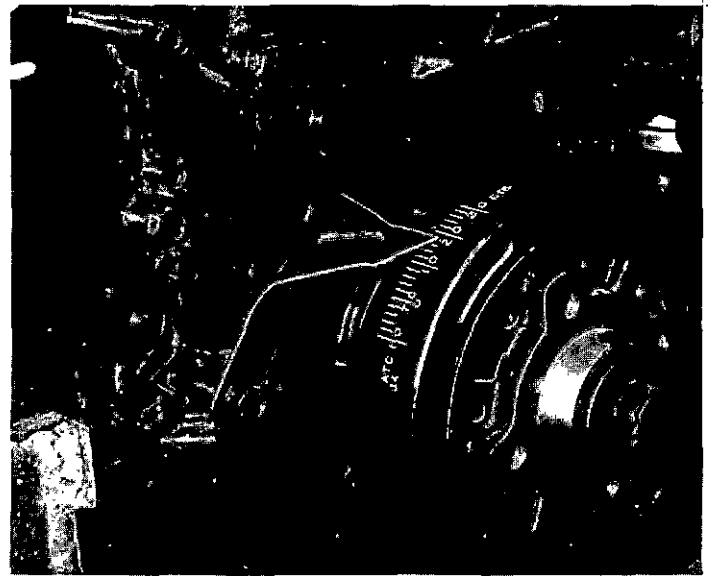
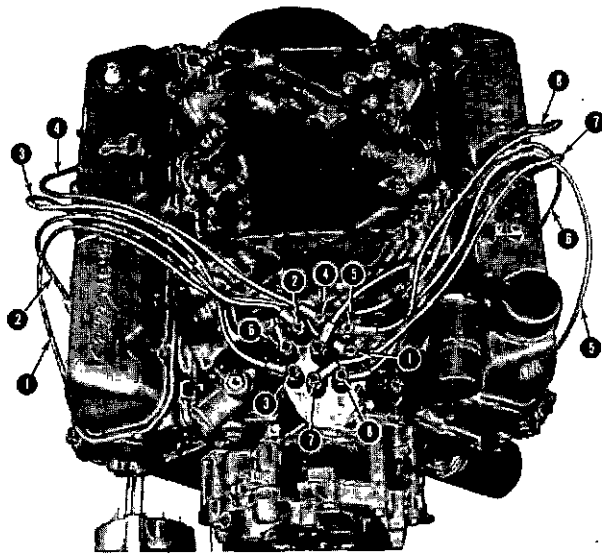


FIG. 6 Engine Timing and Cylinder Firing Order — Typical — Industrial and Irrigation Engines

### Initial Ignition Timing

1. Clean and mark the specified timing mark with chalk or white paint.
2. Disconnect the vacuum line and plug the disconnected vacuum line.
3. Connect a timing light to the No. 1 cylinder spark plug wire. Connect a tachometer to the engine.
4. Start the engine and reduce the idle speed to 600 rpm to be sure that the centrifugal advance is not operating. Adjust the initial ignition timing to specifications by rotating the distributor in the proper direction.
5. Check the centrifugal advance for proper operation by starting the engine and accelerating it to approximately 2000 rpm. If the ignition timing advances, the centrifugal advance mechanism is functioning properly. Note the engine speed when the advance begins and the amount of total advance. Stop the engine.
6. Unplug the vacuum line and connect it to the distributor vacuum advance unit. Start the engine and accelerate it to approximately 2000 rpm. Note the engine speed when the advance begins and the total amount of advance. Advance of the ignition timing should begin sooner and advance farther than when checking the centrifugal advance alone. Stop the engine.
7. If the vacuum advance is not functioning properly, remove the distributor and check it on a distributor tester. Replace the diaphragm unit if the vacuum portion is out of calibration.

### DUAL-ADVANCE DISTRIBUTOR

Adjust the centrifugal advance before adjusting the vacuum advance.

#### Centrifugal Advance

1. Operate the distributor in the direction of rotation and adjust the speed to the initial rpm setting listed in the specifications. Move the protractor scale so that one of the flashes lines up with the zero degree mark.
2. Slowly increase the rpm to the setting specified for the first advance reading listed in the specifications.

If the correct advance is not indicated at this rpm, stop the distributor and bend one spring adjustment bracket to change its tension (Figure 7). Bend the adjustment bracket away from the distributor shaft to decrease advance (in-

- crease spring tension) and toward the shaft to increase advance (decrease spring tension). After the adjustment is made, identify the bracket so as not to repeat the adjustment on the same spring.
3. After an adjustment has been made to one spring, check the minimum advance point again.
  4. Operate the distributor at the specified rpm to give an advance just below the maximum. If this advance is not to specifications, stop the distributor and bend the other spring bracket to obtain the correct advance.
  5. Check the advance at all rpm settings listed in the specifications. Operate the distributor both up and down the rpm range.

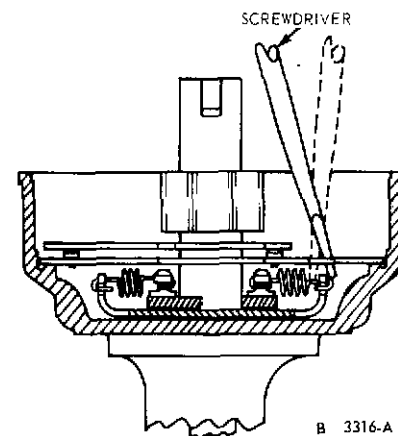


FIG. 7 Centrifugal Advance Adjustment

#### Vacuum Advance

1. Connect the test set vacuum line to the fitting on the diaphragm.
2. Set the test set to 0 degree advance, 0 vacuum, and at 1000 rpm.
3. Check the advance at the first vacuum setting given in the specifications.

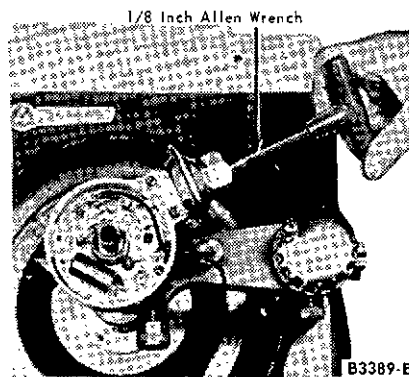


FIG. 8 Vacuum Advance Adjustment

- If the advance is incorrect and adjustment is required, disconnect the vacuum line and insert a 1/8 inch socket head wrench in the end of the diaphragm (Figure 8). Turn the wrench clockwise to increase the vacuum advance or counterclockwise to decrease it. removal of a washer will increase advance.
- After one vacuum setting has been adjusted, the others should be checked. Do not change the original rpm setting when going to a different vacuum setting. If the other settings are not within limits, there is incorrect spring tension, leakage in the vacuum chamber and/or line, or the wrong fiber stop has been installed in the vacuum chamber of the diaphragm housing.

To check the diaphragm for leakage:

Remove the vacuum line from the distributor. Adjust the vacuum pressure of a distributor tester to its maximum position. Hold your hand over the end of the tester's vacuum hose and note the maximum reading obtained. **Do not exceed 25 inches Hg.**

If the maximum reading is 25 inches Hg or less, connect the tester's vacuum line to the vacuum fitting on the diaphragm to be tested without changing any of the adjustments. The maximum gauge reading should not be less than it was above. If it is less, the diaphragm is leaking and should be replaced.

## BREAKER POINTS AND/OR CONDENSER

### Breaker Point Alignment

The breaker points must be accurately aligned and stroke squarely to assure normal breaker point life. Misalignment of these breaker point surfaces can cause premature wear, overheating and pitting.

- Turn the cam so that the breaker points are closed, then check the alignment of the points (Figure 9).

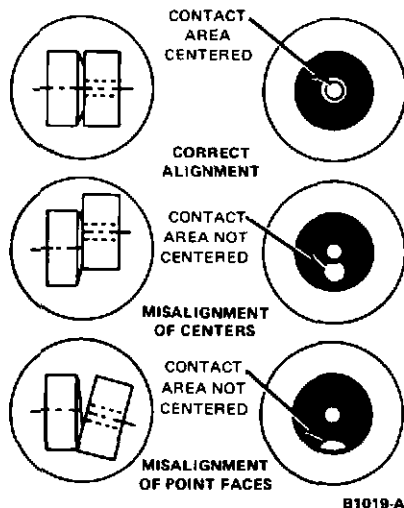


FIG. 9 Checking Breaker Point Alignment

If the distributor is on the engine, close the points by proceeding as follows:

- With the ignition switch off, crank the engine by using an auxiliary starter switch.
- Using the tool shown (Figure 10) and exerting very light pressure, align the breaker point bracket. **Do not bend the breaker arm.**
- After the breaker points have been properly aligned, adjust the breaker point gap.

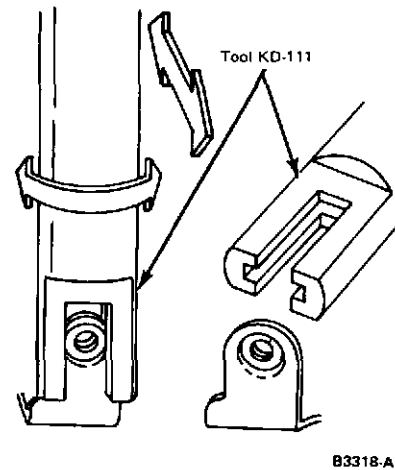


FIG. 10 Using Alignment Tool

### Breaker Point Gap Adjustment

A scope, a dwell meter, or a feeler gauge can be used to check the gap of new breaker points.

A scope or a dwell meter should be used to check the gap of used breaker points. Due to the roughness of used points, it is not advisable to use a feeler gauge to check the gap.

To check and adjust the breaker points with a feeler gauge:

- Check and adjust the breaker point alignment.
- Rotate the distributor until the rubbing block rests on the peak of a cam lobe.

If the distributor is on the engine, place the rubbing block on the peak of the cam by proceeding as follows:

Crank the engine with an auxiliary starter switch.

Insert the correct thickness blade of a clean feeler gauge between the breaker points (Figure 11). Adjust the points to the correct gap and tighten the screws.

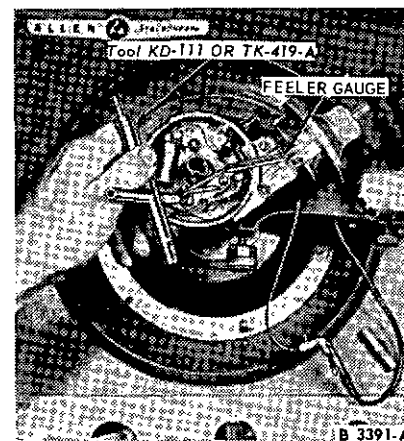


FIG. 11 Adjusting New Breaker Point Gap

Clean the cam, then apply a light film of distributor cam lubricant (C4AZ-19D530-A) to the cam when new points are installed. **Do not use engine oil to lubricate the distributor cam.** Set the ignition timing.

Also, set the contact dwell to the low setting.

To check and adjust the breaker points with a scope or a dwell meter, refer to the manufacturer's instructions.

### Breaker Point Spring Tension Adjustment

Correct breaker point spring tension is essential to proper engine operation and normal breaker point life. If the spring tension is too great, rapid wear of the breaker arm rubbing block will result, causing the breaker point gap to close up and retard the spark timing. If the spring tension is too weak, the breaker arm will flutter at high engine rpm resulting in an engine miss.

To check the spring tension, place the hooked end of the spring tension gauge over the movable breaker point. Pull the gauge at a right angle (90 degrees) to the movable arm until the breaker points just start to open. A dwell meter can be used to determine exactly when the breaker points open. If the tension is not within specifications, adjust the spring tension.

1. Disconnect the primary lead wire and the condenser lead.

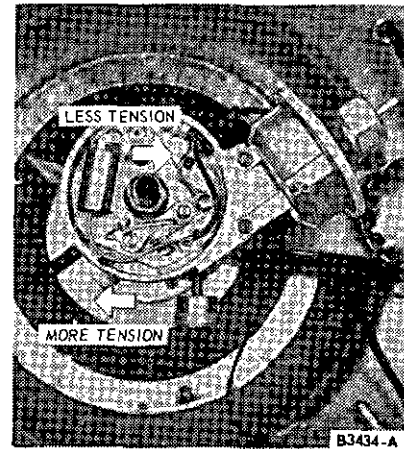


FIG. 12 Adjusting Breaker Point Spring Tension

2. Loosen the nut holding the spring in position. Move the spring toward the breaker arm pivot to decrease tension and in the opposite direction to increase tension.
3. Tighten the locknut; then, recheck spring tension. Repeat the adjustment until the specified spring tension is obtained.

To adjust the spring tension see Figure 12.

4. Connect the primary lead wire and the condenser lead.

## REMOVAL AND INSTALLATION (INDUSTRIAL ENGINES)

### BREAKER POINTS AND/OR CONDENSER

#### Removal

1. Remove the distributor cap and rotor.
2. Disconnect the primary and the condenser wires from the breaker point terminal.
3. Remove the breaker point assembly and condenser attaching screws. Lift the breaker point assembly and condenser out of the distributor.

#### Installation

1. Clean the distributor cam thoroughly.
2. Apply a light film of distributor cam lubricant C4AZ-19D530-A on the cam. **Do not use any type of oil.**
3. Place the breaker point assembly and the condenser in position and install the attaching screws.
4. Align and adjust the breaker points.
5. Connect the primary and condenser wires to the breaker point terminal.
6. Install the rotor and the distributor cap.

### VACUUM ADVANCE UNIT

#### Removal

1. Remove the distributor cap and rotor.
2. Disconnect the vacuum line.
3. Remove the spring clip that secures the diaphragm link to the movable breaker plate.
4. Remove the diaphragm unit attaching screws, and carefully remove the unit.

#### Installation

1. Position the diaphragm unit on the distributor and hook the diaphragm link in position.
2. Install the spring clip that secures the diaphragm link to the movable breaker plate. Install the diaphragm unit attaching screws.
3. Connect the vacuum line.
4. Install the rotor and the distributor cap.

### SPARK PLUG WIRE

When removing the wires from the spark plugs, grasp, twist and pull the moulded cap by hand only. Do not pull on the wire because the wire connection inside the cap may become separated or the boot may be damaged.

#### Removal

1. Disconnect the wires from the spark plugs and distributor cap.
2. Lift the wires from the clip on the valve rocker arm cover and remove the wires.
3. Remove the coil high tension lead.

#### Installation

1. Insert each wire in the proper socket of the distributor cap. Be sure the wires are forced all the way down into their sockets. Cylinders are numbered from front to rear; right bank 1-2-3-4, left bank 5-6-7-8.
2. Remove the wire retaining bracket from the old spark plug wire set and install it on the new set in the same relative position. Install the wires in the brackets on the valve rocker arm covers. Connect the wires to the proper spark plugs. Install the coil high tension lead.
3. Install the wires in a counterclockwise direction in the firing order (1-5-4-2-6-3-7-8) starting in the No. 1 socket. Note that the wires are positioned in this bracket in a special order from front to rear (7-5-6-8).

### SPARK PLUGS

#### Removal

1. Disconnect the wire from each spark plug by grasping, twisting and then pulling the moulded cap of the wire only. **Do not pull on the wire because the wire connection inside the cap may become separated or the weatherseal may be damaged.**

- After loosening each spark plug one or two turns, clean the area around each spark plug port with compressed air, then remove the spark plugs.

### Installation

After cleaning, the electrodes must be dressed with a small file to obtain flat parallel surfaces on both the center and side electrodes (Figure 13). Set the spark plug gap to specifications by bending the ground electrode (Figure 14); all spark plugs, new or used, should have the gap checked and reset as required.

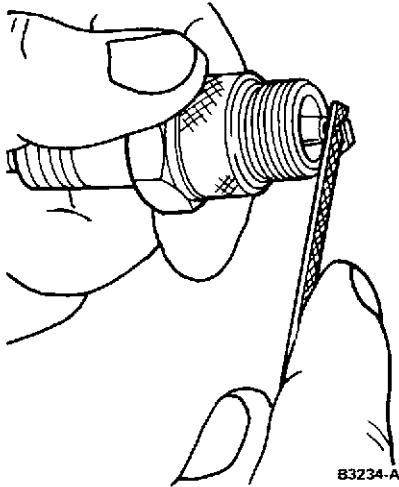


FIG. 13 Filing Spark Plug Electrode

## DISTRIBUTOR

### Removal

- Remove the air cleaner. Disconnect the primary wire from the coil. Disconnect the vacuum advance line(s) at the distributor. Remove the distributor cap.
- Scribe a mark on the distributor body and the cylinder block indicating the position of the body in the block, and scribe another mark on the distributor body indicating

the position of the rotor. These marks can be used as guides when installing the distributor in a correctly timed engine.

- Remove the distributor hold down bolt and clamp. Lift the distributor out of the block.

Do not rotate the crankshaft while the distributor is removed, or it will be necessary to time the engine.

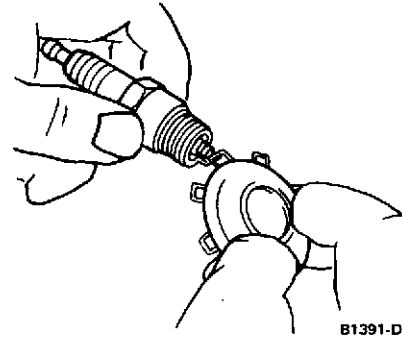


FIG. 14 Checking and Setting Spark Plug Gap

### Installation

- If the crankshaft was rotated while the distributor was removed from the engine, it will be necessary to time the engine. Rotate the crankshaft until No. 1 piston is on TDC after the compression stroke. Align the TDC mark on the timing pointer with the timing pin on the crankshaft damper. Position the distributor in the block with the rotor at the No. 1 firing position.

Make sure the oil pump intermediate shaft properly engages the distributor shaft. It may be necessary to crank the engine with the starter, after the distributor drive gear is partially engaged to engage the oil pump intermediate shaft.

Install, but do not tighten, the retaining clamp and bolt. Rotate the distributor to advance the timing to a point where the breaker points are just starting to open. Tighten the clamp.

- If the crankshaft has not been moved, position the distributor in the block with the rotor aligned with the mark

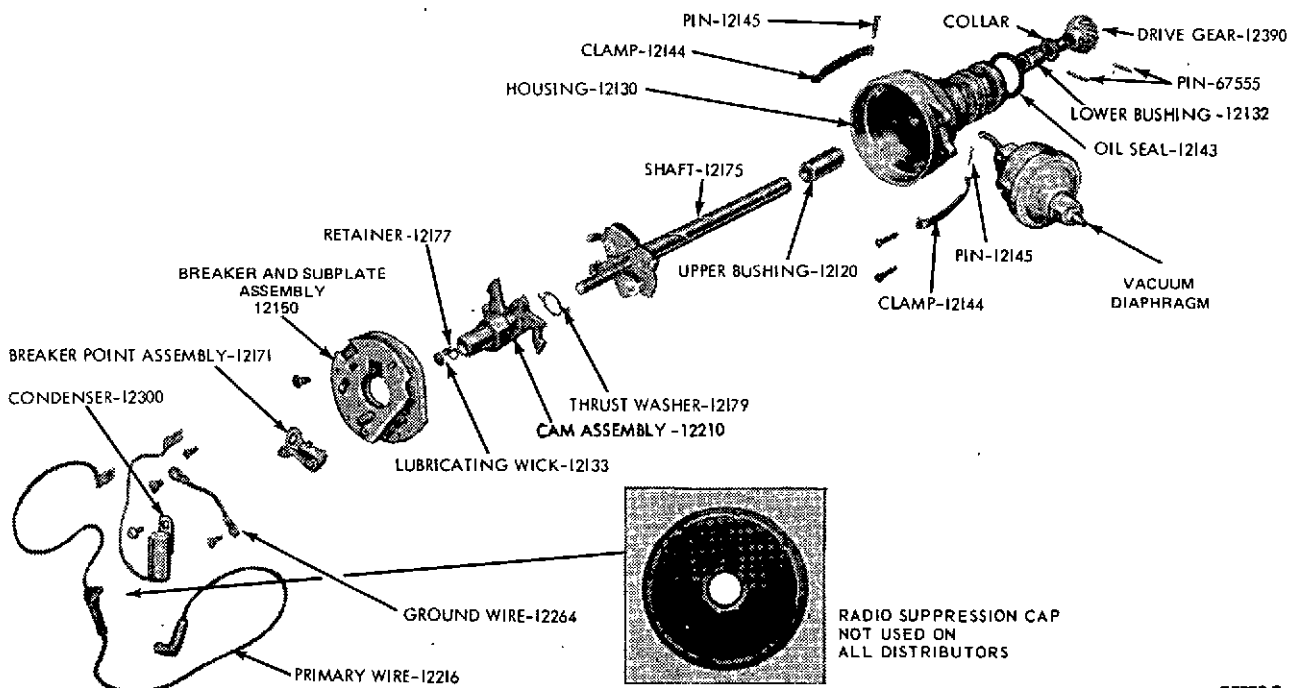


FIG. 15 Breaker Plate Installed

- previously scribed on the distributor body and the marks on the distributor body and cylinder block in alignment.
3. Install the distributor cap.
  4. Connect the primary wire to the coil.
  5. Check the ignition timing with a timing light and adjust to specifications. Connect the vacuum line, and check the advance with the timing light when the engine is accelerated.
  6. Install the air cleaner.

### BREAKER PLATE AND SUB-PLATE

Refer to Figure 15 for the correct location of parts.

#### Removal

1. Remove the distributor cap and rotor.
2. Remove the breaker point assembly and the condenser. Remove the vacuum diaphragm.

3. Working from the inside of the distributor, pull the primary wire through the opening out of the distributor.
4. Remove the sub-plate attaching screws and lift the assembly from the distributor.

#### Installation

1. Place the breaker plate assembly in position in the distributor.
2. Install the sub-plate hold down screws (the ground wire should be under the sub-plate hold down screw from which it was removed).
3. Insert the primary wire in the distributor. Install the breaker points and the condenser. Connect the primary wire and the condenser wire to the breaker point terminal. Install the vacuum diaphragm.
4. Install the rotor and the distributor cap.

## CLEANING AND INSPECTION

### SPARK PLUGS

Examine the firing of the spark plugs, noting the type of deposits and the degree of electrode erosion. Refer to Figure 16 for the various types of spark plug fouling and their causes.

Clean the plugs on a sand blast cleaner, following the manufacturer's instructions. **Do not prolong the use of the abrasive blast as it will erode the insulator and electrode.**

Examine the plug carefully for cracked or broken insulators, badly pitted electrodes, and other signs of failure. Replace as required.

### DISTRIBUTOR

Soak all parts of the distributor assembly (except the condenser, breaker point assembly, lubricating wick, vacuum diaphragm, distributor base oil seal and electrical wiring) in a mild cleaning solvent or mineral spirits. Do not use a harsh cleaning solution. Wipe all parts that cannot be immersed in a solvent with a clean dry cloth.

After foreign deposits have been loosened by soaking, scrub the parts with a soft bristle brush. **Do not use a wire brush, file, or other abrasive object.** Dry the parts with compressed air.

Inspect the distributor cam lobes for scoring and signs of wear. If any lobe is scored or worn, replace the distributor.

Inspect the breaker plate assembly for signs of distortion, wear or damage. Replace the breaker plate assembly if it is damaged.

Inspect all electrical wiring for fraying, breaks, etc. and replace any that is not in good condition.

Check the distributor base for cracks or other damage.

Check the diaphragm housing, bracket, and rod for damage. Check the vacuum line for damage. Test the diaphragm for leakage as explained under Distributor Test. Replace all defective parts.

The breaker point assembly consists of the stationary point bracket assembly, breaker arm and the primary wire terminal.

Breaker points should be inspected, cleaned and adjusted as necessary. Breaker points can be cleaned with chloroform and a stiff bristle brush. Replace the breaker point assembly if the contacts are badly burned or excessive metal transfer between the points is evident (Figure 17). Metal transfer is considered excessive when it equals or exceeds the gap setting specifications.

#### Distributor Cap

Clean the distributor cap with a soft bristle brush and mild cleaning solvent or mineral spirits. Dry the cap with compressed air. Inspect the cap for cracks, burned contacts, broken carbon button, carbon tracks or dirt or corrosion in the sockets. Replace the cap if it is damaged.

#### Rotor

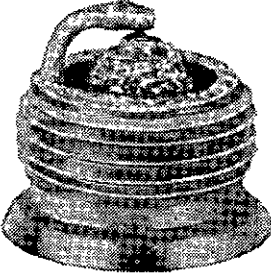
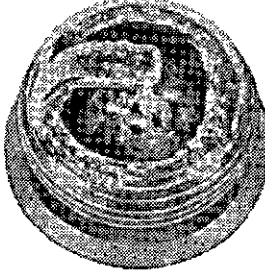
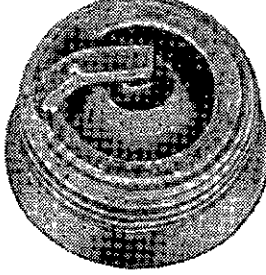
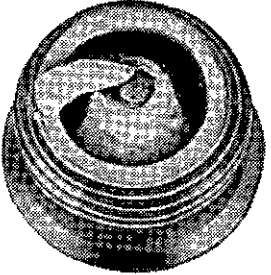
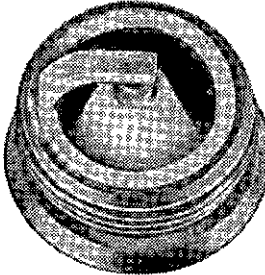
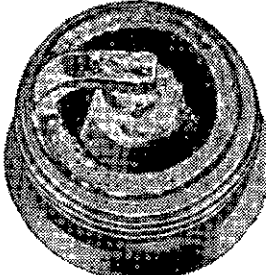
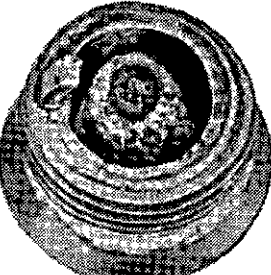
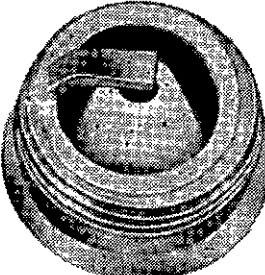
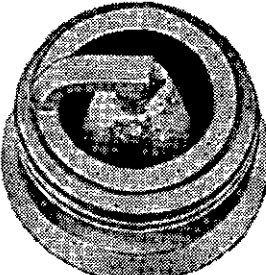
Clean the rotor with a soft bristle brush and mild cleaning solvent or mineral spirits. Dry the rotor with compressed air. Inspect the rotor for being broken, cracked, having carbon tracks, or burning. Replace the rotor if it is corroded or damaged.

#### Secondary Wiring

Wipe the wires with a damp cloth and check for breaks or cracked insulation. Inspect the terminals and boots for looseness or corrosion. Replace any wires that are not in good condition.

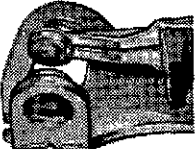
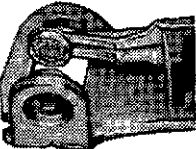
#### Coil

Wipe the coil with a damp cloth and check for any cracks or other defects.

<p style="text-align: center;"><b>GAP BRIDGED</b></p>  <p>IDENTIFIED BY DEPOSIT BUILD-UP CLOSING GAP BETWEEN ELECTRODES. CAUSED BY OIL OR CARBON FOULING. REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE, THE PLUG CAN BE CLEANED.</p>	<p style="text-align: center;"><b>OIL FOULED</b></p>  <p>IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. REPLACE THE PLUG. IF ENGINE IS NOT REPAIRED, USE A HOTTER PLUG.</p>	<p style="text-align: center;"><b>CARBON FOULED</b></p>  <p>IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES. CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.</p>
<p style="text-align: center;"><b>WORN</b></p>  <p>IDENTIFIED BY SEVERELY ERODED OR WORN ELECTRODES. CAUSED BY NORMAL WEAR. SHOULD BE REPLACED</p>	<p style="text-align: center;"><b>NORMAL</b></p>  <p>IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP.</p>	<p style="text-align: center;"><b>LEAD FOULED</b></p>  <p>IDENTIFIED BY DARK GRAY, BLACK, YELLOW OR TAN DEPOSITS OR A FUSED GLAZED COATING ON THE INSULATOR TIP. CAUSED BY HIGHLY LEADED GASOLINE. REPLACE THE PLUG.</p>
<p style="text-align: center;"><b>PRE-IGNITION</b></p>  <p>IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALLIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE. CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING. REPLACE THE PLUG.</p>	<p style="text-align: center;"><b>OVERHEATING</b></p>  <p>IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLuish-BURNT APPEARANCE OF ELECTRODES, CAUSED BY ENGINE OVERHEATING, WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.</p>	<p style="text-align: center;"><b>FUSED SPOT DEPOSIT</b></p>  <p>IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUBBLES OR BLISTERS. CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE. OTHERWISE REPLACE PLUG.</p>

83235-B

FIG. 16 Spark Plug Inspection

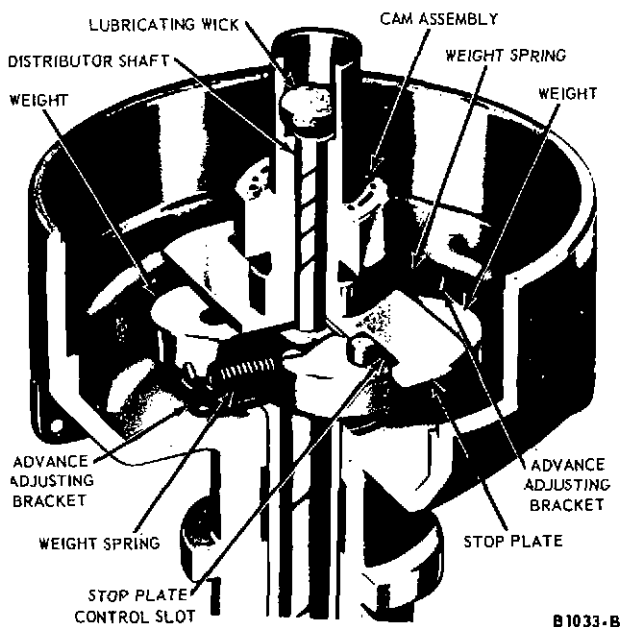
CONDITION	CAUSED BY
 BURNED	Incorrect voltage regulator setting. Radio condenser installed to the distributor side of the coil.
 EXCESSIVE METAL TRANSFER OR PITTING	Incorrect alignment. Incorrect voltage regulator setting. Radio condenser installed to the distributor side of the coil. Ignition condenser of improper capacity. Extended operation of the engine at speeds other than normal.

81443-C

FIG. 17 Breaker Point Inspection

## PRESTOLITE DISTRIBUTORS (MARINE & IRRIGATION ENGINES) DESCRIPTION AND OPERATION

The centrifugal advance distributor is a straight mechanical-type unit. A governor-type centrifugal advance is located below the stationary breaker plate (Figure 18). Two centrifugal weights cause the cam to advance or move ahead with respect to the distributor drive shaft the rate of advance is controlled by two calibrated springs.



B1033-B

FIG. 18 Centrifugal Advance Mechanism

### ADJUSTMENTS AND REPAIRS BREAKER POINTS AND/OR CONDENSER

#### Removal

1. Remove the distributor cap and the rotor. Be sure to loosen the distributor cap retaining screws before removing the cap.
2. Disconnect the primary and the condenser wires from the breaker point assembly.
3. Remove the breaker point assembly and condenser retaining screws. Lift the breaker point assembly and condenser out of the distributor.

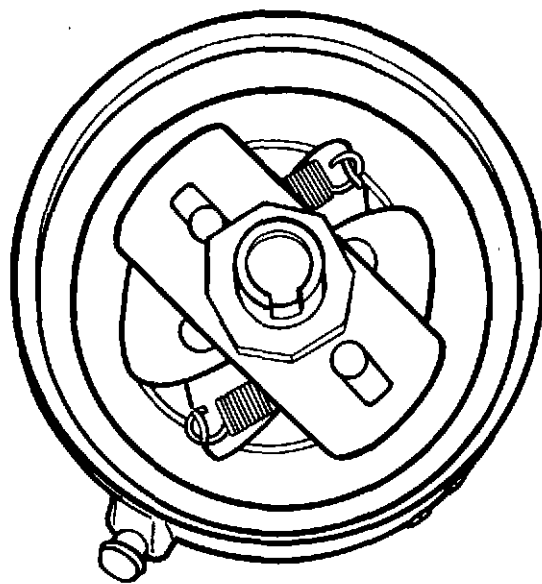


FIG. 19 Weights, Springs, and Cam Installed

#### Installation

1. Place the breaker point assembly and the condenser in position and install the retaining screws.
2. Align and adjust the breaker point assembly.
3. Connect the primary and condenser wires to the breaker point assembly.
4. Install the rotor and the distributor cap.

### BREAKER PLATE AND SUB-PLATE Removal

1. Remove the distributor cap and rotor.
2. Working from the inside of the distributor, pull the primary wire through the opening out of the distributor.
3. Remove the sub-plate attaching screws and lift the assembly from the distributor.

### Installation

1. Place the breaker plate assembly in position in the distributor.
2. Install the sub-plate hold down screws.
3. Insert the primary wire in the distributor. Install the breaker points and the condenser. Connect the primary wire and the condenser wire to the breaker point terminal.
4. Install the rotor and the distributor cap.

### CAM AND CENTRIFUGAL ADVANCE WEIGHTS

#### Removal

1. Remove the breaker plate and sub-plate from the distributor.
2. **Mark one of the distributor weight springs and its brackets. Also mark one of the weights and its pivot pin.**
3. Carefully unhook and remove the weight springs.
4. Lift the lubricating wick from the cam assembly. Remove the cam assembly retainer and lift the cam assembly off the distributor shaft. Remove the thrust washer.
5. Lift the weights out of the distributor.

#### Installation

1. If the weights were removed, fill the grooves in the weight pivot pins with distributor cam lubricant (C4AZ-19D530-A).

Position the weights in the distributor (**the marked weight is placed on the marked pivot pin**) and install the weight retainers.

2. Place the thrust washer on the shaft.
3. Fill the grooves in the upper portion of the distributor shaft with distributor cam lubricant (C4AZ-19D530-A).
4. Install the cam assembly. **Be sure that the marked spring bracket on the cam assembly is near the marked spring bracket on the stop plate.**

**Place a light film of distributor cam lubricant (C4AZ-19D530-A) on the distributor cam lobes. Install the retainer and the wick. Oil the wick with SAE-10W engine oil.**

5. Install the weight springs. **Be sure that the marked spring is attached to the marked spring brackets.**
6. Install the plate assembly.
7. Install the primary wire in the distributor. Connect the primary and condenser wires to the breaker point terminal.
8. Adjust the breaker point gap or dwell as required.

### DISTRIBUTOR

#### Removal

1. Remove the air cleaner. Disconnect the primary wire from the coil. Remove the distributor cap.
2. Scribe a mark on the distributor body and the cylinder block indicating the position of the body in the block, and scribe another mark on the distributor body indicating the position of the rotor. These marks can be used as guides when installing the distributor in a correctly timed engine.
3. Remove the distributor hold down bolt and clamp. Lift the distributor out of the block.

**Do not rotate the crankshaft while the distributor is removed, or it will be necessary to time the engine.**

#### Installation

1. If the crankshaft was rotated while the distributor was removed from the engine, it will be necessary to time the engine. Rotate the crankshaft until No. 1 piston is on TDC after the compression stroke. Align the TDC mark on the timing pointer with the timing pin on the crankshaft damper. Position the distributor in the block with the rotor at the No. 1 firing position.

**Make sure the oil pump intermediate shaft properly engages the distributor shaft. It may be necessary to crank the engine with the starter, after the distributor drive gear is partially engaged to engage the oil pump intermediate shaft.**

**Install, but do not tighten, the retaining clamp and bolt. Rotate the distributor to advance the timing to a point where the breaker points are just starting to open. Tighten the clamp.**

2. If the crankshaft has not been moved, position the distributor in the block with the rotor aligned with the mark previously scribed on the distributor body and the marks on the distributor body and cylinder block in alignment.
3. Install the distributor cap.
4. Connect the primary wire to the coil.
5. Check the ignition timing with a timing light and adjust to specifications.
6. Install the air cleaner.

### MAJOR REPAIR OPERATIONS

To perform the operations in this section, it will be necessary to remove the distributor from the engine and place it in a vise.

#### BENCH DISASSEMBLY

Refer to Figure 20 for the location of parts.

#### CONVENTIONAL IGNITION SYSTEM DISTRIBUTOR

1. Remove the rotor.
2. Disconnect the primary wire, the jumper strap, and the condenser wire from the breaker point assemblies.
3. Remove the retaining screws from the breaker point assemblies and condenser. Lift the breaker point assembly and the condenser out of the distributor.
4. Working from the inside of the distributor, pull the primary wire through the opening in the distributor.
5. Remove the breaker point and condenser plate retaining screws and lift the plate out of the distributor.
6. **Mark one of the distributor weight springs and its brackets. Also mark one of the weights and its pivot pin.**
7. **Carefully unhook and remove the weight springs.**
8. **Lift the lubricating wick from the cam assembly. Remove the cam assembly retainer and lift the cam assembly off the distributor shift. Remove the thrust washer.**
9. **Lift the weights out of the distributor.**
10. **If the gear and shaft are to be used again, mark the gear and the shaft so that the pin holes can be easily aligned for assembly. Remove the gear roll pin and then remove the gear.**
11. Remove the shaft collar roll pin.
12. Invert the distributor and place it on a support in a position that will allow the distributor shaft to clear the support plate and press the shaft out of the collar and the distributor housing.
13. Remove the distributor shaft upper bushing.
14. Remove the distributor shaft lower bushing.

#### BENCH ASSEMBLY

##### ORIGINAL SHAFT AND GEAR

1. Oil the new upper bushing, and install it on the bushing replacer tool. Then install the upper bushing. When the tool bottoms against the distributor base, the bushing will be installed to the correct depth.
2. Burnish the bushing to the proper size.
3. Invert the distributor and install the lower bushing in a similar manner.

4. Oil the shaft and slide it into the distributor body.
  5. Place the collar in position on the shaft and align the holes in the collar and shaft, then install a new pin.
  6. Check the shaft end play with a feeler gauge placed between the collar and the base of the distributor. If the end play is not within limits, replace the shaft and gear.
  7. Press the gear on the shaft, using the marks made on the gear and shaft as guides to align the pin holes.
  8. Remove the distributor from the press. Install the gear retaining pin.
  9. Position the distributor in a vise. Fill the grooves in the weight pivot pins with distributor cam lubricant (C4AZ-19D530-A).
  10. Position the weights in the distributor (the marked weight is placed on the marked pivot pin) and install the weight retainers.
  11. Place the thrust washer on the shaft.
  12. Fill the grooves in the upper portion of the distributor shaft with distributor cam lubricant (C4AZ-19D530-A).
  13. Install the cam assembly. Be sure that the marked spring bracket on the cam assembly is near the marked spring bracket on the stop plate.
- Place a light film of distributor cam lubricant (C4AZ-19D530-A) on the distributor cam lobes. Install the retainer and the wick. Saturate the wick with SAE 10W engine oil.
14. Install the weight springs. Be sure that the marked spring is attached to the marked spring brackets.
  15. Place the breaker point and condenser plate in position and install the retaining screws.
  16. Working from the inside of the distributor, push the primary wire through the opening in the distributor housing.
  17. Place the breaker point assembly and the condenser in position and install the retaining screws.

18. Align and adjust the breaker point assembly.
19. Connect the primary wire and the condenser wire to the breaker point assembly.
20. Install the rotor and the distributor cap.
21. Check and adjust (if necessary) the centrifugal advance mechanism.

#### NEW SHAFT AND GEAR

The shaft and gear are replaced as an assembly. One part should not be replaced without replacing the other.

1. Follow steps 1, 2, 3 and 4 under "Installing Original Shaft and Gear Conventional Ignition System Distributor."
2. Insert a .024-inch feeler gauge between the collar and distributor base. Slide the collar on the shaft. While holding the collar in place against the distributor base, drill a 1/8-inch hole through the shaft using the hole in the collar as a pilot. Remove the feeler gauge.
3. Position the gear on the end of the shaft. Install the assembly in a press.
4. With the backing screw on the support tool tightened enough to remove all end play, press the gear on the shaft to the specified distance from the bottom face of the gear to the bottom face of the distributor mounting flange (Figure 14). Drill a 1/8-inch hole through the shaft using the hole in the gear as a pilot.
5. Remove the distributor from the press. Install the collar retaining pin (Figure 6) and the gear retaining pin (Figure 4).
6. On a conventional ignition system distributor, complete the assembly by following steps 10 thru 21 under "Bench Assembly Original Shaft and Gear".

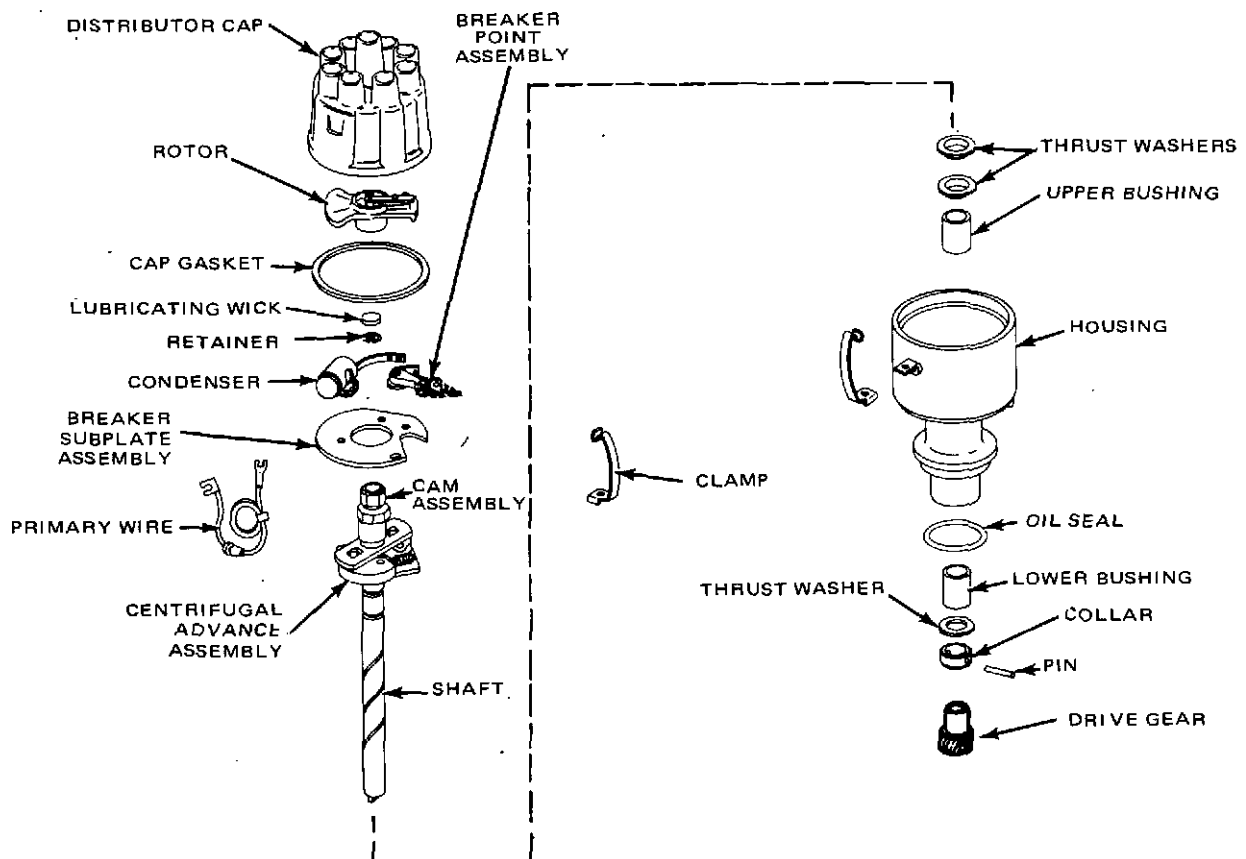


FIG. 20 Distributor Assembly (Conventional)

### Mechanical Operation

1. Turn the switch to the SET position.
2. Adjust the SET TACH control so that tachometer pointer is on the SET line.
3. Turn the switch to the SYNC position and check to make sure that the drive chuck is securely tightened on the distributor shaft.
4. Turn the motor switch to the left for 8 cylinder setting.
5. Adjust the speed control to vary the distributor speed between 400 and 4000 engine rpm, or at the maximum speed of the engine on which the distributor is used. Erratic or thin faint flashes of light preceding the regular flashes as the speed of rotation is increased can be due to weak breaker arm spring tension or binding of the breaker arm on the pivot pin.
6. Operate the distributor at approximately 2500 engine rpm and move the protractor scale so that the zero degree mark on the scale is opposite one of the neon flashes. The balance of all the flashes should come within 1 degree, plus or minus, evenly around the protractor scale. A variation larger than 1 degree or erratic or wandering flashes may be caused by a worn cam or distributor shaft or a bent distributor shaft.

### Dwell Angle

1. Turn the switch to the CAM position. Operate the distributor at about 1000 rpm.
2. Turn the test selector switch to the cam angle position and operate the distributor at approximately 1000 engine rpm.
3. Adjust the breaker point gap until the dwell angle is to specifications.

### Distributor Spark Advance Test

The spark advance is checked to determine if the ignition timing advances in proper relation to engine speed and load.

1. Check the contact dwell. If the contact dwell or the breaker point gap is not within specifications, adjust the breaker points.
2. Check the breaker arm spring tension and adjust it, if necessary.

### Centrifugal Advance

1. Set the test set to 0 degree advance and the initial rpm setting listed in the specifications.
2. Operate the distributor in the direction of rotation and slowly increase the rpm to the setting specified for the first advance reading listed in the specifications.

If the correct advance is not indicated at this rpm, stop the distributor and bend one spring adjustment bracket to change its tension (Figure 7). Bend the adjustment bracket away from the distributor shaft to decrease advance (increase spring tension) and toward the shaft to increase advance (decrease spring tension). After the adjustment is made, identify the bracket.

3. After an adjustment has been made to one spring, check the minimum advance point again.
4. Operate the distributor at the specified rpm to give an advance just below the maximum. If this advance is not to specifications, stop the distributor and bend the other spring bracket to give the correct advance.
5. Check the advance at all rpm settings listed in the specifications. Operate the distributor both up and down the rpm range.

## Part 3 — Fuel Systems 460 Engines

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DESCRIPTION .....	3-01	Primary Systems .....	3-04
DIAGNOSIS AND TESTING		Secondary Systems .....	3-08
General Information .....	3-02	Service Procedures .....	3-10
Pressure Test .....	3-03	Carburetor Adjustments .....	3-17
Capacity Test .....	3-03		

### IDENTIFICATION

The carburetor identification number is found on the upper air horn flange of the carburetor. An identification tag is attached to the lower left hand body area of the carburetor. The basic part number for all carburetors is 9510. To procure replacement parts, it is necessary to know the part number prefix and suffix.

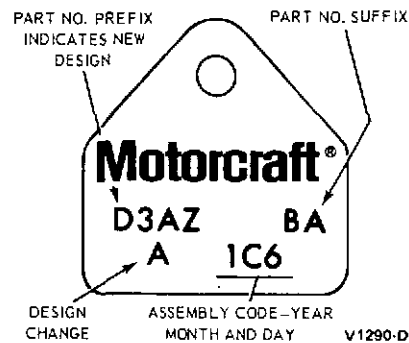
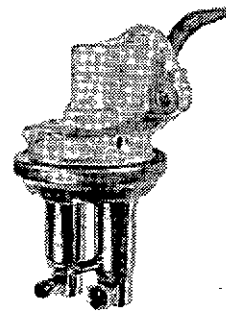


FIG. 1 Carburetor Identification — Typical

### DESCRIPTION

The fuel system includes a mechanical fuel pump with a replaceable fuel filter if so equipped (Figure 2). It is mounted on the left side of the cylinder front cover.

The 460 engines use either a Holley Model 4150 or Model 4160 carburetor.



460 CID V-8

FIG. 2 Mechanical Fuel Pump

## DIAGNOSIS AND TESTING

### GENERAL INFORMATION

Water and dirt that accumulate in the fuel tank can cause a restricted fuel line or filter and malfunction of the fuel pump or carburetor. Condensation, which is the greatest source of water entering the fuel tank, is formed by moisture in the air when it strikes the cold interior walls of the fuel tank.

If the accumulation of dirt and water in the filter is excessive, the fuel tank should be removed and flushed, and the line from the fuel pump to the tank should be blown out.

Air leakage in the fuel inlet line can cause low fuel pump pressure and volume.

A restricted fuel tank vent can cause low fuel pump pressure and volume and can result in collapsed inlet hoses or a collapsed fuel tank.

High or low pressure are the two most likely fuel pump troubles that will affect engine performance. Low pressure will cause a lean mixture and fuel starvation at high speeds and excessive pressure will cause high fuel consumption and carburetor flooding.

Dirt accumulation in the fuel and air passages, improper idle adjustments, and improper fuel level are the major sources of carburetor troubles.

SYMPTOM	PROBABLE CAUSE	
Low Fuel Pump Pressure	Diaphragm stretched or leaking. Fuel pump diaphragm spring is weak. Cam eccentric worn or undersize. Excessive clearance between rod and fuel pump. Fittings loose or cracked. Fuel pump screen clogged.	Fuel line cracked or broken. Fuel pump valves seating improperly. Dirt in fuel tank and/or lines. Fuel tank vent restricted. Diaphragm ruptured.
High Fuel Pump Pressure	Diaphragm spring too strong <i>or improper spring.</i>	
Low Fuel Pump Volume with Normal Pressure	Fuel filter clogged. Fuel pump to carburetor inlet line obstructed, crimped or leaks.	Restriction in fuel supply line to fuel pump.
Fuel Pump Leaks	Diaphragm defective. Fittings loose.	
Fuel Pump Leaks Oil	Fuel pump retaining bolts loose.	Mounting gasket defective.
Fuel Tank and/or Inlet Line Hoses Collapsed	Fuel tank vent restricted.	
Flooding or Leaking Carburetor	Cracked carburetor body. High fuel level or float setting. Fuel inlet needle not seating properly or worn needle and/or seat.	Ruptured accelerating pump diaphragm (where applicable). Excessive fuel pump pressure.
Hard Starting	Improper starting procedure causing a flooded engine. Improper carburetor fuel level. Improper idle adjustments. Sticking or incorrectly seating fuel inlet needle.	Incorrect fuel pump pressure. Restrictions or air leaks in the choke vacuum or hot air passages. Dirty air cleaner element.
Stalling	Incorrect idle fuel mixture. Engine idle speed too slow. Dirt, water or ice in fuel filter. Fuel line restricted or leaking air. Fuel tank vent restricted. Leaking intake manifold or carburetor gaskets.	Carburetor icing (cold, wet or humid weather). Incorrect throttle linkage adjustment to carburetor. Clogged air bleeds or idle passages. Defective fuel pump. Excessive looseness of throttle shaft in bore(s) of throttle body.
Rough Idle	Incorrect idle mixture adjustment. Idle adjusting needle(s) grooved, worn, or otherwise damaged. Idle air bleeds restricted. Accelerating pump discharge check valve not seating properly.	Idle air or fuel passages restricted. Idle discharge holes not in proper relation to throttle plate. Excessive dirt in air cleaner. High or low float setting.

SYMPTOM	PROBABLE CAUSE	
<p>Poor Acceleration</p>	<p>Poor acceleration complaints fall under one of three headings: the engine is sluggish on acceleration, the engine stalls when accelerated, or the engine hesitates or develops a flat spot when accelerated. Poor acceleration is caused by either an excessively lean or rich mixture on acceleration and/or defects of improper adjustments in the ignition system.</p> <p><b>A LEAN MIXTURE CAN BE CAUSED BY:</b>            Low fuel pump pressure.            Sticking fuel inlet needle.            Low fuel level or float setting.            Restriction in main fuel passage.            Air leak between the carburetor and the manifold caused by loose mounting bolts or defective gasket.            Air leak at the throttle shaft caused by a worn throttle shaft.            Accelerating pump diaphragm defective.</p>	<p>Incorrect accelerating pump stroke adjustment.            Accelerating pump fuel inlet or outlet valve not seating.            Restriction in the accelerating pump discharge passage.            Air leak at the accelerating pump cover caused by a defective gasket or warped pump cover.</p> <p><b>A RICH MIXTURE CAN BE CAUSED BY:</b>            Excessive fuel pump pressure.            High fuel level or float setting.            Fuel inlet needle not seating properly or worn needle and/or seat.            Excessively dirty air cleaner.            Incorrect accelerating pump stroke adjustment.            Restricted air bleeds.            Worn or damaged main metering jet.            Accelerating pump outlet valve not seating properly.</p>
<p>Inconsistent Engine Idle Speed</p>	<p>Incorrect throttle linkage adjustment to carburetor.            Governor not adjusted properly or faulty.            Binding or sticking throttle linkage.            Sticking carburetor throttle shaft.</p>	<p>Excessive looseness of throttle shaft in bores of throttle body.            Incorrectly installed throttle plates.            Sticking fuel inlet needle.            Defective spark valve or gasket (manual choke carburetor).</p>
<p>Surging Above Idle Speed</p>	<p>Clogged main jets.            Improper size main jets.            Low fuel level or float setting.            Low fuel pump pressure or volume.</p>	<p>Clogged fuel filter or fuel pump filter screen.            Distributor vacuum passage clogged.            Defective spark valve or gasket.</p>
<p>Reduced Power Output</p>	<p>Float setting too high or too low.            Fuel pump pressure too high or too low.            Improper size or obstructed main jets.            Restricted air bleeds.</p>	<p>Restriction in main fuel passages.            Excessive dirt in air cleaner.            Throttle plate not fully open.            Faulty choke operation.            Improper throttle linkage or governor adjustment.</p>

### PRESSURE AND CAPACITY (VOLUME) TESTING

To determine that the fuel pump is in satisfactory operating condition, tests for both fuel pump pressure and fuel pump capacity (volume) should be performed.

The tests are performed with the fuel pump installed on the engine and the engine at normal operating temperature at idle speed.

**Before the tests, make sure the replaceable fuel filter has been changed if so equipped within the recommended maintenance interval. When in doubt, install a new filter.**

#### Pressure Tests

Refer to the fuel pump specifications and note the fuel pump pressure and capacity (volume) design tolerances.

1. Remove the air cleaner assembly. Disconnect the fuel inlet line or the fuel filter at the carburetor. Use care to prevent combustion due to fuel spillage.

2. Connect a pressure gauge, a restrictor and a flexible hose (Figure 3) between the fuel filter and the carburetor. **NOTE: Inside diameter of smallest passage in test flow circuit must not be smaller than .220.**

3. Position the flexible fuel outlet hose and the restrictor so the fuel can be discharged into a suitable, graduated container (Figure 3).

4. Before taking a pressure reading operate the engine at the specified idle rpm and vent the system into the container by opening the hose restrictor momentarily.

5. Close the hose restrictor, allow the pressure to stabilize, and note the reading. (Refer to the Specifications in this Part.

If the pump pressure is not within specifications, and the fuel lines and filter are in satisfactory condition, the pump is defective and should be replaced.

If the pump pressure is within specifications, perform the tests for fuel capacity (volume).

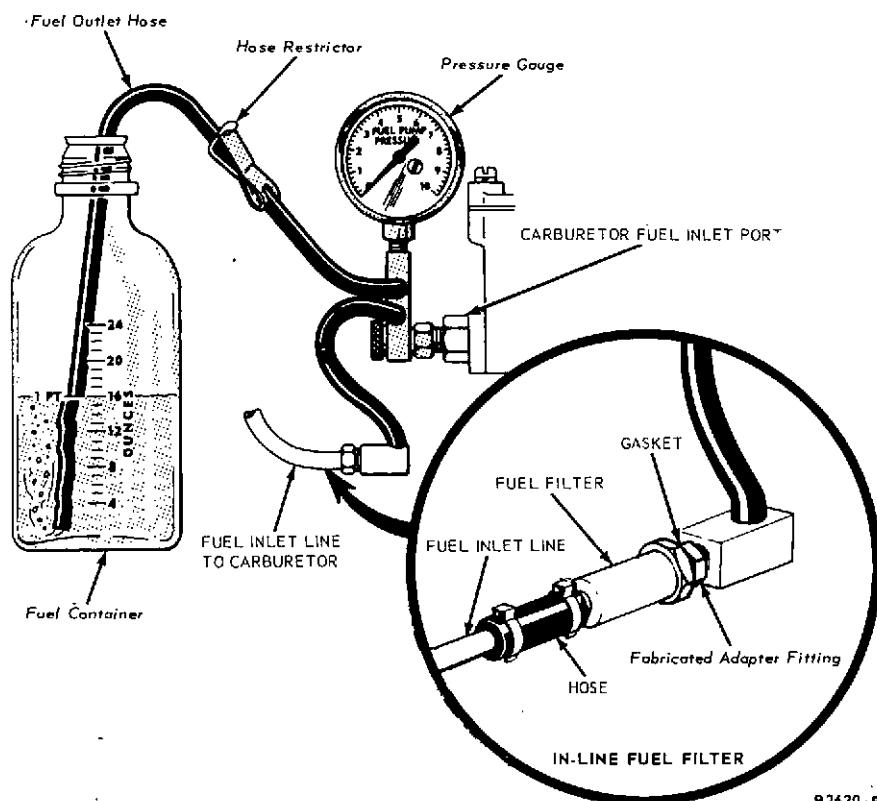
### Capacity (Volume) Test

With the fuel pump pressure within specifications, test the capacity (volume) as follows:

1. Operate the engine at the specified idle rpm.

2. Open the hose restrictor and expel the fuel into the container (Figure 3), while observing the time required to expel one pint. Close the restrictor. One pint or more of fuel should be expelled within the specified time limit.

If the pump volume is below specifications, repeat the test using an auxiliary fuel supply and a new fuel filter. If the pump volume meets specifications while using the auxiliary fuel supply. Check for a restriction in the fuel supply from the tank and for the tank not venting properly.



B2630-B

FIG. 3 Typical Fuel Pump Pressure and Capacity Test Equipment

## MODEL 4150 AND 4160 CARBURETOR SYSTEMS

### PRIMARY SYSTEMS

#### FUEL INLET SYSTEM

The fuel inlet system consists of a fuel bowl, fuel inlet fitting, fuel inlet needle and seat and a float assembly. A fuel screen or filter is usually installed in the inlet fitting. **CAUTION:** Where there is no filter in the inlet fitting, an inline filter must be used to prevent malfunction due to dirty fuel.

Many different types of floats have been used. Early production used side hinged rectangular brass floats. There were two different versions of this float. Later production used a half moon brass float (Figure 4) or a nitrophyl (cellular plastic material) float (Figure 5).

The fuel inlet valve (needle and seat) and the float assembly must maintain the fuel level at the prescribed specification.

**NOTE:** The basic fuel metering systems are calibrated to deliver the proper mixture only when the fuel is adjusted to the correct level. A float bumper spring is installed under the float level in many applications to stabilize the float movement.

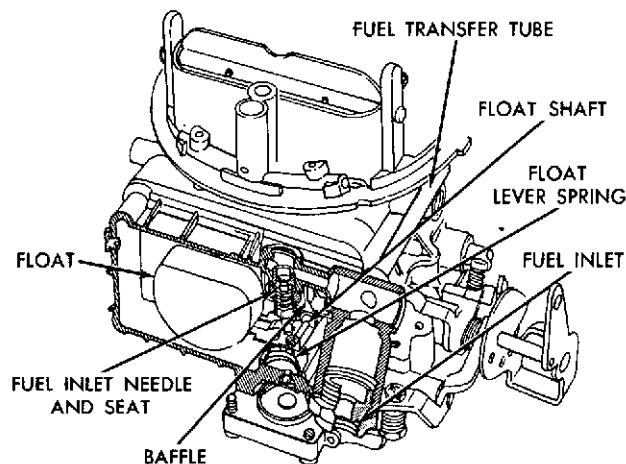


FIG. 4 Fuel Inlet System

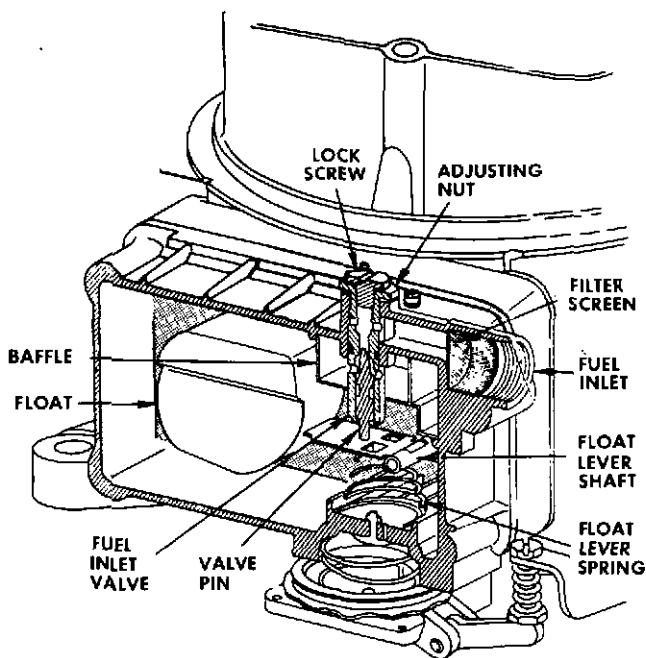


FIG. 5 Fuel Inlet System

With the externally adjustable needle and seat the fuel level can be adjusted (to the bottom of the threads in the sight plug hole) without removing any other part of the carburetor.

To adjust an internal needle and seat it is necessary to remove the carburetor from the engine.

The fuel bowl is vented internally to the air horn by a vent tube in the carburetor body.

On the standard 4V units a fuel transfer tube transfers fuel from the primary fuel inlet fitting to the secondary fuel bowl. The transfer tube is sealed at either end with an "O" ring.

**NOTE:** When adjusting the fuel level on the secondary side of the 4V units, it is necessary to run the engine for two or three minutes to stabilize the fuel level. A very small amount of fuel is used from the secondary side at idle and it is easy to make a false (low) adjustment of the fuel level. If there is any question about the level, loosen a lower bowl screw and drain a small amount of fuel into a pan. Tighten the bowl screw and let the bowl refill to the adjusted level. After attaining the correct level, install and retighten the sight plugs.

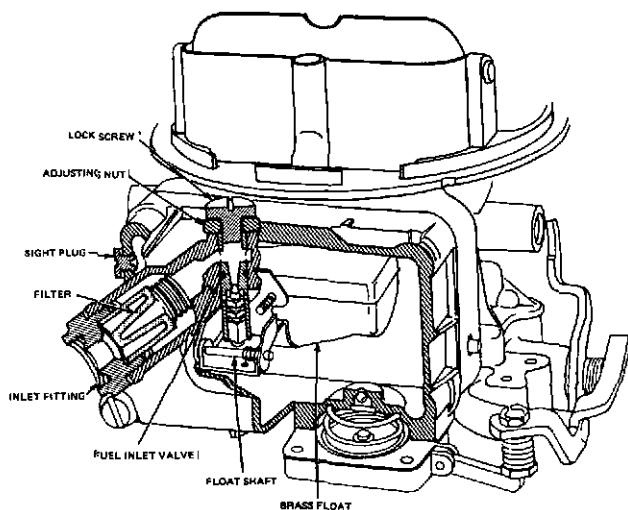


FIG. 6 Fuel Inlet System

### IDLE SYSTEM

At idle system (Figure 7) supplies the air fuel mixture to operate the engine at idle and low speeds. Idle fuel enters the system through the main jet into the main well. Some applications include an idle tube in the main well to meter the fuel (Figure 8). Other applications use a horizontal passage from the main well to the idle well and an idle channel restriction for metering purposes. The restriction has been installed in several different locations.

In either type, air enters the idle air bleed and mixes with the fuel after the fuel flows through the idle tube or restriction. At curb idle the throttle valves are almost closed. This creates a high vacuum below the throttle valve with near atmospheric pressure above the valve. As the throttle valves are opened the transfer slot is progressively exposed to vacuum and the air-fuel emulsion is also discharged from the transfer slot. The air-fuel mixture from the idle passage and the transfer slot supplies the necessary fuel to operate the engine at lower speeds and loads (Figure 8).

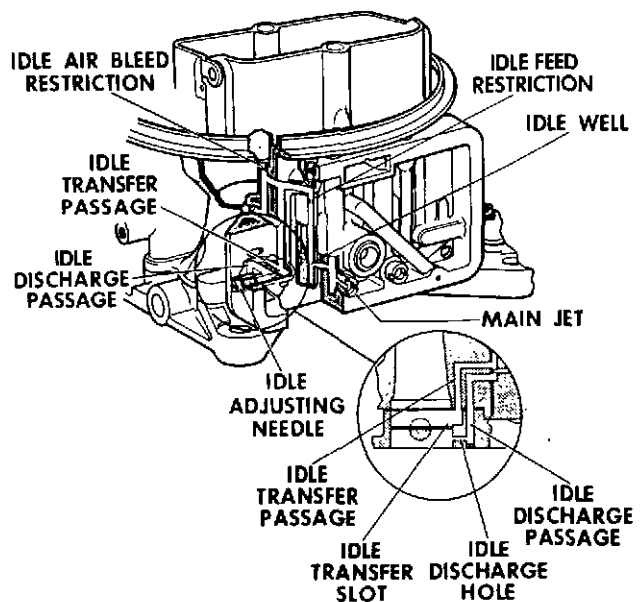


FIG. 7 Idle System Primary Side 4V

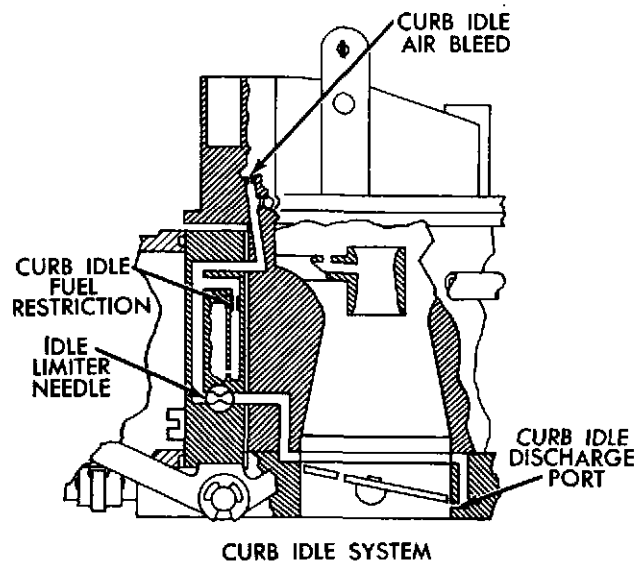


FIG. 8 Curb Idle system, Primary Idle Transfer System

A low pressure or partial vacuum is created in the booster venturi and the main metering system starts to flow. This moderate opening (transition) of the throttle is commonly called "tip in". When the throttle valves are opened, the accelerator pump system mechanically squirts raw fuel into the venturi to prevent a stumble until the mixture from the main metering system "catches up" with the increased air flow. (This supplementary fuel requirement is needed more during rapid throttle openings.)

A hesitation or "sag" at tip in is one of the most common carburetor problems. A low fuel level, a partially clogged idle tube or restriction gummed-up air bleeds or a manifold leak can cause a "sag" during tip in. Any problem in the accelerator pump system will also cause a problem.

### MAIN METERING SYSTEM (PRIMARY)

The main metering system on both models discussed in this section are very similar.

At higher speeds the vacuum is increased at the main discharge nozzle in the center of the booster venturi.

This vacuum or pressure differential causes fuel to flow through the main metering jet into the main well. The fuel moves up the main well past one or more air bleed holes from the main airwell. These air bleed holes are supplied with the filtered air from the "high speed" air bleeds in the air horn. The mixture of fuel and air moves up the main well and through a channel to the main discharge nozzle in the booster venturi (Figures 10 and 11).

Many booster venturi have tabs or projections which assist in providing unique distribution of the air-fuel mixture in the intake manifold as required for certain engines.

The booster venturi in this series of carburetors are not replaceable, although many carburetors use separate booster castings that are permanently installed in the main body casting.

### POWER ENRICHMENT SYSTEM (PRIMARY)

During high speed or heavy load operation, when manifold vacuum is low, the power system provides added fuel for power operation. A vacuum passage in the throttle body transmits vacuum to the power valve vacuum chamber in the main body. All of the power valves used in this series of carburetors are actuated by a vacuum diaphragm. Manifold vacuum is applied to the vacuum side of the diaphragm to hold it closed at idle and normal moderate load conditions.

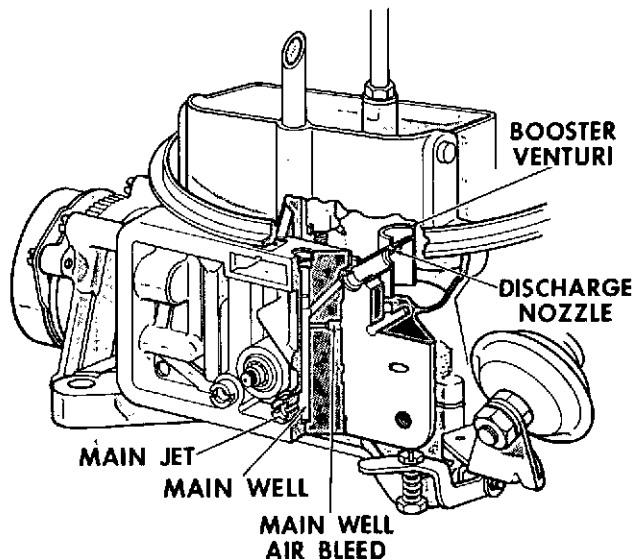


FIG. 10 Main Metering System

When manifold vacuum drops below the power valve's calibration, the power valve spring opens the valve to admit additional fuel. This fuel is metered by the power valve channel restrictions in the metering body. The fuel flows through the restrictions into the main well and is added to the fuel flowing from the main metering jets (Figure 12).

There are many power valve variations, differentiated by size of valves and fuel passages, as well as a wide range of vacuum settings.

When servicing a carburetor the power valve supplied in the repair kit or the valve listed in the service parts list should be used. Each power valve is stamped with the vacuum setting, (example: 65 would indicate the valve would operate at 6.5 inches of vacuum). A manufacturing code is also stamped on the valve.

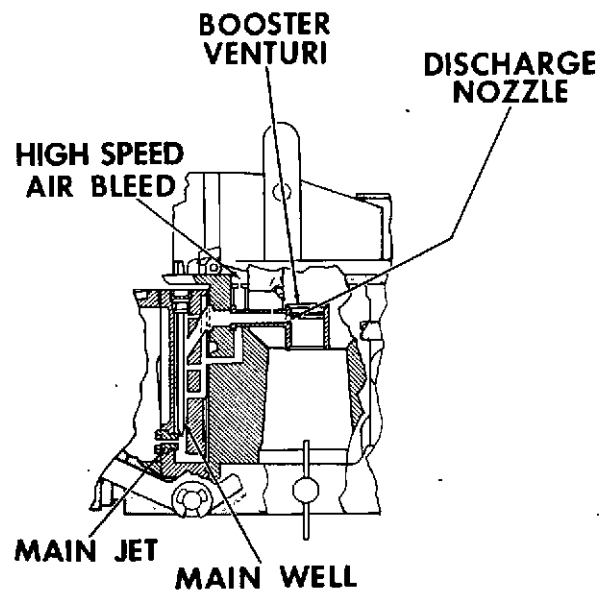


FIG. 11 Side view Main Metering System

**NOTE:** It is very important that the proper gasket is used on the valve and the valve be torqued to 100 in. lb. (Many valves are considered faulty because fuel leaks around the gasket and through the threads.) A sudden change in idle characteristic or sudden stalling due to idle richness can result from a leaking power valve diaphragm. The power valve diaphragm should be tested on a distributor test machine vacuum system or with a hand vacuum pump equipped with a piece of rubber tubing that will cover the diaphragm side of the valve.

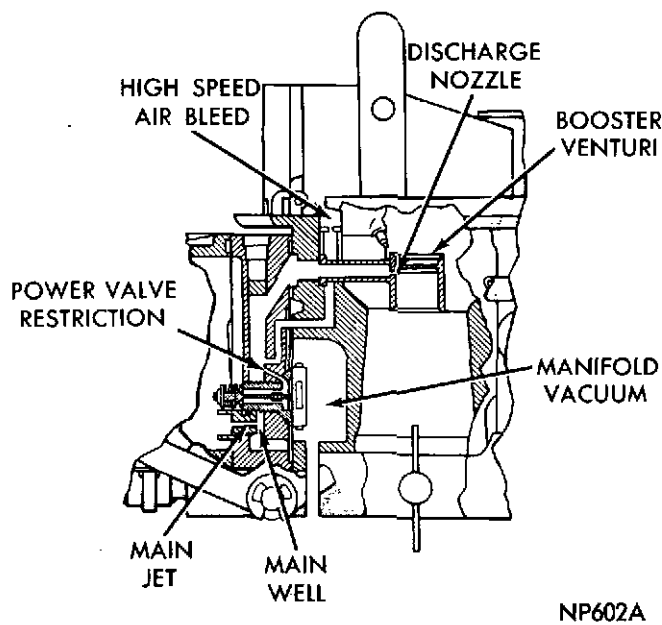


FIG. 12 Power Enrichment System

Contrary to many technician's belief that backfiring ruptures power valves, we find it extremely difficult to create a failure by backfire. In reviewing reported instances of severe backfiring on vehicles (which usually turn out to be caused by ignition problems) power valve diaphragm failures are seldom found.

### ACCELERATING PUMP SYSTEM

During acceleration the air flow through the carburetor responds almost immediately to the increase throttle opening. Since fuel is heavier than air, it has a slower response. The accelerator pump system mechanically supplies fuel until the other fuel metering systems can once again supply the proper mixture.

The diaphragm type pump is located in the bottom of the primary fuel bowl.

Locating the pump in the bottom of the fuel bowl assures a more solid charge of fuel (fewer bubbles).

When the throttle is opened, the pump linkage, actuated by a cam on the throttle lever, forces the pump diaphragm up. As the diaphragm moves up, the pressure forces the pump inlet check ball or valve onto its seat, thereby preventing the fuel from flowing back into the fuel bowl (Figure 13).

The fuel passes through a short passage in the fuel bowl into the long diagonal passage in the metering body. It next goes into the main body passage and then the pump discharge chamber. The pressure of the fuel causes the discharge valve to raise and fuel is then discharged into the venturi.

The pump override spring is an important part of all accelerator pump systems. When the accelerator is moved rapidly to the wide open position, the override spring is compressed and allows the full pump travel. The spring applies pressure to maintain the pump discharge. Without the spring the pump linkage would be bent or broken due to the resistance of the fuel which is not compressible.

As the throttle move toward the closed position, the linkage returns to its original position and the diaphragm return spring forces the diaphragm down. The pump inlet check valve is moved off its seat and the diaphragm chamber is refilled with fuel from the fuel bowl.

There are many variations in the accelerator pump system. First, there are different capacity pump diaphragms and covers. There are a variety of pump cams and there are two locating holes in each cam. Most applications use a ball intake check valve. Several later applications use a plastic "umbrella" type intake valve.

Accelerator pump delivery rate is important and is controlled by the pump cam, linkage, the override spring and the size of the discharge holes.

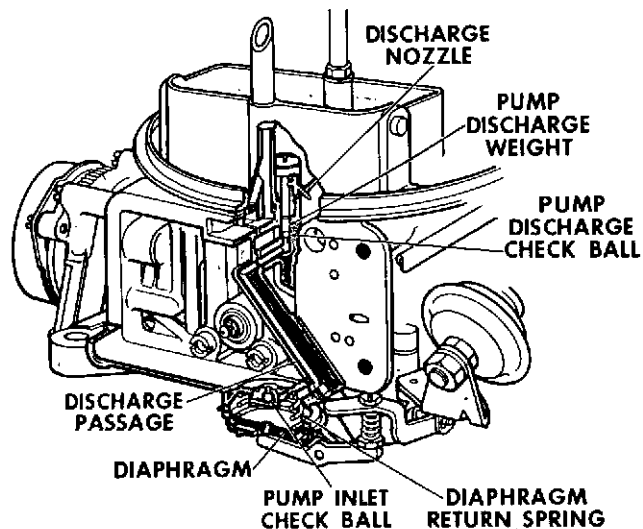


FIG. 13 Accelerator Pump System

### CHOKE SYSTEMS

The choke system provides the richer mixture required to start and run a cold engine. A fully or partially closed choke valve creates a vacuum below the valve so that fuel is discharged from both the idle and main metering systems. Closing the choke plate results in greater enrichment. The richer mixtures are needed because the cold fuel will not vaporize readily and much of the fuel condenses on the walls of the cold intake manifold.

The integral choke has the bimetal assembly and vacuum piston housing mounted on the carburetor. In this model the heat required to operate the bimetal is supplied from an intake manifold cross-over tube or a heat stove mounted on or in the exhaust manifold (Figure 14).

Some of these systems may use an electric heating element to assist and speed up choke "come off" time to meet tighter emission requirements.

A fast idle cam and linkage permits higher engine RPM when the engine is cold. An unloader tab is provided on the throttle lever will mechanically open the choke plate when the throttle lever is held at the wide open position. This permits the operator to relieve an over-choke or flooded condition. Some applications may delete the fast idle cam feature.

Electric chokes, where the bimetal assembly is heated only by an electrical resistor are becoming more popular for certain applications.

Hand operated chokes are used on many special applications.

### INTEGRAL AUTOMATIC CHOKE

When the accelerator pedal is depressed and released the choke thermostatic spring pushes the choke valve to a fully or partially closed position and the fast idle cam to a corresponding fast idle position. A cold engine at lower temperatures will allow the choke valve to close completely and the fast idle cam to move to its top step.

A manifold vacuum passage through the carburetor body is connected to the bottom end of the choke piston cavity. When the engine starts, the vacuum acting on the bottom of the choke piston, opens the valve to a predetermined position established by the "choke piston travel adjustable stop". This initial vacuum opening is called the "choke qualifying dimension", "vacuum break", "vacuum kick" or "vacuum pull down."

The choke plate may open further under increasing airflow conditions.

The choke heat tube, usually asbestos covered, connects the heat source with the heat tube connection of the choke housing. After the piston is pulled down to its stop, a vacuum bypass slot or hole in the center of the piston is opened up and increased hot air is circulated in the housing to further heat the bimetal spring. As the spring warms up, its tension on the choke shaft will be relaxed and allow the choke valve to open gradually to the wide open position. The choke bimetal cover has index marks and an arrow indicating the lean direction. Different applications require different settings. When the engine first starts, the fast idle cam can be "kicked down" to a lower step and speed by tapping the throttle lever lightly.

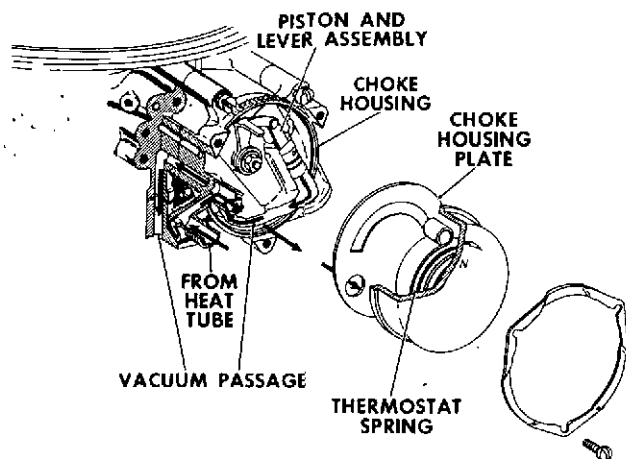


FIG. 14 Integral Automatic Choke

### ELECTRIC CHOKES

Electric chokes function somewhat similarly and require nearly the same hardware as integral systems, except for the bimetal cover assembly. The electric choke differs in bimetal cover assembly design. A resistor is built into the cap assembly and provides a direct heat supply for the bimetal. This type of choke system may be adjusted for choking duration on the engine by readjusting or repositioning the index setting of the bimetal cap. During carburetor design the rate of temperature increase is varied slightly by changing airflow thru the cap by means of a restriction in the manifold vacuum passage. The primary means of substantially altering choking time is by changing the bimetal temperature rate or resistance (number of coils in the resistor). This choke system may be used with aftermarket intake manifolds not incorporating a heat tube.

Electric chokes may be designed for either 6V or 12V engine systems, however, most are designed for the more recent 12V systems.

**NOTE:** Care must be taken to properly connect to the basic 12V supply and not to ignition or coil, which have reduced voltage during operating conditions. A low voltage will not open the choke completely. The ignition firing efficiency would additionally be impaired if choke voltage were taken here.

### HAND OPERATED CHOKES

The most important hand choke problem to watch for is to be sure that the choke will open and close properly. If the knob on the choke cable is too close to the instrument panel, the engine vibration will have a tendency to pull the choke valve partly closed. This creates a rich condition at higher speeds.

## SECONDARY SYSTEMS

### VACUUM SYSTEMS SECONDARY OPERATION

At lower speeds the secondary throttle valves remain closed, allowing the engine to maintain proper air-fuel velocities and distribution for lower speed, light load operation. When engine demand increases to a point where additional breathing capacity is needed, the vacuum controlled secondary throttle valves begin to open automatically (Figure 15).

Vacuum from one of the primary venturi and one of the secondary venturi is channeled to the top of the secondary diaphragm. The bottom of the diaphragm is open to atmospheric pressure. At higher speeds and higher primary venturi vacuum, the diaphragm, operating through a rod and secondary throttle lever, will commence to open the secondary throttle valves. This action will start to compress the secondary diaphragm spring.

As the secondary throttle valves open further a vacuum signal is created in the secondary venturi. This additional vacuum assists in opening the secondary throttle valves to the maximum designed opening. The secondary opening rate is controlled by the diaphragm spring and the size of the vacuum restrictions in the venturi.

When the engine speed is reduced, venturi vacuum decreases and the diaphragm spring starts to push the diaphragm down to start the closing of the secondaries. Closing the primary throttle valves moves the secondary throttle connecting link.

Most production applications have a ball check and bypass bleed installed in the diaphragm passage. The ball permits a smooth even opening of the secondaries, but lifts off the inlet bleed to cause rapid closing of the secondaries when the primary throttle valves are closed.

**CAUTION:** No attempt should be made to convert vacuum operated secondaries to mechanical operation. Bolts or screws should never be installed in the slot in the secondary throttle lever.

## SECONDARY FUEL METERING SYSTEMS

### FUEL INLET SYSTEMS

All secondary systems in these models have a separate fuel bowl. Fuel is usually supplied to the secondary bowl by a transfer tube from the primary fuel inlet fitting. Some models have bowls with center hinged floats which use exterior plumbing.

The secondary fuel bowl is equipped with a fuel inlet valve and float assembly similar to the primary side.

The specified fuel level on the secondary side is usually slightly lower than the primary side.

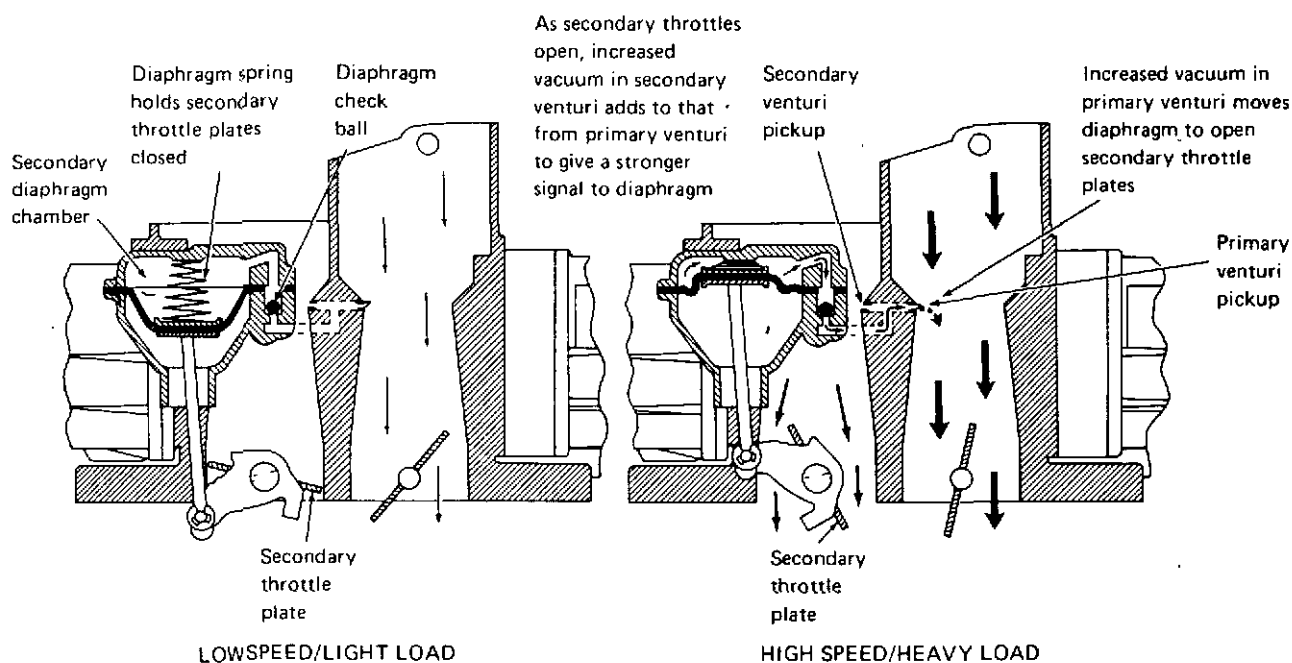


FIG. 15 Vacuum Operated

**NOTE:** Some applications include a balance tube which vents vapors and excess fuel back to the primary bowl. The secondary fuel inlet system is calibrated to deliver the proper mixture to the other systems only when the fuel is at the specified level.

#### SECONDARY IDLE SYSTEM — MODEL 4150

If the secondary system were to remain inoperative over long periods, portions of the system would become blocked with gum and varnish. To prevent this condition and maintain stable fuel level control, an idle system is incorporated on the secondary side to insure the use of fuel from the secondary side under various operating conditions and also maintain stable fuel levels and balanced idle mixtures.

Fuel flows from the secondary fuel bowl through the secondary main metering jet, through a passage into the idle well, then up a vertical passage and through the idle feed restriction. Here the fuel blends with a small amount of air entering through the secondary idle air bleed. This air-fuel emulsion flows down a vertical passage to the secondary idle discharge port below the throttle valves. As the secondary throttle valve opens, exposing the transfer slot to vacuum, the air-fuel mixture flows from both the idle passage and the idle transfer slot (Figure 16).

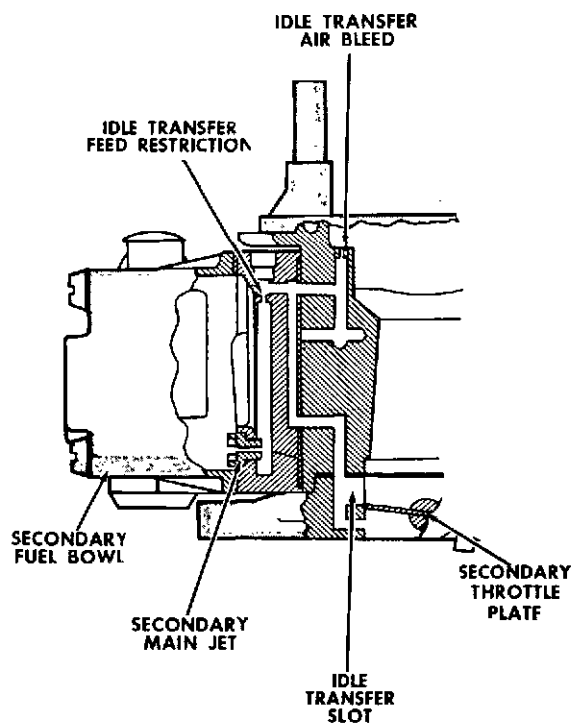


FIG. 16 Secondary Idle and Transfer System

#### SECONDARY MAIN METERING SYSTEM — MODEL 4150

The operation of the secondary main metering system is similar to the operation of the primary main metering system (Figure 10).

#### SECONDARY POWER ENRICHMENT — MODEL 4150

Many 4150 models do not have power enrichment on the secondary side. However, where installed, the secondary metering body uses a power valve and channel restrictions similar to the primary side.

#### SECONDARY FUEL METERING SYSTEM — MODEL 4160 (Figure 17)

The 4160 model secondary metering body (plate) is enclosed within the fuel bowl. The metering body is attached to the carburetor body with six clutch head screws.

Fixed main metering restrictions are located in the bottom of the metering body. Fuel for the idle and idle transfer system as well as fuel for the main metering system enters the main well through these restrictions. Idle fuel wells branch off of each main well. Fuel travels up the idle wells through an idle restriction where it is mixed with air entering through the secondary idle air bleeds. Air enters the main well through the secondary high speed air bleeds.

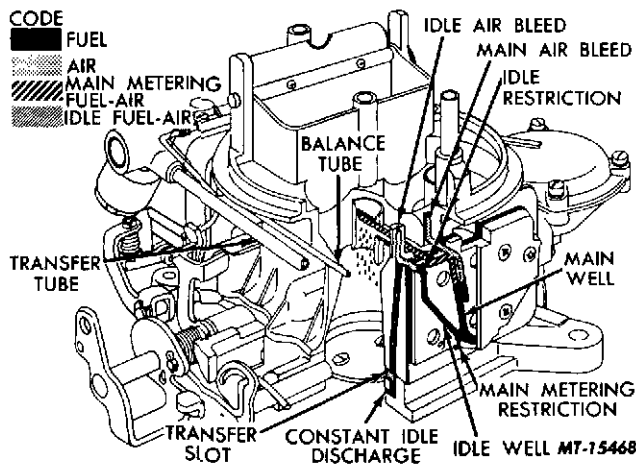


FIG. 17 Model 4160 Secondary System

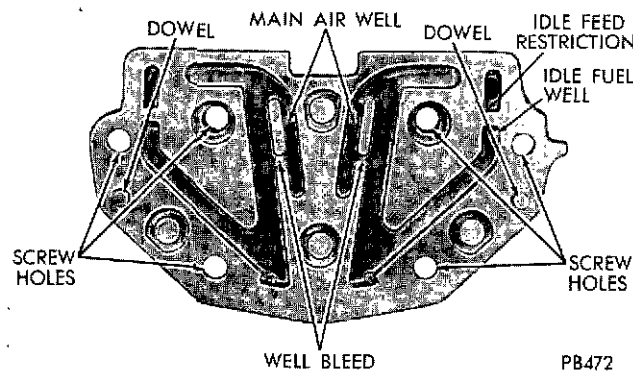


FIG. 18 Late Secondary Metering Body

The air and fuel emulsion is discharged out of the secondary nozzles located in the booster venturi. The secondary transfer and main metering system are only operative when the secondary throttle valves are opened (Figures 18 and 19).

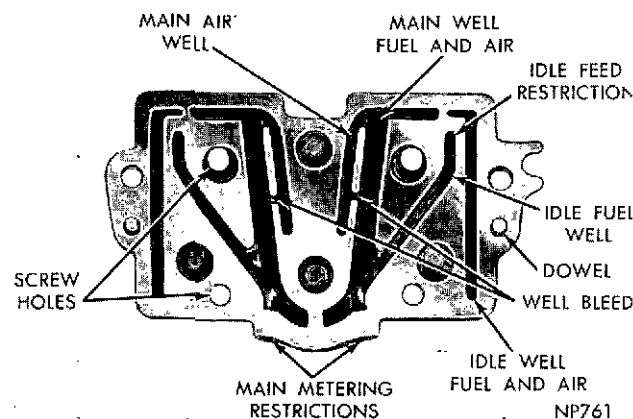


FIG. 19 Early Secondary Metering Body

### SERVICE PROCEDURES

Dirt, dust, water and gum and varnish deposits are some of the main causes of poor carburetor operation.

All parts *except* the secondary diaphragm should be thoroughly cleaned in suitable solvent or commercial carburetor cleaner, then inspected for wear or damage.

All restrictions and channels should be blown out with air (See Figures 22 and 38).

Experienced technicians develop their own order or method of disassembly. It is probably best for a beginner to break the carburetor down into subassemblies, keeping the related parts together. The most important tool or asset of any carburetor repairman is a keen sense of observation.

**NOTE:** Before disassembling any carburetor in this series place the carburetor on a suitable stand or legs. Legs can be made from four two-inch cap screws and eight nuts. Screw one nut on each cap screw about one inch from the end. Place in the mounting holes and install the other nut on the top. This procedure prevents nicks or damage to the throttle valves or shafts.

### DISASSEMBLY MODEL 4150 AND 4160

Many carburetors do not have all the hardware noted in the following Steps.

1. Remove integral choke assembly and fast idle cam (if used) (Figure 27).
2. Remove choke fast idle lever screw and lever, remove "E" clip, fast idle cam and lever (if used).
3. Remove secondary vacuum diaphragm assembly from carburetor body (if used) (Figure 24).
4. Remove four fuel bowl screws and primary fuel bowl assembly by sliding straight off transfer tube (Figure 28).
5. Remove primary metering body by sliding straight off dowels or balance tube.
6. Remove power valve using 1" wrench or power valve socket. Remove power valve gasket and pump transfer tube with "O" rings (if used) from metering body (Figure 30).

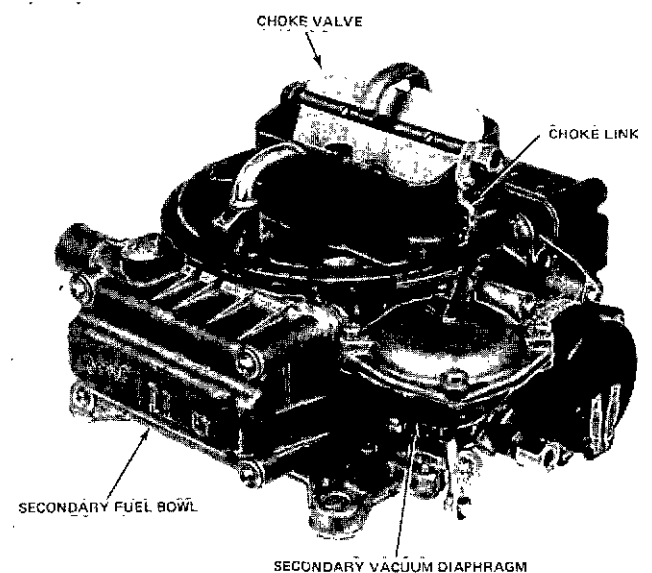


FIG. 20 Secondary Side Model 4160. Internal Fuel Inlet Needle and Seats.

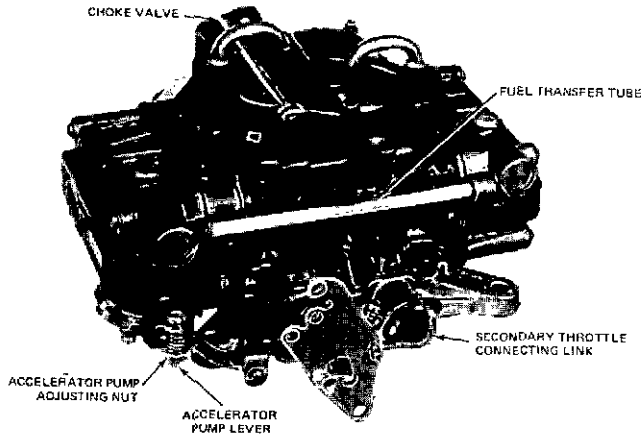


FIG. 21 Throttle Lever Side, Model 4160

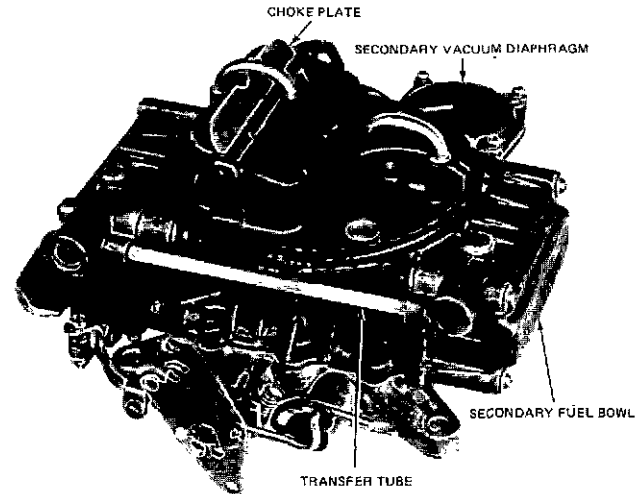


FIG. 23 Throttle Lever Side, Model 4160

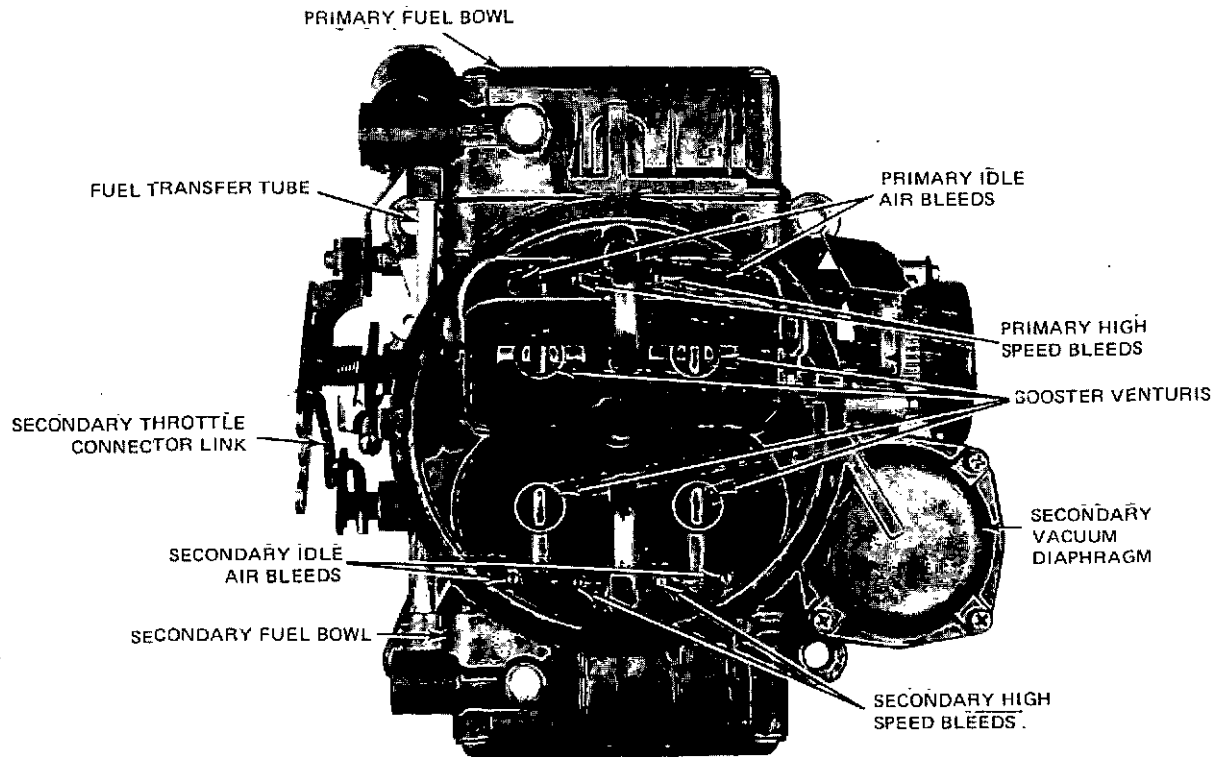


FIG. 22 Top View, Model 4160, showing Idle Air and High Speed Bleeds

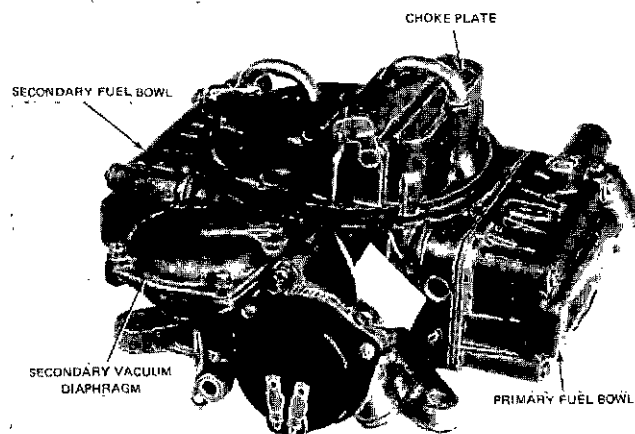


FIG. 24 Choke Housing Side Model 4160, Internally Adjusted Needle and Seat

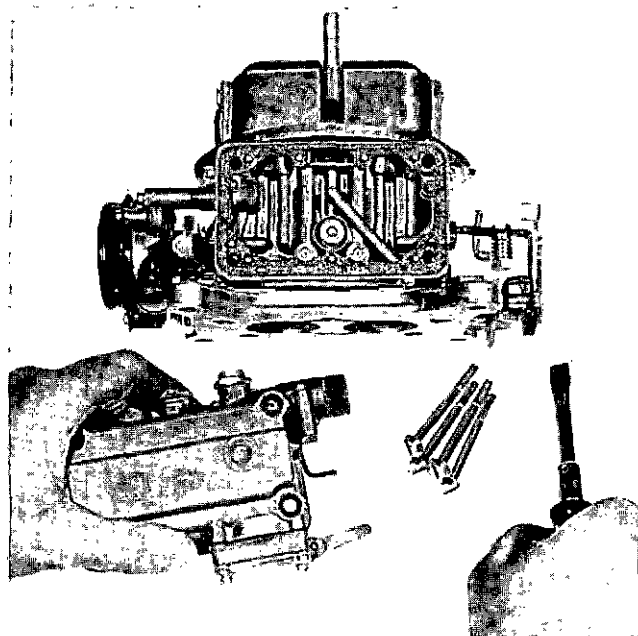


FIG. 25 Removal or Installation of Primary Fuel Bowl

7. Remove gasket and main metering jets using 3/8 inch wide screwdriver or proper jet socket (Figure 31).
8. Turn idle limiter caps "clockwise" to stops. Remove caps by prying off of idle mixture screws (if used). (NOTE: Be careful not to bend screws). Count and record exact number of "clockwise" turns to seat each screw lightly. The same number of turns must be maintained from the seat upon reinstallation. Remove screws and gaskets from metering body. Remove vent baffle (Figure 31).
9. Remove screws attaching accelerator pump cover to fuel bowl. Remove cover and carefully remove pump diaphragm and spring (Figure 32 and 33).
10. Remove fuel inlet fitting with screen or filter and gasket (Figure 34).
11. Externally Adjustable Needle and Seat: Remove the fuel inlet baffle and remove the retainer, float assembly and float spring (if spring is used). Remove the adjustment lock screw. Turn the adjustment nut counterclockwise. Remove the locknut, gasket and fuel inlet needle and seat

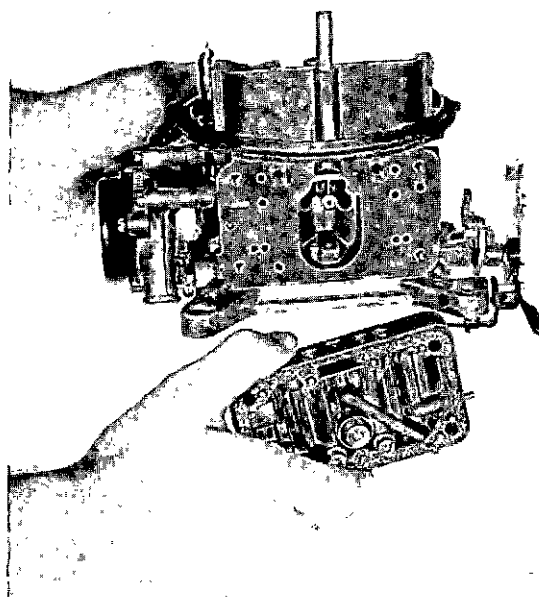


FIG. 26 Removal or Installation of Primary Metering Body

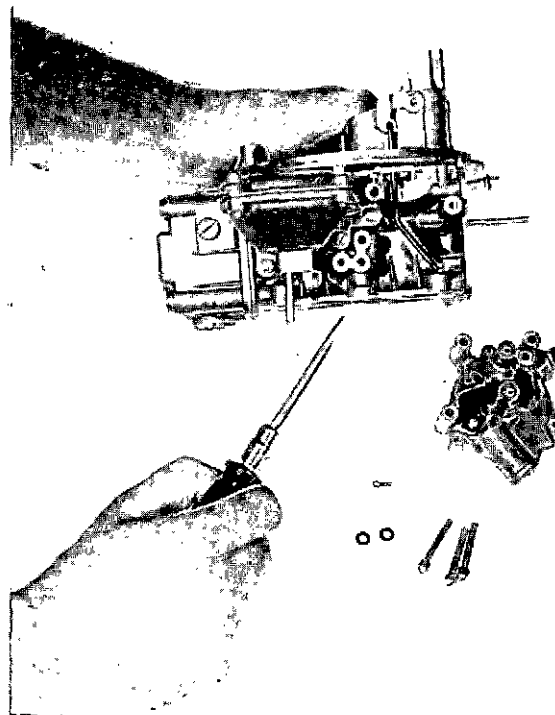


FIG. 27 Removal or Installation of Integral Automatic Choke

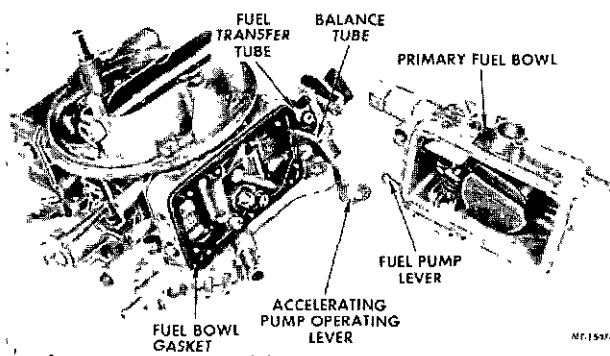


FIG. 28 Removing or Installing Primary Fuel Bowl

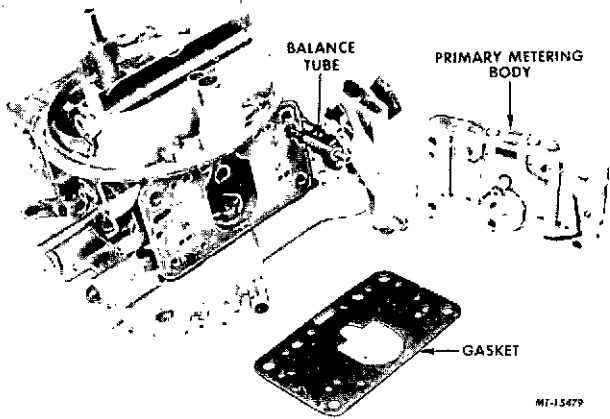


FIG. 29 Removing or Installing Primary Metering Body (with pump transfer tube)

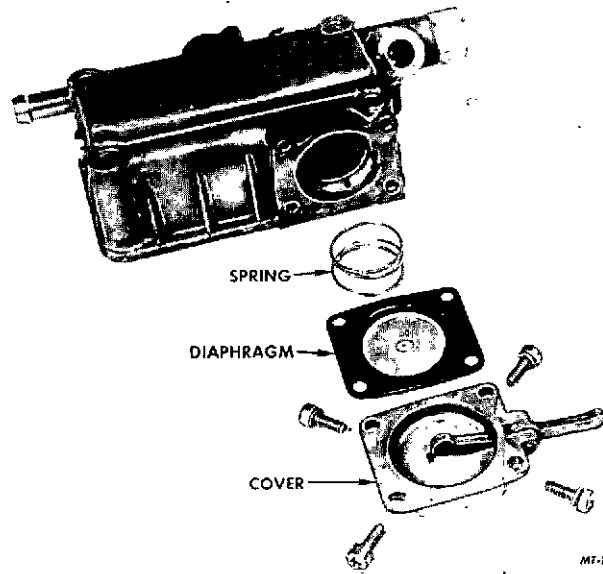


FIG. 32 Accelerator Pump, Disassembled Plastic Pump Inlet Valve

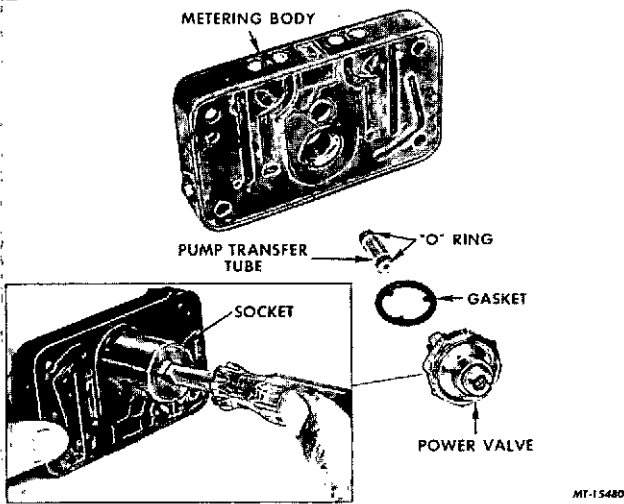


FIG. 30 Primary Metering Body with Acceleration Pump Transfer Tube (Disassembled View)

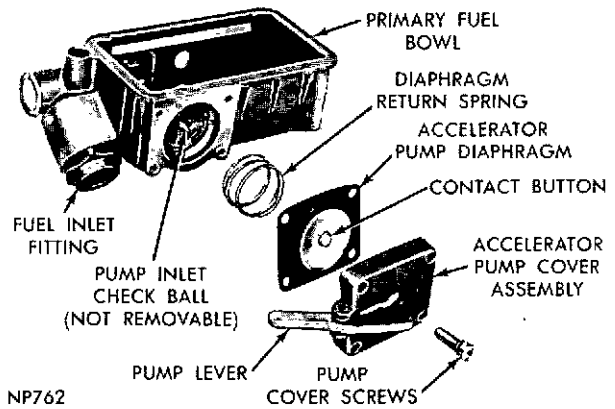


FIG. 33 Accelerator Pump, Disassembled Ball Check Valve

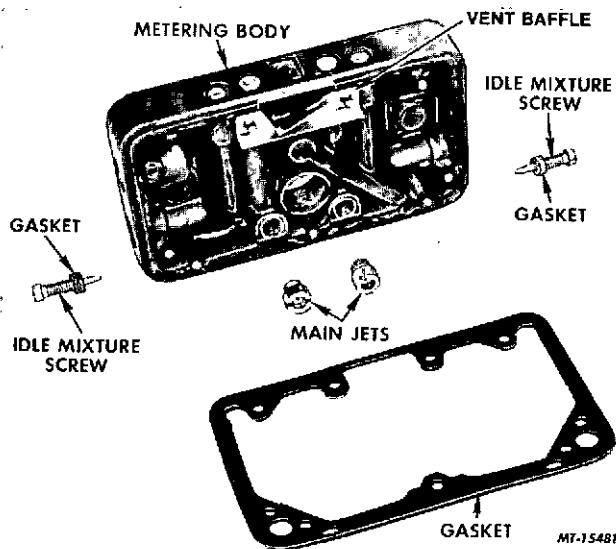


FIG. 31 Primary Metering Body, Fuel Bowl Side (Disassembled View)

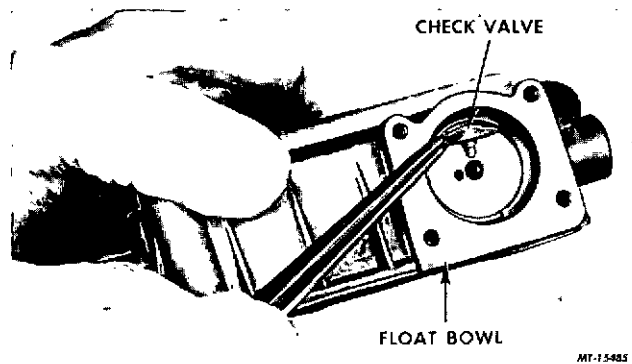


FIG. 34 Removal or Installation of the Plastic Pump Intake Check Valve

12. Internal Needle and Seat: Remove float retainer "E" clip, then slide float and spring out of float chamber. Remove baffle, fuel inlet valve and seat. Discard gasket (Figure 35).
13. Remove the plastic accelerator pump inlet check valve (Figure 34). **NOTE: THE BALL TYPE INLET CHECK VALVE IS NOT REMOVABLE.**

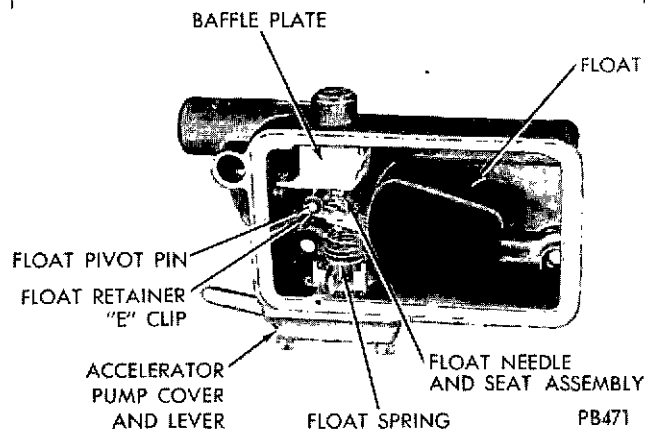


FIG. 35 Fuel Bowl Assembly Internal Adjusted Needle and Seat

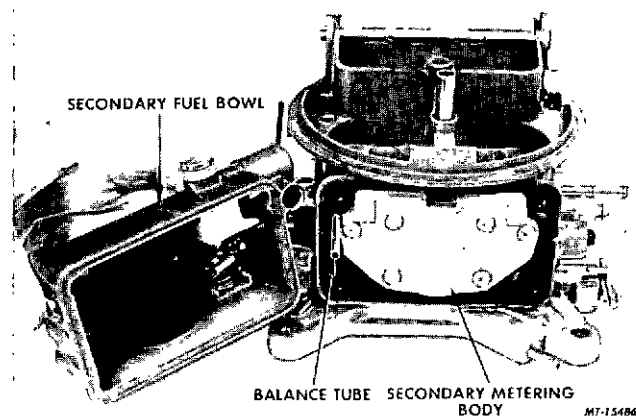


FIG. 36 Removal or Installation of Secondary Fuel Bowl (Model 4160)

14. Remove secondary fuel bowl from carburetor body (Figure 36). **NOTE:** Disassembly of the secondary fuel bowl is similar to the primary bowl. The fuel inlet baffles are not interchangeable.
15. Remove secondary metering body plate and gaskets from main body (Figure 37). **NOTE:** A clutch head screwdriver must be used. Do not attempt to make one from a regular screwdriver. Remove balance tube washers and "O" ring.  
MODEL 4150 Disassembly of the secondary metering body is similar to the disassembly of the primary metering body (Figure 39).
16. Remove choke rod and seal (Figure 20). Unless the choke valve is bent or damaged, DO NOT remove. **NOTE:** The choke valve screws are staked to prevent loosening and care is necessary to avoid breaking or stripping the threads in the choke shaft. If necessary to remove valve, remove staking with a file before loosening screws.
17. Remove pump discharge nozzle retaining screw, then lift out discharge nozzle. Remove gaskets from nozzle (top and bottom), invert carburetor and drop out pump discharge needle or check ball and weight from discharge passage.

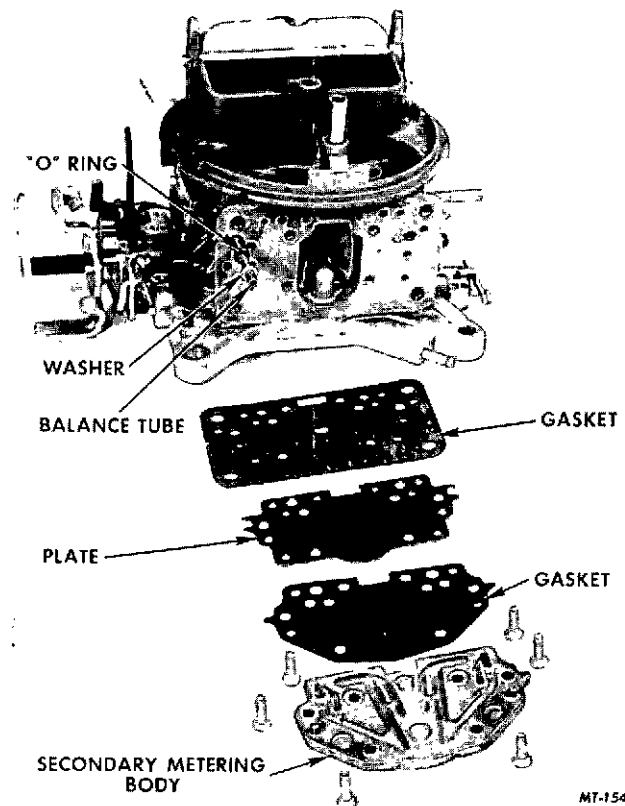


FIG. 37 Removal or Installation of Secondary Metering Body (Model 4160)

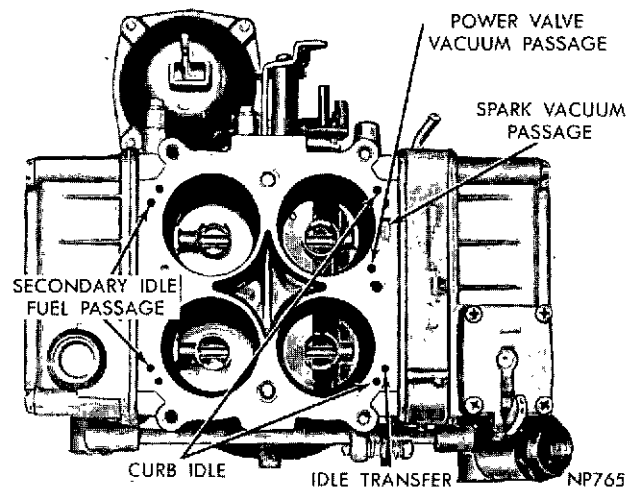


FIG. 38 Main Body Passage Identification

18. Invert carburetor and remove the throttle body attaching screws. Remove the throttle body and gasket. Remove accelerator pump operating lever, adjusting screw and spring, low idle speed screw and spring, curb idle speed screw and spring, and secondary connecting rod. **CAUTION:** If the throttle valves are nicked or damaged, it will be necessary to install a new throttle body or obtain a new carburetor.
19. Disassemble the secondary diaphragm. **CAUTION:** Loosen four screws carefully and free up cover to prevent catching edges of diaphragm in cover screws (Figure 39).

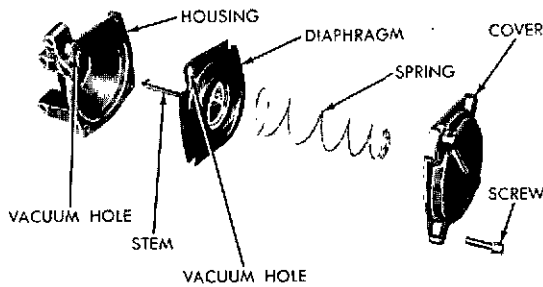


FIG. 39 Disassembly or Assembly of Secondary Vacuum Diaphragm

### CLEANING

Carburetor parts cleaning is thoroughly covered in the introductory section.

**NOTE:** Cleaning, proper assembly, the use of the correct parts, proper torquing of all screws and correct adjustments are necessary to achieve correct carburetor service.

### REASSEMBLY

#### ASSEMBLING PRIMARY METERING BODY

1. Install idle mixture screw gaskets in passages. Use head of screw to push into place.

**NOTE:** Inspect mixture screws. If the tapered portion is grooved or ridged, a new mixture screw should be installed to insure ability to maintain the correct idle mixture. Turn screws in lightly against their seats. Back each screw out the exact number of turns recorded during disassembly (Figure 31).

2. Install a new gasket on power valve and install with proper wrench or socket. Torque to 100 in. lbs. (Figure 30).
3. Install main metering jets using proper screwdriver or jet wrench (Figure 31).
4. Install fuel baffle (if used). Press metering body and fuel bowl gasket down firmly on the dowels (Figure 31). **CAUTION:** Be sure you are using the correct metering body gasket and that bowl gasket is not covering the accelerator pump passage.

#### ASSEMBLY FUEL BOWLS — (PRIMARY)

1. Install plastic accelerator pump check valve in fuel bowl (Figure 34) (if used).
2. If ball type, check ball clearance under retaining bar is proper (Figure 40).
3. Install pump diaphragm return spring, diaphragm and pump cover. Be sure diaphragm is centered and contact button is toward pump lever in cover. Install four attaching screws and tighten evenly.
4. External adjusted fuel inlet needle and seat: Apply lubricating oil or vaseline on a new "O" ring seal and slide it on the needle and seat assembly.
5. Install the fuel inlet needle and seat assembly through the top of the fuel bowl. Then install the adjusting nut gasket. Align the flats of the seat and the adjusting nut and install the nut. Install the lock screw and gasket. Invert the bowl and turn the adjusting nut until top of float is parallel to top of bowl. This preliminary adjustment will run the engine until the fuel level can be properly checked through the sight plug hole after the carburetor has been installed on the engine (Figure 41).

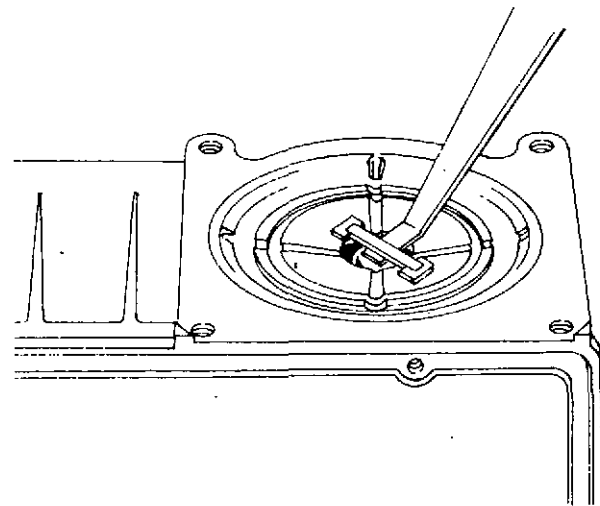


FIG. 40 Checking Pump Intake Ball Valve Clearance

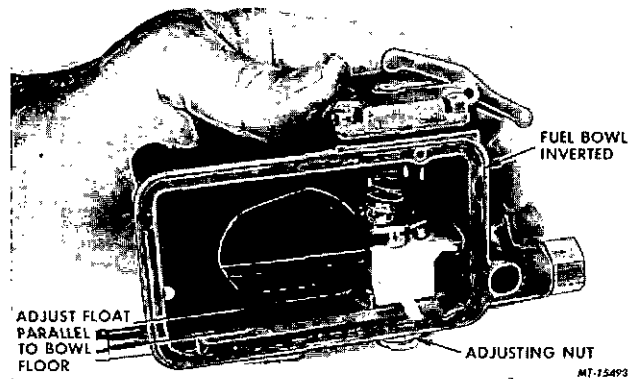


FIG. 41 Preliminary Float Adjustment Externally Adjustable Fuel Inlet Valve — Internally Adjusted Fuel Inlet is Similar

6. Slide the inlet baffle into the grooves (Figure 41).
7. Install float spring (if used) on float lever and then install the assembly on the float shaft. Be sure spring is properly located on fuel bowl floor. Install the float retainer.
8. Install new gasket on fuel inlet fitting, install screen or filter element. Tighten fitting securely.

#### SECONDARY FUEL BOWL — (EXTERNAL NEEDLE AND SEAT)

Assemble the secondary fuel bowl by following Steps 4 through 8 under assembly primary fuel bowls.

#### FUEL BOWLS WITH INTERNAL ADJUSTED FUEL INLET NEEDLE AND SEAT (Figure 35)

Disregard Steps 4 and 5 under external adjusting needle and seats.

1. Install gasket on fuel inlet seat and install in fuel bowl.
2. Tighten securely with proper wrench.
3. Install fuel inlet needle.
4. Install float assembly as described under Step 7. To adjust the dry float setting (internally adjusted needle and seat), adjust float parallel to bowl floor as illustrated in (Figure 41). If an adjustment is necessary, carefully bend float tang until proper adjustment has been obtained using care not to nick or damage portion of tang which contacts needle.

**ASSEMBLING MAIN BODY**

1. Place a new gasket on throttle body, then lower main body down on throttle body.  
**NOTE: BE SURE THE GASKET FITS THE THROTTLE BODY AND MAIN BODY.**
2. Hold assembly together, invert assembly and install attaching screws. **CAUTION: Primary throttle bores must be on primary venturi side (choke side).** Install levers, springs and screws into throttle body. Torque attaching screws evenly in stages to 50 in. lb. (Figure 42).
3. Install accelerator pump discharge needle or ball and weight (if used) in pump discharge passage under choke valve.
4. Install pump discharge nozzle gasket on nozzle screw, install nozzle, second gasket and install assembly in position. Tighten screw securely.

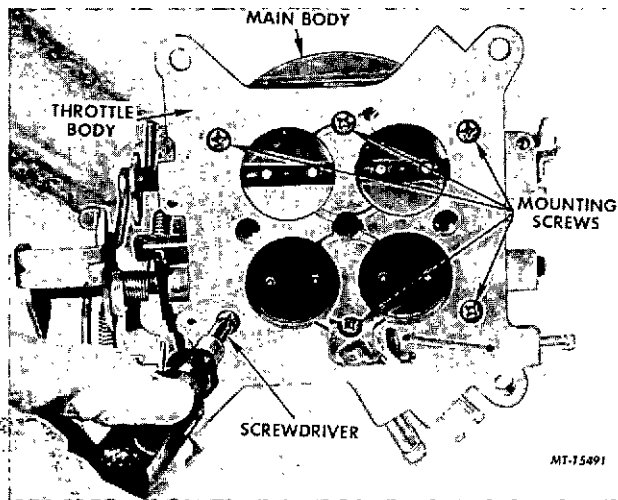


FIG. 42 Installing and Torquing Throttle Body Screws

**MODEL 4160 ASSEMBLY**

- A. Install balance tube into main body. **CAUTION: Install new "O" rings and washers at each end. Be sure "O" rings and washers are seated in recesses on both primary and secondary side (Figure 43); otherwise fuel leakage will occur.**
- B. Install a new secondary metering body (plate) to main body gasket followed by the metering body (plate) (Figure 37). Install six clutch head screws. Tighten evenly and securely with a proper clutch head screwdriver.
- C. Position balance tube so that only 1" extends beyond the secondary metering body (Figure 43).
- D. Adjust primary and secondary dry fuel levels to specification.

**PRIMARY BOWL AND METERING BODY ASSEMBLY**

1. If metering body and bowl gaskets were not installed previously under No. 4, describing assembly primary metering body (also secondary on model 4150), do so now. Press gaskets down firmly on dowels, not only to hold them in place but to prevent bowl gasket from interfering with the float (Figures 29 and 31).
2. Install eight bowl screw gaskets on the screws. **NOT IN THE RECESSES.**  
**NOTE: This prevents shearing off gasket fibers which could enter the fuel bowl and partially stop up a main metering jet.**

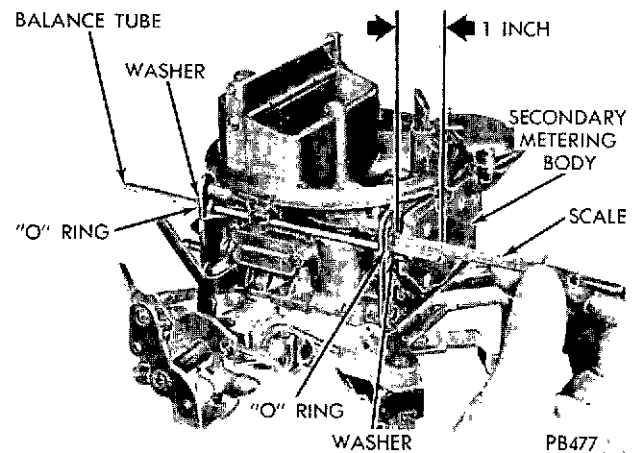


FIG. 43 Adjusting Balance Tube Model 4160

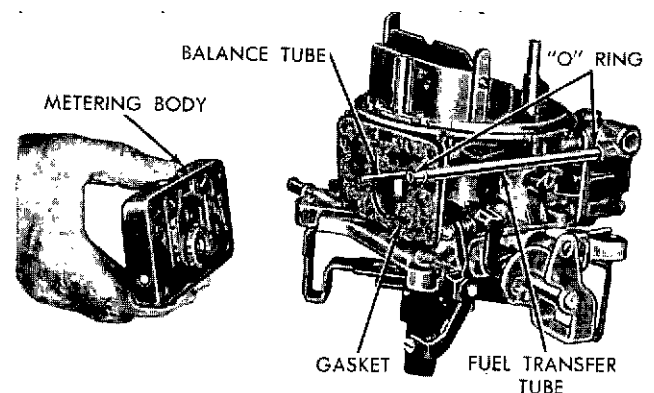


FIG. 44 Installing Primary Metering Body (Model 4160)

3. Carefully install primary metering body over balance tube (if used) and press firmly on dowels (Figure 44).
4. Install fuel bowl on metering body, positioning pump lever in proper position over pump operating lever.  
Carefully install four bowl screws and gaskets and torque all bowl screws evenly in stages to 25-30 in. lb.
5. Install a new "O" ring on the extreme end of each end of fuel transfer tube. Apply Vaseline lightly on "O" ring and install transfer tube into opening in primary fuel bowl. The "O" ring will roll into proper position as tube is installed (Figure 29).

The secondary metering body of the model 4160 was installed under "B", Model 4160 assembly.

**MODEL 4150 SECONDARY BOWL AND METERING BODY ASSEMBLY**

1. Install secondary metering jets, power valve (if used) and bowl vent (if used). Install metering body gaskets. Press firmly on metering body. Install bowl gasket on face of metering body. Press down firmly on the nine dowels, similar to the primary installation.
2. Carefully slide secondary fuel bowl on fuel transfer tube and seat on gasket. Install four bowl screws and gaskets and torque evenly in stages to 25-30 in. lb.
3. Install accelerator pump discharge needle or ball and weight (if used) in pump discharge passage (in air horn).
4. Install pump discharge nozzle gasket on nozzle screw, install nozzle, second gasket and install assembly in position. Tighten screw securely.

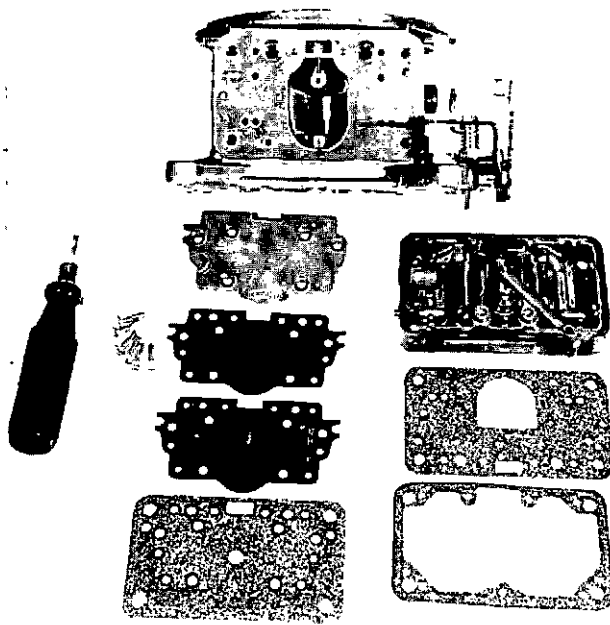


FIG. 46 Comparison Secondary Metering Bodies Model 4160  
Left — Model 4150 Right

#### ASSEMBLING SECONDARY DIAPHRAGM (Figure 39)

1. Position diaphragm in lower housing so that the diaphragm vacuum hole is aligned with vacuum hole in lower cover.
2. Install diaphragm return spring with small end snapped over button in cover.
3. Stand diaphragm stem and lower housing in a socket or support to keep the diaphragm in position as the spring and cover are installed.
4. Align vacuum port in cover with port in housing. Install cover and four cover screws. Tighten securely.
5. Check diaphragm by pressing in on stem and placing finger over port. Diaphragm should stay in retracted position.
6. Install new gasket in vacuum passage recess in diaphragm housing. Engage diaphragm in secondary lever. Install housing on carburetor body, install screws and tighten securely.

#### CARBURETOR ADJUSTMENTS

##### CHECKING ACCELERATOR PUMP LEVER CLEARANCE (Figure 47)

1. With throttle valves held wide open and the pump lever held down, it should be possible to insert a .015 in. min. — .062 in. max. gauge between adjusting nut and lever.
2. If adjustment is necessary, adjust pump override screw until correct clearance has been obtained.
3. There must be no free movement of pump lever when throttle lever is at curb idle.

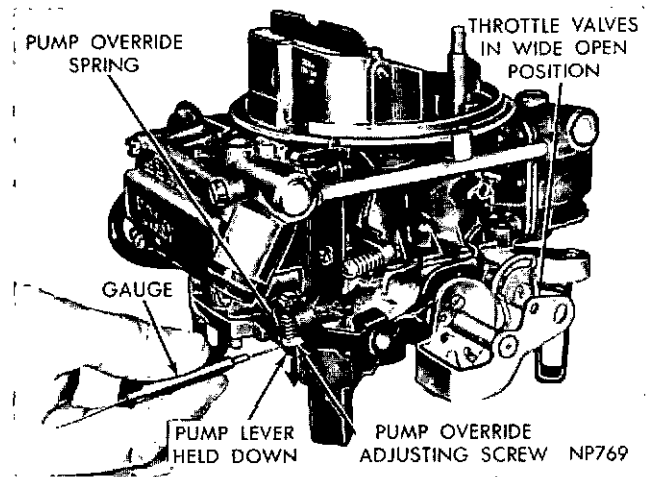


FIG. 47 Pump Override Screw Adjustment

##### ADJUSTING SECONDARY THROTTLE STOP (IF USED) (Figure 48)

Back the secondary throttle stop screw out until the secondary throttle valves are closed in the throttle bore. Turn the screw in (clockwise) until it just touches the stop on the lever, then give it an additional 1/4 turn.

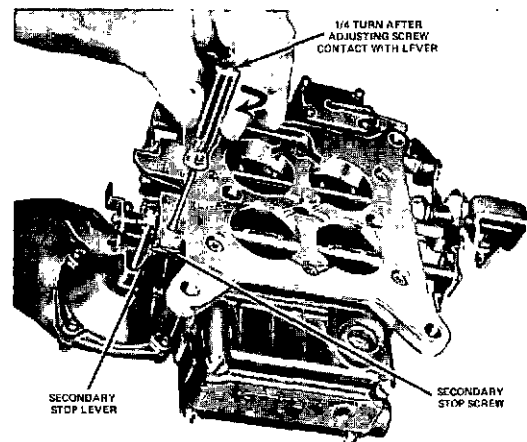


FIG. 48 Secondary Throttle Valve Adjustment

#### INTEGRAL CHOKE ADJUSTMENTS

##### CHOKE QUALIFYING

Remove choke thermostat housing cover (plastic).

A paper clip (.030 to .036 dia.) must be bent as shown to provide an end no longer than 1/8 inch. The bent end of the clip should be inserted into the piston bore until the end of

the bore slot is hooked as shown. Move the piston and levers (bimetal lever must be in contact with piston lever adjusting tab) in a choke closing direction until the edge of the piston slot engages the end of the paper clip. The resulting choke valve opening (clearance to the air horn wall) may then be adjusted by bending the piston lever adjusting tab.

##### CHOKE BIMETAL ADJUSTMENT

Set choke bimetal cover to specifications.

### CHOKE UNLOADER ADJUSTMENT

The choke unloader is a mechanical device to partially open the choke at wide open throttle. It is used to eliminate choke enrichment during cranking of an engine. Engines which have been flooded or stalled by excessive choke enrichment can be cleared by use of the unloader. Adjust the system as follows:

1. Qualify the choke control lever, if necessary.
2. Hold the throttle valves in the wide open position. Insert the specified drill shank or gauge between the upper edge of the choke valve and inner wall of air horn.
3. With a finger lightly pressing against the choke control lever or plate, a slight drag should be felt as the gauge is withdrawn. If an adjustment is necessary, bend the indicated throttle lever tang until correct opening has been obtained.

DRILL INSERTED BETWEEN WALL  
OF AIR HORN AND CHOKE VALVE

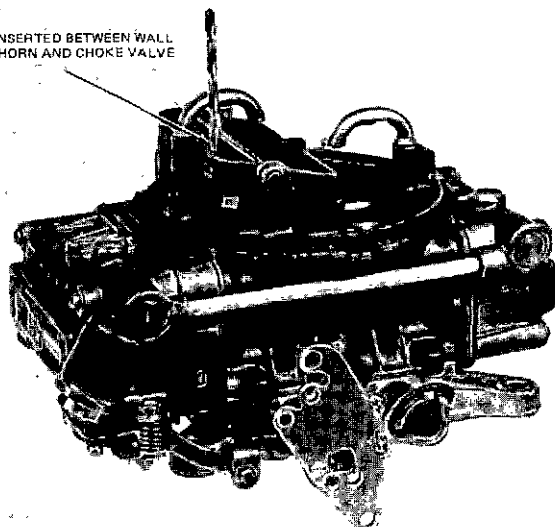


FIG. 49 Choke Unloader Adjustment

### CURB IDLE ADJUSTMENT

Connect tachometer to engine, tachometer should have  $1\frac{1}{2}$  to  $2\frac{1}{2}$  accuracy and an expanded scale of 0-1000 R.P.M. or 400-800 R.P.M.

1. Adjust idle mixture screws fully in until they are lightly seated. Back them out  $1\frac{1}{2}$  revolutions. This will provide sufficient adjustment to be able to start the engine.
2. Be sure the engine is thoroughly warmed up. Adjust the curb idle speed to specification by turning the throttle stop screw "in" to increase idle speed, or "out" to decrease idle speed.
3. Turn the idle mixture adjustment screws inward until the engine speed begins to drop due to a lean mixture. Next, turn the screws outward until the engine speed begins to drop due to an excessively rich mixture. Then, turn the screws inward to a point between these two extremes to obtain maximum engine smoothness and rpm.

4. Reset idle speed to specifications.
5. Recheck idle mixture adjustment and reset if necessary. transmission in neutral, open throttle and close the choke.
6. Disconnect tachometer from engine.

### ERRATIC ENGINE IDLE

If the engine idle is erratic or rough after correct idle adjustment, check the following items:

1. Recheck spark plugs and spark plug wires. Be sure all cylinders are firing. A missing cylinder or occasional misfire will turn an engine that is a minor emitter into a gross emitter.
2. Check for vacuum leaks (vacuum lines or manifold).

### LOW IDLE SPEED ADJUSTMENT

With engine at correct operating temperature and condition as in above procedure and curb idle adjusted to specifications, proceed as follows:

1. Set the low idle speed to specifications by adjusting the low idle speed adjusting screw.

### FAST IDLE ADJUSTMENT

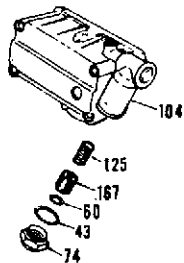
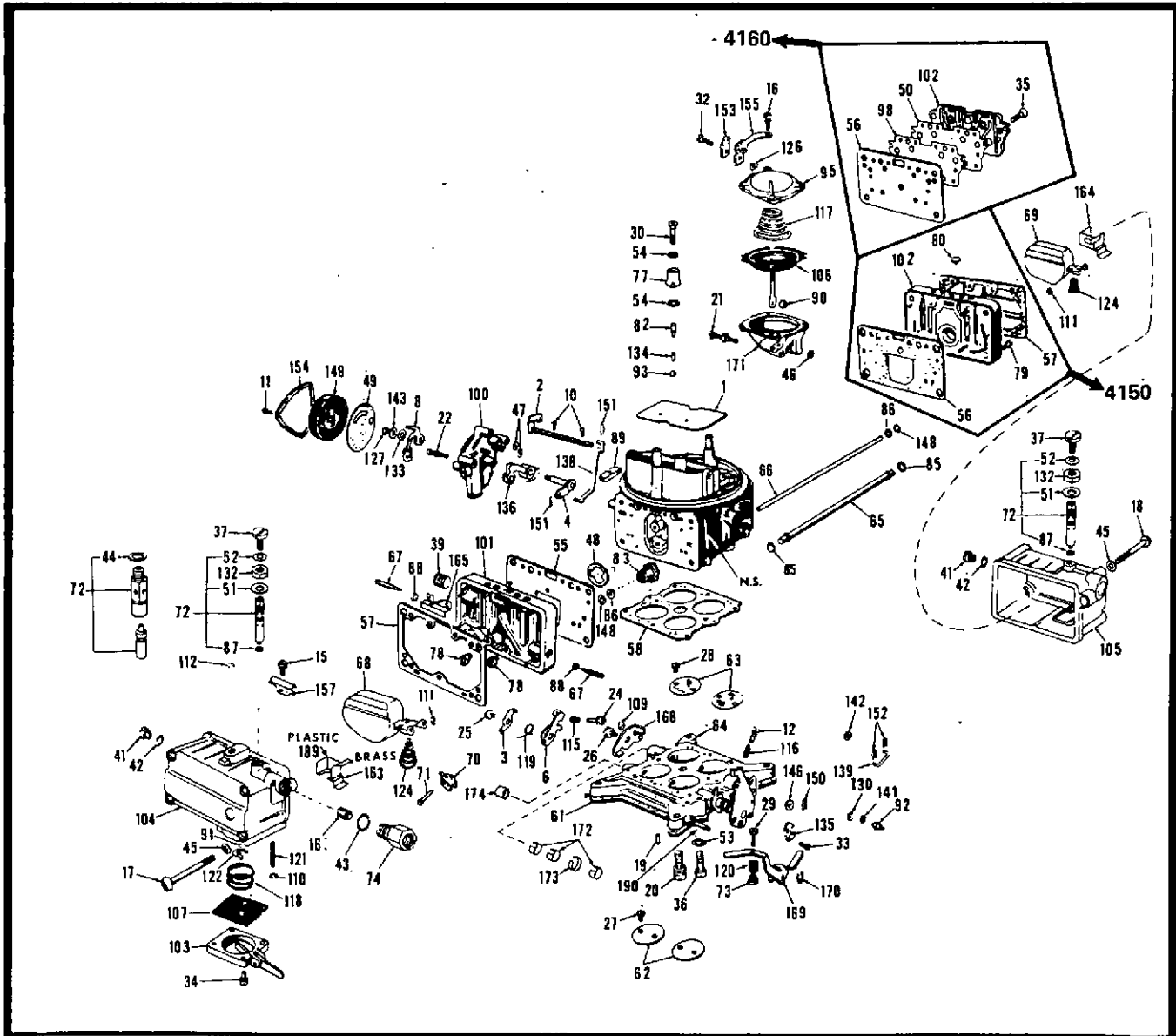
1. Remove air cleaner.
2. Attach tachometer.
3. With engine off and at normal operating temperature, transmission in neutral, open throttle, and close the choke.
4. Close throttle, then release choke to place fast idle screw on highest speed step. Move fast idle cam until screw drops down to second step of the cam against the first step shoulder.
5. Without touching throttle, start engine, allow engine speed to stabilize and observe tachometer. Engine should operate at specified fast idle speed. Readjust fast idle screw if necessary.

### IDLE ADJUSTMENT PROCEDURE WITH ANALYZER

There are a number of infra-red and ultra-violet exhaust gas analyzers in use in all parts of the country. Instructions for use of this equipment varies by test equipment manufacturer. It is recommended that the various equipment manufacturer's instructions be followed for all idle adjustments.

# EXPLODED VIEW

## MODELS 4150 AND 4160



END INLET FILTER BOWL

# TYPICAL NOMENCLATURE

Index Number	Part Name	Index Number	Part Name	Index Number	Part Name
1	Choke Plate	61	Flange Gasket	127	Choke Thermostat Shaft Nut
3	Fast Idle Pick-up Lever	62	Throttle Plate - Primary		Throttle Lever Ball Nut
4	Choke Housing Shaft & Lever Assy.	63	Throttle Plate - Secondary	132	Fuel Valve Seat Adj. Nut
8	Choke Therm. Lev., Link & Piston Assembly	64	Throt. Body & Shaft Assembly	133	Choke Thermostat Lever Spacer
10	Choke Plate Screw	65	Fuel Line Tube	134	Pump Check Ball Weight
11	Therm. Housing Clamp Screw	67	Idle Adjusting Needle	135	Pump Cam
12	Throttle Stop Screw	68	Float & Hinge Assy. - Primary	138	Choke Rod
15	Air Vent Clamp Screw & L. W.	69	Float & Hinge Assy. - Secondary	139	Throttle Connecting Rod
16	Sec. Diaph. Assy. Cov. Scr. & L. W.	73	Pump Lever Adjusting Screw Fitting	141	Throttle Lev. Ball Nut Washer
17	Fuel Bowl to Main Body Screw - Primary	77	Pump Discharge Nozzle	143	Choke Shaft Nut Lock Washer
18	Fuel Bowl to Main Body Screw - Secondary	78	Main Jet - Primary	149	Therm. Hsg. Assy. - Complete
19	Diaph. Lever Adjusting Screw	82	Pump Discharge Needle Valve	150	Throt. Connector Pin Retainer
20	Throt. Body Screw & Lock Washer	83	Power Valve Assy. - Primary	151	Choke Rod Retainer
21	Diaph. Hsg. Assy. Scr. & L. W.	85	Fuel Line Tube "O" Ring Seal	152	Throt. Connecting Rod Cotter Pin
22	Choke Housing Screw & L. W.	87	Fuel Valve Seat "O" Ring Seal	154	Thermostat Housing Clamp
26	Diaph. Lev. Assy. Scr. & L. W.	88	Idle Needle Seal	157	Air Vent Rod Clamp
27	Throt. Plate Screw - Primary	89	Choke Rod Seal	161	Filter Screen
28	Throt. Plate Screw - Secondary	90	Diaphragm Housing Check Ball-Sec.	163	Baffle Plate - Primary (Brass)
29	Pump Lever Adjusting Screw	91	Pump Inlet Check Ball	164	Baffle Plate - Secondary
30	Pump Discharge Nozzle Screw	92	Throttle Lever Ball	165	Metering Body Vent Baffle
33	Pump Cam Lock Screw	93	Pump Discharge Check Ball	167	Fuel Inlet Filter
34	Fuel Pump Cov. Assy. Scr. & L. W.	95	Sec. Diaphragm Housing Cover	168	Diaphragm Lever Assembly
35	Secondary Metering Body Screw	98	Secondary Metering Body Plate	169	Pump Operating Lever
36	Throt. Body Screw - Special	99	Air Vent Cap	170	Pump Operating Lever Retainer
37	Fuel Valve Seat Lock Screw	100	Choke Hsg. & Plugs Assembly	171	Secondary Diaphragm Housing
41	Fuel Level Check Plug	101	Main Metering Body & Plugs Assy. - Primary	172	Throt. Shaft Brg. Pri. & Sec. (Ribbon)
42	Fuel Level Check Plug Gasket	102	Main Metering Body & Plugs Assy. - Secondary	173	Throt. Shaft Brg. Pri. & Sec. (Ribbon)
44	Fuel Valve Seat Gasket	103	Fuel Pump Cover Assembly	174	Throt. Shaft Bearing - Pri. (Solid)
45	Fuel Bowl Screw Gasket	104	Fuel Bowl & Plugs Assy.-Primary	189	Baffle Plate - Primary (Plastic)
46	Sec. Diaphragm Housing Gasket	106	Secondary Diaph. & Rod Assv.	***	Fuel Valve Clip
47	Choke Housing Gasket	107	Pump Diaphragm Assembly	190	Pump Oper. Lever Stud
49	Choke Thermostat Housing Gasket	109	Secondary Diaph. Link Retainer		
50	Sec. Metering Body Plate Gasket	110	Air Vent Rod Spring Retainer		
51	Fuel Valve Seat Adj. Nut Gasket	111	Float Retainer		
52	Fuel Valve Seat Lock Screw Gasket	112	Air Vent Valve Retainer		
53	Throt. Body Screw Gasket	113	Choke Control Lever Retainer		
54	Pump Discharge Nozzle Gasket	115	Fast Idle Cam Lever Screw Spring		
55	Metering Body Gasket - Primary	116	Throttle Stop Screw Spring		
56	Metering Body Gasket - Secondary	117	Secondary Diaphragm Spring		
57	Fuel Bowl Gasket	118	Diaphragm Return Spring		
58	Throttle Body Gasket	119	Fast Idle Cam Lever Spring		
60	Fuel Inlet Filter Gasket	120	Pump Lev. Adj. Screw Spring		
		122	Pump Inlet Check Ball Ret. Spring		
		124	Float Spring - Pri. & Sec.		
		125	Fuel Inlet Filter Spring		

## Part 4 Charging System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
DESCRIPTION AND OPERATION		Bench Test .....	4-03
Alternator .....	4-01	ADJUSTMENTS	
DIAGNOSIS AND TESTING		Belt Adjustments .....	4-07
MOTOROLA .....	4-02	REMOVAL AND INSTALLATION .....	4-08
DIAGNOSIS AND TESTING		OVERHAUL .....	4-08
FORD ALTERNATOR			
On-Vehicle Test .....	4-03		

### DESCRIPTION AND OPERATION ALTERNATOR

The Alternator charging system is a negative ground system, and consists of an alternator, a regulator, a charge indicator, a storage battery, and associated wiring.

The alternator is belt driven from the engine. Current is supplied from the alternator-regulator system to the rotating field of the alternator through two brushes to two slip rings.

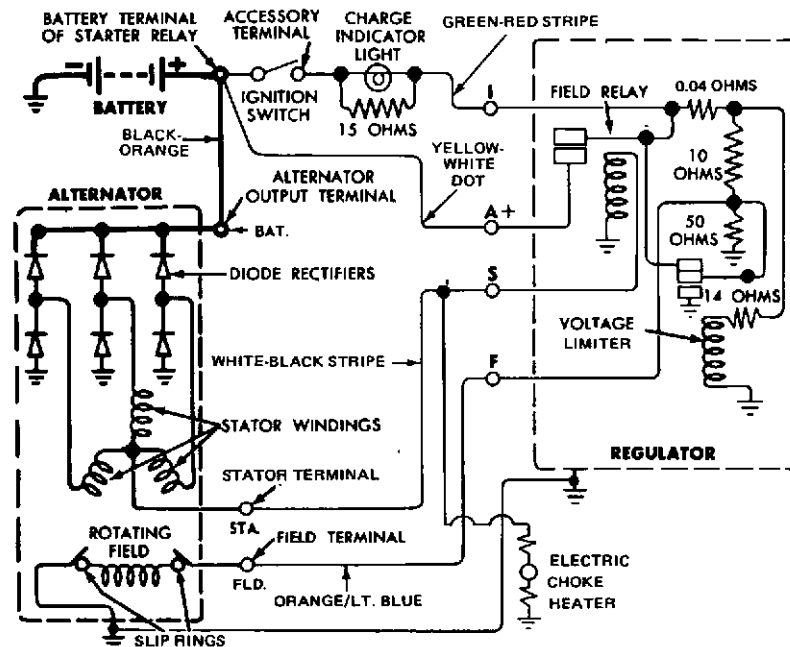
The alternator produces power in the form of alternating current. The alternating current is rectified to direct current by six diodes. The alternator regulator automatically adjusts the alternator field current to maintain the alternator output voltage within prescribed limits to correctly charge the battery.

If a charge indicator lamp is used in the charging system (Figure 1), the system operation is as follows: When the ignition switch is turned ON, a small electrical current flows through the lamp filament (turning the lamp ON) and through the alternator regulator to the alternator field. When the engine is started, the alternator field rotates and produces a voltage in the stator winding. When the voltage at

the alternator stator terminal reaches about 3 volts, the regulator field relay closes. This puts the same voltage potential on both sides of the charge indicator lamp causing it to go out. When the field relay has closed, current passes through the regulator A terminal and is metered to the alternator field.

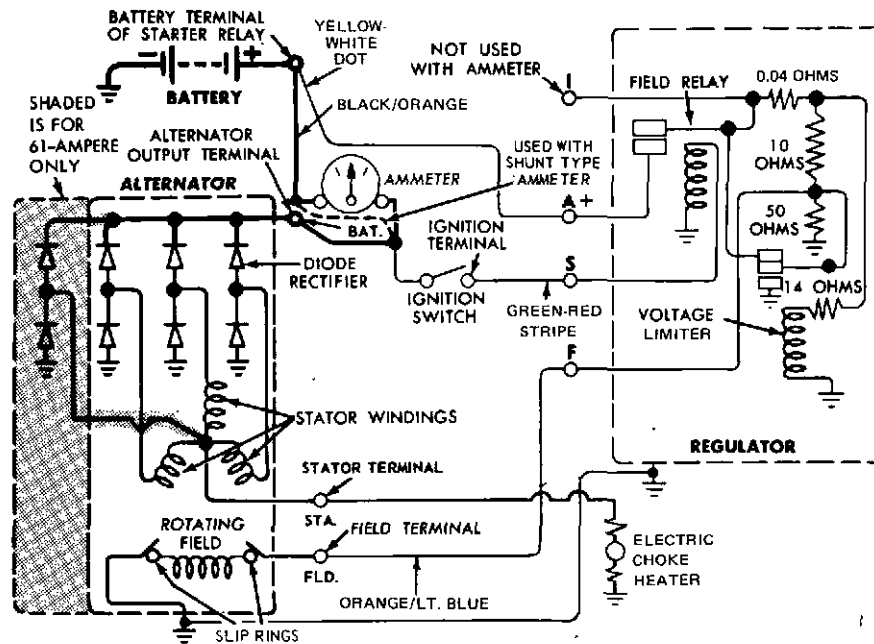
If an ammeter is used in the charging system (Figure 2), the regulator I terminal and the alternator stator terminal are not used. When the ignition switch is turned ON, the field relay closes and electrical current passes through the regulator A terminal and is metered to the alternator field. When the engine is started, the alternator field rotates causing the alternator to operate. The ammeter indicates current flow into (charge) or out of (discharge) the vehicle battery.

The 460 engine uses either a Ford alternator or a Motorola alternator. Most of this section applies to the Ford alternator, because the Motorola unit is serviced by them.



J1210-L

FIG. 1 Alternator Charging System — Indicator Light



J1205-J

FIG. 2 Alternator Charging System — Ammeter

## DIAGNOSIS AND TESTING — MOTOROLA

Before performing charging system tests on the engine, note the complaint such as: slow cranking, battery dead or using an excessive amount of water, top of battery wet, ammeter shows charge at all times and/or never goes out. This information will aid in isolating the part of the system causing the problem. The battery must be in proper state of charge (at least 1.200 specific gravity).

The following tests are made with the alternator in the engine with output and regulator connections maintained to the alternator except as noted in Steps 3 and 5. The field lead and voltage regulator are disconnected for these tests.

Test precautions:

- DO NOT disconnect alternator output lead while alternator is operating.
  - DO NOT disconnect voltage regulator while alternator is operating.
  - DO NOT ground field terminal.
  - Check battery condition. Use a fully charged battery when testing alternator.
  - Disconnect ground cable of battery when removing and installing the alternator.
- All readings indicated are for correct operation.

### TEST 1 — IGNITION ON — ENGINE NOT RUNNING

(Refer to Figure 3)

Correct voltage at regulator terminal is approximately 1.5 to 2.5 volts. This test evaluates excitation circuit.

If voltage at regulator terminal is:

- 5.0 to 7.0 volts = open rotor (field circuit)
  - .75 to 1.1 volts = grounded rotor circuit
  - 8.5 to 10.0 volts = open in regulator's load circuit
  - 0 volts = open ignition switch or excitation resistor
- If test results are uncertain, make Test 2.

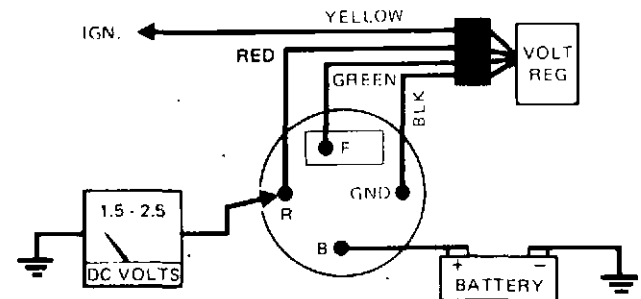


FIG. 3 Ignition On — Engine Not Running

### TEST 2 — IGNITION ON — ENGINE NOT RUNNING

(Refer to Figure 4)

The voltage regulator may be bypassed with a short jumper between the regulator and field terminals. If jumper provides approximate correct voltage, fault is in the regulator. No change from high voltage indicates that the defect is in the brush or rotor circuit.

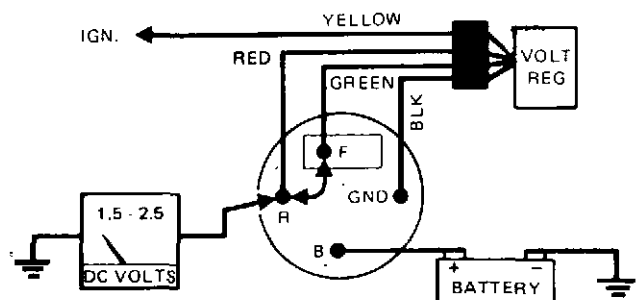


FIG. 4 Ignition On — Engine Not Running

### TEST 3 — FIELD DRAW TEST — IGNITION OFF

(Refer to Figure 5)

This test evaluates complete field circuit, independent of voltage regulator. Circuit is through brushes, slip rings, field coil to ground. Current should be 2 to 2.5 amps. If less than this, check brushes and slip rings. It is desirable to use a field rheostat in series with meter for protection of the meter. If

field is shorted, excessive current would flow through meter and possible damage would result.

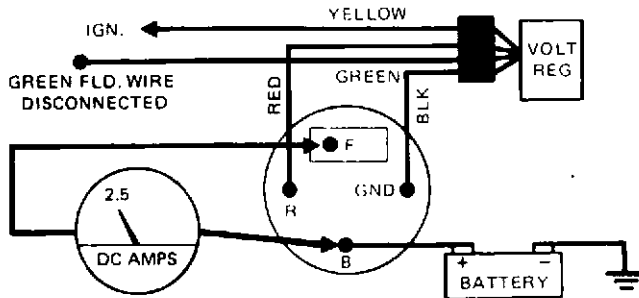


FIG. 5 Field Draw Test — Ignition Off

#### TEST 4 — IGNITION ON — ENGINE RUNNING AT FAST IDLE

(Refer to Figure 6)

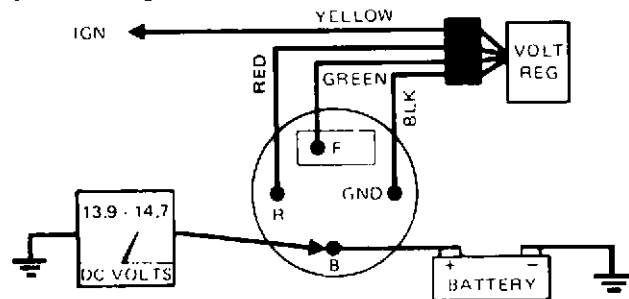


FIG. 6 Ignition On-Engine Running at Fast Idle

Voltage indicated is usually 13.9 to 14.7 volts depending on regulator ambient temperature. High voltage may be due to a poor ground connection. If ground connection is not faulty, regulator will require replacement.

#### TEST 5 — FIELD TERM DISCONNECTED VOLTAGE REGULATOR PLUG DISCONNECTED BATTERY TERMINAL SHORTED TO FIELD TERMINAL

##### IGNITION ON — ENGINE RUNNING AT IDLE

This test isolates defect to either the alternator or regulator. If voltage at auxiliary terminal rises to 15-16 volts now, when it did not in Test 4 with regulator connected, then defect is in regulator and it should be replaced. If voltage does not rise at auxiliary terminal, defect is in alternator stator or rectifier diodes, if field circuit checked out properly. For defects in stator or diodes, remove alternator.

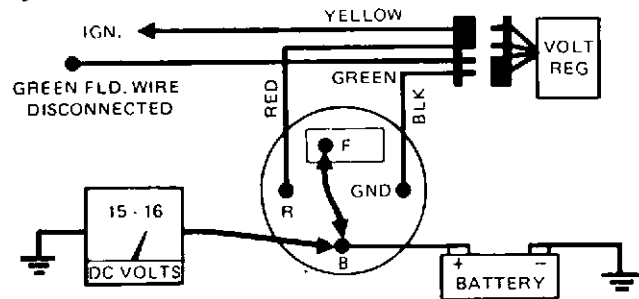


FIG. 7 Field Term Disconnected Volt Reg. Plug Disconnected. Bat. Term. Shorted to Fld. Term. Ignition On — Engine Running at Idle

## DIAGNOSIS AND TESTING FORD ALTERNATOR

Certain tests outlined are illustrated in the schematic and in pictorial form. The schematic illustrates the internal connections of the Rotunda equipment so these connections can be duplicated when this equipment is not available. The various circuits involved in the tests can be selected by means of switches without the necessity of changing connections when the illustrated equipment is used. This reduces the time required to test units and circuits on the vehicle.

Where applicable, the tests are divided into On The Vehicle and On the Test Bench procedures. Either procedure can be followed depending on the equipment available for the tests.

Troubleshooting or diagnosis is required before actual repairs can be made in the electrical system. Even where an obvious fault makes the replacement of a unit necessary, you must still find out why the unit failed. When a trouble is diagnosed correctly, unnecessary repairs are prevented, the time the engine is out of service will be decreased, and the repairs that are made will be permanent.

### ON VEHICLE TESTS

Before performing charging system tests on the engine, note the complaint such as: slow cranking, battery dead or using an excessive amount of water, top of battery wet, ammeter shows charge at all times and/or no charge, alternator warning lamp does not come on and/or never goes out. This information will aid in isolating the part of the system causing the problem. The battery must be in proper state of charge (at least 1.200 specific gravity).

#### Visual Inspection

1. Check the battery posts and battery cable terminals for clean and tight connections. Remove the battery cables (if corroded), clean and install them securely.

2. Check for clean and tight wiring connections at the alternator, regulator and engine.
3. Check the alternator belt tension and tighten to specification (if necessary).

### INDICATOR LIGHT — ALTERNATOR CHARGING SYSTEM

#### Normal Charge Indicator

With Ignition switch off . . . alternator lamp is off.

With ignition switch on (engine not running) . . . alternator lamp is on.

With ignition switch on (engine running) . . . alternator lamp is off.

1. If the charge indicator lamp does not come on with the ignition key in the ON position and the engine not running, check the I wiring circuit for an open circuit or burned out charge indicator lamp (ignition switch to regulator I terminal).
2. If the charge indicator light does not come on, disconnect the wiring plug connector at the regulator and connect a jumper wire from the I terminal of the regulator wiring plug to the negative battery post cable clamp.
3. The charge indicator lamp should go on with the ignition key turned to the ON position.
4. If the charge indicator bulb does not go on, check the bulb for continuity and replace (if burned out).
5. If the bulb is not burned out, an open circuit exists between the ignition switch and the regulator.

A good indication of a problem in the I wiring circuit (ignition switch to regulator I terminal) will show when the charge indicator light goes out with high engine rpm. This is caused by an open circuit in the 15 ohm resistor wire (connected in parallel with the indicator light) generally at the terminal point (either end of the resistor wire).

## AMMETER-ALTERNATOR CHARGING SYSTEM

### Normal Charge Indicator

With ignition switch off and no electrical load . . . ammeter should show 0 or center scale.

With ignition switch on and engine running . . . needle deflects towards charge and returns toward center scale in two steps (fully charged battery).

With ignition switch off and lights on . . . ammeter should show between 0 and discharge scale.

### Tests Using a Voltmeter

When performing charging system tests with a voltmeter, turn OFF all lights and electrical components. Place the engine in neutral. The battery must be charged to at least 1.200 specific gravity before starting the test. before starting the test.

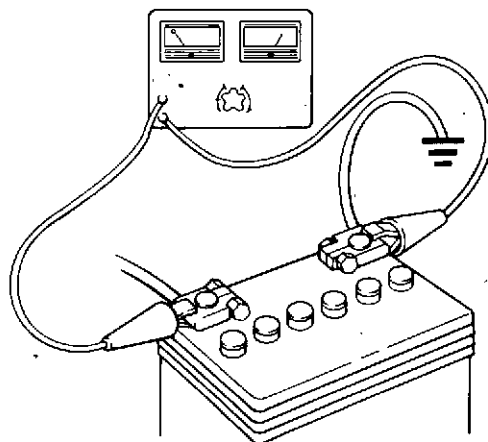
### Voltmeter Test Procedure

1. Connect the negative lead of the voltmeter to the negative battery cable clamp (not bolt or nut), and the positive lead of the voltmeter to the positive battery cable clamp (not bolt or nut) (Figure 9).
2. Record the battery voltage reading shown on the voltmeter scale.
3. Connect the red lead of a tachometer to the distributor terminal of the coil and the black tachometer lead to a good ground.
4. Then, start the engine and operate the engine at approximately 1500 rpm. With no other electrical load the voltmeter reading should increase 1 volt and not exceed 2 volts above the first recorded battery voltage reading. The reading should be taken when the voltmeter needle stops moving.
5. With the engine running, turn on all the electric equipment.
6. Increase the engine speed to 2000 rpm. The voltmeter should indicate a minimum of 0.5 volt above the first recorded battery voltage (Figure 8).

If the above tests indicate proper voltage readings, the charging system is operating normally. Proceed to Test Results if a problem still exists.

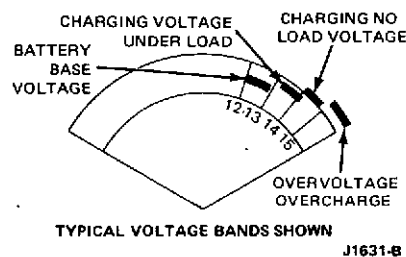
### Test Results

1. If the voltmeter reading indicates over voltage (more than 2.0 volts above battery voltage), stop the engine and check the ground connections between the regulator and alternator and/or regulator to engine. Clean and tighten connections securely and repeat the Voltmeter Test Procedure.



VOLTMETER CONNECTIONS - TO BATTERY

K2628-A



J1631-B

FIG. 8 Voltmeter Test Scale

2. If over voltage condition still exists, disconnect the regulator wiring plug from the regulator and repeat the Voltmeter Test Procedure.
3. If over voltage condition disappears (voltmeter reads battery voltage), replace voltage regulator and repeat the voltmeter test procedure.
4. If over voltage still exists with the regulator wiring plug disconnected, repair the short in the wiring harness between the regulator and regulator. Then, replace the regulator and connect the regulator wiring plug to the regulator and repeat the Voltmeter Test Procedure.
5. If the voltmeter reading does not increase (one volt), check for the presence of battery voltage at the alternator BAT terminal and the regulator A terminal. Repair the wiring if no voltage is present at these terminals, and repeat the Voltmeter Test Procedure.
6. If the voltmeter reading does not increase one volt above battery voltage, proceed to the next step before performing other tests, the field circuit (regulator plug to alternator) must be checked for a grounding condition. If the field circuit is grounded and the jumper wire is used as a check at the regulator wiring plug from the A to F terminals (Figure 10), excessive current will cause heat damage to the regulator wiring plug terminals and may burn the jumper wire (Figure 10). Also, if the field circuit was grounded, the connector wire inside the regulator will be burned open and an under voltage condition will result.
8. The field circuit should be checked with the regulator wiring plug disconnected and an ohmmeter connected from the F terminal of the regulator wiring plug to the battery ground. The ohmmeter should indicate between 4 and 250 ohms (Figure 11).
9. A check for the regulator burned-open wire is made by connecting an ohmmeter from the I to F terminals of the regulator (Figure 12). The reading should indicate 0 (no resistance). If the reading indicates approximately 10 ohms, the connector wire inside the regulator is open. **The field circuit grounded condition must be found and repaired before installing a new regulator.**

FIG. 9 Voltmeter-to-Battery Connections

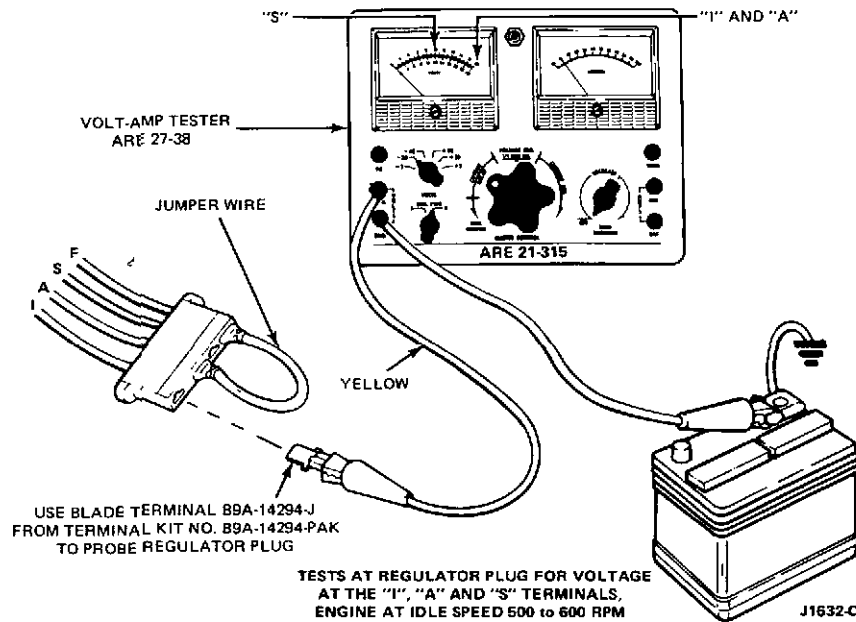


FIG. 10 Regulator Plug Voltage Tests

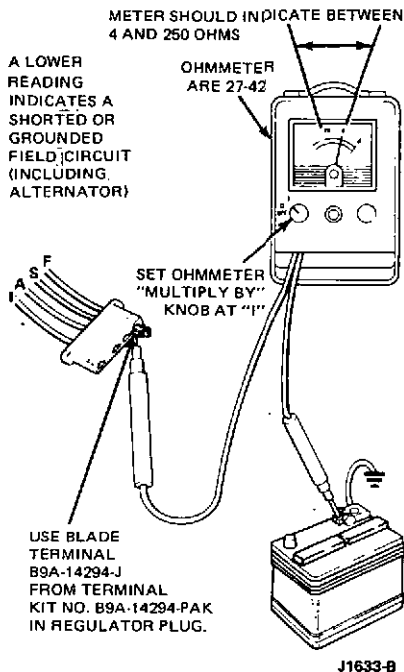


FIG. 11 Field Circuit Test

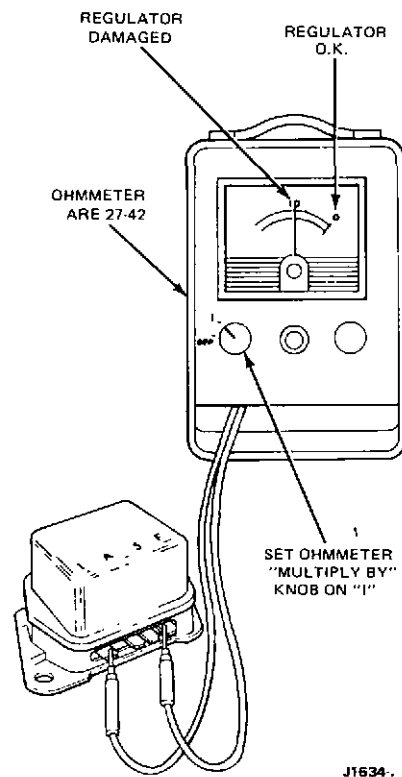
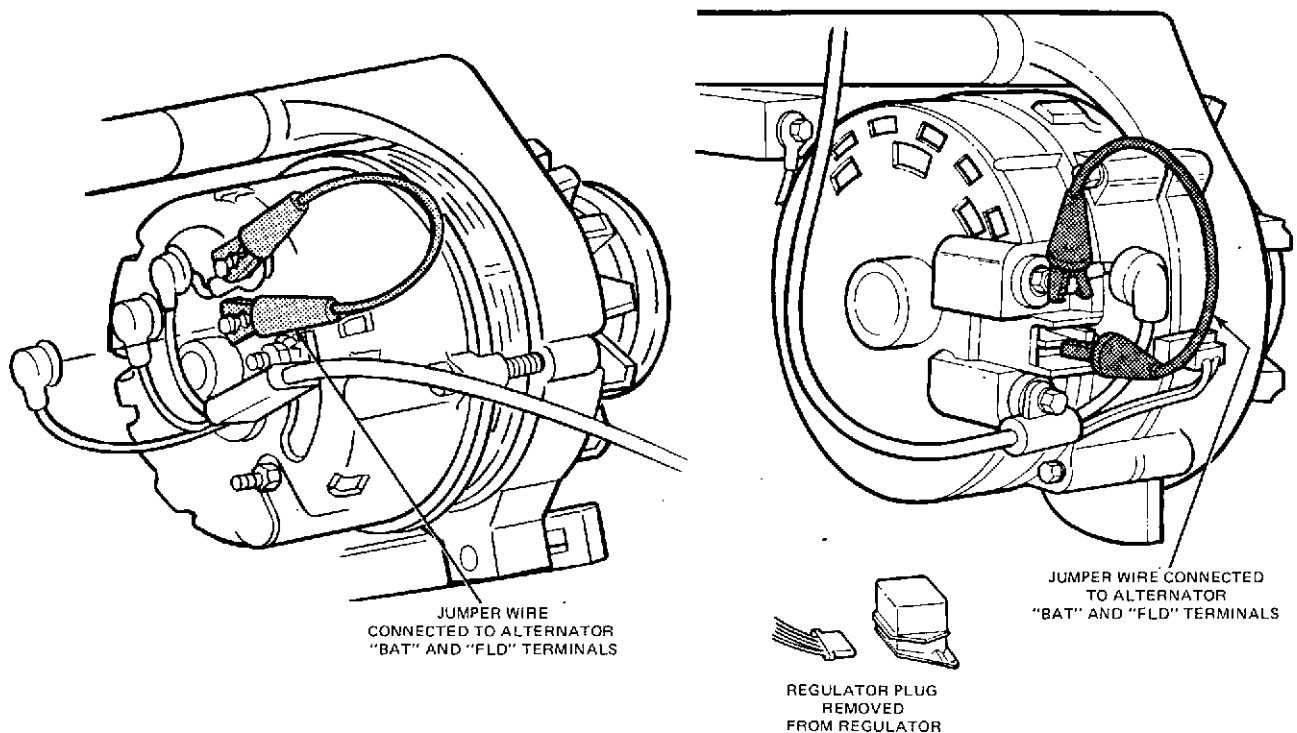


FIG. 12 Regulator Burned — Open Connector Wire Test

### Field Circuit and Alternator Tests

1. If the field circuit is satisfactory, disconnect the regulator wiring plug at the regulator and connect the jumper wire from the A to the F terminals on the regulator wiring plug (Figure 10).
2. Repeat the Voltmeter Test Procedure.
3. If the Voltmeter Test Procedure still indicates a problem (under voltage), remove the jumper wire from the regulator plug and leave the plug disconnected from the regulator. Then, connect a jumper wire to the FLD and BAT terminals on the alternator (Figure 13).
4. Repeat the Voltmeter Test Procedure.
5. If the Voltmeter Test results are now satisfactory, repair the wiring harness from the alternator to the regulator. Then, **remove the jumper wire at the alternator and connect the regulator wiring plug to the regulator.**
6. Repeat the Voltmeter Test Procedure to be sure the charging system is operating normally.
7. If the Voltmeter Test results still indicate (under voltage), repair or replace the alternator. With the jumper wire removed, connect the wiring to the alternator and regulator.
8. Repeat the Voltmeter Test Procedure.



J1636-B

FIG. 13 Jumper Wire Connections

### Regulator I and S Circuit Tests

#### S Circuit — With Ammeter

1. Connect the positive lead of the voltmeter to the S terminal of the regulator wiring plug (Figure 10). Then, turn the ignition switch to the ON position. Do not start the engine.
2. The voltmeter reading should indicate battery voltage.
3. If there is no voltage reading, disconnect the positive voltmeter lead from the positive battery clamp and repair the S wire lead from the ignition switch to the regulator wiring plug.
4. Connect the positive voltmeter lead to the positive battery cable terminal, connect regulator wiring plug to regulator and repeat the Voltmeter Test Procedure.

#### S and I Circuit — With Indicator Light

1. Disconnect the regulator wiring plug and install a jumper wire between the A and F terminals.
2. With the engine idling, connect the positive lead of the voltmeter to the S terminal and then to the I terminal of the regulator wiring plug (Figure 10). The voltage of the S circuit should read approximately 1/2 of the I circuit.
3. If no voltage is present, repair the alternator or the wiring circuit at fault. Reconnect the positive voltmeter lead to the positive battery terminal.
4. If the above circuit tests are satisfactory, install a new regulator.
5. Then, remove the jumper wire from the regulator wiring plug and connect the wiring plug to the regulator. Repeat the Voltmeter Test Procedure.

#### Diode Test — On Vehicle

1. Disconnect voltage regulator wiring plug.
2. Connect a jumper between "A" and "F" terminal of voltage regulator wiring plug.
3. Connect voltmeter to battery cable clamps.
4. Start engine — let engine run at idle.

5. Read and record voltmeter reading.
6. Move positive voltmeter lead to "S" terminal in voltage regulator wiring plug.
7. Note voltmeter reading.

#### Test Results

1. If voltmeter reads 1/2 of battery voltage, diodes are okay.
2. If voltmeter reads approximately 1.5 volts, alternator has shorted **negative** diode, or a grounded stator winding.
3. If voltmeter reads approximately 1.5 volts less than battery voltage, alternator has shorted **positive** diode.
4. If voltmeter reads about 1.0 to 1.5 volts less than 1/2 battery voltage, alternator has an **open positive** diode.
5. If voltmeter reads about 1.0 to 1.5 volts more than 1/2 battery voltage, alternator has an **open negative** diode.

### BENCH TESTS

#### RECTIFIER SHORT OR GROUNDED AND STATOR GROUNDED TEST — ON BENCH

These tests are performed with an ARE 27-42 ohmmeter. Set the Multiply By knob at 10, and calibrate the ohmmeter as directed inside the instrument cover.

Contact one ohmmeter probe to the alternator BAT terminal and the other probe to the STA terminal. Then, reverse the ohmmeter probes and repeat the test. A reading of about 60 ohms should be obtained in one direction and no needle movement with the probes reversed. A reading in both directions indicates a bad positive diode, a grounded positive diode plate or a grounded BAT terminal.

Perform the same test using the STA and GND (ground) terminals of the alternator. A reading in both directions indicates either a bad negative diode, a grounded stator winding, a grounded stator terminal, a grounded positive diode plate, or a grounded BAT terminal.

Infinite readings (no needle movement) in all four probe positions in the preceding tests indicates an open STA terminal lead connection inside the alternator.

**FIELD OPEN OR SHORT CIRCUIT TEST — ON BENCH**

This test is performed with an ohmmeter (Tool ARE 27-42). Set the ohmmeter Multiply By knob at 1 and calibrate the ohmmeter as directed inside the instrument cover.

Contact the alternator field terminal with one probe and the ground terminal with the other probe. Then, spin the alternator pulley. The ohmmeter reading should be between 4 and 250 ohms, and should fluctuate while the pulley is turning. An infinite reading (no meter movement) indicates an open brush lead, worn or stuck brushes, or a bad rotor assembly. An ohmmeter reading less than 4 ohms indicates a grounded brush assembly, a grounded field terminal or a bad rotor.

**DIODE TEST — ON BENCH**

Remove the rectifier assembly from the alternator as outlined under Disassembly. Set the ohmmeter Multiply By knob at 10 and calibrate the meter as directed inside the cover.

To test one set of diodes, contact one probe to the terminal bolt as shown in Figure 14 and contact each of the three stator lead terminals with the other probe. Reverse the probes and repeat the test. All diodes should show a low reading of about 60 ohms in one direction, and an infinite reading (no needle movement) with the probes reversed. Repeat the preceding tests for the other set of diodes except that the other terminal screw is used.

If the meter readings are not as specified, replace the rectifier assembly.

**STATOR COIL OPEN OR GROUNDED TEST — ON BENCH**

These tests are made to determine if the stator coil is operating properly. Disassemble the stator from the alternator as outlined under Disassembly.

Set the ARE 27-42 ohmmeter Multiply By knob at 1, and calibrate the meter as directed inside the cover. Connect the ohmmeter probes between each pair of stator leads (3 different ways). The ohmmeter must show equal readings for each pair of stator leads. Replace the stator if the readings are not the same.

Set the ARE 27-42 ohmmeter Multiply By knob at 1000. Connect the ohmmeter probes to one of the stator leads and to the stator laminated core. Be sure that the probe makes a good electrical connection with the stator core. The meter should show an infinite reading (no meter movement). If the meter does not indicate an infinite reading (no meter movement), the stator winding is shorted to the core and must be replaced. Repeat this test for each of the stator leads.

**ADJUSTMENTS  
BELT ADJUSTMENTS**

1. Check the belt tension with Tool T63L-8620-A. The belt should be within specifications (Specifications Section).
2. If the belt is not within specifications, loosen the alternator mounting bolt to a snug position and loosen the adjusting arm bolts.

3. Apply pressure on the alternator front housing only and tighten the adjusting arm to alternator bolt.
4. Check the belt tension using Tool T63L-8620-A. Adjust the belt for specified tension.
5. Tighten all mounting bolts.

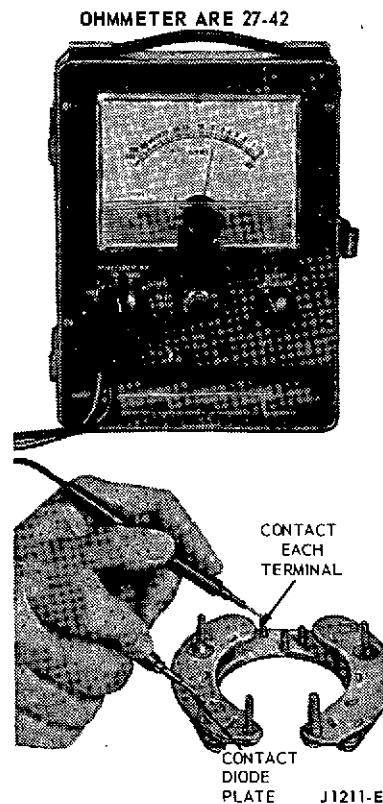


FIG. 14 Diode Test — Rear Terminal Alternator

**ROTOR OPEN OR SHORT CIRCUIT TEST — ON BENCH**

Disassemble the front housing and rotor from the rear housing and stator as outlined under Disassembly. Set the ohmmeter (ARE 27-42) Multiply By knob at 1 and calibrate the meter as directed inside the ohmmeter cover.

Contact each ohmmeter probe to a rotor slip ring. The meter reading should be 4 or 5 ohms. A higher reading indicates a damaged slip ring solder connection or a broken wire. A lower reading indicates a shorted wire or slip ring. Replace the rotor if it is damaged and cannot be repaired.

Contact one ohmmeter probe to a slip ring and the other probe to the rotor shaft. The meter reading should be infinite (no deflection). A reading other than infinite indicates the rotor is shorted to the shaft. Inspect the slip ring soldered terminals to be sure they are not bent and touching the rotor shaft, or that excess solder is grounding the rotor coil connections to the shaft. Replace the rotor if it is shorted and cannot be repaired.

## REMOVAL AND INSTALLATION

### Removal

1. Disconnect the battery ground cable.
2. Loosen the alternator mounting bolts and remove the adjustment arm-to-alternator attaching bolt.
3. Remove the electrical connectors from the alternator.
4. Disengage the alternator belt. Remove the alternator mounting bolt, and remove the alternator.

### Installation

1. Install the alternator wiring harness. Position the alternator to the engine, and install the spacer (if used) and the alternator mounting bolt. Tighten the bolt only finger tight.
2. Install the adjustment arm-to-alternator attaching bolt.
3. Position the belt on the pulley and adjust the belt tension using Tool T63L-8620-A. Apply pressure on the alternator front housing only, when tightening the belt. Tighten the adjusting arm bolt and the mounting bolt.
4. Connect the battery ground cable.

## OVERHAUL — FORD ALTERNATOR

### Disassembly

Figure 15 shows a disassembled view of the alternator.

1. Mark both end housings and the stator with a scribe mark for assembly.
2. Remove the three housing through bolts.
3. Separate the front housing and rotor from the stator and rear housing.
4. Remove all the nuts and insulators from the rear housing and remove the rear housing from the stator and rectifier assembly.
5. Remove the brush holder mounting screws and remove the holder, brushes, brush springs, insulator and terminal.
6. If replacement is necessary, press the bearing from the rear housing supporting the housing on the inner boss.
7. If the rectifier assembly is being replaced, unsolder the stator leads from rectifier terminals, and separate the stator from the rectifier assembly. Use a 100-watt soldering iron.
8. Original production alternators will have one of three types of rectifier assembly circuit boards (Figure 16); one has the circuit board spaced away from the diode plates with the diodes exposed. Another type is a single circuit

board with built-in diodes. The third type circuit board has built-in diodes with an additional booster diode plate containing two diodes. This circuit board is used only in the 61-ampere alternator.

If the alternator rectifier has an exposed board, remove the screws from the rectifier by rotating the bolt heads 1/4 turn clockwise to unlock them and then remove the screws (Figure 16). Push the stator terminal straight out on a rectifier with the diodes built into the circuit board (Figure 16). Avoid turning the screw while removing, to make certain that the straight knurl will engage the insulators when installing. Do not remove the grounded screw (Figure 17).

9. Remove the drive pulley nut with the tool shown in Figure 18; then, pull the lock washer, pulley, fan, fan spacer, rotor and rotor stop from the rotor shaft.
10. Remove the three screws that hold the front end bearing retainer, and remove the retainer. If the bearing is damaged or has lost its lubricant, support the housing close to the bearing boss, and press out the old bearing from the housing.
11. Perform a diode test and a field open or short circuit test (Refer to Testing in this Part).

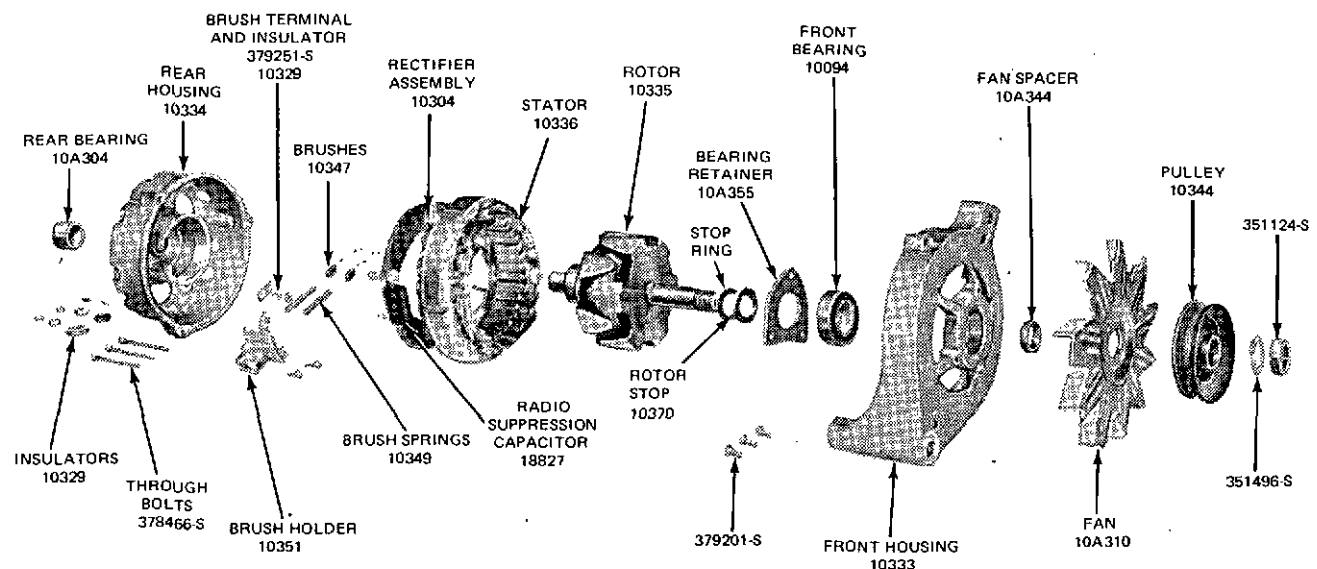
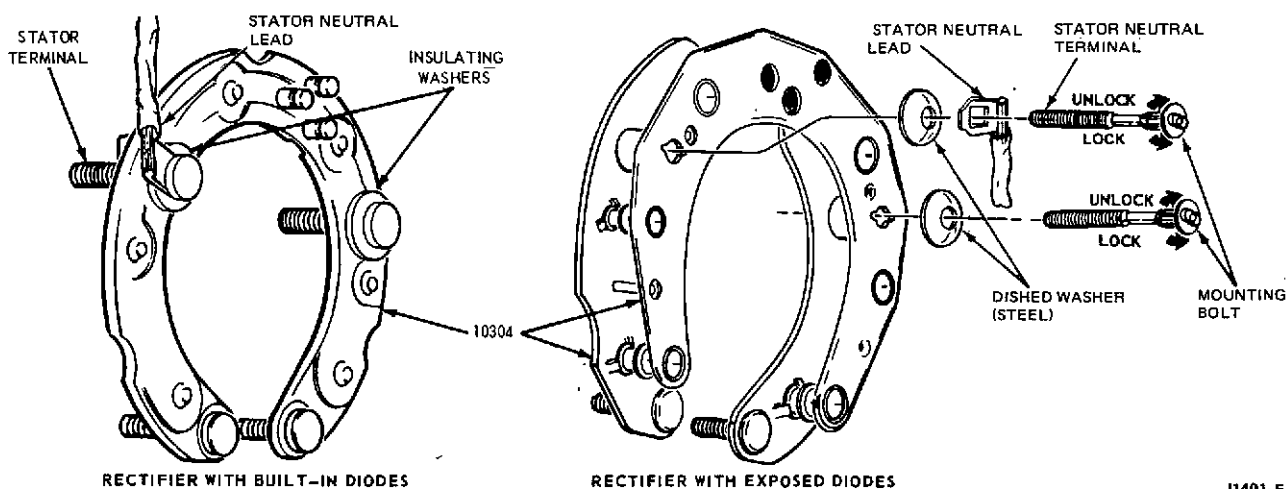
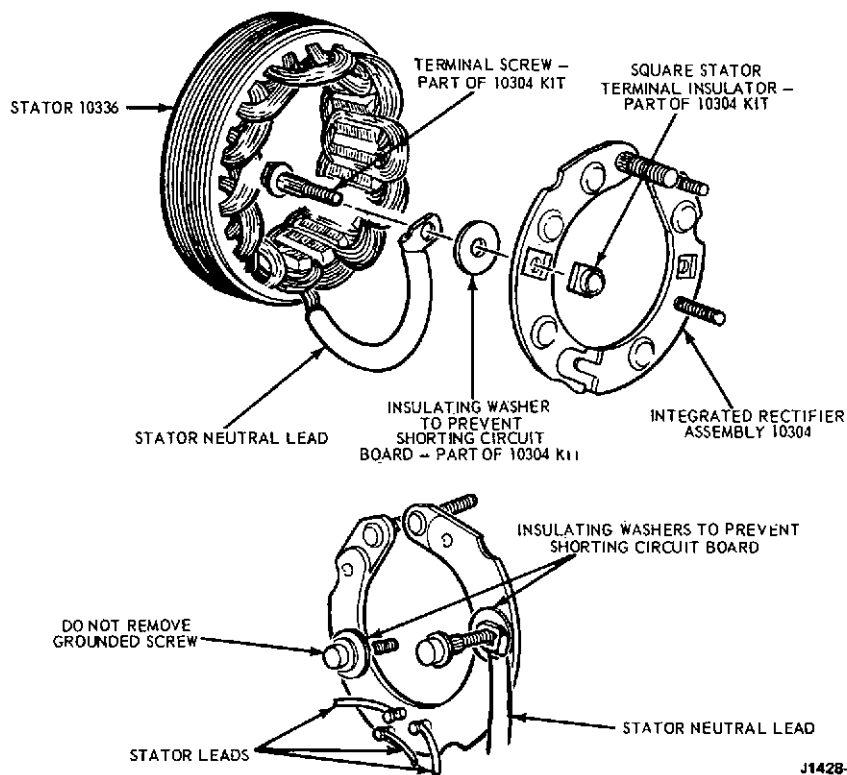


FIG. 15 Disassembled Alternator



J1401-F

FIG. 16 Rectifier Assembly



J1428-C

FIG. 17 Stator Terminal Installation — Integral Rectifier Circuit Board

### Assembly

1. The rotor, stator and bearings must not be cleaned with solvent. Wipe these parts off with a clean cloth.
2. Press the front bearing in the front housing bearing boss (put pressure on the bearing outer race only), and install the bearing retainer (Figure 15).
3. If the stop-ring on the rotor drive shaft was damaged, install a new stop-ring. Push the new ring on the shaft and in the groove. **Do not open the ring with snap ring pliers as permanent damage will result.**
4. Position the rotor stop on the drive shaft with the recessed side against the stop-ring.
5. Position the front housing, fan, spacer, fan, pulley and lock washer on the drive shaft and install the retaining nut. Tighten the retaining nut with the tool shown in Figure 18 to the specified torque.
6. If the rear housing bearing was removed, support the housing on the inner boss and press in a new bearing flush with the outer end surface.
7. Place the brush springs, brushes, brush terminal and terminal insulator in the brush holder and hold the brushes in position by inserting a piece of stiff wire in the brush holder as shown in Figure 19.
8. Position the brush holder assembly in the rear housing and install the mounting screws. Position the brush leads in the brush holder as shown in Figure 20.
9. Wrap the three stator winding leads around the rectifier terminals and solder them. Use a 100-watt soldering iron and rosin-core solder. Position the stator neutral lead eyelet on the stator terminal screw and install the screw in the rectifier assembly (Figure 21).

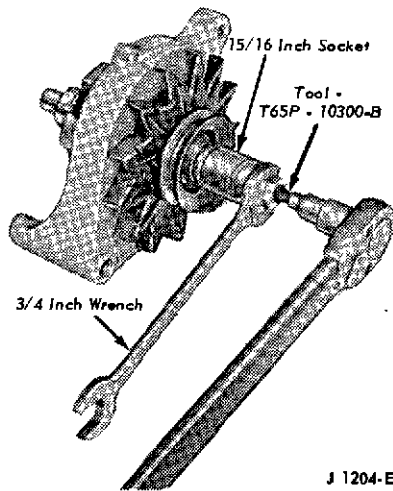


FIG. 18 Pulley Removal

J 1204-E

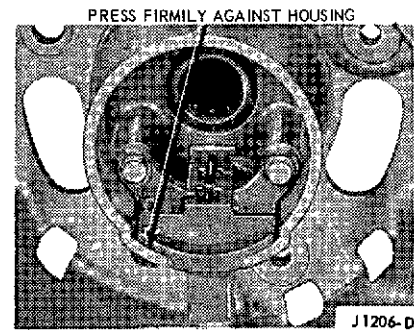


FIG. 20 Brush Lead Positions

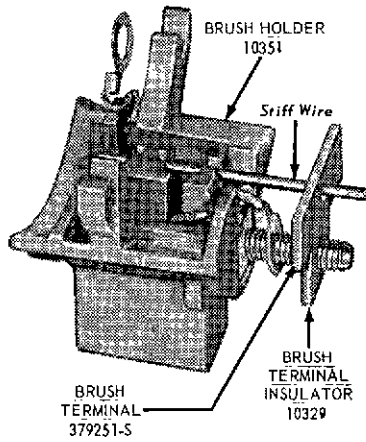


FIG. 19 Brush Holder Assembly

J 1203-C

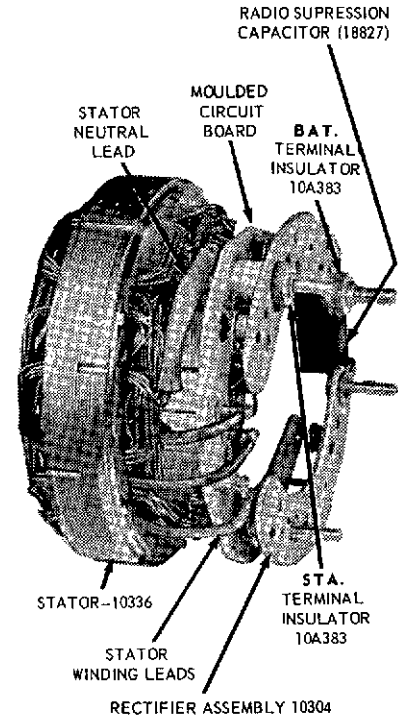


FIG. 21 Stator Lead Connections

J 1167-F

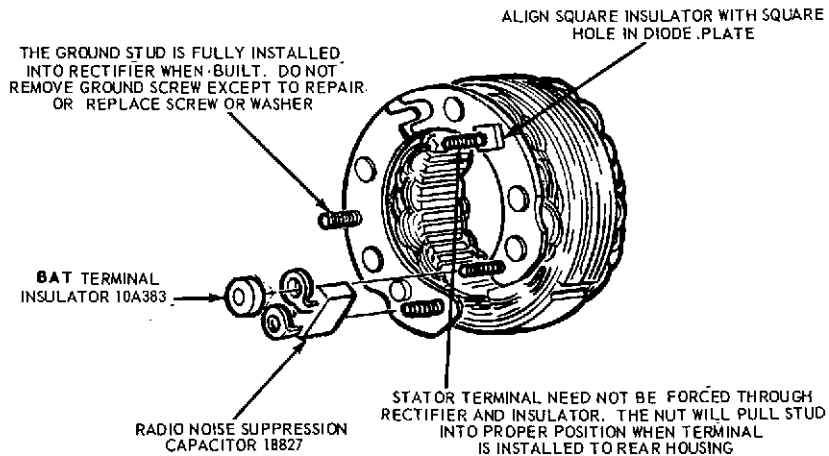


FIG. 22 Terminal Insulators — Fiber Glass Circuit Board

10. For a rectifier with the diodes exposed, insert the special screws through the wire lug, dished washers and circuit board (Figure 16). Turn them 1/4 turn counterclockwise to lock them. For single circuit boards with built-in diodes, insert the screws straight through the wire lug, insulating washer and rectifier into the insulator (Figure 12).

**The dished washers are to be used only on the circuit board with exposed diodes (Figure 16).** If they are used on the single circuit board, a short circuit will occur. A flat insulating washer is to be used between the stator terminal and the board, when a single circuit board is used (Figure 17).

11. Position the radio noise suppression capacitor on the rectifier terminals. On the circuit board with exposed diodes, install the STA and BAT terminal insulators (Figure 21). On the single circuit board, position the square hole in the rectifier assembly (Figure 17). Position the BAT terminal insulator (Figure 22) on the BAT terminal.

Position the stator and rectifier assembly in the rear housing. Make certain that all terminal insulators are seated properly in their recesses. Position the STA (black), BAT (red), and FLD (orange) insulators on the terminal bolts, and install the retaining nuts (Figure 23).

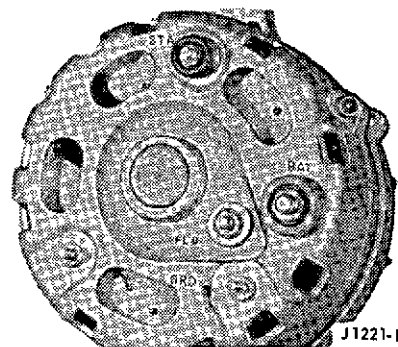


FIG. 23 Alternator Terminal Locations

12. Wipe the rear end bearing surface of the rotor shaft with a clean lint-free rag.
13. Position the rear housing and stator assembly over the rotor and align the scribe marks made during disassembly. Seat the machined portion of the stator core into the step in both end housings. Install the housing through bolts. Remove the brush retracting wire, and put a daub of waterproof cement over the hole to seal it.

## Part 5 — Component Index

COMPONENT INDEX	PAGE	COMPONENT INDEX	PAGE
DESCRIPTION AND OPERATON .....	5-01	Bench Tests .....	5-04
TESTING .....	5-02	REMOVAL AND INSTALLATION .....	5-04
On-Vehicle .....	5-02	OVERHAUL .....	5-05

### DESCRIPTION AND OPERATION

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start. Heavy cables, connectors, and switches are used in the starting system because of the large current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. Loose or corroded connections or partially broken cables will result in slower than normal cranking speeds, and may even prevent the starter from cranking the engine.

### SOLENOID ACTUATED STARTER

Major assembly components of the solenoid actuated starter are the frame and field coil assembly, armature assembly, brush plate assembly, drive assembly, shift lever assembly, drive housing assembly and starter solenoid assembly (Figure 1).

The motor is a four-brush, four-field, four-pole wound unit.

The solenoid assembly is mounted to a flange on the starter drive housing. The entire shift lever mechanism and the solenoid plunger are enclosed in the drive housing, thus protecting them from exposure to dirt and road splash.

A metal heat shield protects the solenoid from heat radiated by the exhaust pipe and manifold. Without this shield, plastic parts of the solenoid could be damaged by excessively high temperatures, and the solenoid could fail.

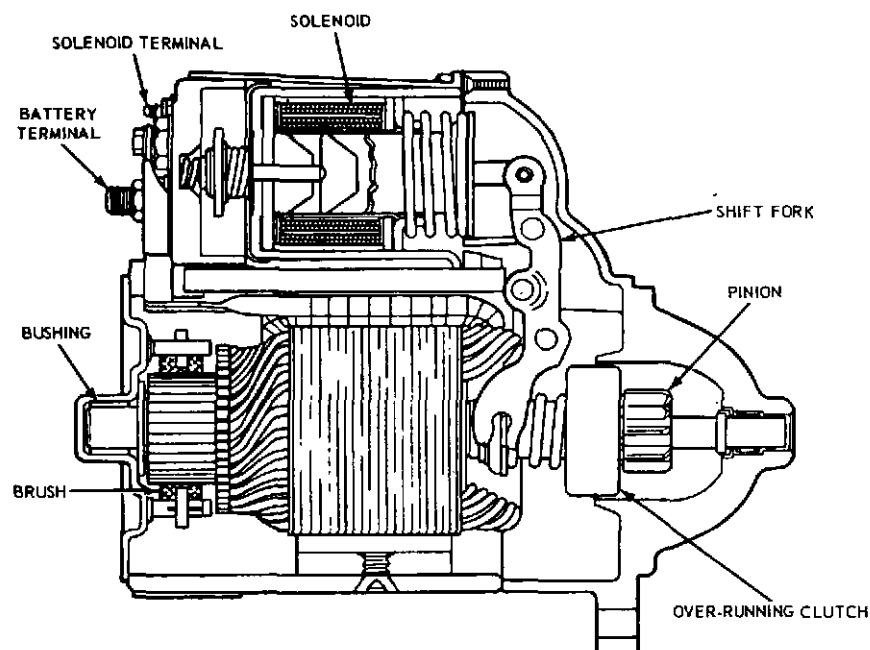
Always install a heat shield whenever a starter has been removed and repaired or replaced, or whenever the shield has fallen off or has been damaged. Service Kit D3AF-11K138-AA contains the attaching screws and a universal shield for use on all engines with solenoid starters.

The solenoid incorporates two windings: a pull-in winding and hold-in winding. Together they provide the magnetic attraction to pull the solenoid plunger into the solenoid.

### SOLENOID OPERATION

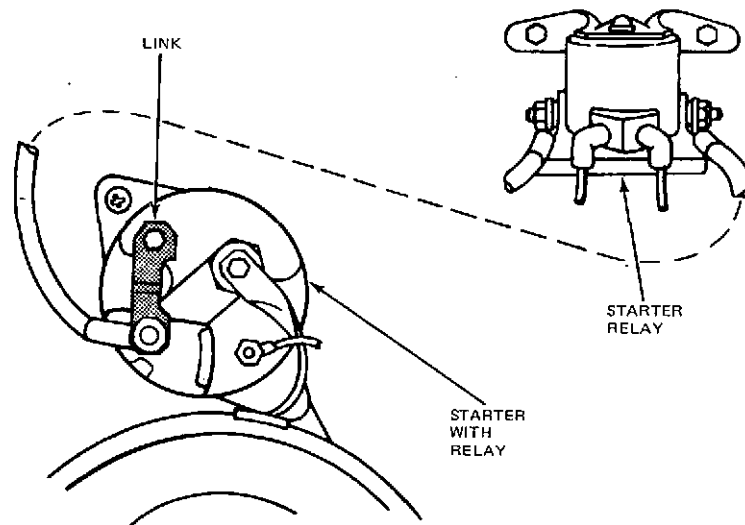
Engine cranking occurs when the solenoid on the starter is energized through the starter control (ignition) switch. When energized, the solenoid shifts the starting motor pinion into mesh with the engine flywheel ring gear.

Simultaneously, the main contacts of the solenoid are closed and battery current is directed to the starting motor, causing the armature to rotate.



J1414-A

FIG. 1 Solenoid Actuated Starter Cross Section



J1641-C

FIG. 2 Solenoid Connector Link

After the engine starts, the starter drive is disengaged only when the ignition switch is turned from the START to the ON position. This opens the circuit to the starter solenoid and the solenoid return spring causes the shift lever to disengage the starter drive from the engine flywheel ring gear.

The starting motor is protected from short duration excessive speed by an overrunning clutch incorporated in the starter drive. The overrunning clutch permits the drive pinion gear to rotate faster than the armature as the engine starts and picks up speed, thus protecting the armature from being driven by the engine.

### CONNECTOR LINK

In the solenoid actuated starter heavy battery current is carried to the starter windings by contacts in the solenoid.

If the solenoid actuated starter is installed on engines with a starter relay, a special "connector link" is installed on the solenoid (Figure 2). This link connects the battery terminal with the solenoid operating windings. Thus, when the key is turned to the START position, the starter relay is actuated, sending battery current to the starter solenoid. The current operates the solenoid and then the starter through solenoid internal contacts.

When replacing starters or starter solenoids, be sure to replace the link. If a link is not used on a starter relay equipped engine, the engine will not start.

## TESTING BOOSTER BATTERY

You should connect a booster battery to the starting system for cases of a starter that will not crank the engine or a starter that cranks the engine very slowly, for you may have run your battery down while trying to get the engine started.

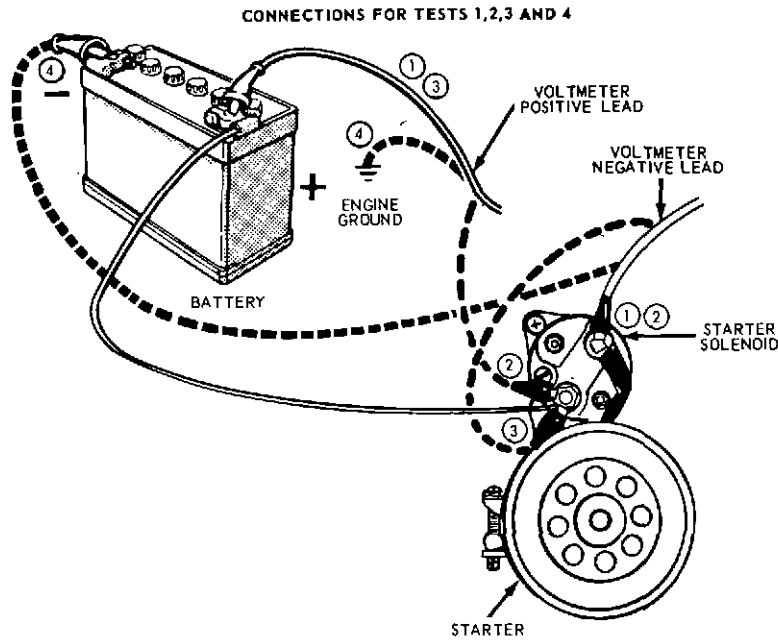
If the starter does not turn the engine over, even with a booster battery attached, refer to the following tests. **Be certain that correct battery polarity is observed when using a booster battery; positive-to-positive and negative-to-negative connection of the auxiliary cables.**

### ON VEHICLE TESTING STARTER CRANKING CIRCUIT TEST

These tests will determine whether or not there is excessive resistance in the cranking circuit. Make each test connection as shown in Figure 3. While cranking the engine, observe the voltage drop reading for each test. **Disconnect and ground the high tension lead from the ignition coil to**

**prevent the engine from starting. Connect a remote control switch between the battery terminal of the starter relay and the S terminal of the relay.** The voltage drop in the circuit will be indicated by the voltmeter (0 to 2 volt range). Maximum allowable voltage drop should be:

1. 0.5 volt with the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery positive terminal (Figure 3, connection 1).
2. 0.3 volt with the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery terminal of the starter solenoid (Figure 3, connection 2).
3. 0.2 volt with the voltmeter negative lead connected to the battery terminal of the starter solenoid and the positive lead connected to the positive terminal of the battery (Figure 3, connection 3).
4. 0.1 volt with the voltmeter negative lead connected to the negative terminal of the battery and the positive lead connected to the engine ground (Figure 3, connection 4).



J1413-B

FIG. 3 Starter Cranking Circuit Test

**STARTER LOAD TEST**

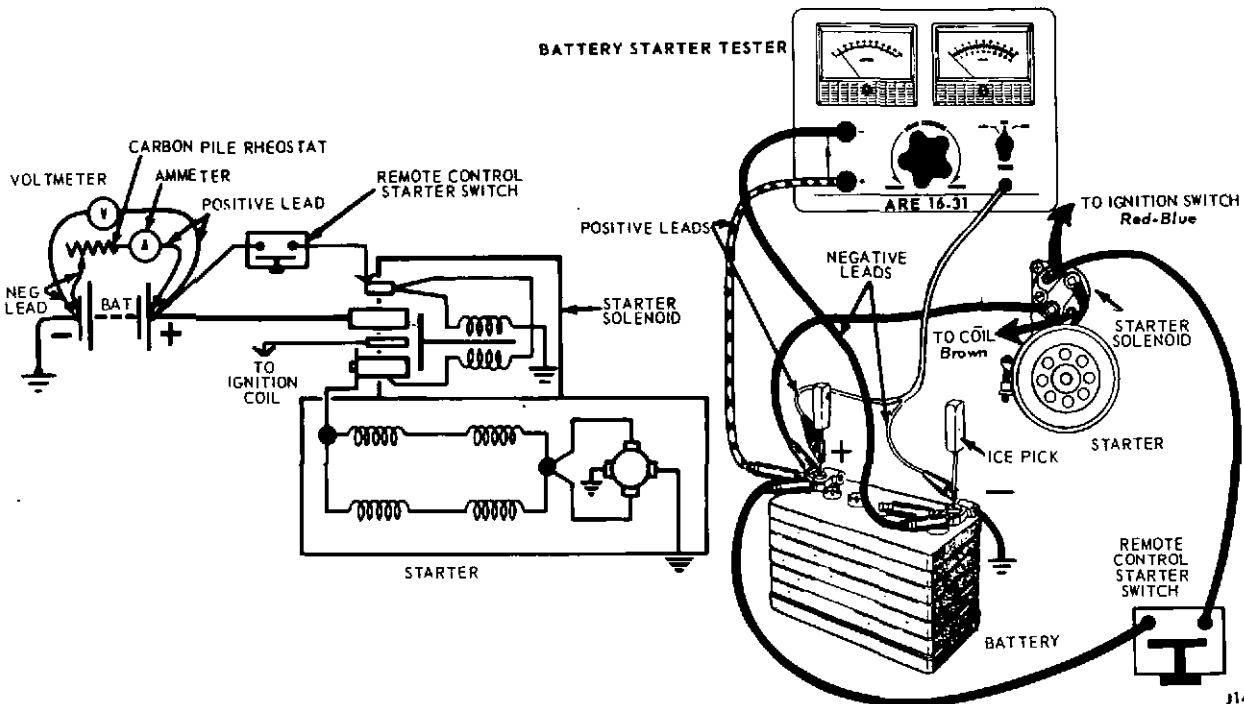
Connect the test equipment as shown in Figure 4. Be sure that no current is flowing through the ammeter and heavy-duty carbon pile rheostat portion of the circuit (rheostat at maximum counterclockwise position).

Crank the engine with the ignition OFF, and determine the exact reading on the voltmeter. This test is accomplished by disconnecting and grounding the high tension lead from the ignition coil, and by connecting a jumper from the battery terminal of the starter solenoid to the ignition switch "S" terminal of the solenoid.

Stop cranking the engine, and reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while the starter cranked the engine. The ammeter will indicate the starter current draw under load.

**STARTER SOLENOID TEST**

If the solenoid does not pull in (starter load test) measure the voltage between the starter mounted solenoid switch terminal and ground with the ignition closed. If the



J1415-B

FIG. 4 Starter Load Test

reading is 10 volts or more, a worn or damaged solenoid is indicated. Remove the starter assembly for solenoid replacement.

## BENCH TESTS

### STARTER NO-LOAD TEST

This test will uncover such faults as open or shorted windings, rubbing armature, and bent armature.

Make the test connections as shown in Figure 5. The starter will run at no load. Be sure that no current is flowing through the ammeter (rheostat at maximum counterclockwise position). Determine the exact reading on the voltmeter.

Disconnect the starter from the battery, and reduce the resistance of the rheostat until the voltmeter indicates the same reading as that obtained while the starter was running. The ammeter will indicate the starter no-load current draw.

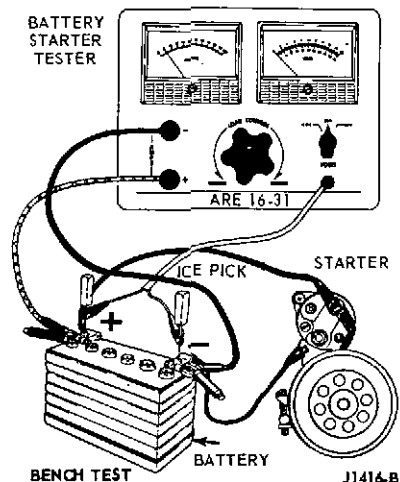


FIG. 5 Starter No-Load Test on Test Bench

### ARMATURE OPEN CIRCUIT TEST

An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit windings, passes under a brush.

### ARMATURE AND FIELD GROUNDED CIRCUIT TEST

This test will determine if the winding insulation has failed, permitting a conductor to touch the frame or armature core.

To determine if the armature windings are grounded, make the connections as shown in Figure 6. If the voltmeter indicates any voltage, the windings are grounded.

Grounded field windings can be detected by making the connections as shown in Figure 7. If the voltmeter indicates any voltage, the field windings are grounded.

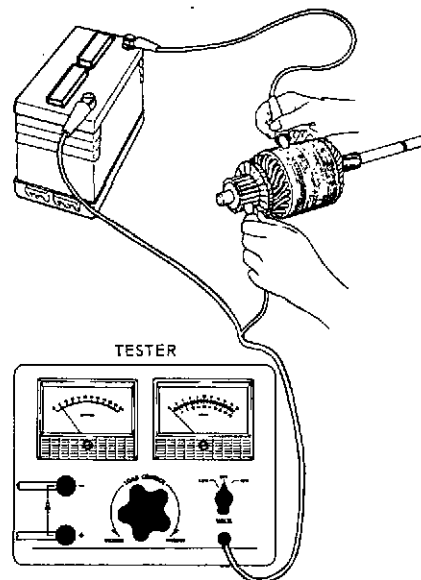


FIG. 6 Armature Grounded Circuit Test

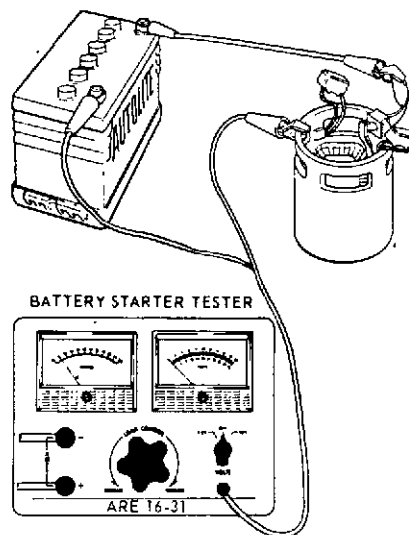


FIG. 7 Field Grounded Circuit Test

## REMOVAL AND INSTALLATION

### SOLENOID ACTUATED STARTER

#### Removal

1. Disconnect the battery ground cable, and raise the vehicle on a hoist.
2. Disconnect the cable and wires at the terminals on the solenoid.
3. Remove the starter mounting bolts and remove the starter assembly.

#### Installation

1. Position the starter assembly to the starter mounting plate and start the mounting bolts.

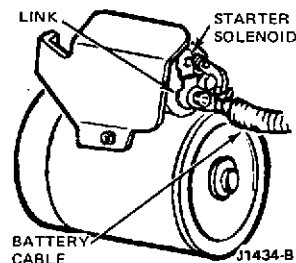


FIG. 8 Starter Cable Connections

2. Snug the starting motor mounting bolts while holding the starter squarely against the mounting surface and fully inserted into the pilot hole. Tighten the mounting bolts to 15 to 20 ft-lb.

3. Connect the cable and wires to the terminals on the solenoid (Figure 8). Tighten the battery cable nut to 45 to 95 in-lb torque.
4. Connect the battery ground cable.

## OVERHAUL SOLENOID ACTUATED STARTER

### Disassembly

1. Disconnect the copper strap from the starter terminal on the solenoid, remove the retaining screws and remove the solenoid from the drive housing (Figure 9).
2. Loosen the retaining screw and slide the brush cover band back on the starter frame for access to the brushes.
3. Remove the commutator brushes from their holders. Hold each spring away from the brush with a hook, while sliding the brush out of the holder.
4. Remove the through-bolts and separate the drive-end housing, starter frame and brush end plate assemblies.
5. Remove the solenoid plunger and shift fork assembly. If either the plunger or fork is to be replaced, they can be separated by removing the roll pin.
6. Remove the armature and drive assembly from the frame. Remove the drive stop ring and slide the drive assembly off the armature shaft.
7. Remove the drive stop ring retainer from the drive housing.

### CLEANING AND INSPECTION

1. Do not wash the drive because the solvent will wash out the lubricant causing the drive to slip. Use a brush or compressed air to clean the drive, field coils, armature, commutator, armature shaft front end plate, and rear end housing. Wash all other parts in solvent and dry the parts.

2. Inspect the armature windings for broken or burned insulation and unsoldered connections.
3. Check the armature for open circuits and grounds.
4. Check the commutator for runout (Figure 10). Inspect the armature shaft and the two bearings for scoring and excessive wear. On a starter with needle bearings apply a small amount of grease to the needles. If the commutator is rough, or more than 0.005 inch out-of-round, turn it down.

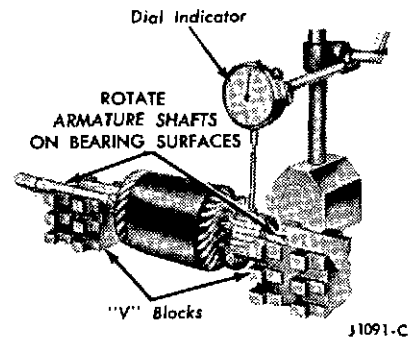


FIG. 10 Commutator Runout Check

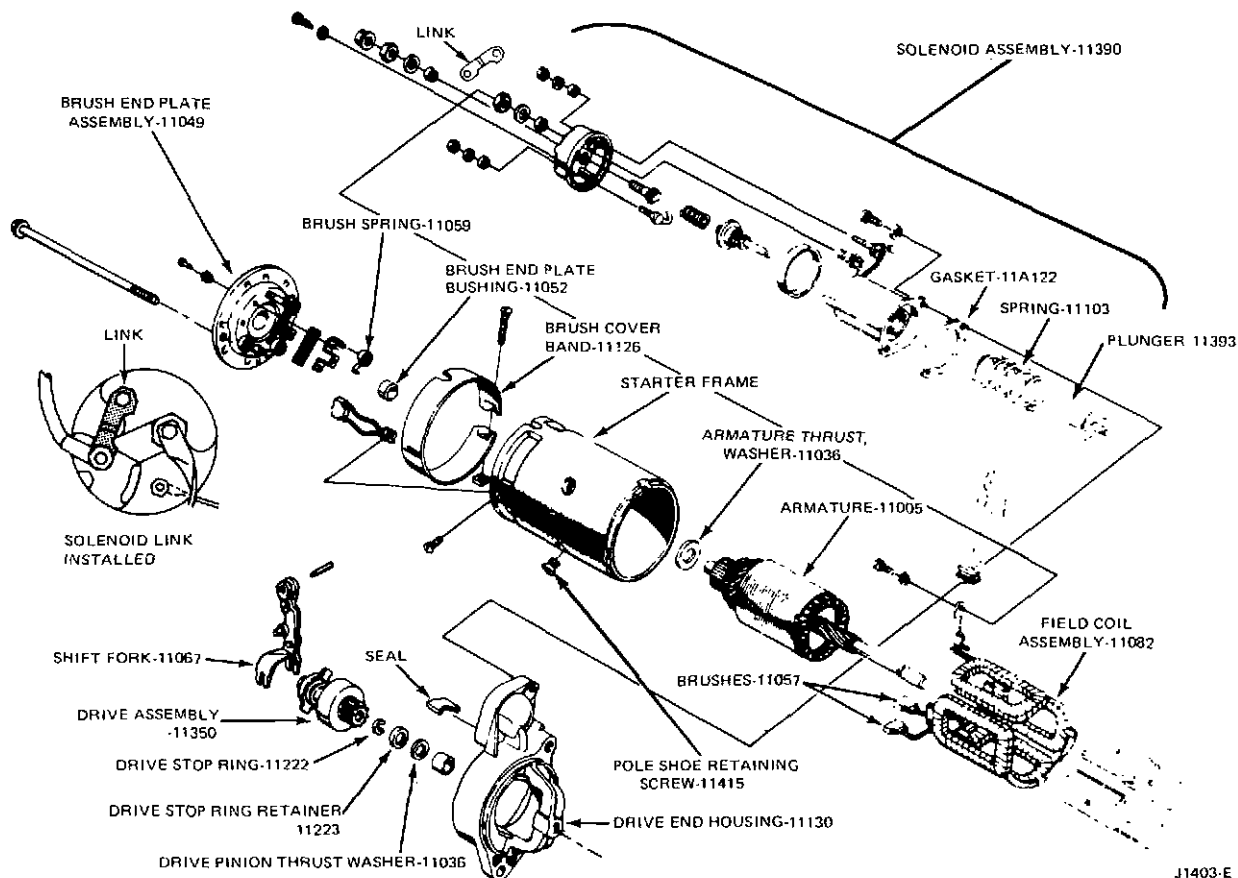
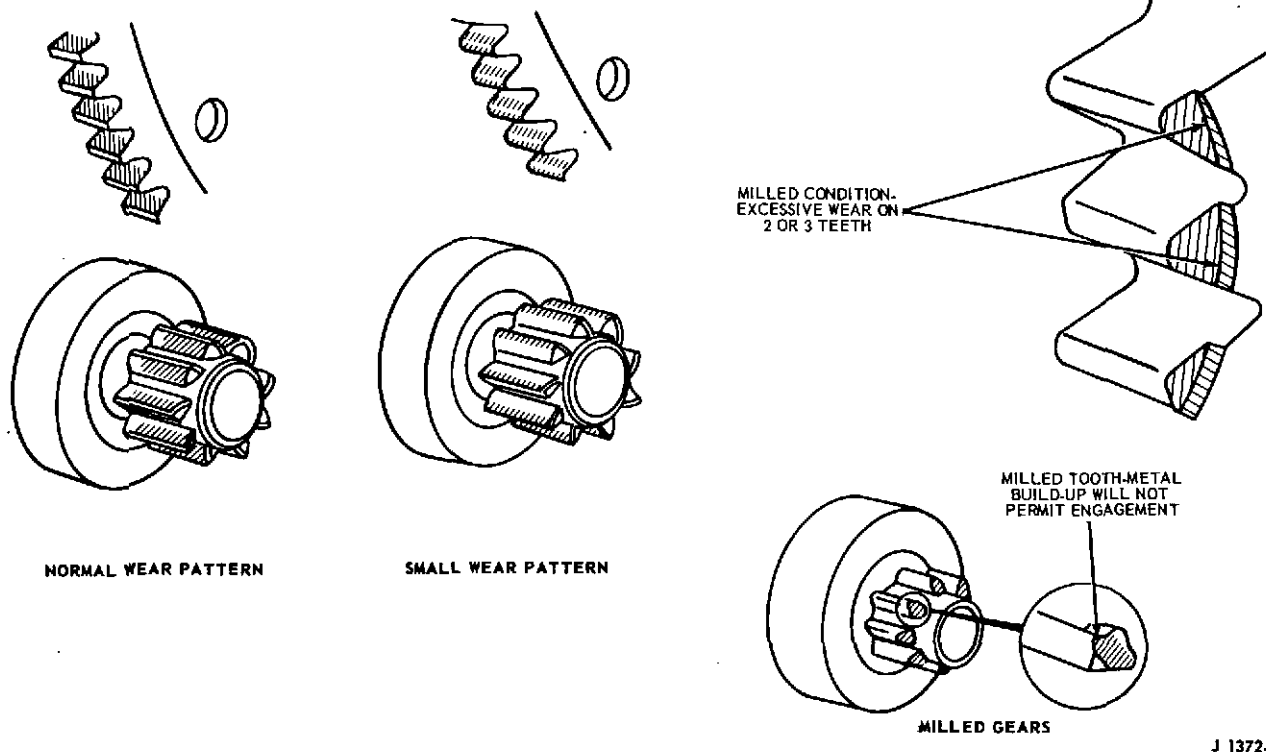


FIG. 9 Starter Disassembled

5. Check the brush holders for broken springs and the insulated brush holders for shorts to ground. Tighten any rivets that may be loose. Replace the brushes if worn to 1/4 inch in length.
  6. Check the brush spring tension. Replace the springs if the tension is not within specified limits (80 ounces minimum).
  7. Inspect the field coils for burned or broken insulation and continuity. Check the field brush connections and lead insulation. A brush kit is available. All other assemblies are to be replaced rather than repaired.
  8. Examine the wear pattern on the starter drive teeth. The pinion teeth must penetrate to a depth greater than 1/2 the ring gear tooth depth (Figure 11), to eliminate premature ring gear and starter drive failure.
  9. Replace starter drives and ring gears with milled, pitted or broken teeth of evidence or inadequate engagement (Figure 11).
3. Place a new retainer in the drive housing. Apply a small amount of lubriplate to the drive end of the armature shaft. Place the armature and drive assembly into the drive housing. Be sure that the shift lever tangs properly engage the drive assembly.
  4. Apply a small amount of lubriplate on the commutator end of the armature shaft.
  5. Position the frame and field assembly to the drive housing. Be sure that the frame is properly indexed to the drive housing assembly.
  6. Position the brush plate assembly to the frame assembly. Be sure that the brush plate is properly indexed to the frame. Install the through-bolts and tighten to 45 to 85 in-lbs.
  7. Place the brushes in their holders. Pull each spring away from the holder with a hook to allow entry of the brush. Center the brush springs on the brushes. Press the insulated brush leads away from all other interior components to prevent possible shorts.
  8. Position the rubber gasket between the solenoid mounting and the upper outside surface of the frame. Position the starter solenoid with metal gasket (if used), and install the solenoid mounting screws.
  9. Connect the copper strap to the starter terminal on the solenoid.
  10. Position the cover band and tighten the retaining screw.
  11. Connect the starter to a battery to check its operation.

### Assembly

1. Install a small amount of lubriplate on the the armature shaft splines. Install the drive assembly on the the armature shaft and install a new stop ring (Figure 9).
2. Apply a small amount of lubriplate on the shift lever pivot pin. Position the solenoid plunger and shift lever assembly in the drive housing.



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FIG. 11 Pinion and Ring Gear Wear Patterns

## BRUSH REPLACEMENT

Replace the starter brushes when they are worn to 1/4 inch. Always install a complete set of new brushes.

1. Disconnect the copper strap from the starter terminal on the solenoid.
2. Loosen the retaining screw and slide the brush cover band back on the starter frame for access to the brushes.
3. Remove the commutator brushes from their holders. Hold each spring away from the brush with a hook, while sliding the brush out of the holder.
4. Remove the through-bolts and separate the drive end housing, starter frame and brush end plate assemblies.
5. Remove the ground brush retaining screws from the frame and remove the brushes.
6. Cut the insulated brush leads from the field coils, as close to the field connection point as possible.
7. Clean and inspect the starter motor.
8. Replace the brush end plate, if the insulator between the field brush holder and the end plate is cracked or broken.
9. Position the new insulated field brushes lead on the field coil connection. Position and crimp the clip provided with the brushes to hold the brush lead to the connection. Solder the lead, clip, and connection together, using rosin core solder. Use a 300-watt iron.
10. Install the ground brush leads to the frame with the retaining screws.
11. Clean the commutator with 00 or 000 sandpaper.
12. Apply a small amount of lubriplate on the commutator end of the armature shaft.
13. Position the rubber gasket over the solenoid plunger lever, then position the frame to the end housing so that the wide slot in the frame clears the plunger lever and the end housing dowel is indexed with its frame slot.
14. Position the brush plate assembly to the frame assembly. Be sure that the brush plate is properly indexed to the frame. Install the through-bolts, making certain that the insulated brush lead is not between the through-bolt and the frame, and tighten to 45 to 85 in-lbs.
15. Place the brushes in their holders. Pull each spring away from the holder with a hook to allow entry of the brush. Center the brush springs on the brushes. Press the insulated brush leads away from all other interior components to prevent possible shorts.
16. Slide the cover band into position and tighten the retaining screw.
17. Connect the copper strap to the starter terminal on the solenoid.
18. Connect the starter to a battery to check its operation.

## Part 7 Cooling

COMPONENT INDEX	Page	COMPONENT INDEX	Page
DESCRIPTION AND OPERATION .....	7-01	ADJUSTMENTS	
Coolant .....	7-01	Drive Belt .....	7-02
TESTING .....	7-02	Belt Tension .....	7-02
Pressure Test .....	7-02	CLEANING AND INSPECTION .....	7-03
Thermostat Test .....	7-02		

### DESCRIPTION AND OPERATION

A series-parallel flow cooling system is employed on the 460 engines (Figure 1). The water passages from the pump are routed through cast passages in the front cover to the cylinder block. The cast iron water pump is isolated from the aluminum front cover by a steel plate to preclude erosion of the aluminum cover. Coolant flows through the cylinder block to the rear, up through the deck and forward through the cylinder head to the water crossover in the intake manifold. Bleed holes in the cylinder block and head are located under each spark plug for additional water flow and cooler spark plug temperatures. The by-pass to the suction side of the pump, and the water thermostat which is retained by an outlet connection, are located in the manifold water crossover.

**NOTE:** The cooling system may change on marine engines as they are marinized. The water pump may be deleted on ski boat engines.

### COOLANT (INDUSTRIAL)

Correct coolant level is essential for maximum circulation and adequate cooling. In addition, for the cooling system to perform its function, it must receive proper care. This includes keeping the radiator fins clean and a periodic inspection of the cooling system for leakage.

Use care when removing the pressure cap to avoid injury from escaping steam or hot water.

When the cooling system is drained, fill the system with specified coolant.

All coolant added should be the specified mixture of Ford permanent anti-freeze and water. If Ford Permanent Anti-freeze is not available, another reputable permanent anti-freeze may be used and diluted with an equal quantity of water.

Ordinary tap water may be used in an emergency except in areas where the water is known to be exceptionally hard or to have a high alkali content. The cooling system should be drained and flushed and the proper mixture of anti-freeze added as soon as possible, however.

To avoid possible overheating in very hot weather, do not use mixtures with more than 50 percent anti-freeze except in areas where anti-freeze protection below -35 degrees F is required. In this case, refer to the coolant mixture chart on the Ford Permanent Anti-freeze container.

A standard ethylene glycol hydrometer can be used to check the protection level of the long-life coolant.

To prevent damage to the cooling system during periods of below freezing ambient temperature, when water or anti-freeze is added to the supply tank, always operate the engine at fast idle for 30 minutes before letting the engine set in the OFF position for prolonged periods. This will allow a uniform mixture throughout the cooling system and prevent damage by freezing, when sufficient anti-freeze is used.

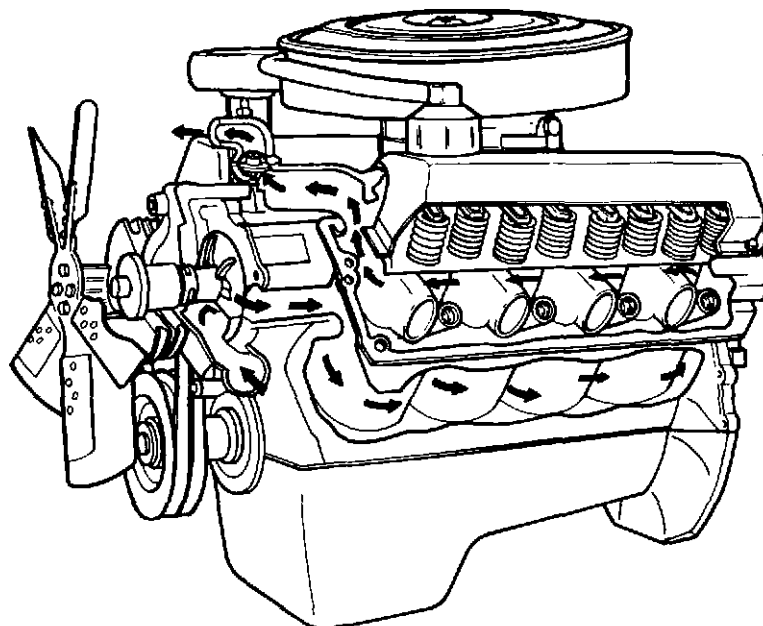


FIG. 1 Cooling System

## DRAINING AND FILLING THE SYSTEM

To prevent loss of anti-freeze when draining the radiator, attach a hose on the radiator drain cock and drain the coolant from the radiator into a clean container.

To drain the radiator, open the drain cock located at the bottom of the radiator and remove the radiator or supply tank cap. The cylinder block is drained by removing the drain plugs located on both sides of the block.

To fill the cooling system, install the cylinder block drain plug(s) and close the radiator drain cock.

After the initial fill, the coolant level will drop approximately 1 quart after the engine has been operated about 20 minutes at 2000 rpm. This is due to the displacement of entrapped air. Refill radiator as required.

## TESTING

### PRESSURE TEST

It is recommended that a cooling system pressure test gauge be used to properly test the system for:

- Blown or leaking cooling system sealing gaskets.
- Internal or external cooling leakage.
- Pressure cap malfunction.

Some modification of existing pressure testers may be required in order to use this procedure.

- Shut the engine off. **To prevent loss of coolant and to avoid the danger of being burned, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then, turn cap again slowly counterclockwise to remove.**
- After the cooling system pressure has been released, remove the radiator cap, wet the rubber sealing surface and re-install cap tightly on the radiator.
- Disconnect the electrical connector from the engine temperature sending unit and remove the temperature sending unit from the manifold.

With the radiator cap installed, only a small amount of coolant will be lost when the sending unit is removed.

- Install an adaptor fitting tightly (3/8 N.P.T. male thread on one end, and a hose connection on the other end to accommodate the tester hose) into the intake manifold or cylinder head in place of the sending unit.
- Remove the radiator overflow hose from the retainer clips. **Make sure the hose is firmly installed on the radiator overflow tube and is in good condition.** Insert the free end of the overflow hose into a container of water.
- Attach the pressure pump and gauge to the adapter fitting and pressurize the cooling system until bubbles are observed in the water container. Discontinue pumping when bubbles appear.

When the bubbles cease, read the pressure gauge.

The gauge reading is the pressure relief of the cap and should be within specifications. If the pressure reading exceeds the specified limit, replace the radiator cap.

- If bubbles continue and the pressure drops below 10 psi for engines with a 13 psi system, or below 5 psi for a 7 psi system, the radiator cap is not holding pressure. Release pressure and wash cap in clean water to dislodge

any foreign matter from the valves. Check the rubber sealing surface of the cap and also the cap sealing surface in the radiator neck. Inspect the cam lock flanges on both sides of the filler neck for maximum cap engagement.

- Re-check the cooling system as outlined in Step 6. If the cap still does not hold pressure, the cap is damaged and must be replaced. Recheck system after a new cap is installed to assure that the system will now hold pressure.
- If the bubbles in the water container cease and the radiator cap is within pressure specifications, observe gauge reading for approximately two minutes. Pressure should not drop during this time.
- If pressure drops, check for leaks at engine to radiator hoses, by-pass hose, thermostat housing gasket, etc. Any leaks which are found must be corrected and the system re-checked.
- If the system holds pressure, remove the radiator cap to release the pressure; then, reinstall the cap.
- Remove the adapter from the manifold or cylinder head and reinstall the temperature sending unit. Check coolant level and replenish, if necessary, with the correct coolant solution.

### THERMOSTAT TEST

It is good practice to test new thermostats before installing them in the engine.

Remove the thermostat and immerse it in boiling water. Replace the thermostat if it does not open more than 1/4 inch.

If the problem being investigated is insufficient heat, the thermostat should be checked for leakage. This may be done by holding the thermostat up to a lighted background. Light leakage around the thermostat valve (thermostat at room temperature) is unacceptable and the thermostat should be replaced. It is possible, on some thermostats, that a slight leakage of light at one or two locations on the perimeter of the valve may be detected. This should be considered normal.

## ADJUSTMENTS

### DRIVE BELT

The fan drive belt should be properly adjusted at all times. A loose drive belt can cause improper alternator, fan and water pump operation. A belt that is too tight places a severe strain on the water pump and alternator bearings.

A properly tensioned drive belt minimizes noise and also prolongs the service life of the belt. Therefore, it is recommended that a belt tension gauge be used to check and adjust the belt tension. **Any belt that has been operated for a minimum of 10 minutes is considered a used belt, and when adjusted, it must be adjusted to the used tension shown in the specifications.**

### BELT TENSION

- Install the belt tension tool on the drive belt (Figure 2) and check the tension.

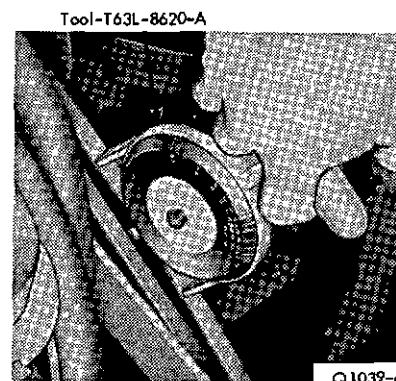


FIG. 2 Belt Tensioning

2. If adjustment is necessary, loosen the alternator mounting bolts and move the alternator adjusting arm bolts. Move the alternator toward or away from the engine until the correct tension is obtained. Remove the gauge.
3. Tighten the alternator adjusting arm bolt and the mounting bolts. Install the tension gauge and check the belt tension.

### **THERMOSTAT REPLACEMENT**

Do not attempt to repair the thermostat. It should be replaced if it is not operating properly. Check the thermostat before installing it, following the procedure under Thermostat Testing.

#### **Removal**

1. Drain the cooling system so that the coolant level is below the thermostat.
2. Remove the water outlet housing retaining bolts. Bend the upper hose upward and remove the thermostat and gasket.

#### **Installation**

1. Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with water-resistant sealer. Position the water outlet housing gasket on the intake manifold opening.
2. Install the thermostat in the intake manifold opening with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.
3. Position the water outlet housing against the intake manifold. Install and torque the retaining bolts to specifications.
4. Fill and bleed the cooling system. Operate the engine until normal operating temperature is reached; then check the coolant level and check for leaks.

### **CLEANING AND INSPECTION COOLING SYSTEM**

To remove rust, sludge and other foreign material from the cooling system, use either FoMoCo Regular Cooling System Cleanser or in severe cases use Heavy Duty Cleanser. Removal of such material restores cooling efficiency and avoids overheating.

In severe cases where cleaning solvents will not properly clean the cooling system for efficient operation, it will be necessary to use the pressure flushing method.

Various types of flushing equipment are available. If pressure flushing is used, make sure the cylinder head bolts are properly tightened to prevent possible water leakage into the cylinders.

**Always remove the thermostat prior to pressure flushing.**

**A pulsating or reversed direction of flushing water flow will loosen sediment more quickly than a steady flow in the normal direction of coolant flow.**

## Part 8 Specifications

### GENERAL

Displacement (Cubic Inches) .....	.460
Bore and Stroke .....	4.36 x3.850
Compression Ratio .....	8:1 or 9:1
Oil Pressure — Hot @ 2000 rpm (psi) .....	.35-65
Firing Order	
Rev. Rotation .....	1-8-7-3-6-2-4-5
Std. Rotation .....	1-5-4-2-6-3-7-8
Oil Capacity (Qts.) — (add 1 qt. with filter change) .....	.5

### CYLINDER BLOCK

Cylinder Bore Diameter .....	4.3600-4.3636
Maximum Out-of-Round .....	.0015
	Wear Limit — 0.005
Maximum Taper .....	.001
	Wear Limit — 0.010
Crankshaft to Rear Face of Block	
Runout TIR Maximum .....	.0005
Lifter Bore Diameter .....	0.8752-0.8767
Main Bearing Bore Diameter .....	3.1922-3.1930
Distributor Shaft Bearing Bore Diameter .....	0.5160-0.5175
Head Gasket Surface Flatness .....	0.003 inch in any
	6 inches or 0.006 inch overall
Head Gasket Surface Finish (RMS).....	.60-150
Bore Surface Finish (RMS) .....	18-38

### CYLINDER HEAD

Combustion Chamber Volume .....	.94-7-97.7
Valve Guide Bore Diameter —	
Standard Intake and Exhaust .....	0.3433-0.3443
Valve Seat Width — Intake and Exhaust .....	0.060-0.080
Valve Seat Angle — Intake and Exhaust .....	45°
Valve Seat Runout — Maximum .....	0.002
Valve Arrangement (Front to Rear) .....	Right I-E-I-E-I-E-I-E
	Left E-I-E-I-E-I-E-I
Gasket Surface Flatness .....	0.003 inch in any
	6 inches or 0.006 inch overall
Gasket Surface Finish RMS .....	.61-150

### VALVE ROCKER ARMS, PUSH RODS AND LIFTERS

Rocker Arm Lift Ratio .....	1.73:1
Valve Push Rod Runout (Maximum) .....	0.015
Hydraulic Lifter Standard Diameter .....	0.8740-0.8745
Hydraulic Lifter Clearance to Bore .....	0.0007-0.0027
	Wear Limit — 0.005
Hydraulic Lifter Leakdown Rate .....	5-50 Seconds Maximum —
	at 1/16 inch plunger travel
Hydraulic Lifter Collapsed Gap	
Allowable .....	0.075-0.175
Desirable .....	0.100-0.150

**VALVES**

Valve Stem Diameter	
Intake and Exhaust — Standard	0.3416-0.3423
0.003 Oversize	0.3446-0.3453
0.015 Oversize	0.3566-0.3573
0.030 Oversize	0.3716-0.3723
Valve Face Angel	44°
Valve Stem to Valve Guide Clearance —	
Intake and Exhaust	0.0010-0.0027
	Wear Limit — 0.0055
Valve Face Runout	0.0020
Valve Head Diameter	
Intake	2.075-2.090
Exhaust	1.6461-1.661
Valve Spring Free Length — Approximate	2.07
Valve Spring Out of Square — Maximum	.5/64 (.078)
Valve Spring Pressure —	
Lts. at Specified Length	76-84 @ 1.81
	Wear Limit — 68 @ 1.81
	240-265 @ 1.33; Marine 300-330 @ 1.32
	Wear Limit — 216 @ 1.33; Marine 280 @ 1.32
Valve Spring Assembled Height —	
Pad to Retainer	1-51/64-1-53/64

**CAMSHAFT AND BEARINGS**

Camshaft Color Code White	Standard Rotation
Camshaft No Color Code	Reverse Rotation
Camshaft Journal Diameter Standard	2.1238-2.1248
Camshaft Journal Runout — Maximum	0.005
Camshaft Journal to Bearing Clearance	0.001-0.003
	Wear Limit — 0.006
Camshaft Journal Out-of-Round —	
Maximum	0.0005
Camshaft End Play	0.001-0.007
	Wear Limit — 0.009
Camshaft Lobe Lift —	
Intake	0.2530
Exhaust	0.2780
Maximum Allowable Lobe Lift Loss	0.005
Bearing Inside Diameter	2.1258-2.1268
Camshaft Bearing Location — No: 1 Bearing	0.040-0.060*
Timing Chain Deflection — Maximum	0.500
Theoretical Valve Lift —	
Intake	0.4377
Exhaust	0.4809
Assembled Gear Face Runout — Maximum	
Crankshaft and Camshaft	0.005
Gear Backlash	0.002-0.004

\*Distance in inches that the front edge of the bearing is installed toward the rear from the front face of the cylinder block.

**CRANKSHAFT AND FLYWHEEL**

Main Bearing Journal Diameter	2.9994-3.0002
Main Bearing Journal Runout — Maximum	0.002
Main Bearing Journal Out-of-Round —	
Maximum	0.0006
	Wear Limit — 0.005
Main Bearing Journal Taper — Maximum	0.0006 Inch
Connecting Rod Journal Diameter	2.4992-2.5000
Connecting Rod Journal Out-of-Round —	
Maximum	0.0006
Connecting Rod Bearing Journal Taper —	
Maximum	0.0006 Per Inch
Thrust Bearing Journal Length	1.124-1.126
Crankshaft Free End Play	0.004-0.008
	Wear Limit — 0.012

**MAIN BEARINGS**

Crankshaft Clearance	
Desired .....	0.0008-0.0015
Allowable	
No. 1 .....	0.0004-0.0020
No. 2, 3, 4, 5 .....	0.0008-0.0026
Wall Thickness	
Standard .....	0.0955-0.0960
0.002 Undersize .....	0.0965-0.0970

**CONNECTING ROD**

Piston Pin Bore I.D. Standard .....	1.0386-1.0393
Piston Pin Bore Out-of-Round and Taper .....	0.0004
Bearing Bore Diameter .....	2.6522-2.6530
Bearing Bore Out-of-Round and Taper .....	0.0004
Connecting Rod Length —	
Center to Center .....	6.6035-6.6065
Twist Total Difference — Maximum .....	0.024*
Bend Total Differenc — Maximum .....	0.012*
Side Clearance .....	0.010-0.020
	Wear Limit — 0.023

\*Pin bore and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of an 8-inch long bar measured 4 inches on each side of rod.

**CONNECTING ROD BEARINGS**

Bearing to Crankshaft Clearance	
Desired .....	0.0008-0.0015
Allowable .....	0.0008-0.0026
Wall Thickness	
Standard .....	0.0756-0.0761
Undersize (0.002) .....	0.0766-0.0771

**PISTONS**

Piston Diameter* —	
Coded Red .....	4.3585-4.3591
Coded Blue .....	4.3597-4.3603
0.003 Oversize .....	4.3609-4.3615
Piston to Cylinder Bore Clearance .....	0.0022-0.0032
Piston Pin Bore Diameter .....	1.0402-1.0405
Ring Groove Width, Compression Top .....	0.080-0.0815
Compression Bottom .....	0.080-0.0815
Oil Ring .....	0.188-0.189

\*Measured at the piston pin bore centerline at 90° to the pin bore.

**PISTON PIN**

Piston Pin Diameter — Standard .....	1.0398-1.0403
0.001 Oversize .....	1.0410-1.0413
Piston Pin Length .....	3.290-3.320
Piston Pin to Piston Clearance .....	0.0002-0.0004
Piston Pin to Connecting Rod	
Bushing Clearance .....	Interference Fit

**PISTON RINGS**

Top Compression Ring Width .....	0.077-0.078
Bottom Compression Ring Width .....	0.077-0.078
Top Compression Ring Side Clearance .....	0.0025-0.0045
	Wear Limit — 0.006
Bottom Compression Ring Side Clearance .....	0.0025-0.0045
	Wear Limit — 0.006
Oil Ring Side Clearance .....	Snug
Top Compression Ring Gap Width .....	0.010-0.020
Bottom Compression Ring Gap Width .....	0.010-0.020
Oil Ring Gap (Steel Rail) .....	0.015-0.055

**OIL PUMP**

Relief Valve Spring Tension — (Lbs. @ Specified Length) .....	20.6-22.6 @ 2.490
Drive Shaft to Housing Bearing Clearance .....	0.0015-0.0029
Relief Valve Clearance .....	0.0015-0.0029
Rotor Assembly End Clearance .....	0.001-0.004
Outer Race to Housing Clearance (Radial) .....	0.001-0.013

**TORQUE LIMITS — FT.-LBS.**

**NOTE: All values given are in Ft.-Lbs. unless otherwise stated. Oil threads with lightweight engine oil unless the threads require oil-resistant or water resistant water.**

Cylinder Head Bolts	
Step 1 .....	70-80
Step 2 .....	100-110
Step 3 .....	130-140
Main Bearing Cap Bolts .....	95-105
Oil Pan to Cylinder Block 1/4-20 .....	7-9
5/16-18 .....	9-11
Oil Pan Drain Plug .....	15-25
Intake Manifold to Cylinder Head .....	22-32
Exhaust Manifold to Cylinder Head .....	28-33
Oil Pump to Cylinder Block .....	22-32
Oil Pump Cover Plate .....	6-10
Oil Pump Pick-Up Tube to Oil Pump .....	Press Fit
Flywheel to Crankshaft .....	75-85
Valve Rocker Arm Stud to Cylinder Head .....	18-25
Vibration Damper to Crankshaft .....	70-90
Pulley to Vibration Damper .....	35-50
Water Pump to Front Cover .....	12-15
Valve Rocker Arm Cover .....	5-6
Fuel Pump .....	19-27
Connecting Rod Nuts .....	40-45
Cylinder Front Cover .....	12-18
Water Outlet Housing .....	10-15
Camshaft Sprocket to Camshaft .....	40-45
Camshaft Thrust Plate to Block .....	9-12
Alternator Pivot Bolt .....	45-57

**TORQUE LIMITS FOR VARIOUS SIZE BOLTS — FT.-LBS.**

**CAUTION: If any of these torque limits disagree with any of those listed previously, the preceding limits prevail.**

Size (Inches) .....	Torque (Ft.-Lbs.)
1/4-20 .....	6-9
5/16-18 .....	12-18
5/16-24 .....	14-20
3/8-16 .....	22-32
3/8-24 .....	27-38
7/16-14 .....	40-55
1/2-13 .....	55-80
9/16-18 .....	85-120

**IGNITION SYSTEM**

- Initial Spark Advance — BTDC .....10°
- Breaker Arm Spring Tension (ounces) .....17-21
- Contact Spacing ..... .014-.019
- Dwell Angle at Idle Speed ..... Industrial, 24°-30°;  
Marine, 31°
- Gear Location Dimension — Distributor ..... 4.031-4.038  
(Distance from bottom of Mounting Flange to Bottom of Gear).
- Shaft End Play — Distributor ..... 0.024-0.035
- Condenser
  - Capacity — Microfarads ..... 0.21-0.25
  - Minimum Leakage — Megohms ..... 10
  - Maximum Series Resistance Ohms ..... 1
- Coil
  - Primary Resistance Wire — Ohms ..... 1.40-1.54 (75°)
  - Secondary Resistance Ohms ..... 7600-8800 (75°)
  - Average Draw
    - Engine Stopped ..... 4.5
    - Engine Idling ..... 2.5
    - Primary Circuit Resistance Ohms ..... 1.30-1.40 (25°F)
  - Spark Plugs
    - Plugs
      - Industrial ..... ARF-42
      - Marine ..... ARF-32
    - Size
      - Industrial ..... 14mm
      - Marine ..... 14mm

**Industrial Distributor**

Centrifugal Advance. Set the test stand to 00° at 250 rpm and 0 inches of vacuum.

Distributor (rpm)	Advance (Degrees)	Vacuum (Inches of Mercury)
500	1-1/2-3	0
750	4-1/2-6	0
1000	6-1/2-8	0
1500	9-1/2-11	0
2000	11-1/2-13	0

Vacuum Advance. Set the test stand at 0° at 1000 rpm and 0 inches of Hg.

1000	0-1-1/2	5
1000	6-9	10
1000	6-9	15
1000	6-9	20

**Marine Distributor**

0-550	-	0
900	8	0
2000	15	0

**FUEL SYSTEM**

- Fuel Pump Static Pressure @ 500 rpm .....5.7-7.7
- Minimum Fuel Pump Volume Flow @ 500 rpm ..... 1 Pint/20 Sec.
- Eccentric Total Lift ..... 0.890-0.910

**COOLING SYSTEM**

- Thermostat
  - Low Temperature ..... Opens 157°-164°F  
Fully Open — 184°F
  - High Temperature ..... Opens 188°-195°F  
Fully Open — 212°
- Drive Belt Tension ..... New — 140 Lbs.  
Used — 100 lbs. (any belt operated over 10 minutes)

<b>CARBURETORS</b>	<b>DIF TA</b>	<b>D4JL J</b>
<b>Carburetor Size</b>		
Throttle Bore Diameter		
Primary —	1.687	1.686
Secondary —	1.687	1.686
Venturi Diameter		
Primary —	1.375	1.375
Secondary —	1.437	1.437
<b>Fuel System</b>		
Fuel Level (Wet)	①	③ ⑤
Float Level (Dry)	②	②
<b>Main Metering System</b>		
Main Jet		
Primary —	#72	#722
Secondary —	#84	N/A
Power Valve Timing	8.5	8.5
Idle Mixture (Primary Setting)	1½	1½
<b>Accelerator Pump System</b>		
Capacity — C. C/10 Strokes	18-22	17-27
Pump Rod Location	#2	#2
Override Spring Adjustment	.015	.015
Pump Cam Color	Red	Red
<b>Idle Speed</b>		
Curb Idle RPM	550-575	550-575
Fast Idle RPM	1500	1500
Choke Cover Setting	Index	Index
Dechoke	.300"	.300"
Choke Qualifying	.140"	.140"
Secondary Throttle Opening	¼-½	¼-½
Supplier	Holley	Holley
Supplier I.D. Number	6361	7128
Carburetor Model	4150C	4160C

## Notes:

- ① Lower Edge of Sight Plug Hole.
- ② Parallel with Float Bowl Floor (bowl inverted).
- ③ ½" Primary ⅝" Secondary.
- ④ ½" Primary ¾" Secondary.
- ⑤ Use Kent Model Gauge #10193.

**DECIMAL AND METRIC EQUIVALENTS**

<b>Fractions</b>	<b>Decimal In.</b>	<b>Metric MM.</b>	<b>Fractions</b>	<b>Decimal In.</b>	<b>Metric MM.</b>
1/64	.015625	.39688	33/64	.515625	13.09687
1/32	.03125	.79375	17/32	.53125	13.49375
3/64	.046875	1.19062	35/64	.546875	13.89062
1/16	.0625	1.58750	9/16	.5625	14.28750
5/64	.078125	1.98437	36/64	.578125	14.68437
3/32	.09375	2.38125	19/32	.59375	15.08125
7/64	.109375	2.77812	39/64	.609375	15.47812
1/8	.125	3.1750	5/8	.625	15.87500
9/64	.140625	3.57187	41/64	.640625	16.27187
5/32	.15625	3.96875	21/32	.65625	16.66875
11/64	.171875	4.36562	43/64	.671875	17.06562
3/16	.1875	4.76250	11/16	.6875	17.46250
13/64	.203125	5.15937	45/64	.703125	17.85937
7/32	.21875	5.55625	23/32	.71875	18.25625
15/64	.234375	5.95312	47/64	.734375	18.65312
1/4	.250	6.35000	3/4	.750	19.05000
17/64	.265625	6.74687	49/64	.765625	19.44687
9/32	.28125	7.14375	25/32	.78125	19.84375
19/64	.296875	7.54062	51/64	.796875	20.24062
5/16	.3125	7.93750	13/16	.8125	20.63750
21/64	.328125	8.33437	53/64	.828125	21.03437
11/32	.34375	8.73125	27/32	.84375	21.43125
23/64	.359375	9.12812	55/64	.859375	21.82812
3/8	.375	9.52500	7/8	.875	22.22500
25/64	.390625	9.92187	57/64	.890625	22.62187
13/32	.40625	10.31875	29/32	.90625	23.01875
27/64	.421875	10.71562	59/64	.921875	23.41562
7/16	.4375	11.11250	15/16	.9375	23.81250
29/64	.453125	11.50937	61/64	.953125	24.20937
15/32	.46875	11.90625	31/32	.96875	24.60625
31/64	.484375	12.30312	63/64	.984375	25.00312
1/2	.500	12.70000	1	1.00	25.40000

METRIC-ENGLISH CONVERSION TABLE

Multiply	by	to get equivalent number of:	Multiply	by	to get equivalent number of:
Inch	<b>LENGTH</b> 25.4	millimetres (mm)	Foot/sec <sup>2</sup>	<b>ACCELERATION</b> 0.304 8	metre/sec <sup>2</sup> (m/s <sup>2</sup> )
Foot	0.304 8	metres (m)	Inch/sec <sup>2</sup>	0.025 4	metre/sec <sup>2</sup>
Yard	0.914 4	metres	Pound-inch	<b>TORQUE</b> 0.112 98	newton-metres (N-m)
Mile	1.609	kilometres (km)	Pound-foot	1.355 8	newton-metres
Inch <sup>2</sup>	<b>AREA</b> 645.2	millimetres <sup>2</sup> (mm <sup>2</sup> )	Horsepower	<b>POWER</b> 0.746	kilowatts (kW)
Foot <sup>2</sup>	6.45	centimetres <sup>2</sup> (cm <sup>2</sup> )	Inches of water	<b>PRESSURE OR STRESS</b> 0.249 1	kilopascals (kPa)
Yard <sup>2</sup>	0.092 9	metres <sup>2</sup> (m <sup>2</sup> )	Pounds/sq. in.	6.895	kilopascals
Inch <sup>3</sup>	<b>VOLUME</b> 16 387.	metres <sup>2</sup>	BTU	<b>ENERGY OR WORK</b> 1 055.	joules (J)
Quart	16.387	mm <sup>3</sup>	Foot-pound	1.355 8	joules
Gallon	0.016 4	cm <sup>3</sup>	Kilowatt-hour	3 600 000.	joules (J = one W's)
Yard <sup>3</sup>	0.946 4	litres (l)	Foot candle	<b>LIGHT</b> 1.076 4	lumens/metre <sup>2</sup> (lm/m <sup>2</sup> )
Pound	0.946 4	litres	Miles/gal	<b>FUEL PERFORMANCE</b> 0.425 1	kilometres/litre (km/l)
Ton	3.785 4	litres	Gal/mile	2.352 7	litres/kilometre (l/km)
Ton	0.764 6	metres <sup>3</sup> (m <sup>3</sup> )	Miles/hour	<b>VELOCITY</b> 1.609 3	kilometres/hr. (km/h)
Pound	<b>MASS</b> 0.453 6	kilograms (kg)			
Ton	907.18	kilograms (kg)			
Ton	0.907	tonne (t)			
Kilogram	<b>FORCE</b> 9.807	newtons (N)			
Ounce	0.278 0	newtons			
Pound	4.448	newtons			
Degree Fahrenheit	<b>TEMPERATURE</b> (°F-32)÷ 1.8	degree Celsius			