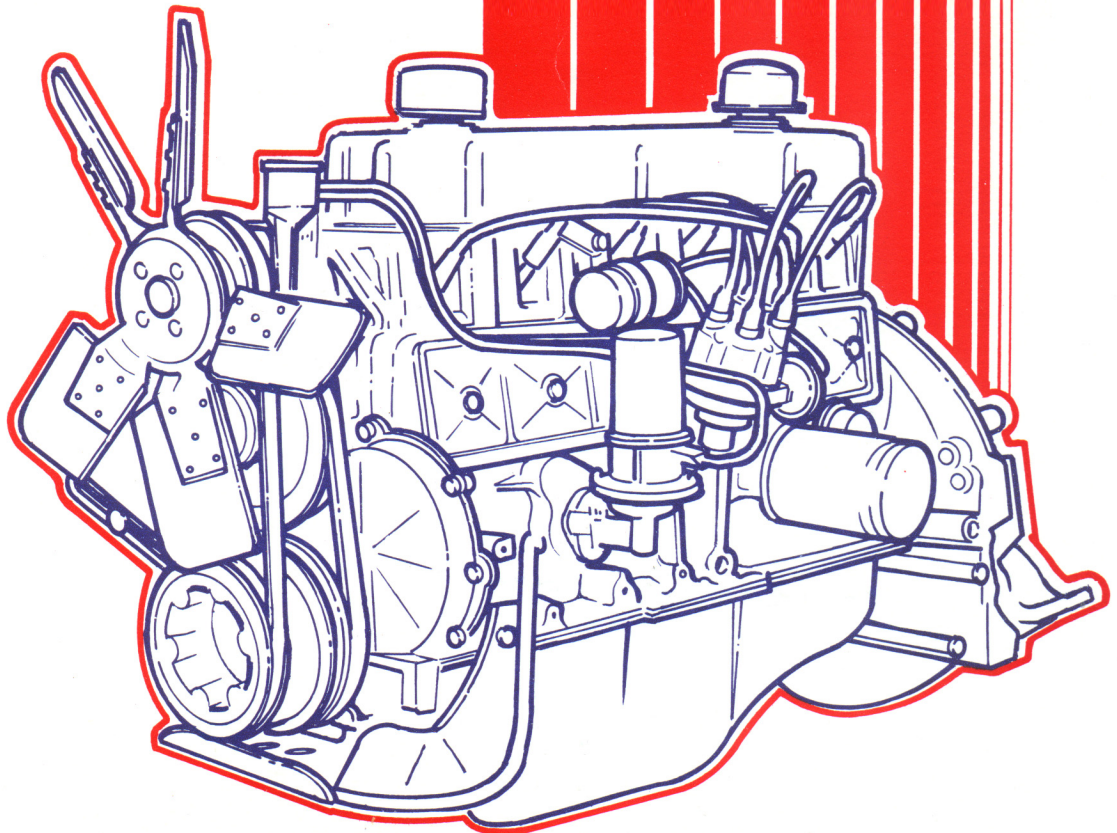




Power
Products

CSG-649 INDUSTRIAL SERVICE MANUAL



⚠ WARNING: ⚠

The Engine Exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Introduction

This Service Manual provides the Service technician with information for the proper servicing of the Ford 300 CID Industrial Engine.

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
FORD PARTS AND SERVICE DIVISION
POWER PRODUCTS OPERATIONS
3000 SCHAEFER ROAD
P.O. BOX 6011
DEARBORN, MICHIGAN 48121

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.

NOTE: *The recommendations and suggestions contained in this publication are made to assist the distributor in improving his distributorship parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual shall govern.*

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK. If you have a manual transmission, it should be in REVERSE.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts, especially the fan and belts, whenever the engine is running.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.

CSG-649 GASOLINE ENGINE

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Part 1 Basic Engine

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IDENTIFICATION

An Identification Decal (Figure 1) is affixed to the left side of the rocker cover of the 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.

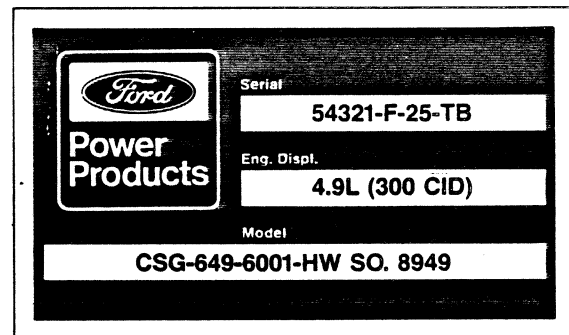


FIG. 1 Engine I.D. Decal

DESCRIPTION

The Ford 300 cubic inch six-cylinder engine is available as an engine assembly or a complete ready-to-run power unit. In addition, a full range of optional equipment is available to custom tailor the engine or power unit to individual requirements.

The cylinder block is manufactured from cast iron using the Ford-pioneered precision casting process. This process provides ultra-lightweight design with a maximum of strength and rigidity. Special design features of the cylinder block include seven main bearings and full-length, full-circle water jackets. The seven main bearings provide a rugged "foundation" for extra durability and a smoothness of operation comparable to many V-8s. The full-length, full-circle water jackets help eliminate hot-spots and provide more uniform cylinder wall expansion under heavy-duty operation.

The precision molded, cast-alloy iron crankshaft is carried in seven replaceable copper-lead alloy main bearings. Crankshaft end thrust is controlled by the flanges of the No. 5 main bearing.

The aluminum alloy piston has three rings; two compression and one oil control. The autothermic, semi-dish type cam ground pistons give longer life with a minimum of maintenance. The connecting rods are forged steel and use replaceable copper-lead bearings.

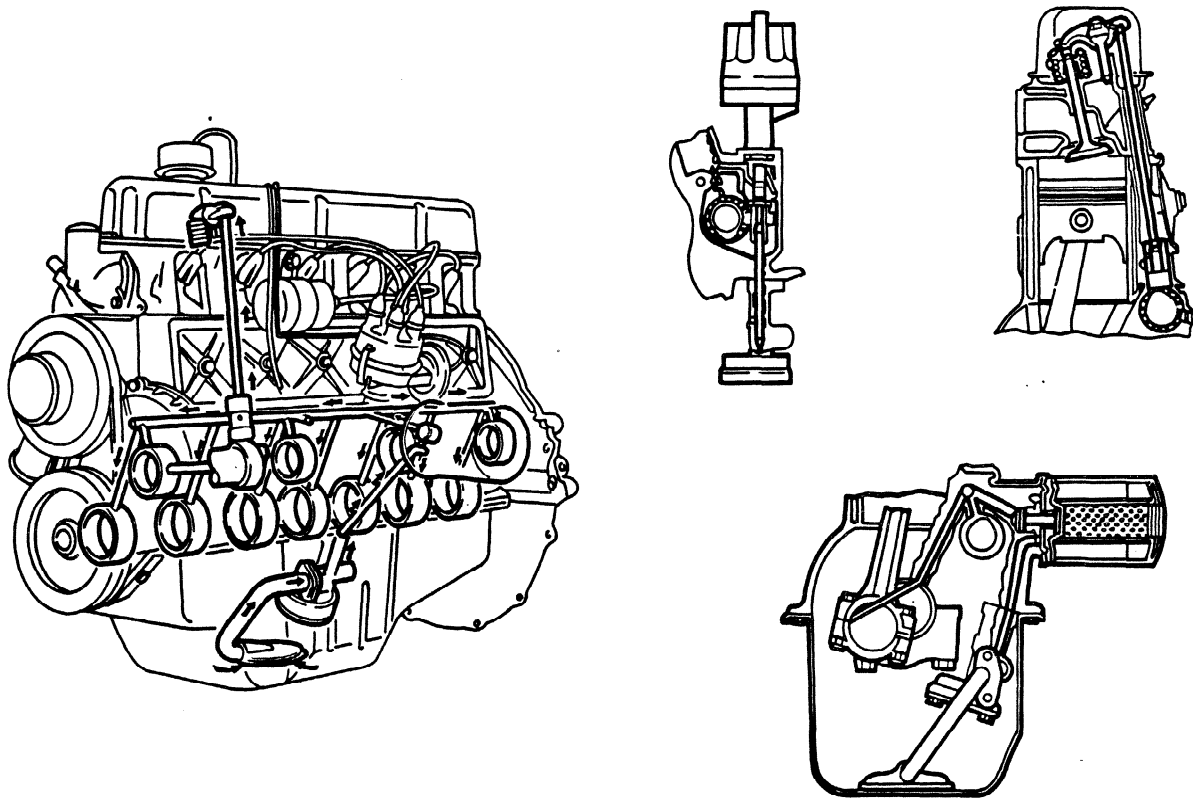
The camshaft is supported by four bearings pressed into the block. It is driven by gears from the crankshaft. Camshaft end play is controlled by a plate bolted to the front of the block. The distributor, located on the left side of the engine, is driven by a gear on the camshaft. The distributor drives the rotor-type oil pump through an intermediate driveshaft.

The cylinder head assembly contains the fuel intake passages, the valves, and the individual valve rocker arm assemblies. Valve guides are an integral part of the head. Optional hard-faced intake and exhaust valve seat inserts are pressed into the heads. The intake and exhaust valves are actuated through hydraulic valve lifters and rocker arms. Rocker arms are individually pedestal-mounted with a provision for adjustment.

A chamber (heat riser), cast into the intake manifold between the carburetor and exhaust manifold provide the heat to vaporize the incoming fuel charge until the engine reaches operating temperature.

The engine is equipped with a crankcase ventilation system that vents crankcase fumes through two vented oil fill caps on the rocker arm cover.

The 300 power unit is a complete ready-to-run engine mounted on a foot-type frame. Included are radiator, pusher or puller-type fan, power take-off instruments, throttle, choke, air cleaner, fuel tank, exhaust pipe, and a sheet metal shroud enclosing the front, rear and top of unit.



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FIG. 2 300 CID Engine

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 the heater hose and crankcase ventilation hose, if so equipped. Remove valve rocker arm cover.
2. Remove the rocker arm stud nut, fulcrum seat and rocker arm. Use the adapter for ball end push rods.
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 and in the same plane as the push rod movement (Figure 3).
4. Connect an auxiliary starter switch in the starting circuit. Crank the engine with the ignition switch OFF.
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 specification.
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 fulcrum seat and stud nut. Adjust the valve clearance.
10. Install the valve rocker arm cover and the air cleaner.

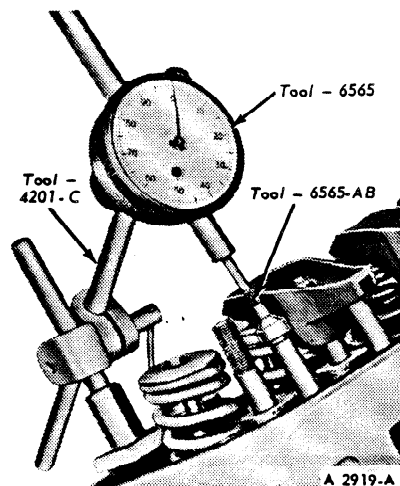


FIG. 3 Typical Camshaft Lobe Lift

COMPRESSION TEST

COMPRESSION GAUGE CHECK

The following procedure is to be used when checking compression:

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. Crank the engine (with the ignition switch OFF) at least five (5) pumping strokes and record the highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat the check on each cylinder cranking the engine approximately the same number of compression strokes.

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.

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 by preventing a check valve from seating and causing 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 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.
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 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.
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.

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		

FIG. 4 Quick Reference Compression Pressure Limit Chart

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 5) 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 or give an erroneous reading.
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.



FIG. 5 Crankcase Ventilation System Tester

CRANKCASE VENTILATION REGULATOR VALVE TEST

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

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

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 6).
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.

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 if the mounting flange runout exceeds specifications. Replace it or reinstall it on the flywheel.

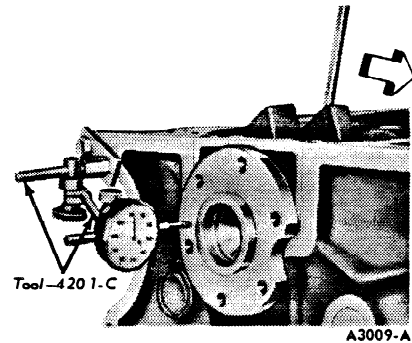


FIG. 6 Checking Crankshaft End Play

CAMSHAFT END PLAY

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 or gear hub (Figure 7). 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 the 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.

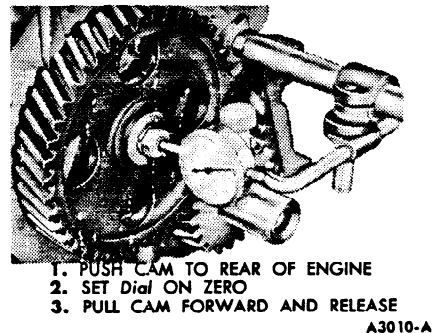


FIG. 7 Checking Camshaft End Play — Typical

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 damage 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

Check the exhaust control valve for freedom from binding throughout the valve travel. If necessary, free the shaft with exhaust control valve solvent. If the solvent does not eliminate the binding condition, replace the component parts.

Inspect the manifold(s) for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service. Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY

Cleaning

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

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

Inspection

Inspect the pad at the valve end of the rocker arms 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.

On the ball stud rocker arms, check the rocker arm and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm stud and nut for stripped or broken threads.

PUSH RODS

Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air.

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 8).

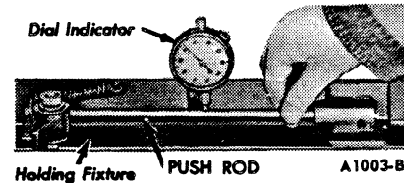


FIG. 8 Checking Push Rod Runout

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. Using cleaning solvent to remove dirt, grease and other deposits, clean all bolt holes.

Remove all deposits from the valves with a fine wire brush or buffing wheel.

Inspection

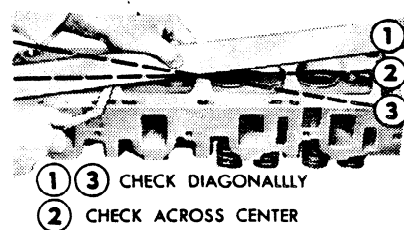
Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

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.

CYLINDER HEAD FLATNESS

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Figure 9) for conformance to specifications. If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.010 inch from the original gasket surface.**



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FIG. 9 Checking Cylinder Head Flatness

VALVE SEAT RUNOUT

Check the valve seat runout with an accurate gauge (Figure 10). Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat.

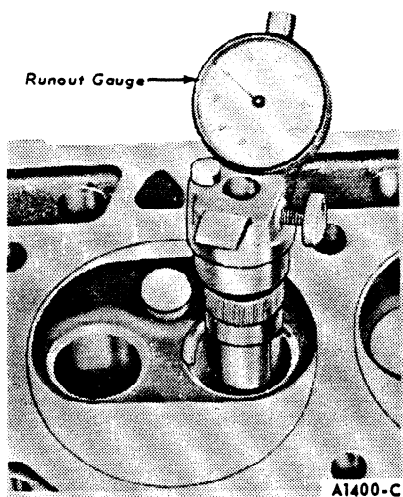


FIG. 10 Checking Valve Seat Runout

VALVE SEAT WIDTH

Measure the valve seat width (Figure 23). Reface the valve seat(s) if the width is not within specifications.

VALVES

The critical inspection points and tolerances of the valve are illustrated in Figure 24. Refer to specifications for wear limits. Inspect the valve face and the edge of the valve head for pits, grooves or scores. 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 or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

VALVE FACE RUNOUT

Check the valve face runout. It should not exceed the specified wear limit. If the runout exceeds the wear limit, the valve should be replaced or refaced as outlined under Refacing Valves in this section.

VALVE STEM CLEARANCE

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Figure 11 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.

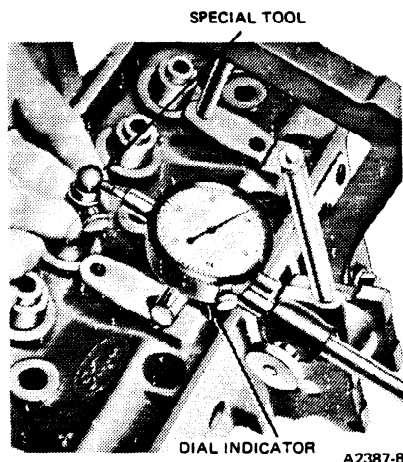


FIG. 11 Checking Valve Stem Clearance

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.

VALVE SPRING PRESSURE

Check the valve spring for proper pressure (Figure 12) at the specified spring lengths. Weak valve springs cause poor performance; therefore, if the pressure of any spring is lower than the wear limit, replace the spring.

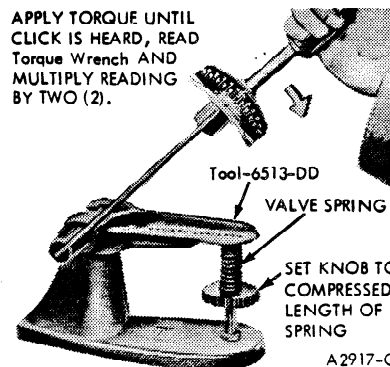


FIG. 12 Checking Valve Spring Pressure

VALVE SPRING SQUARENESS

Check each spring for squareness using a steel square and a surface plate (Figure 13). Stand the spring and square on end on the surface plate. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and square. If the spring is out-of-square more than $5/64$ inch, replace it.

Follow the same procedure to check new valve springs before installation.

Make certain the proper spring (color coded) is installed.

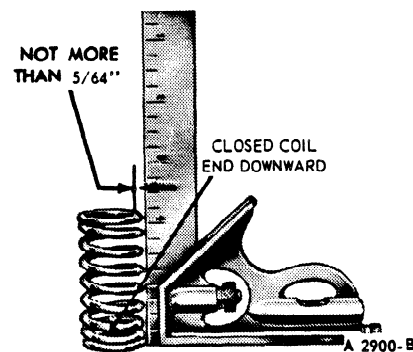


FIG. 13 Checking Valve Spring Squareness

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 or the procedure in this manual.

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.

It is not necessary to replace the gears in sets. Replace the camshaft gear and check the backlash, runout, etc., to determine if the crankshaft gear should be replaced.

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.

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 camshaft 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.

CRANKSHAFT

Cleaning

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

Clean the oil seal contact surface at the rear of the crankshaft 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 surfaces become polished. A finely polished surface may produce poor sealing or cause premature seal wear.**

INSPECTION

Inspect the main and connecting rod journals for cracks, scratches, grooves or scores.

Measure the diameter of each journal in at least four places to determine out-of-round, taper or undersize condition (Figure 14).

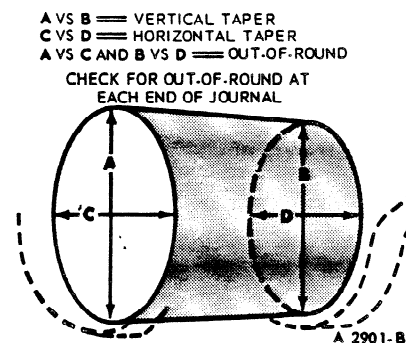


FIG. 14 Crankshaft Journal Measurement

On an engine used with a manual shift transmission, 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 15). Replace the bushing if it is damaged or the ID is not within specifications.

Inspect the pilot bearing, when used, for roughness, evidence of overheating or loss of lubricant. Replace if any of these conditions are found.

Inspect the rear oil seal surface of the crankshaft for excessively deep grooves, nicks, burrs, porosity, or scratches which could damage the oil seal lip during installation. Remove all nicks and burrs and polish the chamfered edge and oil seal contact surface with crocus cloth.

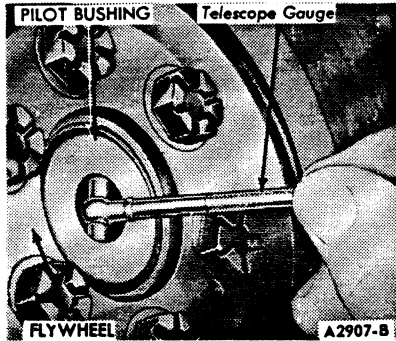


FIG. 15 Checking Clutch Pilot Bushing Wear

FLYWHEEL

Inspection

Inspect the flywheel for cracks, heat checks, 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 or the piston pin hole is not in proper relation to the piston skirt and ring grooves.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, 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 maximum limit and/or if the rod is fractured, it should be replaced.

On connecting rods that have a piston pin bushing, check the piston pin to connecting rod bushing clearance. Replace the connecting rod if the bushing is so worn that it cannot be reamed or honed for an oversize pin.

Check the ID of the connecting rod piston pin bore. Replace the connecting rod if the pin bore is not within specifications. Replace defective connecting rod nuts and bolts.

After the connecting rods are assembled to the piston, check the 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 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 groove with a ring groove cleaner (Figure 16). Make sure the oil ring slots (or holes) are clean.

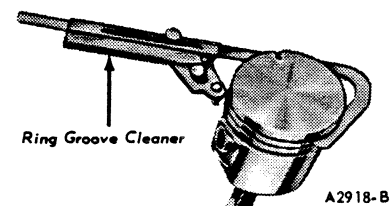


FIG. 16 Cleaning Ring Grooves — Typical

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 have high steps, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the piston top 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 at the centerline of the piston bore and at 90 degrees to the pin bore axis.** 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 Pistons and Connecting Rods Assembly in the pertinent engine section.

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. It is good practice to always install new rings when overhauling an engine. **Rings should not be transferred from one piston to another regardless of mileage.**

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 bearing shells.**

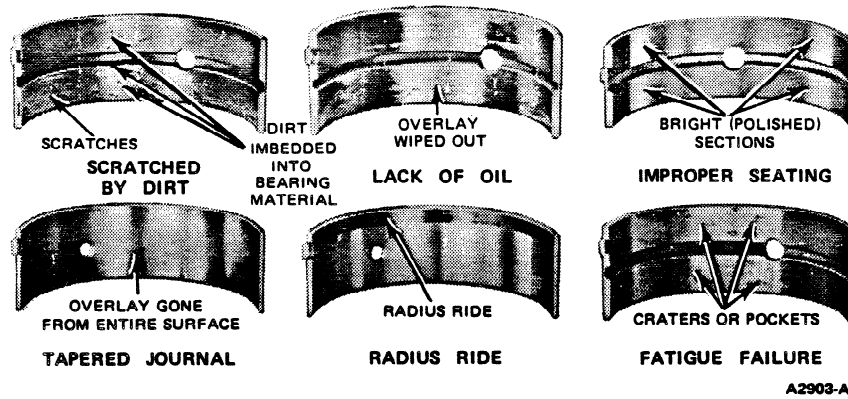


FIG. 17 Typical Bearing Failures

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of bearings that should be replaced and the causes are shown in Figure 17. 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. Fit new bearings following the recommended procedure 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 in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the 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.

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 cracked 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. Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications, but not to exceed **0.010 inch stock removal from the original gasket surface.**

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 18). 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 damage, but the out-of-round and taper are within limits, it may be possible to remove such damage by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits.

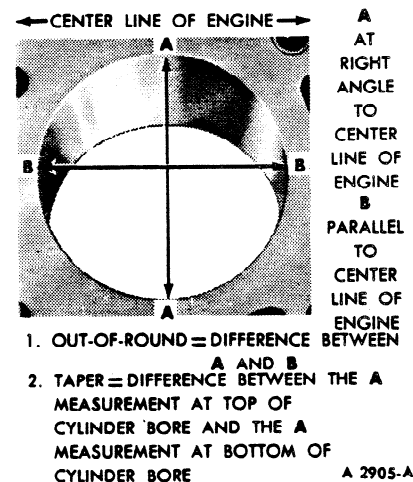


FIG. 18 Cylinder Bore Out-of-Round and Taper

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. Check the gasket surface for damage caused by over-torqued bolts. Straighten the surface as required to restore original flatness.

Replace the pan if repairs cannot be made.

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 or scoring.

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 19).

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 20).

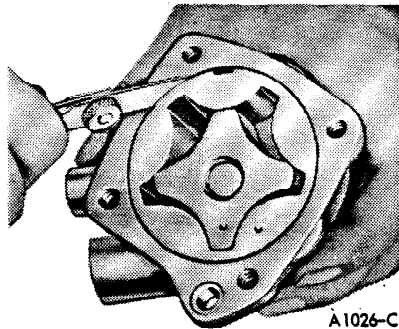


FIG. 19 Checking Outer Race-to-Housing Clearance

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.

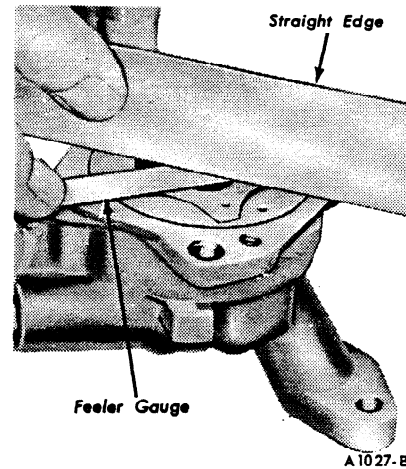


FIG. 20 Checking Rotor End Play

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.

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

Cleaning

Do not attempt to clean the crankcase ventilation regulator valve; replace it at the recommended maintenance interval.

The oil filler tube breather cap, located on the valve rocker arm cover, should be cleaned at the proper mileage interval. Remove the cap and wash it in a low-volatility, petroleum-base solvent. Shake the cap dry and install it. Do not dry with compressed air as air pressure may damage the filter element.

Clean the crankcase ventilation system connection(s) on the carburetor spacer or intake manifold by probing the inlet nipple with a flexible wire or bottle brush.

Clean the hoses 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 21) 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.

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 interfer-

ence 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 22). 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 23).

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.

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).

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.

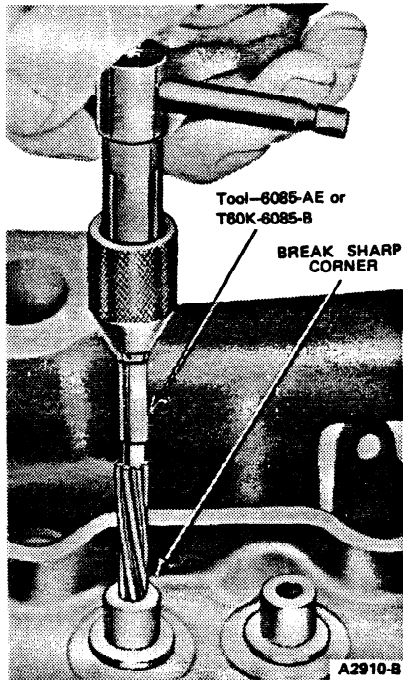


FIG. 21 Reaming Valve Guides

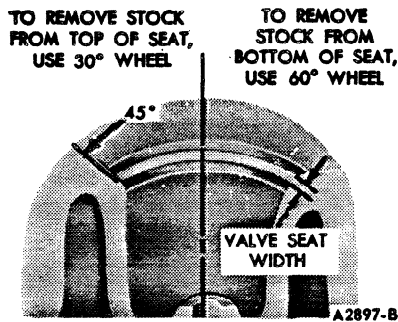


FIG. 22 Refacing Valve Seat

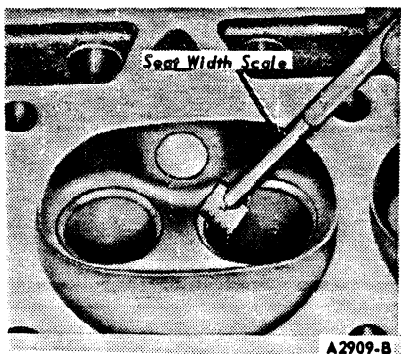


FIG. 23 Checking Valve Seat Width

VALVES

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

Discard any 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.

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 24), 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.

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.

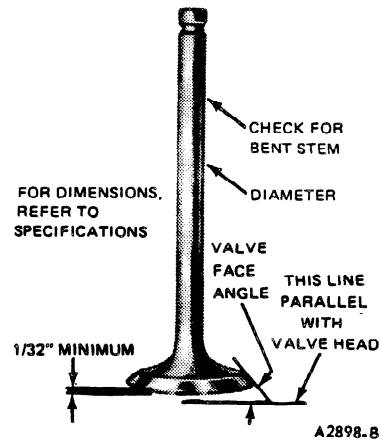


FIG. 24 Critical Valve Dimensions

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.

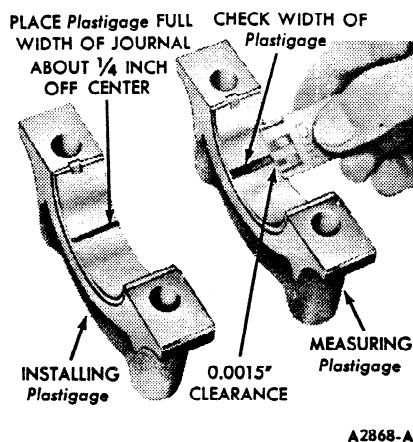


FIG. 25 Installing and Measuring Plastigage

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 one half of a 0.001 or 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.
2. If fitting a main bearing, position a jack under counterweight adjoining bearing which is being checked. Do not place jack under front post of crankshaft. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.
3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center (Figure 25).
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, try 0.001 or 0.002 inch undersize bearings in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 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, 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 .003 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 0.003 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). Measure the piston diameter in line with the centerline of the piston pin and at 90° to the piston pin axis.
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 26). 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 27). 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 lands have high steps, the piston should be replaced.

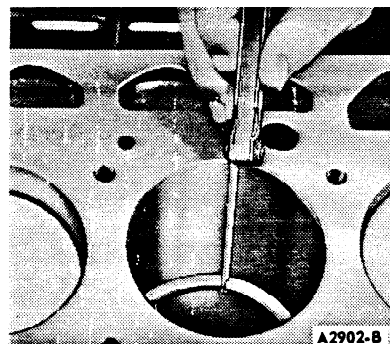


FIG. 26 Checking Piston Ring Gap

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 AND / OR SHAFT ASSEMBLY

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.

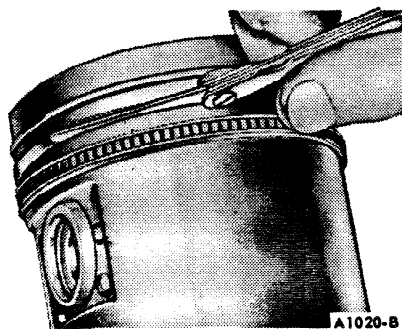


FIG. 27 Checking Piston Ring Side Clearance

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 front cover on engines using cast iron material.
5. Cylinder head, along the rocker arm cover gasket surface.

The following procedures 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.

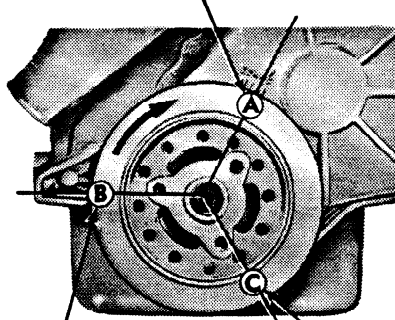
ADJUSTMENTS

VALVE CLEARANCE (1978 AND PRIOR)

1. Install an auxiliary starter switch. Crank the engine with the ignition switch OFF.
2. Make two chalk marks on the crankshaft damper (Figure 28). Space the marks approximately 120 degrees apart so that, with the timing mark, the damper is divided into three equal parts (120 degrees is 1/3 of the distance around the damper circumference).

STEP 1—SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE ADJUST NO. 1 INTAKE AND EXHAUST

STEP 4—ADJUST NO. 6 INTAKE AND EXHAUST



STEP 2—ADJUST NO. 5 INTAKE AND EXHAUST

STEP 3—ADJUST NO. 3 INTAKE AND EXHAUST

STEP 5—ADJUST NO. 2 INTAKE AND EXHAUST

STEP 6—ADJUST NO. 4 INTAKE AND EXHAUST

A 2925-A

FIG. 28 Valve Clearance

3. Rotate the crankshaft until No. 1 piston is on TDC at the end of the compression stroke. Check the breakaway torque (torque required to turn nut in a counterclockwise direction) of each stud nut. Replace the stud nut if the breakaway torque does not meet specifications. If, after replacing the stud nut, the breakaway torque still is not within specifications, replace the stud.

4. With No. 1 piston on TDC at the end of the compression stroke, adjust the intake and exhaust valve clearance for No. 1 cylinder. Loosen the rocker arm stud nut until there is end clearance in the push rod, then tighten the nut to just remove all the push rod to rocker arm clearance. This may be determined by rotating and/or moving the push rod with the fingers as the stud nut is tightened (Figure 29). When the push rod to rocker arm clearance has been eliminated, tighten the stud nut an additional 1 turn to place the hydraulic lifter plunger in the desired operating range.

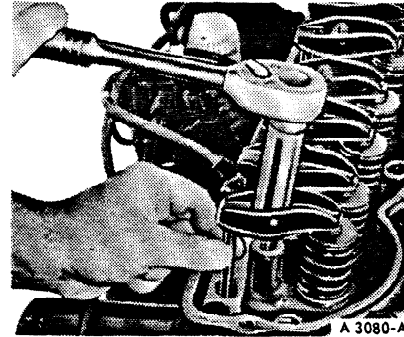


FIG. 29 Valve Clearance Adjustment

5. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, 1/3 turn at a time, in the direction of rotation, while adjusting the valves in the firing order sequence, 1-5-3-6-2-4. This procedure requires two complete turns of the crankshaft.
6. Operate the engine and check for rough engine idle or a noisy lifter(s). Valve clearance set too tight will cause rough idle and valve clearance set too loose will cause a noisy lifter(s). If it has been determined that these conditions are caused by improper valve clearance, readjust the affected valve(s).

REMOVAL AND INSTALLATION CRANKCASE VENTILATION SYSTEM

Removal

1. Remove the air cleaner.
2. Grasp the crankcase ventilation regulator valve and pull upwards to remove it from the rocker arm cover.
3. Remove the regulator valve from the vent hose and remove the vent hose from the inlet tube in the intake manifold.
4. Remove the inlet tube from the intake manifold.
5. Remove the air inlet hose from the oil fill cap and carburetor air cleaner.

Installation

1. Install the inlet tube in the intake manifold.
2. Install the hose on the inlet tube in the intake manifold. Install the regulator valve in the hose.
3. Insert the regulator valve into the rocker arm cover mounting grommet.

Connect the air inlet hose to the oil fill cap and carburetor air cleaner.

4. Install the air cleaner. Operate the engine and check for leaks.

VALVE ROCKER ARM COVER AND ROCKER ARM

Removal

1. Disconnect the inlet air hose at the oil fill cap. Remove the air cleaner.
2. Disconnect the throttle rod from the carburetor throttle lever. Remove the cable retracting spring. Remove the throttle cable bracket from the cylinder head and position the cable and bracket assembly out of the way.
3. Remove the crankcase ventilation regulator valve from the valve rocker arm cover, if so equipped. Remove the cover bolts and remove the valve rocker arm cover.

- Remove the valve rocker arm stud nut, fulcrum seat and rocker arm.

Inspect the rocker arm cover bolts for defective seals under the bolt heads and replace as necessary. If removal of the rocker arm stud is necessary, refer to the procedure in this section.

The valve rocker arm assembly is shown in Figure 30.

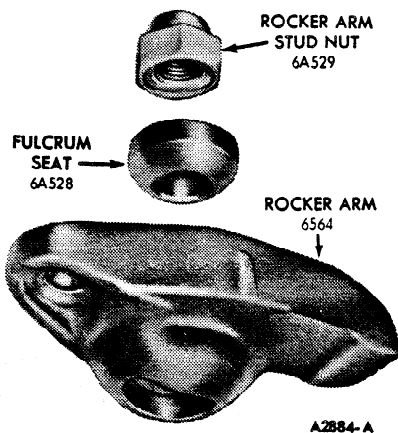


FIG. 30 Valve Rocker Arm Assembly

Installation

- Apply Lubriplate to the top of the valve stem and at the push rod guide in the cylinder head.
- Apply Lubriplate to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Install the valve rocker arm, fulcrum seat and stud nut. Adjust the valve clearance following the procedure under Valve Clearance Adjustment.
- Clean the valve rocker arm cover and the cylinder head gasket surface. Apply oil-resistant sealer to one side of a new cover gasket. Lay the cemented side of the gasket in place in the cover. Be sure the gasket is seated properly around the extruded bolt holes.
- Install the cover on the cylinder head. Make sure the gasket seats evenly all around the head. Partially tighten the cover bolts in sequence, starting at the middle bolts. Then torque the bolts to specifications in the same sequence.
- Install the crankcase ventilation regulator valve in the rocker arm cover, if so equipped. Install the throttle cable bracket on the cylinder head and connect the cable to the carburetor.
- Connect the inlet air hose to the oil fill cap.

MANIFOLDS

Removal

- Remove the air cleaner. Disconnect the choke cable at the carburetor. Disconnect the throttle rod from the carburetor throttle lever.
- Disconnect the fuel inlet line and the distributor vacuum line from the carburetor.
- Remove the bolts and nuts attaching the manifolds to the cylinder head. Lift the manifold assemblies from the engine. Remove and discard the gaskets.
- To separate the manifolds, remove the nuts joining the intake and exhaust manifolds.

Installation

If the exhaust gas control valve requires replacement, follow the procedures in the pertinent section.

- Clean the mating surfaces of the cylinder head and manifolds.
 - If one of the manifolds is to be replaced, remove the tube fittings from the discarded manifolds and install them in the new manifold as required. Also install new studs in the new manifold.
 - If the intake and exhaust manifolds have been separated, coat the mating surfaces lightly with graphite grease and place the exhaust manifold over the studs on the intake manifold. Install the lock washers and nuts. Tighten them finger tight.
 - Install a new intake manifold gasket.
 - Coat the mating surfaces lightly with graphite grease. Place the manifold assemblies in position against the cylinder head. **Make sure that the gaskets have not become dislodged. Install the attaching washers, bolts and nuts.** Torque the bolts and nuts to specifications in the sequence shown in Figure 31.
- If the intake and exhaust manifolds were separated, tighten the nuts joining them.
- Connect the crankcase vent hose to the intake manifold inlet tube and position the hose clamp.
 - Connect the fuel inlet line and the distributor vacuum line to the carburetor.
 - Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
 - Install the air cleaner. Adjust the engine idle speed and idle fuel mixture.

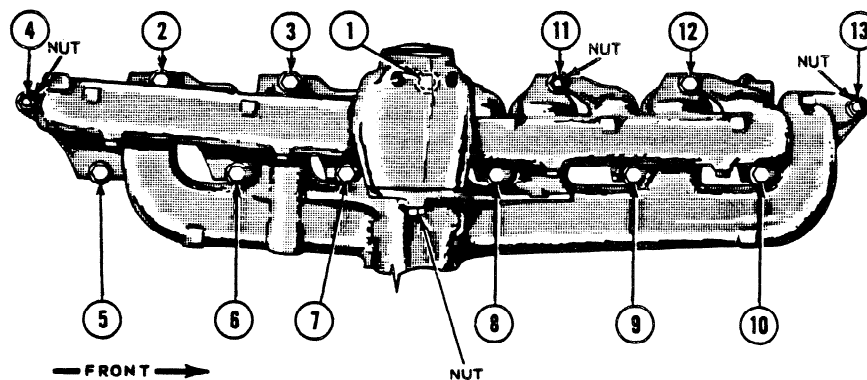


FIG. 31 Intake and Exhaust Manifolds Torque Sequence

CYLINDER HEAD

Removal

If the cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly. Transfer all valves, springs, seals, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves and check valve guide clearances before assembling the used parts to the new cylinder head.

1. Drain the cooling system.
2. Remove the air cleaner.
3. Remove the crankcase ventilation regulator valve, if so equipped, from the rocker arm cover. Disconnect the vent hose at the intake manifold inlet tube.
4. Disconnect and remove the carburetor fuel inlet line and the distributor vacuum line.
5. Disconnect the choke cable at the carburetor and position the choke cable and housing out of the way.
6. Disconnect the throttle rod from the carburetor throttle lever.
7. Disconnect the radiator upper hose at the coolant outlet elbow.
8. Remove the coil bracket attaching bolt and position the coil out of the way.
9. Remove the valve rocker arm cover. Loosen the rocker arm stud nuts so that the rocker arms can be rotated to one side.
10. Remove the valve push rods in sequence and identify them so that they can be installed in their original position.
11. Disconnect the spark plug wires at the spark plugs.
12. Remove the cylinder head bolts. Install the cylinder head lifting eyes in the locations shown in Figure 32. Position a floor crane and attach the hoist and lifting sling to the lifting eyes. Lift the cylinder head and intake and exhaust manifolds assembly off the engine. **Do not pry between the head and block as the gasket surfaces may become damaged.**

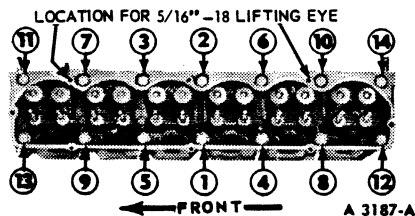


FIG. 32 Cylinder Head Bolts Torque Sequence

Installation

1. Clean the cylinder head and cylinder block gasket surfaces. Clean the exhaust pipe.
2. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the head and block gasket surfaces.
3. Position the gasket over the dowel pins on the cylinder block.
4. Install lifting eyes on the cylinder head in the location shown in Figure 32 and use a floor crane and lifting sling to lift the cylinder head over the cylinder block. Lower it carefully until it is properly positioned on the block and dowel pins. Remove the hoist and lifting eyes.
5. Coat the threads of the cylinder head bolts with engine oil. Install the bolts.
6. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown in Figure 32. Torque the bolts to specifications.
7. Apply Lubriplate to both ends of the push rods. Install the push rods in their original bores, positioning the lower end of the rods in the valve lifter sockets.

8. Apply Lubriplate to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Position the rocker arms and tighten the stud nuts just enough to hold the push rods in position. Adjust the valve clearance, following the procedure in this section.
9. Clean the valve rocker arm cover. Coat one side of a new valve rocker arm cover gasket with oil-resistant sealer. Lay the cemented side of the gasket in place in the cover. Position the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and torque in sequence (starting in the center) to specifications.
10. Connect the spark plug wires to the spark plugs.
11. Connect the crankcase vent hose to the inlet tube in the intake manifold. Install the crankcase ventilation regulator valve in the valve rocker arm cover.
12. Position the fuel inlet line and the distributor vacuum line on the engine. Connect the distributor vacuum line to the distributor and carburetor. Connect the carburetor fuel inlet line to the carburetor and fuel pump.
14. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
15. Connect the radiator upper hose to the coolant outlet housing.
16. Fill and bleed the cooling system.
17. Operate the engine until engine temperatures have stabilized. Adjust the engine idle speed and idle fuel mixture. Check for fuel, oil and coolant leaks.
18. Install the air cleaner.

VALVE SPRING, RETAINER AND STEM SEAL

Broken valve springs or defective valve stem seals and retainers may be replaced without removing the cylinder head providing damage to the valve or valve seat has not occurred.

Removal

1. Remove the air cleaner.
2. Disconnect the throttle rod from the carburetor throttle lever. Disconnect the choke cable at the carburetor.
3. Remove the crankcase ventilation regulator valve from the valve rocker arm cover and remove the valve rocker arm cover. Remove the applicable spark plug.
4. Crank the engine until the applicable piston is on TDC after the compression stroke.
5. Install an air line adapter in the spark plug hole (Figure 33) and connect the air line.

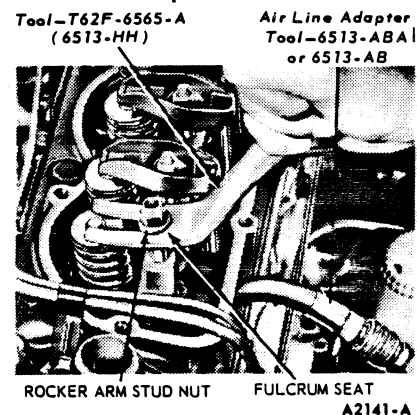


FIG. 33 Compressing Valve Spring — In Chassis

- Remove the applicable valve rocker arm stud nut, fulcrum seat, valve rocker arm and push rod. Install the stud nut and position the compressor tool as shown in Figure 33. Compress the valve spring and remove the retainer locks, spring retainer and valve spring. Remove and discard the valve stem seal (Figure 34).

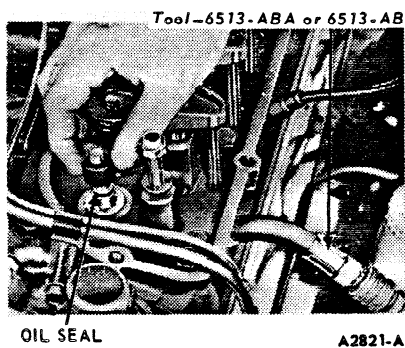


FIG. 34 Removing or Installing Valve Stem Seal

If air pressure fails to hold the valve in the closed position during this operation, it can be presumed that the valve is not seating or is damaged. If this condition occurs, remove the cylinder head for further inspection.

- If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.
- Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs as outlined on page 1-17.
- If the condition of the valve proved satisfactory, hold the valve in the closed position and apply air pressure within the cylinder.

Installation

- Oil the valve stem with heavy SE engine oil and install a new valve stem seal (Figure 34). Place the spring in position over the valve. Be sure the closed coil end is next to the cylinder head. Install the valve spring retainer. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut.
- Apply Lubriplate to both ends of the push rod. Install the push rod. Apply Lubriplate to the tip of the valve stem.
- Apply Lubriplate to the fulcrum seat and socket. Install the valve rocker arm, fulcrum seat and stud nut. Adjust the valve clearance following the procedure given on page 1-15 under Valve Clearance Adjustment.
- Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
- Clean the valve rocker arm cover. Coat one side of a new gasket with oil-resistant sealer. Position the gasket on the rocker arm cover; be sure the cemented side is towards the cover. Install the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and torque them in sequence (starting in the center) to specifications.
- Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
- Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the air cleaner.

VALVE LIFTER

Removal

- Remove the air cleaner. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.
- Disconnect the choke cable at the carburetor. Disconnect the throttle cable at the carburetor.
- Remove the coil bracket attaching bolt and position the coil out of the way.
- Remove the valve rocker arm cover.
- Disconnect the spark plug wires at the spark plugs and the secondary high tension wire from the coil. Remove the distributor cap and spark plug wire assembly.
- Remove the valve push rod cover.
- Loosen the rocker arm stud nut(s) until the rocker arm(s) can be disengaged from the push rod(s). Remove the push rod(s). Remove the valve lifter(s) with the tool shown in Figure 35. If more than one push rod and valve lifter is removed, do it in sequence and place the parts in a rack so they can be installed in their original locations.

Installation

- Clean the rocker arm cover, push rod cover, cylinder head and block gasket surfaces.
- Apply Lubriplate to the cam lobe contact surface of the valve lifter(s). Coat the rest of the valve lifter(s) with engine oil. Install the valve lifters with the tool shown in Figure 35.

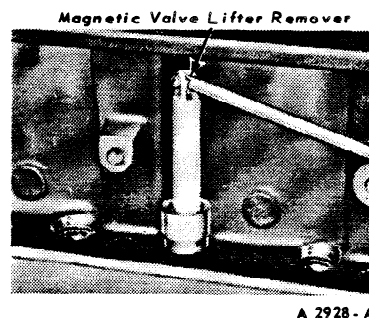


FIG. 35 Removing or Installing Valve Lifters

- Apply Lubriplate to both ends of the push rod(s). Install the push rod(s) in sequence. Engage the rocker arm(s) with push rod(s) and tighten the rocker arm stud nut(s) sufficiently to hold the push rod(s) in place. Be sure each push rod is properly seated in the valve lifter socket.
- Adjust the valve clearance, following the procedure given on page 1-15.
- Coat one side of new gaskets with oil-resistant sealer and position the gaskets, cemented side toward the rocker arm and push rod. Install the push rod cover and the rocker arm cover. Torque the cover screws in sequence to specifications. Install the crankcase regulator valve in the rocker arm cover.
- Position the coil on the cylinder head and install the attaching bolt.
- Install the distributor cap and spark plug wire assembly. Connect the spark plug wires and coil secondary high tension wire.
- Connect the throttle cable to the carburetor. Connect the choke cable to the carburetor.
- Install the air cleaner. Start the engine and adjust the carburetor idle speed and fuel mixture.

WATER PUMP

Removal

1. Drain the cooling system. Loosen the alternator adjusting arm bolt and remove the alternator drive belt.
2. Remove the fan and pulley.
3. Disconnect the radiator lower hose and radiator supply line at the water pump.
4. Remove the bolts attaching the water pump to the block. Remove the pump and gasket.

Installation

Before a water pump is re-installed, check it for damage. If it is damaged and requires repair, replace it with a new pump or install a rebuilt pump obtained from a Ford-Authorized Reconditioner.

1. If a new water pump is to be installed, remove the fittings from the old pump and install them on the new pump. Clean all gasket material from the mounting surfaces of the water pump and cylinder block.
2. Position a new gasket, coated on both sides with sealer, on the water pump.
3. Install the pump body on the block. Install the pump attaching bolts, coated with sealer and torque the bolts to specifications.
4. Connect the radiator lower hose, and radiator supply line. Install the pulley and fan. Install the alternator belt and adjust the belt tension. Fill and bleed the cooling system. Operate the engine and check for leaks.

CYLINDER FRONT COVER AND FRONT OIL SEAL

Removal

1. Drain the cooling system and crankcase.
2. Remove the radiator.
3. Remove the alternator adjusting arm bolt, loosen the drive belt and swing the adjusting arm out of the way. Remove the fan and drive belts.
4. Remove the cam screw and washer from the end of the crankshaft and remove the damper (Figure 36).

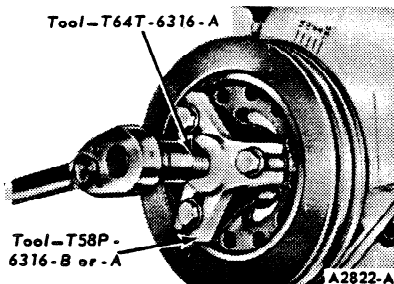


FIG. 36 Removing Crankshaft Damper

5. Remove the oil level dipstick. Remove the oil pan and related parts by following the procedure under Oil Pan Removal. Remove the oil pump screen and inlet tube assembly.
6. Remove the cylinder front cover and discard the gasket. It is good practice to replace the oil seal each time the cylinder front cover is removed.
7. Drive out the old seal with a pin punch. Clean out the recess in the cover.

Installation

1. Coat a new seal with grease and install the seal (Figure 37). Drive the seal in until it is fully seated in the recess. After installation, check to be sure the seal is properly positioned in the cover and the spring is properly positioned in the seal.

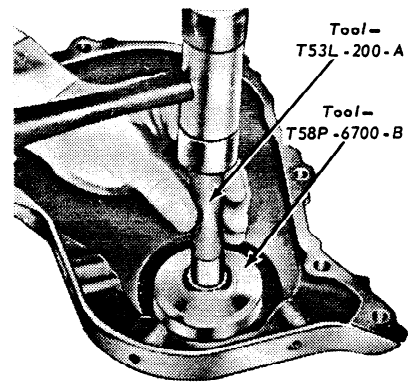


FIG. 37 Installing Crankshaft Front Oil Seal

2. Clean the cylinder front cover and the gasket surfaces of the cylinder block. Coat the gasket surface of the block and cover with oil-resistant sealer. Position a new gasket on the block.
3. Insert the small diameter end of the cover alignment tool in the bore of the cover. Position the cover and pilot assembly over the end of the crankshaft and against the block (Figure 38), being careful to align the cover flush with the cylinder block oil pan gasket surface. Install the alternator adjusting arm and cylinder front cover bolts. Torque all the bolts to specifications.

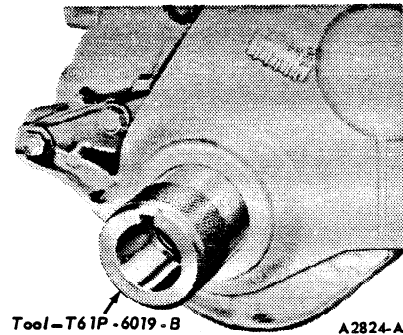


FIG. 38 Aligning Cylinder Front Cover

4. Lubricate the crankshaft with a white lead and oil mixture to facilitate installation and removal of the damper. Lubricate the front oil seal rubbing surface on the damper inner hub and the inner surface (sealing area) of the oil seal with Lubriplate.
5. Align the damper keyway with the key on the crankshaft. Install the damper on the crankshaft as shown in Figure 39.

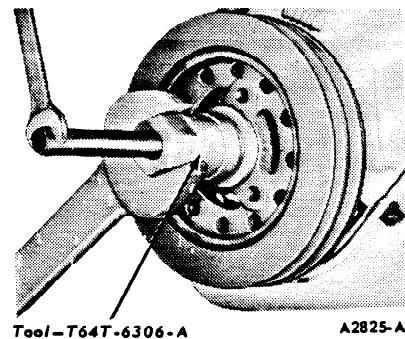


FIG. 39 Installing Damper

6. Install the washer and cap screw. Torque the cap screw to specifications.
7. Apply oil-resistant sealer to the cavities between the rear main bearing cap and cylinder block (Figure 40). Install a new oil pan rear seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.
8. Install new side gaskets on the oil pan with oil-resistant sealer (Figure 40). Position a new cylinder front cover seal on the oil pan.
9. Clean and install the oil pump screen and inlet tube assembly. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.
10. Install the water pump pulley, drive belts and fan. Adjust all drive belt tensions to specifications. Install the radiator.
11. Fill and bleed the cooling system. Fill the crankcase.
12. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

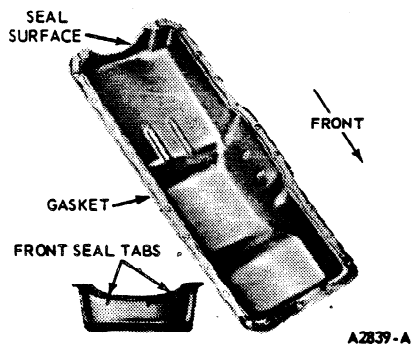


FIG. 40 Oil Pan Gaskets and Front Seal Installed

CAMSHAFT

The camshaft and related parts are shown in Figure 41.

Removal

1. Drain the cooling system and the crankcase.
2. Remove the air cleaner. Remove the crankcase ventilation regulator valve from the rocker arm cover.
3. Disconnect the throttle rod from the carburetor throttle lever. Disconnect the choke cable at the carburetor. Disconnect the throttle at the carburetor and position out of the way.
4. Remove the radiator.
5. Loosen the alternator adjusting arm bolt and remove the drive belt.

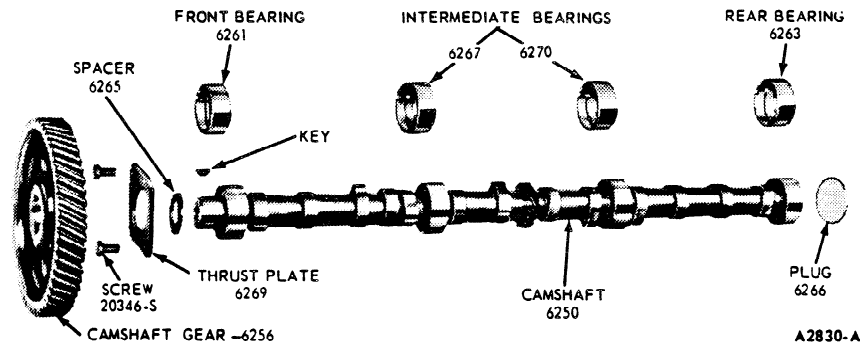


FIG. 41 Camshaft and Related Parts

6. Disconnect the spark plug wires at the spark plugs and disconnect the secondary high tension wire at the ignition coil. Remove the distributor cap and spark plug wires assembly.
7. Disconnect the fuel outlet lines at the fuel pump. Remove the fuel pump mounting bolts and position the fuel pump out of the way.
8. Disconnect the vacuum line at the distributor and the primary wire at the coil. Remove the distributor.
9. Remove the valve rocker arm cover. Loosen the rocker arm stud nuts, move the rocker arms to one side and remove the push rods in sequence. Place the push rods in a rack so they can be installed in their original locations.
10. Remove the valve push rod cover; then remove the valve lifters in sequence, using the tool shown in Figure 35. Place the valve lifters in a tray or rack to facilitate installation in the same sequence in which they were removed.
11. Remove the cap screw and washer from the end of the crankshaft.
12. Remove the damper (Figure 36).
13. Remove the oil pan and related parts by following the procedure under Oil Pan Removal. Remove the oil pump screen and inlet tube assembly.
13. Remove the cylinder front cover and discard the gasket.
14. Check the camshaft end play, the timing gear backlash and the timing gear runout.
15. Turn the crankshaft to align the timing marks as shown in Figure 42.

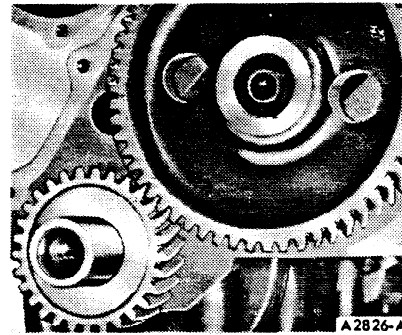


FIG. 42 Aligning Timing Marks

16. Remove the camshaft thrust plate screws (Figure 43). Remove the camshaft. Avoid damaging the camshaft lobes during removal. Press the camshaft out of the gear in an arbor press (Figure 44). Remove the key, thrust plate and spacer.

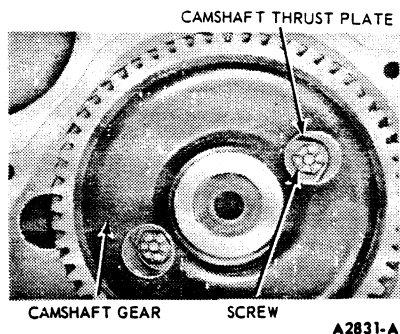


FIG. 43 Removing or Installing Camshaft

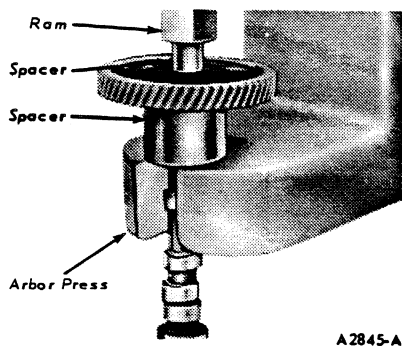


FIG. 44 Removing Fiber Camshaft Gear

Installation

If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the camshaft.

1. Oil the camshaft bearing journals and apply Lubriplate to all the lobes.
2. Install the camshaft and thrust plate.
3. Torque the thrust plate attaching screws to specifications.
4. Position the camshaft gear on the camshaft. Align the timing marks on the timing gears as shown in Figure 42. Install the camshaft gear with the tool shown in Figure 45. Be sure the gear and spacer are tight against the shoulder on the camshaft.
5. Crank the engine until the timing marks are aligned. **Do not turn the crankshaft again until the distributor is installed.**
6. Clean the cylinder front cover and cylinder block gasket surfaces. Install a new oil seal in the cylinder front cover. **Clean the crankshaft damper and inspect it, following the procedures on page 1-08.** Install the cylinder front cover and damper, following the applicable procedure under Cylinder Front Cover Installation.
7. Clean the oil pump screen. Clean the oil pan and the gasket surfaces of the cylinder block. Install the oil pump screen and inlet tube and oil pan, following the procedures under Oil Pan Installation.
8. Lubricate the valve lifters with heavy SE engine oil and install the lifters (Figure 35) in the same bores from which they were removed. Apply Lubriplate to both ends of the push rods and install the push rods in the same sequence that they were removed. Be sure the push rods were seated in the valve lifter sockets.

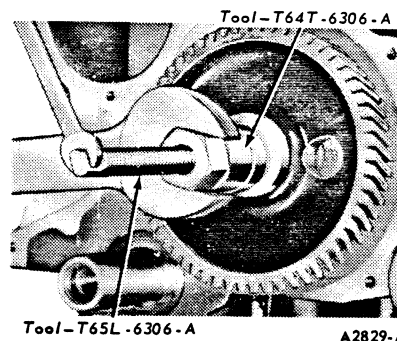


FIG. 45 Installing Camshaft Gear

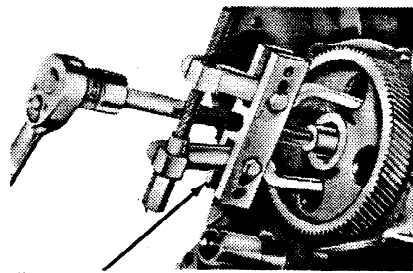
9. Clean the valve push rod cover and cylinder block gasket surfaces. Apply oil-resistant sealer to one side of a new gasket and place the gasket on the push rod cover with the cemented side next to the cover. Install the cover and torque the bolts in sequence to specifications.
10. Apply Lubriplate to the valve pad on the rocker arms. Oil the valve stems with heavy SE engine oil. Align the valve rocker arms with the valves and push rods. Tighten the rocker arm stud nuts sufficiently to hold the push rods in place. Adjust the valve clearance following instructions given in this part under Valve Clearance Adjustment.
11. Clean the valve rocker arm cover and cylinder head gasket surface. Apply oil-resistant sealer to one side of a new gasket and install the gasket on the cover (sealer side against cover). Install the cover and torque the screws in sequence to specifications.
12. Set the distributor rotor so the points are about to open for No. 1 cylinder firing position. Install the distributor. Check the points. If the camshaft timing marks are still aligned (step 6 above), the points should be fully open in No. 1 cylinder firing position. If the points are not open, remove the distributor and rotate the shaft in the proper direction. Install the distributor and hold-down clamp.
13. Clean the fuel pump and cylinder block gasket surfaces. Install the fuel pump with a new gasket. Torque the mounting bolts to specifications. Connect the fuel outlet line to the fuel pump.
14. Install the distributor cap and spark plug wires as an assembly. Connect the spark plug wires to the plugs and the secondary high tension wire to the coil.
15. Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the throttle rod cable housing bracket on the cylinder head. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable and the hand throttle cable.
16. Install the water pump pulley, cooling fan and drive belt. Adjust the belt tension to specifications.
17. Install the radiator. Connect the radiator upper hose to the thermostat housing cover. Connect the lower hose to the water pump.
18. Install the air cleaner.
19. Fill the crankcase and cooling system.
20. Start the engine and check for oil, coolant and fuel leaks. Adjust the ignition timing. Connect the distributor vacuum line to the distributor. Adjust the carburetor idle speed and fuel mixture.

TIMING GEARS

To prevent possible damage to the camshaft lobes, do not rotate the camshaft or crankshaft in the engine without the timing gears installed.

CAMSHAFT GEAR — METAL GEAR**Removal**

1. Drain the cooling system and crankcase.
2. Remove the cylinder front cover and oil pan, following the procedures under Cylinder Front Cover Removal.
3. Check the camshaft end play, the timing gear backlash and the timing gear runout.
4. Crank the engine until the timing marks are aligned as shown in Figure 42.
5. Install the gear puller as shown in Figure 46 and remove the camshaft gear.



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FIG. 46 Removing Metal Camshaft Gear

Installation

If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the gear.

1. Be sure the key and spacer are properly installed. Align the gear keyway with the key and install the gear on the camshaft as shown in Figure 45. Be sure that the timing marks line up on the camshaft and crankshaft gears.
2. Install the cylinder front cover and related parts, following the procedures under Cylinder Front Cover Installation.
3. Fill the crankcase and cooling system. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

CAMSHAFT GEAR — FIBER GEAR**Removal**

1. Drain the cooling system and crankcase.
2. Remove the radiator.
3. Remove the cylinder front cover following the procedures under Camshaft Removal.
4. Check the camshaft end play, the timing gear backlash and the timing gear runout.
5. Remove the camshaft, following the procedures under Camshaft Removal. Press the camshaft gear off the camshaft in an arbor press (Figure 44). Remove the thrust plate, spacer and key.

Installation

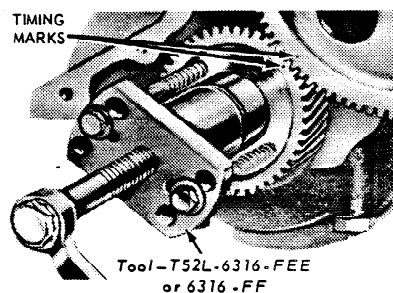
If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the gear.

1. Install the camshaft in the engine and install the spacer and thrust plate on the camshaft. Insert the key in the keyway. Position the camshaft gear on the camshaft with the timing marks aligned (Figure 42) and install it as shown in Figure 44. **Be sure the gear and spacer are tight against the shoulder on the camshaft and that the thrust plate can be moved freely.** Install the thrust plate screws and tighten to specifications.

2. Install the cylinder front cover, oil pan and related parts, following the procedures under Camshaft Installation.
3. Install the radiator.
4. Fill the crankcase and the cooling systems. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

CRANKSHAFT GEAR**Removal**

1. Drain the cooling system and crankcase. Remove the radiator.
2. Remove the cylinder front cover.
3. Remove the oil slinger from the crankshaft. Use the gear puller as shown in Figure 47 and remove the crankshaft gear. Remove the key from the crankshaft.

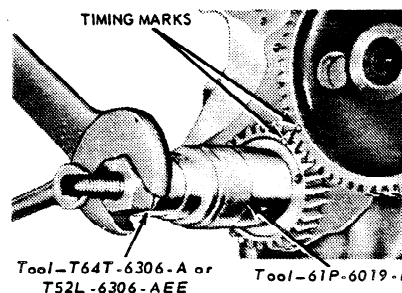
Tool-T52L-6316-FEE
or 6316-FF

A2828-A

FIG. 47 Removing Crankshaft Gear

Installation

1. Install the key in the crankshaft keyway. Install the crankshaft gear, using the tool shown in Figure 48. Install the oil slinger.
2. Replace the crankshaft front oil seal and install the cylinder front cover, following the procedures under Cylinder Front Cover.
3. Install the radiator.
4. Fill the crankcase and the cooling systems. Start the engine and check all gaskets and hose connections for leaks. Adjust the ignition timing.

Tool-T64T-6306-A or
T52L-6306-AEE Tool-61P-6019-B

A2827-A

FIG. 48 Installing Crankshaft Gear

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-) 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 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.

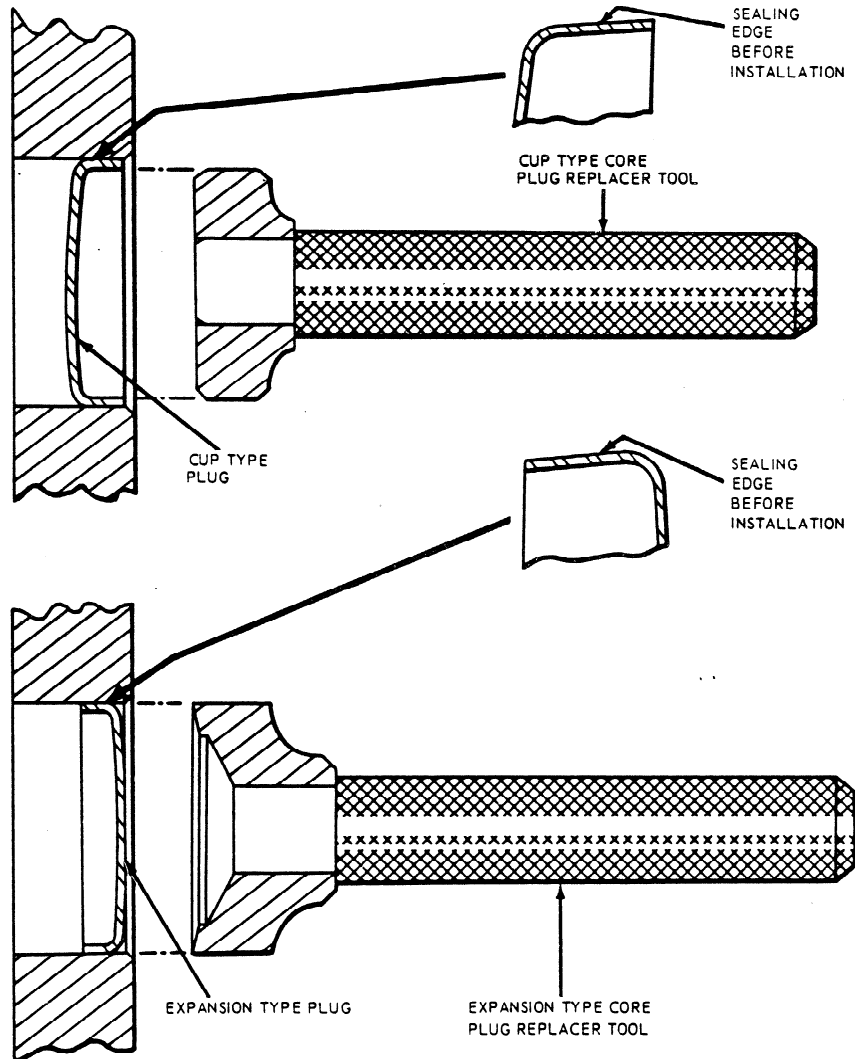
Expansion-Type

Expansion-type core plugs 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.



A 2735 - B

FIG. 49 Typical Core Plugs and Installation Tools

OIL PAN

Removal

1. Drain the crankcase.
2. Remove the oil pan attaching bolts. Remove the oil pump inlet tube attaching bolts. Remove the inlet tube and screen assembly from the oil pump and leave it in the bottom of the oil pan. Remove the oil pan and gaskets. Remove the inlet tube and screen from the oil pan.

Installation

1. Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Remove the rear main bearing cap to oil pan seal and cylinder front cover to oil pan seal. Clean the seal grooves.
2. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Figure 50). Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.

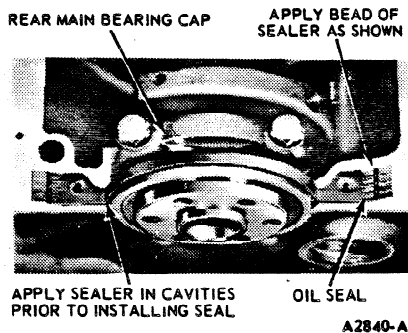


FIG. 50 Installing Oil Pan Rear Seal

3. Install new side gaskets on the oil pan with oil-resistant sealer (Figure 40). Position a new oil pan to cylinder front cover seal on the oil pan.
4. Clean the inlet tube and screen assembly and place it in the oil pan.
5. Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Torque the screws to specifications. Position the oil pan against the cylinder block and install the attaching bolts. Torque the bolts in sequence to specifications.
6. Fill the crankcase and cooling system.
7. Start the engine and check for coolant and oil leaks.

OIL PUMP

Removal

1. Remove the oil pan following the procedures under Oil Pan Removal.
2. Remove the oil pump attaching bolts (Figure 51). Discard the gasket.

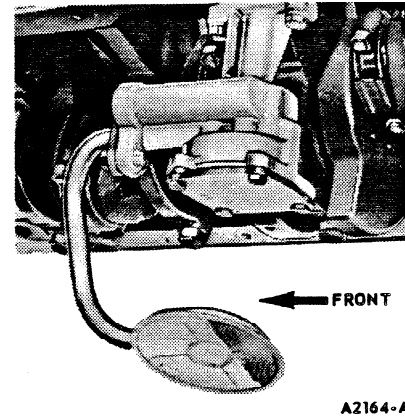


FIG. 51 Oil Pump Installed

Installation

1. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
2. Coat a new oil pump gasket with oil-resistant sealer and position it on the oil pump.
3. Install the oil pump on the cylinder block. Torque the attaching bolts to specifications.

CRANKSHAFT REAR OIL SEAL

If the crankshaft rear oil seal replacement is the only operation being performed, it can be done as detailed in the following procedure. If the oil seal is being replaced in conjunction with a rear main bearing replacement, the engine must be installed on a work stand (Figure 52).

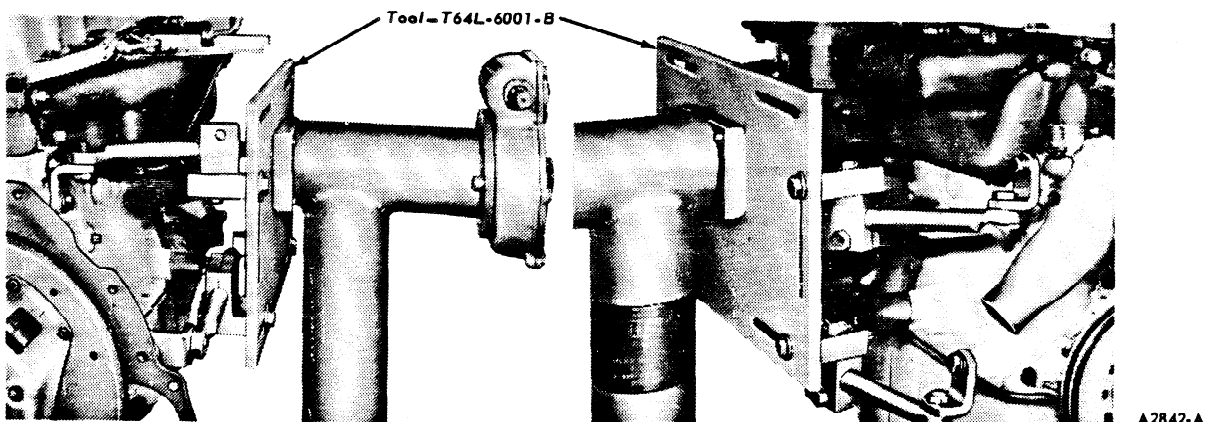


FIG. 52 Engine Mounted on Work Stand — Typical

Removal

1. Remove the starter.
2. Remove the pressure plate and cover assembly and the clutch disc.
3. Remove the flywheel attaching bolts and remove the flywheel and engine rear cover plate.
4. Use an awl to punch two holes in the crankshaft rear oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.
5. Clean the oil seal recess in the cylinder block and main bearing cap.

Installation

1. **Clean, inspect and polish the rear oil seal rubbing surface on the crankshaft.** Coat a new oil seal and the crankshaft with a light film of engine oil. Start the seal in the recess and install it with the tool as shown in Figure 53. Keep the tool straight with the centerline of the crankshaft and install the seal until the tool contacts the block surface. **Remove the tool and inspect the seal to be sure it was not damaged during installation.**
2. Install the engine rear cover plate. Position the flywheel on the crankshaft flange. **Coat the threads of the flywheel attaching bolts with oil-resistant sealer and install the bolts. Torque the bolts in sequence across from each other to specifications.**
3. Install the clutch disc and the pressure plate assembly.

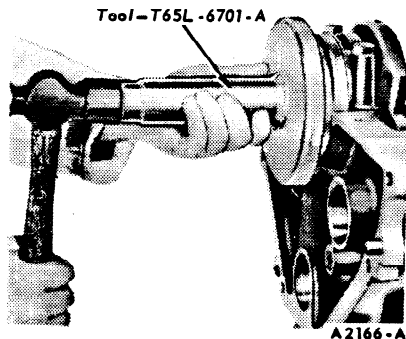


FIG. 53 Installing Crankshaft Rear Oil Seal

MAIN BEARING

Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.

Bearings are available for service in standard sizes or 0.001 and 0.002 inch undersize. Refer to the Parts Catalog the available sizes. Undersize bearings are available for use on journals that have been refinished.

If the rear main bearing is to be replaced, it will be necessary to remove the engine, install it on a work stand, replace the main bearing and replace the crankshaft rear oil seal.

Removal

1. Drain the crankcase. Remove the oil pan and oil pump, following the procedure under Oil Pan Removal.

2. **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.
3. Insert the upper bearing remover (Tool 6331) in the oil hole in the crankshaft journal.
4. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
5. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings or a combination of a standard bearing and a 0.001 or 0.002 inch undersize bearing.

Installation

1. **The upper and lower bearing halves are not interchangeable. The upper half is drilled and grooved to provide entry of oil.** To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Tool 6331 can be inserted in the oil hole in the crankshaft journal. With Tool 6331 positioned in the oil hole, rotate the crankshaft slowly in the opposite direction of engine rotation until the bearing is seated. Remove the tool. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings on page 1-13.
2. After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings, then install the bearing cap. Torque the cap bolts to specifications.
3. Repeat the procedure for the remaining bearings that require replacement.
4. If the thrust bearing cap (No. 5 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 the bearing (Figure 54). Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.
5. **If the rear main bearing is replaced (on a work stand), apply a bead of oil-resistant sealer in each corner of the rear main bearing cap saddle the full length of the saddle. Be sure the main bearing is fitted and the cap bolts torqued to specifications before installing the new crankshaft rear oil seal.**
6. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until the oil emerges from the outlet opening.
7. Install the oil pump and oil pan, following the procedure under Oil Pan Installation.
8. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

CONNECTING ROD BEARING

Removal

1. Drain the crankcase. Remove the oil pan and oil pump, following the procedure under Oil Pan Removal.
2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.
3. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
4. Clean the crankshaft journal. **When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings.**
Refer to page 1-08 for the cleaning and inspection procedures.

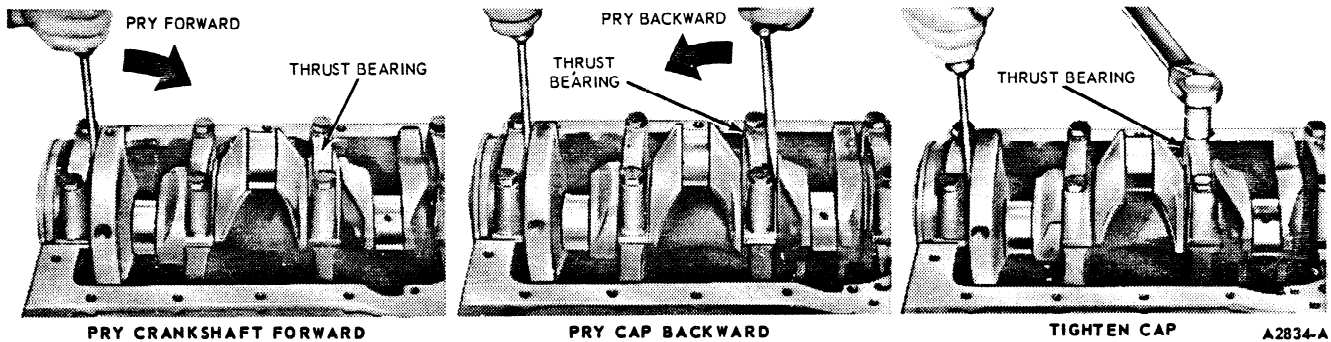


FIG. 54 Aligning Thrust Bearing

Installation

1. Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots.
2. Pull the connecting rod assembly down firmly on the crankshaft journal.
Fit the bearing following procedures given under Fitting Main and Connecting Rod Bearings.
3. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap and torque the nuts to specifications.
4. Repeat the procedure for the remaining connecting rods that require new bearings.
5. Install the oil pan and oil pump, following the procedures under Oil Pan Installation in this section.
6. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

PISTONS AND CONNECTING RODS

Removal

1. Drain the cooling system and the crankcase.
2. Refer to Cylinder Head Removal and remove the cylinder head and related parts.
3. Remove the oil pan following the procedure under Oil Pan Removal. Remove the oil pump inlet tube and the oil pump.
4. Turn the crankshaft until the piston to be removed is at the bottom of the stroke and place a cloth on the piston bead to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**
5. Make sure all connecting rod caps are marked so that they can be installed in their original positions. Remove the connecting rod cap.
6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

Installation

1. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.
2. Oil the piston rings, pistons and cylinder walls with light engine oil.
3. **Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side when installing in the cylinder bore. If a connecting rod is ever transferred 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.**

4. Make sure the ring gaps are properly spaced around the circumference of the piston (Figure 55). Oil the rings, then install a piston ring compressor on the piston. Make sure that the indentation in the head of the piston is toward the front, then push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder (Figure 56). Be sure to guide the connecting rods to avoid damaging the crankshaft journals.

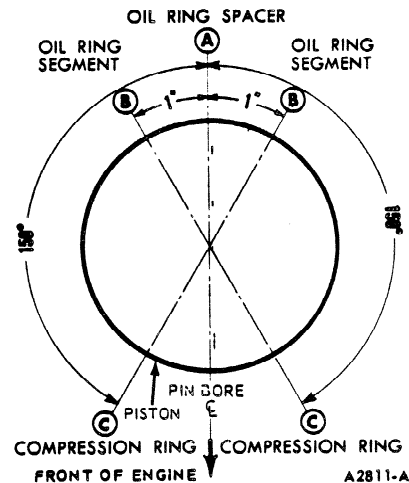


FIG. 55 Piston Ring Gap Spacing

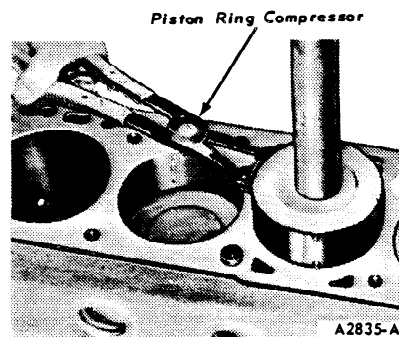


FIG. 56 Piston Installation

5. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.
6. After the bearings have been fitted, apply a light coat of engine oil to the journal and bearings.
7. Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.

8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Figure 57).
9. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts.

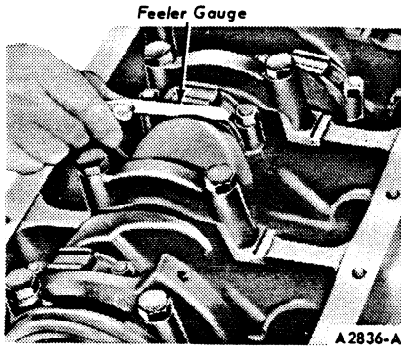


FIG. 57 Checking Connecting Rod Side Clearance

10. Refer to Cylinder Head Installation and install the cylinder head and related parts. Adjust the valve clearance.
11. Fill and bleed the cooling system. Fill the crankcase.
12. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.
13. Operate the engine until temperatures have stabilized. Check and adjust the ignition timing. Adjust the engine idle speed and fuel mixture.

CRANKSHAFT

The crankshaft and related parts are shown in Figure 58.

Removal

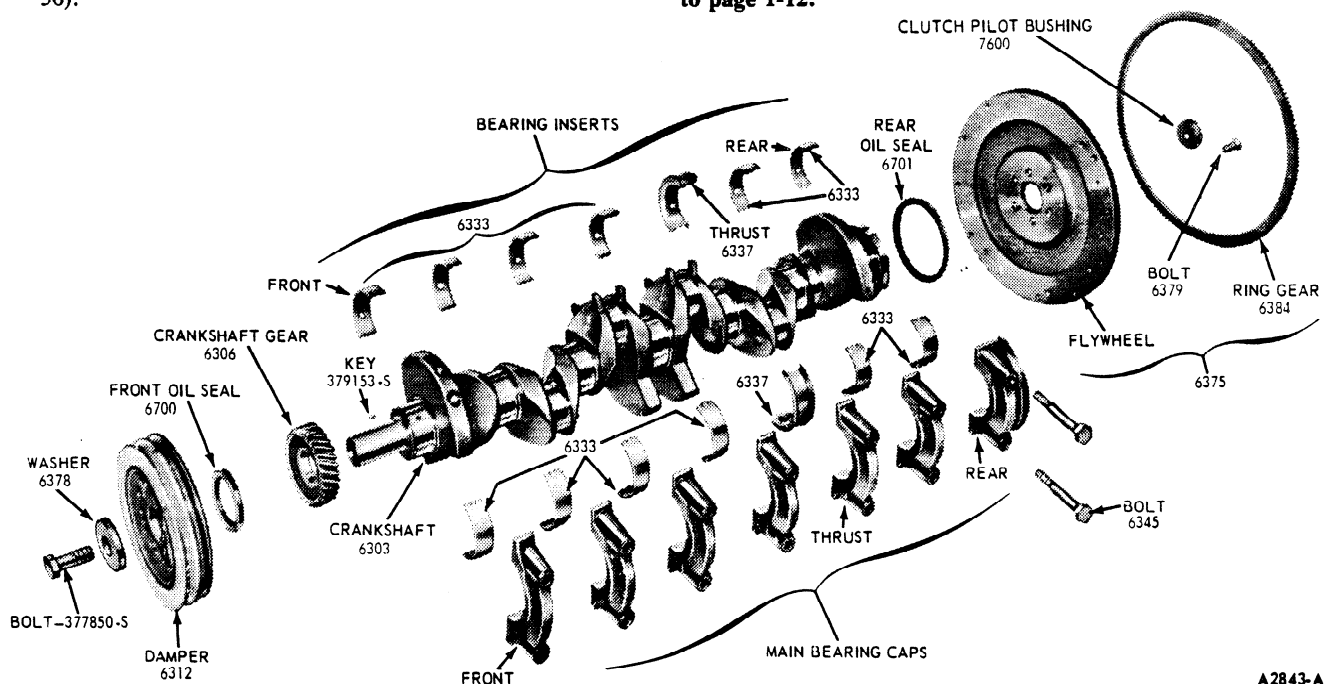
1. Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the oil level dipstick.
3. Remove the crankshaft damper retaining capscrew and lock washer. Remove the crankshaft damper (Figure 36).

4. Remove the cylinder front cover and gasket.
5. Remove the flywheel and engine rear cover plate.
6. Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.
7. Use an awl to punch two holes in the crankshaft oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.
8. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals. Repeat this procedure and remove all connecting rod caps.
9. Remove the clutch pilot bushing if necessary.
10. Align the timing marks (Figure 42). Remove the crankshaft gear (Figure 47).
11. Remove the main bearing caps and bearings.
12. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged.

Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

Refer to page 1-08 for the cleaning and inspection procedures. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

To refinish journals, dress minor imperfections, etc., refer to page 1-12.



A2843-A

FIG. 58 Crankshaft and Related Parts

Installation

1. Remove the main bearing inserts from the block and bearing caps.
2. Remove the bearing inserts from the connecting rod caps.
3. Clean the crankshaft rear oil seal recess in the cylinder block and rear main bearing cap.
4. If the crankshaft main bearing journals have been re-finished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.
5. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided. Be sure the oil holes in the bearing inserts are aligned with the oil holes in the cylinder block transverse webs.
6. Install the lower main bearing inserts in the bearing caps with the tang fitted in the slot.
7. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
8. Check the clearance of each main bearing following procedures given under Fitting Main and Connecting Rod Bearings.
9. After the bearings have been installed, apply a light coat of heavy SE engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). **Be sure that the main bearing caps are installed in their original locations.** Torque the bearing cap bolts to specifications.
10. Install the thrust bearing cap with the bolts finger tight.
11. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Figure 54).
12. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.
13. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.
14. Check the crankshaft end play.
15. If the end play exceeds the wear limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or foreign matter. If the thrust faces are not damaged or dirty, they probably need re-aligning. Install the thrust bearing and align the faces following the recommended procedure (steps 8 through 11). Then check the end play.
16. Coat a new crankshaft rear oil seal with oil and install it (Figure 53). Inspect the seal to be sure it was not damaged during installation.
17. Install the bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.
18. If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearings.
19. Turn the crankshaft throw to the bottom of its stroke and pull the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
20. Install the connecting rod cap and torque the nuts to specifications.
21. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Figure 57).
22. Clean the oil pan, oil pump and oil pump screen.
23. Install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install it with a new gasket. Torque the attaching bolts to specifications.
24. Install the clutch pilot bushing.

25. Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. **Coat the threads of the attaching bolts with oil-resistant sealer and install the bolts.** Torque the bolts to specifications.
26. Turn the engine on the work stand so that the front end is up.
27. Install the crankshaft gear following the procedure under Timing Gear Installation.
28. Install a new crankshaft front oil seal in the cylinder front cover (Figure 37). Install the cylinder front cover and crankshaft damper.
29. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Figure 50). Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with oil-resistant sealer (Figure 40). Position a new oil pan to the cylinder front cover seal on the oil pan and install the oil pan.
30. Install the oil level dipstick.
31. Remove the engine from the work stand. Fill crankcase, check the ignition timing and adjust if necessary.
32. Check the ignition timing and adjust if necessary.

CAMSHAFT BEARING

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters.

1. Mount the engine on a work stand (Figure 52).
2. Remove the camshaft, flywheel and crankshaft, following the appropriate procedures. Push the pistons to the top of the cylinders.
3. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings with the tool shown in Figure 59.
4. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing and tighten the backup nut on the expanding mandrel until the collet fits the camshaft bearing.
5. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. **Be sure to hold a wrench on the end of the puller screw to prevent it from turning.**
6. To remove the front bearing, install the puller screw from the rear of the cylinder block.

Installation

1. Position the new bearings at the bearing bores, and press them in place with the tool shown in Figure 59. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. **Failure to use the correct expanding collet can cause severe bearing damage.** Align the oil holes in the bearings with the oil holes in the cylinder block before pressing bearings into place. **Be sure the front bearing is installed the specified distance below the front face of the cylinder block.**
2. Install the camshaft rear bearing bore plug.
3. Install the camshaft, crankshaft, flywheel and related parts. Do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement.

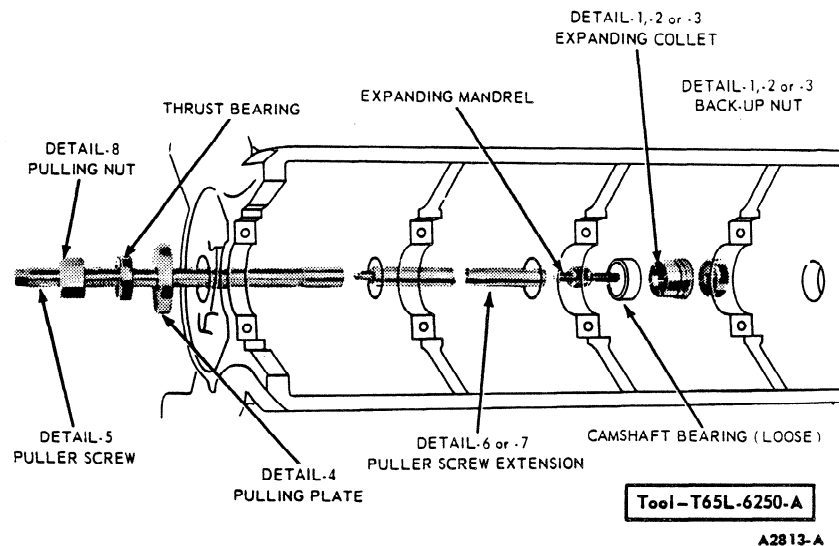


FIG. 59 Replacing Camshaft Bearing

OIL FILTER

Disposable-Type

1. Place a drip pan under the oil filter. Unscrew the filter from the cylinder block with a filter wrench.
2. Coat the gasket on the filter with oil. Place the filter in position on the cylinder block (Figure 60). Hand-tighten the filter until the gasket contacts the adapter face, then advance it 1/2 turn.
3. 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 if necessary.

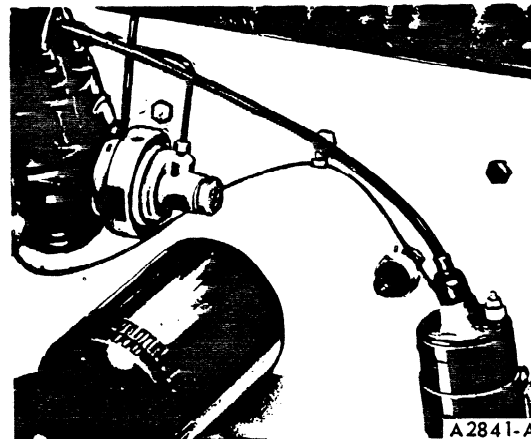


FIG. 60 Oil Filter Installed — Typical

DISASSEMBLY AND ASSEMBLY

When installing nuts or bolts that must be torqued (refer to torque specifications), oil the threads with light weight engine oil. Do not oil threads that require oil-resistant or water-resistant sealer.

ENGINE ASSEMBLY

Disassembly

1. Install the engine on a work stand (Figure 52).
2. Disconnect the spark plug wires at the spark plugs. Disconnect the distributor high tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly.
3. Disconnect the fuel line at the carburetor and fuel pump. Disconnect the vacuum line at the distributor and carburetor. Remove the fuel and vacuum lines.
4. Remove the fuel pump and discard the gasket.
5. Remove the oil pressure sending unit and the oil level dipstick.
6. Disconnect the distributor primary wire at the coil, then remove the distributor. Remove the ignition coil and bracket assembly.
7. Remove the oil filter and oil filter mounting adapter.
8. Remove the crankcase ventilation regulator valve from the valve rocker arm cover. Remove the rocker arm cover.
9. Loosen the rocker arm stud nuts, rotate the rocker arms to one side and remove the push rods in sequence. Place the push rods in a rack so they can be installed in the same location from which they were removed.
10. Remove the valve push rod cover. Remove the valve lifters in sequence (Figure 35) to facilitate installation in the same sequence.
11. Remove the water pump.
12. Remove the carburetor, intake and exhaust manifold and cylinder head as an assembly.
13. Remove the crankshaft damper (Figure 36). Remove the cylinder front cover. Remove the crankshaft front oil seal from the cylinder front cover.
14. Remove the flywheel.
15. Remove the oil pan and oil pump and pickup tube assembly. Discard the gaskets and seals.
16. Check the camshaft end play, the timing gear backlash and the timing gear runout. Position the camshaft gear as shown in Figure 43 and remove the camshaft thrust plate screws. Remove the camshaft, thrust plate and gear as an assembly.
17. Remove the crankshaft gear as shown in Figure 48.
18. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the

- tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**
19. **Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.** Turn the crankshaft until the connecting rod being removed is down. Remove the connecting rod cap.
 20. Push each connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**
 21. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.
 22. Remove the main bearing caps. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Remove the crankshaft rear oil seal. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**
 23. Remove the main bearing inserts from the cylinder block and main bearing caps.
 24. Remove oil dipstick tube from the cylinder head dowel pins and cylinder block drain plugs.
 25. Disassemble the pistons, piston rings and connecting rods, following the procedures under Pistons and Connecting Rods Disassembly.
 26. If the camshaft gear is to be removed from the camshaft, press the camshaft out of the gear in an arbor press.
 27. Remove the thrust plate and spacer. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings. Refer to Camshaft Bearing Replacement.
 28. Remove the carburetor from the intake manifold and discard the gasket. Remove the intake and exhaust manifolds from the cylinder head and separate the manifolds. Disassemble the cylinder head, removing the rocker arms, valves, valve springs, coolant outlet elbow, etc. Place all parts in a rack or identify them so they can be installed in the same location from which they were removed.

Assembly

Many of the procedures given here are condensed from other sections of this manual.

1. Clean and inspect all parts per the appropriate procedures under Cleaning and Inspection, except do not disassemble the oil pump and hydraulic lifters for cleaning.
2. Remove the glaze from the cylinder bores by following the procedures on page 1-14, Refinishing Cylinder Walls.
3. Invert the engine on the work stand. Position new camshaft bearings in the cylinder block, making sure that the oil holes in the bearing are aligned with those in the block. Press them in place (Figure 59). **Be sure the camshaft front bearing is installed the specified distance below the front face of the cylinder block.**
4. Install a new camshaft rear bearing bore plug.
5. Oil the camshaft bearing journals and apply Lubriplate to all the lobes. Then carefully slide the camshaft through the bearings.
6. If the camshaft gear was removed, install the spacer, thrust plate and gear, using the tool shown in Figure 45. Install the thrust plate screws and torque to specifications.
7. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. **Be sure the bearing inserts and bearing bores are clean.**
8. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.
9. Install the lower main bearing inserts in the bearing caps.
10. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
11. Check the clearance of each main bearing following the procedure given on page 1-13.
12. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). **Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.**
13. Install the thrust bearing cap and check the crankshaft end play by following steps 11 through 16 under Crankshaft Installation, page 1-22.
14. Check the camshaft end play, camshaft gear backlash following the procedures on page 1-05. If the end play exceeds specifications, replace the thrust plate. If the gear backlash exceeds specifications, replace the camshaft gear (and crankshaft gear as necessary).
15. Check the camshaft gear runout with a dial indicator. If the gear runout is excessive, replace the gear.
16. Check the piston to cylinder bore fit of each piston following the procedure on page 1-26.
17. Check the end gap of all piston rings on page 1-26. Assemble the pistons, piston rings and connecting rods, following the procedure under Pistons and Connecting Rods Assembly. Check the piston ring side clearance (page 1-00).
18. Install the piston and connecting rod assemblies and check the clearance of the connecting rod bearings. Refer to Piston and Connecting Rod Installation and Connecting Rod Bearing Replacement.
19. Coat a new crankshaft front oil seal with grease and install it in the cylinder front cover (Figure 37).
20. Coat the gasket surfaces of the cylinder front cover and cylinder block with oil-resistant sealer. Position the gasket on the block and install the cover (Figure 38). Torque the bolts to specifications.
21. Lubricate the damper end of the crankshaft with a white lead and oil mixture. Apply Lubriplate to the seal surface of the front oil seal. Apply Lubriplate to the seal surface of the crankshaft damper and install the crankshaft damper (Figure 39).
22. Apply a light film of engine oil on a new crankshaft rear oil seal. Apply Lubriplate to the seal contact surface of the crankshaft and install the seal (Figure 53) the specified distance below the face of the cylinder block. **Be sure the seal was not damaged during installation.**
23. Position the engine rear cover plate on the rear of the cylinder block and install the flywheel on the crankshaft. **Apply oil-resistant sealer to the threads of the flywheel attaching bolts. Install the bolts and torque them to specifications.**
24. Use a new gasket and install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Position a new gasket on the oil pump body and install the oil pump and inlet tube assembly. Torque the attaching bolts to specifications.
25. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.
26. Install new side gaskets on the oil pan with oil-resistant sealer (Figure 40). Position a new cylinder front cover seal on the oil pan and install the oil pan.

27. Coat both sides of a new water pump gasket with water-resistant sealer and position the gasket on the cylinder block. Coat the threads of the water pump bolts with sealer. Install the water pump. Torque the bolts to specifications.
28. Assemble the valves, springs, rocker arms, coolant outlet elbow, etc., following the procedures under Cylinder Head.
29. Place a new cylinder head gasket on the block. Carefully position the cylinder head on the block and install the bolts. Torque the bolts in sequence (Figure 32) to specifications. When cylinder head bolts have been tightened it is not necessary to retorquing the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.
30. Clean the exterior surface of the valve lifters with a clean, lint-free cloth and oil the surface with engine oil. Install the valve lifters (Figure 35) in the same sequence that they were removed.
31. Apply Lubriplate to both ends of the push rods and to the push rod bores in the cylinder head. Install the push rods in the same sequence that they were removed. Be sure the push rods are properly seated in the valve lifters. Engage the rocker arms with the push rods and tighten the stud nuts sufficiently to hold the push rods in place.
32. Adjust the valve clearance as described on page 1-15.
33. Coat the gasket surface of the push rod cover with oil-resistant sealer and position a new gasket on the cover. Install the cover and gasket on the cylinder block. Torque the cover bolts in sequence to specifications.
34. Install the carburetor, intake and exhaust manifold, following the procedure under Intake and Exhaust Manifold Installation.
35. Install a new gasket with oil-resistant sealer on the valve rocker arm cover. Install the cover on the cylinder head and torque the cover screws in sequence to specifications. Install the crankcase ventilation regulator valve in the rocker arm cover.
36. Install the cylinder block drain plugs and oil pressure sending unit. Install the oil level dipstick tube and dipstick fill crankcase.
37. Install the oil filter mounting adapter. Coat the seal surface of a new oil filter with grease (or engine oil). Install the oil filter until the seal surface contacts the cylinder block, then tighten the filter an additional 1/2 turn.
38. Install the ignition coil and bracket.
39. Position No. 1 cylinder on TDC after the compression stroke. Set the distributor points to No. 1 cylinder firing position and install the distributor. With the distributor in points open position (No. 1 cylinder) install the hold-down clamp and screw. Tighten the screw snug, but not tight.
40. Use a new gasket and install the fuel pump. Torque the bolts to specifications. Install the carburetor fuel inlet line and distributor vacuum line.
41. Install the distributor cap and spark plug wires assembly. Connect the spark plug wires. Connect the distributor primary and secondary high tension wires to the ignition coil.
42. Remove the engine from the work stand.

CYLINDER HEAD

Disassembly

1. Remove the coolant outlet housing and thermostat. Discard the gasket.
2. Remove the intake manifold, exhaust manifold and carburetor as an assembly from the cylinder head. Discard the gasket.

3. Remove the spark plugs.
4. Remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. **Be careful not to scratch the cylinder head gasket surface.**
5. Compress the valve springs (Figure 61), then remove the valve spring retainer locks and release the spring.
6. Remove the spring retainer, spring, stem seal and valve (Figure 62). Discard the valve stem seals. Identify all valve parts.

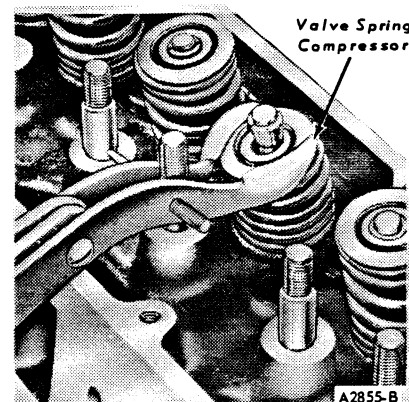


FIG. 61 Compressing Valve Spring on Bench

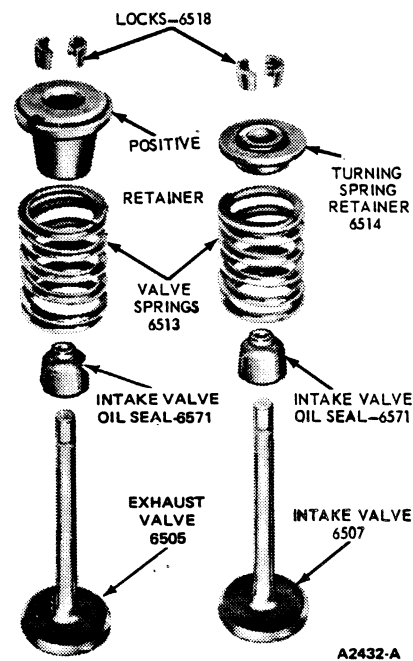


FIG. 62 Valve Assembly

Assembly

1. Lubricate the valve guides and valve stems with heavy SE engine oil. Apply Lubriplate to the tip of the valve stems.
2. Install each valve in the valve guide from which it was removed or to which it was fitted.
3. Oil and install a new intake valve oil seal (Figure 62) on the valves.
4. Install the valve spring over the valve. **Be sure the closed coil end is placed against the cylinder head.**

- Position the spring retainer on all valve springs. Make sure that a positive rotating retainer is used on all of the exhaust valves (Figure 62).
- Compress the spring (Figure 61). Install the retainer locks.
- Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Figure 63).
Check the dividers against a scale. If the assembled height is greater than the specified limit, install the necessary 0.030 inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. **Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.**
- Position a new intake manifold gasket on the cylinder head. Install the intake manifold, exhaust manifold and carburetor as an assembly. Torque the manifold bolts and nuts in sequence (Figure 31) to specifications.
- Using a new gasket coated with water-resistant sealer, install the thermostat and coolant outlet elbow. Torque the attaching bolts to specifications.

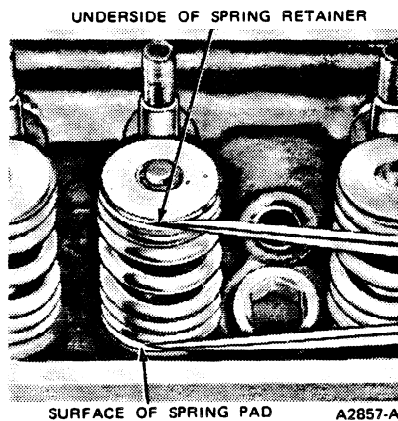


FIG. 63 Checking Valve Spring Assembled Height

VALVE LIFTER

Valve lifters should always be tested after assembly. Refer to the test procedures covered on page 1-04.

Disassembly

Each valve lifter is a matched assembly. If the parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so that they can be installed in their original bores.

- 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 the lock ring.
- Remove the push rod cup, metering valve (disc), plunger and spring.
- Invert the plunger assembly and remove the check valve retainer by carefully prying up on it with a screwdriver. Remove the check valve (disc or ball check) and spring.

For the cleaning and inspection procedures, refer to page 1-07.

Assembly

- Hydraulic valve lifter assembly is shown in Figure 64.
- Place the plunger upside down on a clean work bench.
 - 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).
 - Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.
 - Place the plunger spring and then the plunger (open end up) into the lifter body.
 - Position the metering valve (disc) in the plunger and then place the push rod seat in the plunger.
 - Depress the plunger and position the closed end of the lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger and then depress it again to fully seat the lock ring.
 - Use the hydraulic valve lifter leakdown tester to fill the lifters with test fluid.

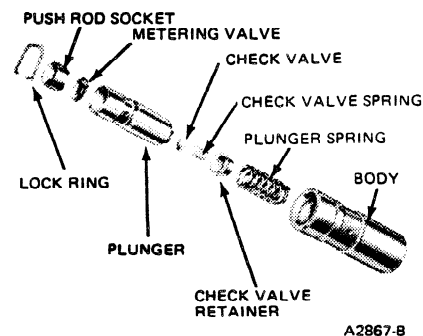


FIG. 64 Hydraulic Valve Lifter Assembly

OIL PUMP

Disassembly

- Remove the cover attaching screws and remove the cover (Figure 65).
- Remove the inner rotor and shaft assembly, then remove the outer race.
- Scrape away the staking marks on the body around the oil pressure relief valve cap. Drill a 1/8-inch hole in the relief valve cap and insert a self-threading sheet metal screw of proper diameter into the cap. Pull the cap out of the chamber. Remove the spring and plunger.

Refer to page 1-11 for the cleaning and inspection and repair procedures.

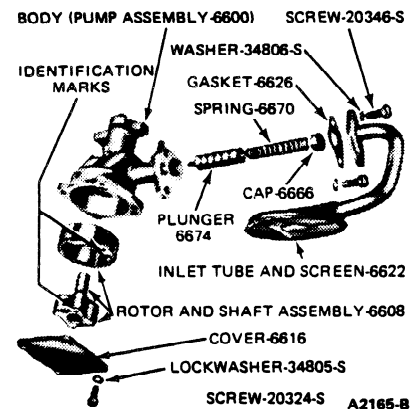


FIG. 65 Oil Pump Assembly

Assembly

1. Clean all parts thoroughly. Install the oil pressure relief valve plunger, spring and new cap. Stake the cap into position.
2. Install the outer race (recessed dot facing out on same side as dot on rotor) and the inner rotor and shaft assembly.

The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.

3. Install the cover and torque the attaching screws to specifications.

PISTON AND CONNECTING ROD**Disassembly**

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.
3. Remove the piston rings. Using an arbor press and the tool shown in Figure 66, press the piston pin from the piston and connecting rod.

Refer to page 1-09 for the cleaning and inspection and repair procedures.

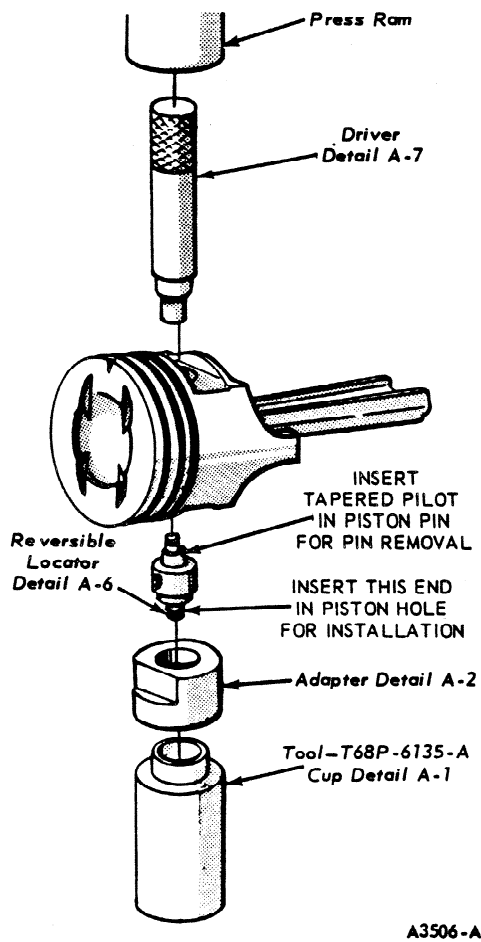


FIG. 66 Removing Piston Pin

Assembly

The piston, connecting rod and related parts are shown in Figure 67. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the 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 bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown in Figure 68.
2. Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod (Figure 69).
3. Check the end gap of all piston rings (page 1-26). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. 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 lands have steps, the piston should be replaced.
5. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

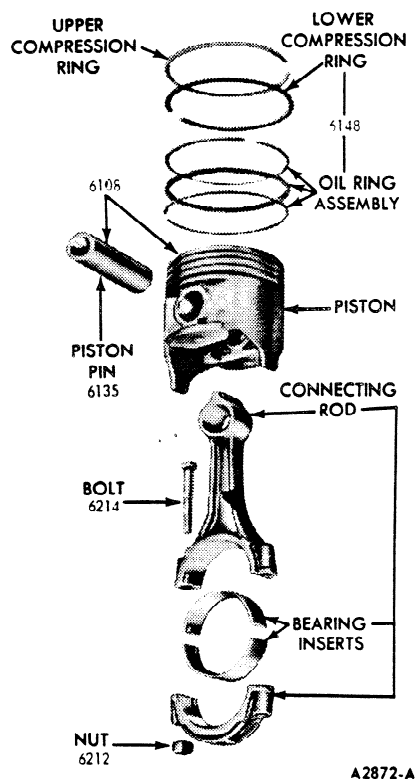
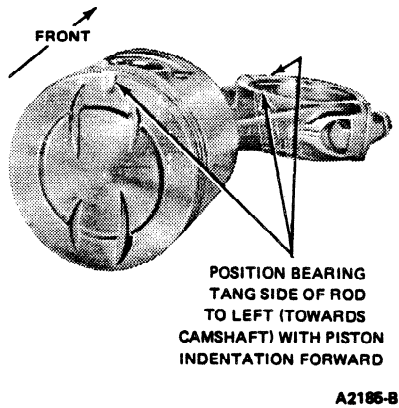


FIG. 67 Piston Connecting Rod and Relating Parts



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FIG. 68 Oil Hole Position

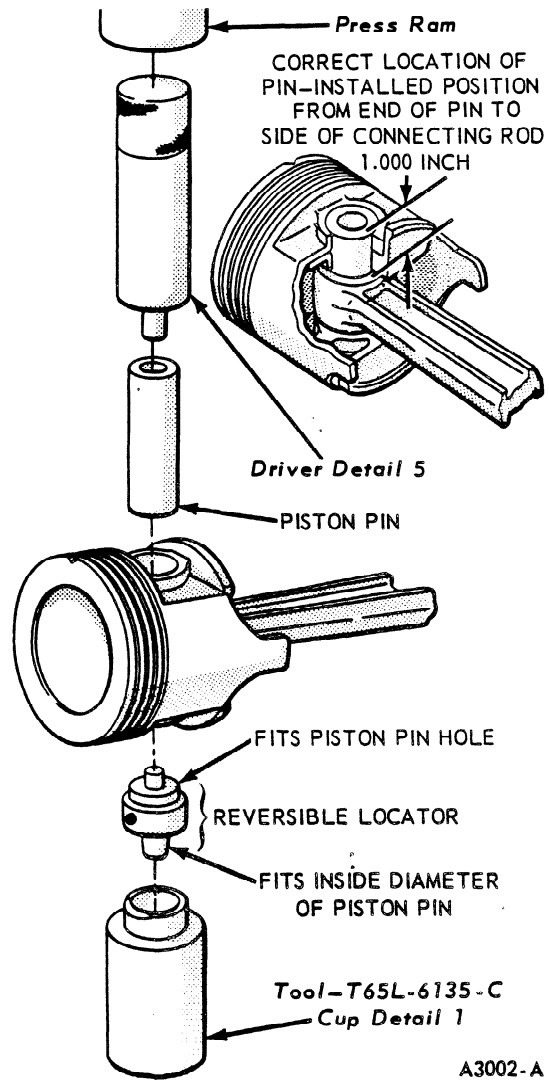
CYLINDER ASSEMBLY OR BLOCK

Disassembly

1. Mount the old engine in a work stand and completely disassemble it, removing the cylinder head and manifolds as an assembly. Follow the procedures given in the Removal and Installation Section of this Part.
2. Remove all serviceable parts not furnished with the new cylinder assembly or block, including the cylinder block drain plugs and cylinder head locating dowels.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly block in the work stand and transfer all serviceable parts removed from the old cylinder engine, following the instructions given in the Removal and Installation Section of this Part.
3. Install the cylinder head locating dowels and block drain plugs.
4. Check all assembly clearances and correct as necessary.



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FIG. 69 Installing Piston Pin

Part 2 Ignition System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
IDENTIFICATION	2-01	REMOVAL AND INSTALLATION	2-08
DESCRIPTION	2-01	Breaker Points and/or	
DIAGNOSIS AND TESTING	2-01	Condenser	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	Vacuum Advance Unit	2-09
Distributor Tests — Off Vehicle	2-05	Breaker Plate and Sub-Plate	2-09
ADJUSTMENTS	2-05	Cam and Centrifugal Advance	
Centrifugal Advance	2-05	Weights	2-09
Vacuum Advance	2-06	Distributor	2-09
Breaker Points and/or		CLEANING AND INSPECTION	2-09
Condenser	2-06	Spark Plugs	2-09
Ignition Timing	2-07	Distributor	2-10

IDENTIFICATION

The distributor identification number is stamped on the distributor housing. The basic part number for distributors is 12100. 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.

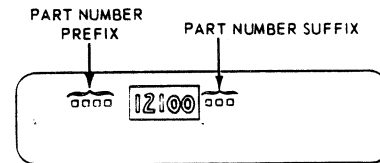


FIG. 1 Distributor Identification

DESCRIPTION

The distributor is located on the right side of the engine. It is equipped with both a vacuum and a centrifugal advance unit to control ignition timing. The vacuum advance governs the ignition timing (spark advance) during low engine speeds (rpm) or low engine loadings. The centrifugal advance, in combination with the vacuum advance, controls the ignition timing at higher engine speeds or heavy engine loads to provide the correct ignition timing for maximum engine performance.

VACUUM SINGLE ADVANCE UNIT

The distributor advance systems are independently operated. The centrifugal advance mechanism (Figure 2), located below the stationary subplate assembly, has centrifugal weights that move inward or outward with changes in engine speed. As engine speed increases the centrifugal weights move ahead with respect to the distributor drive shaft. The rate of advance is controlled by calibrated weight springs.

The vacuum single advance has a spring loaded diaphragm connected to the breaker plate assembly. The diaphragm is moved against the spring pressure by vacuum pressures. When the vacuum increases, the diaphragm causes the movable breaker plate to pivot on the stationary sub-plate. The breaker point rubbing block, which is posi-

tioned on the opposite side of the cam from the pivot pin, then moves opposite to distributor rotation and advances the spark timing. As the movable breaker plate is rotated from retard position to full-advance position, the breaker point dwell will remain constant due to the breaker point rubbing block and the cam rotating on the same axes of the new design breaker plate and sub-plate.

CONVENTIONAL IGNITION SYSTEM

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 resistance wire.
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 wires.
5. Spark plugs.

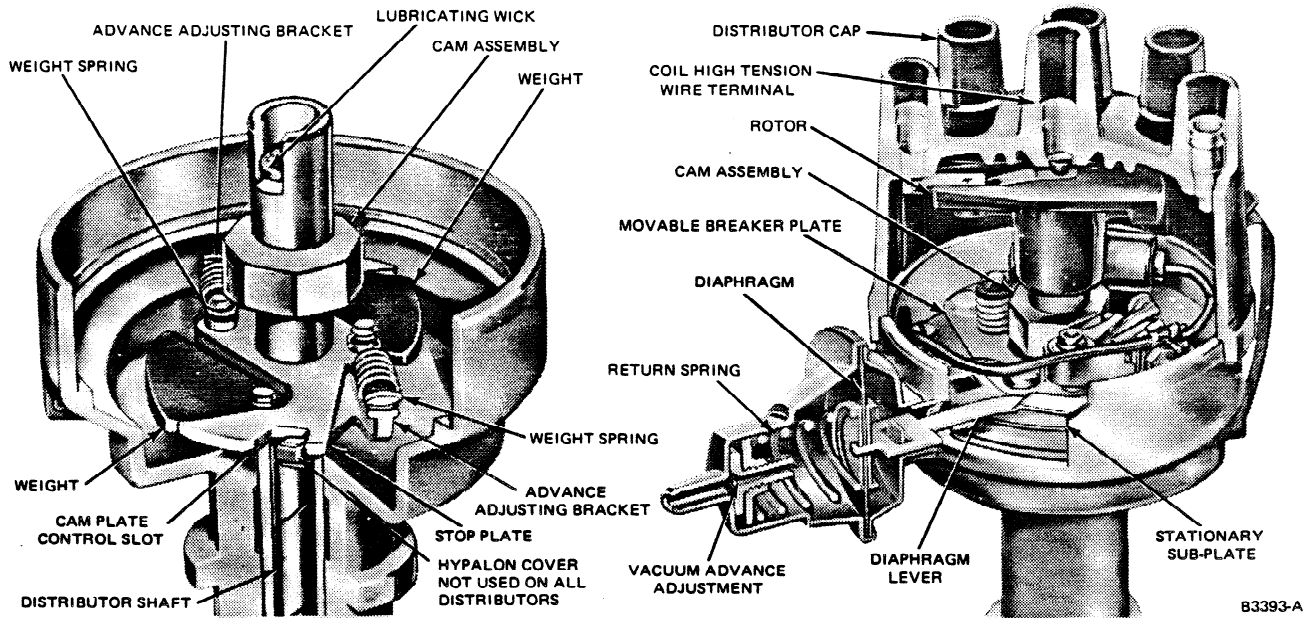


FIG. 2 Advance Mechanisms — Dual Advance Distributor with Single Diaphragm

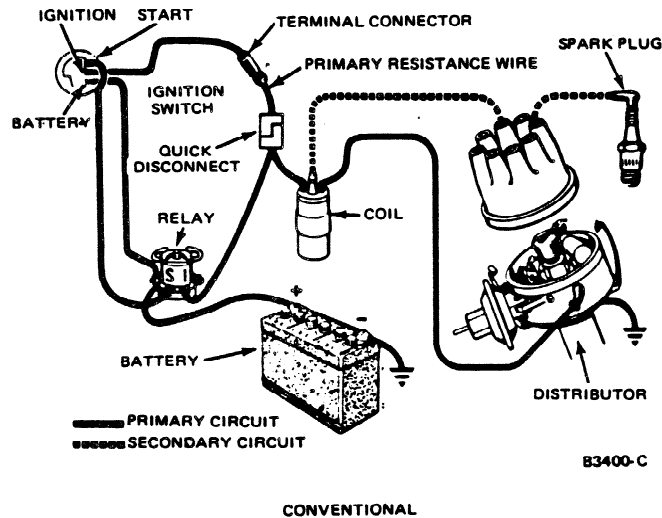


FIG. 3 Typical Conventional Ignition System Circuits

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.

DIAGNOSIS AND TESTING

Ignition systems troubles are caused by a failure in the primary and/or 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; a defective coil; or defective condenser.

A complete test of the primary circuit consists of checking the circuit from the battery to the coil, 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, Resistance Wire, 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. Using insulated pliers, hold the adapter approximately 3/16 inch from the exhaust manifold and crank the engine, using a remote 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.

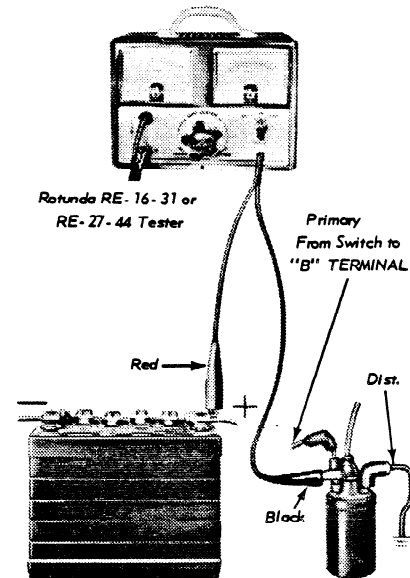
If the spark is good at only some wires, check the resistance of the faulty leads.

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 from the distributor terminal of the coil 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 primary wiring for worn insulation, broken strands, and loose or corroded terminals
 - If the voltmeter reading is less than 4.5 volts the ignition resistor should be replaced.
 - Check the starter-relay-to-ignition switch for damage.



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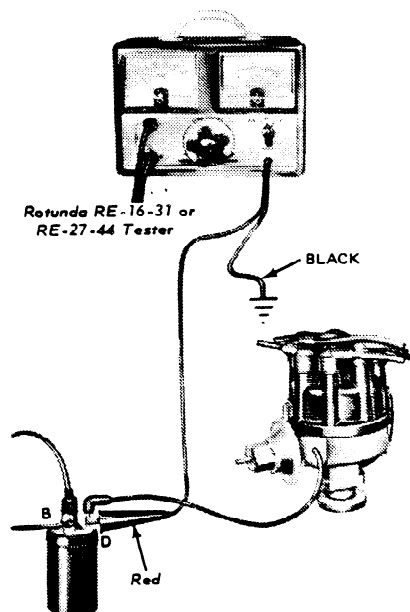
FIG. 4 Battery-to-Coil and Starting Ignition Circuit Test

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 — (Conventional System)

1. Connect the voltmeter leads as shown in Figure 5.
2. Close the breaker points.
3. Turn all accessories off.



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FIG. 5 Coil to Ground Test

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.

Coil Test

Check the coil on a coil tester by 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. 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 a remote 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 the faulty 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.

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 DISTRIBUTOR SHAFT END PLAY

If the shaft end play is not to specifications, check the location of the gear on the shaft. The shaft end play can be checked with the distributor installed on the engine.

1. Mount a dial indicator on the distributor so that the indicator tip rests on the top of the distributor shaft.
2. Push the shaft down as far as it will go and set the dial indicator on zero.
3. Pull the distributor shaft upward as far as it will go and read the end play. The end play should be within specifications with the distributor removed or installed.

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 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 cylinder selector to the figure corresponding to the number of lobes on the cam of the distributor.
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 large. If the dwell angle was above the specified amount, the breaker point gap is too small.

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.
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.
6. Release the auxiliary starter switch and tighten the breaker point assembly 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 distributor cap and coil high tension lead

Connect the distributor vacuum line.

DISTRIBUTOR TESTS — OFF VEHICLE

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 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 points 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 tension 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 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.
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.

Dwell Angle

1. Disconnect and plug the distributor vacuum line.
2. Turn the test selector switch to the correct 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. Unplug and connect the distributor vacuum line.

Breaker Plate Wear

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

Adjust the test set to 0 degree advance, 0 inches vacuum, and 100 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 at the stationary subplate pin or the diaphragm rod is bent or distorted.

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

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.

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 6). 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.

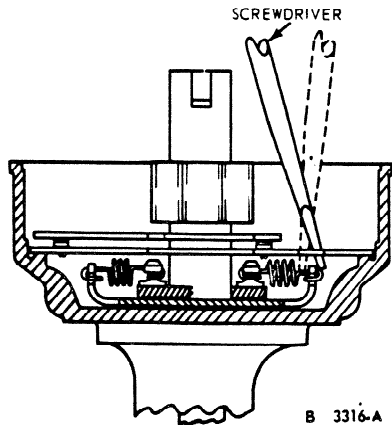


FIG. 6 Centrifugal Advance Adjustment

Vacuum Advance

1. Connect the test set vacuum line to the fitting on the diaphragm.
2. Set the test set at 0 degree advance, 0 vacuum, and at 1000 rpm.
3. Check the advance at the vacuum setting given in the specifications.
4. 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 7). Turn the wrench clockwise to increase the vacuum advance or counterclockwise to decrease it. **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.

To check the diaphragm for leakage:

Install the distributor tester. Do not connect the vacuum line to the distributor.

Adjust the vacuum pressure of the distributor tester to obtain 25 inches Hg. Hold your hand over the end of the tester's vacuum hose and note the reading obtained. **Do not exceed 25 inches Hg.**

If the 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 gauge reading should not be less than it was above. If it is less, the diaphragm is leaking and should be replaced.

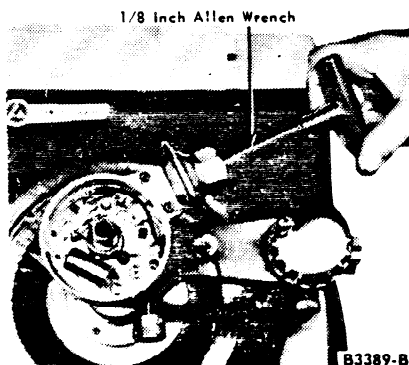


FIG. 7 Vacuum Advance Adjustment

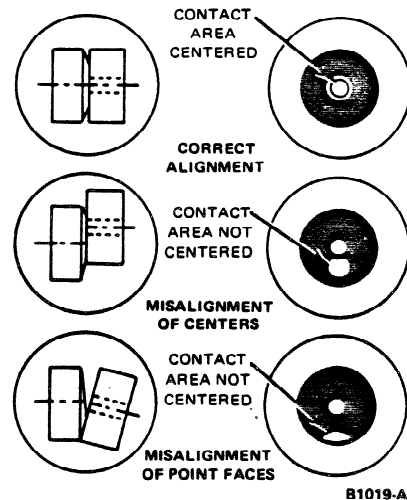


FIG. 8 Checking Breaker Point Alignment

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.

1. Turn the cam so that the breaker points are closed and check the alignment of the points (Figure 8).

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

1. With the ignition switch off and the primary wire disconnected from the coil, crank the engine with an auxiliary starter switch.
2. Using the tool shown (Figure 9) and exerting very light pressure, align the breaker point bracket. **Do not bend the breaker arm.**
3. After the breaker points have been properly aligned, adjust the breaker point gap or dwell.

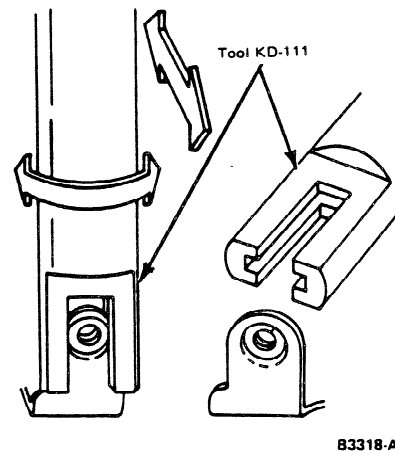


FIG. 9 Using Alignment Tool

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:

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

If the distributor is in 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 blade of a clean feeler gauge between the breaker points (Figure 10). Adjust the points to the correct gap and tighten the screws.

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.

If a scope or a dwell meter is used to adjust new points, be sure the points are in proper alignment. 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.



FIG. 10 Adjusting New Breaker Point Gap

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 on the breaker points, 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 (Figure 11). If the tension is not within specifications, adjust the spring tension.

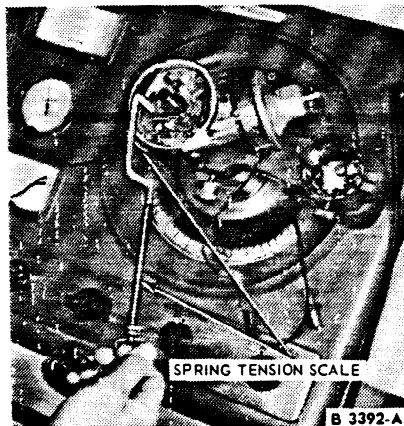


FIG. 11 Checking Breaker Point Spring Tension

To adjust the spring tension (Figure 12):

1. Disconnect the primary lead wire and the condenser lead.
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 lock nut; then check spring tension. Repeat the adjustment until the specified spring tension is obtained.
4. Install the primary lead wire and the condenser lead.

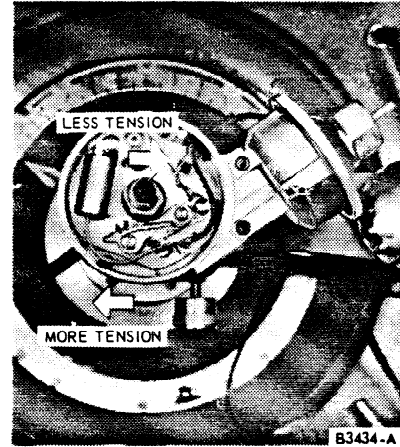


FIG. 12 Adjusting Breaker Point Spring Tension

IGNITION TIMING

Timing Mark Locations

The timing marks and their locations are illustrated in Figure 13.

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

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. Start the engine and accelerate 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 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 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.

REMOVAL AND INSTALLATION BREAKER POINTS AND/OR CONDENSER

Removal

1. Remove the distributor cap and the rotor.
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.

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 retaining screws. Be sure to place the ground wire in the same location as the original installation.
4. Align and adjust the breaker point assembly.
5. Connect the primary and condenser wires to the breaker point assembly.
6. 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 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. Pull the wires from the brackets on the valve rocker arm covers 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. The No. 1 socket is identified on the cap. Install the wires in a clockwise direction.
2. Remove the brackets from the old spark plug wire set and install them 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.

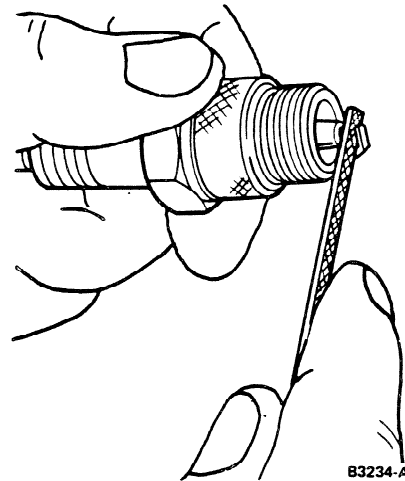


FIG. 14 Filing Spark Plug Electrode

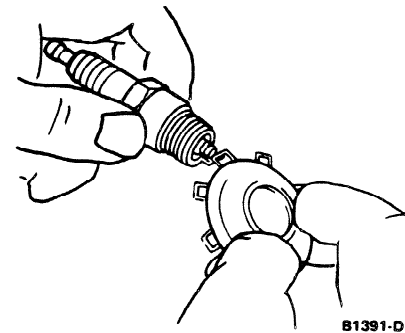


FIG. 15 Checking Spark Plug Gap

SPARK PLUGS

Removal

1. Remove the wires 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.
2. 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.

After cleaning, dress the electrodes with a small file to obtain flat parallel surfaces on both the center and side electrodes (Figure 14). Set the spark plug gap to specifications by bending the ground electrode (Figure 15): all spark plugs, new or used, should have the gap checked and reset as required.

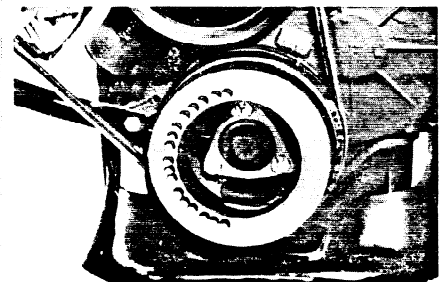
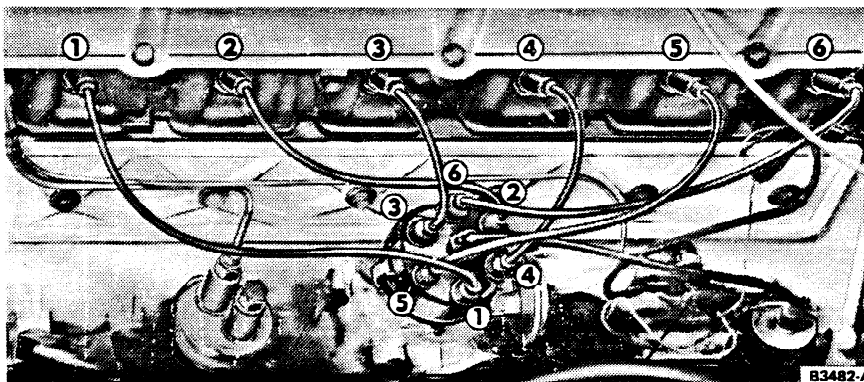


FIG. 13 Engine Timing and Cylinder Firing Order

Installation

1. Install the spark plugs and torque each plug to specifications.
2. Connect the spark plug wires.

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.

BREAKER PLATE AND SUB-PLATE**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.

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. Remove the weight retainers and 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.**

If a new cam assembly is being installed, make sure that the cam is installed with the hypalon covered stop in the correct cam plate control slot. Some distributor stops will not be covered with the hypalon covering. The centrifugal advance range determines whether or not a hypalon cover is required. This can be done by measuring the length of the slot used on the old cam and by using the corresponding slot on the new cam. Some of the cams will have the size of the slot in degrees stamped near the slot. If the wrong slot is used, an incorrect maximum advance will be obtained.

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 diaphragm unit.
8. Install the primary wire in the distributor. Connect the primary and condenser wires to the breaker point terminal.
9. Adjust the breaker point gap or dwell as required.

DISTRIBUTOR**Removal**

1. Remove the air cleaner. Disconnect the primary wire from the coil.
Disconnect the vacuum advance line at the distributor. 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. Connect the vacuum line, and check the advance with the timing light when the engine is accelerated.
6. Install the air cleaner.

CLEANING AND INSPECTION

SPARK PLUGS

Examine the firing ends 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 electrodes.**

After cleaning, examine the plug carefully for cracked or broken insulators, badly pitted electrodes, and other signs of malfunction. 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 cam assembly.

Inspect the breaker plate assembly for signs of distortion. Replace the breaker plate assembly if it is distorted.

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

Check the distributor base for cracks or other damage.

Check the diaphragm housing, bracket, and rod for damage. Test the vacuum hose connections, case and diaphragm for leakage as explained under Distributor Tests. Replace all damaged 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.

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, permanent carbon tracks or dirt or corrosion in the sockets. Replace the cap if it is damaged as above.

Rotor

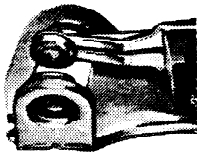

Clean the rotor with a soft bristle brush and mild cleaning solvent or mineral spirits. Dry the rotor with compressed air. Inspect the rotor for cracks or burning. Replace the rotor if it is cracked or burned.

Secondary Wiring

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

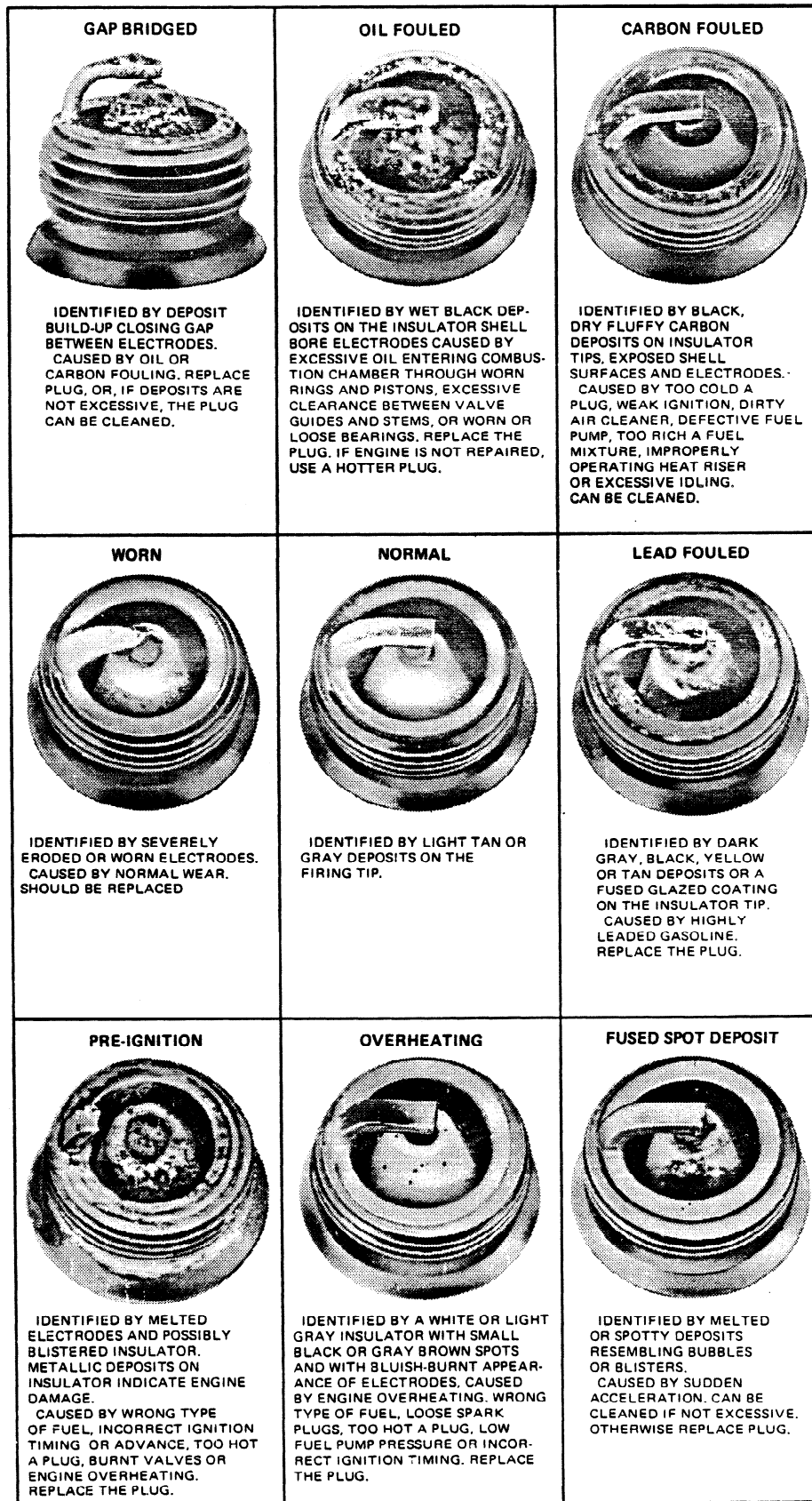
Coil

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

CONDITION	CAUSED BY
 <p data-bbox="440 1528 509 1549">BURNED</p>	<p data-bbox="690 1402 1138 1476">Incorrect voltage regulator setting. Radio condenser installed to the distributor side of the coil.</p>
 <p data-bbox="396 1724 581 1759">EXCESSIVE METAL TRANSFER OR PITTING</p>	<p data-bbox="690 1577 1138 1749">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.</p>

B1443-C

FIG. 17 Breaker Point Inspection



B3235-B

FIG. 16 Spark Plug Inspection

Part 3 — Fuel System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
IDENTIFICATION	3-01	HOLLY 1940 ONE BARREL CARBURETOR	
DESCRIPTION	3-02	Description and Operation	3-12
DIAGNOSIS AND TESTING		Adjustments	3-14
General Information	3-02	Disassembly	3-14
Chart	3-02	Cleaning	3-16
Pressure Tests	3-04	Assembly	3-17
Capacity Test	3-05	HOLLEY MODEL 1904 CARBURETOR	
REMOVAL AND INSTALLATION		Description	3-19
Fuel Pump Assembly	3-05	Operation	3-19
BENDIX ZENITH ONE BARREL		Adjustment	3-20
CARBURETOR		Removal	3-21
Description and Operation	3-05	Disassembly	3-22
Disassembly	3-08	Cleaning and Inspection	3-22
Cleaning	3-10	Assembly	3-22
Inspection	3-10	Installation	3-24
Assembly	3-10		

IDENTIFICATION

The carburetor identification tag is attached to the upper body 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.

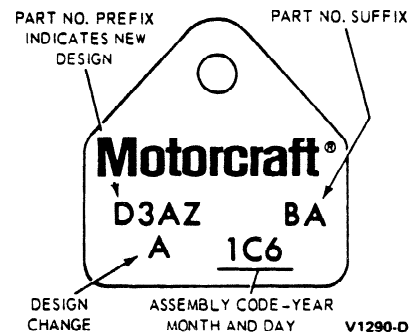


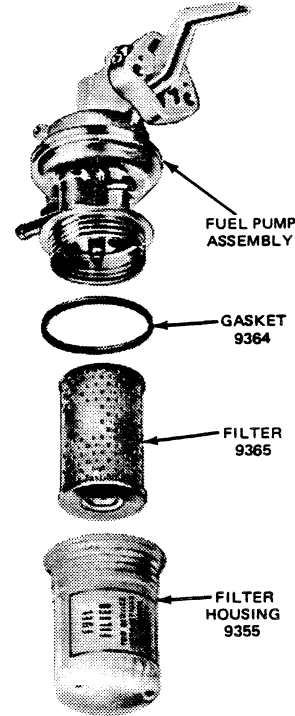
FIG. 1 Typical Carburetor Identification Tag

DESCRIPTION

The fuel system includes a mechanical fuel pump. It is mounted on the lower, left-center of the engine cylinder block. The disposable filter is located on the fuel pump body.

The fuel pumps are mechanically actuated by means of the fuel pump rocker arm and an eccentric on the camshaft.

The 300 CID engines use either a Bendix Zenith one-barrel carburetor or a Holley 1904 or 1940 carburetor. These are covered in detail later in this section.



82322-C

FIG. 2 Fuel Pump — Typical

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.
High Fuel Pump Pressure	Diaphragm spring too strong or improper spring.
Low Fuel Pump Volume with Normal Pressure	Fuel filter clogged. Fuel pump to carburetor inlet line obstructed, crimped or leaks.
Fuel Pump Leaks	Diaphragm defective. Fittings loose.

SYMPTOM	PROBABLE CAUSE	
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 lines 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 needles(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 restricted. Idle discharge holes not in proper relation to throttle plate. Excessive dirt in air cleaner. High or low float setting.
Poor Acceleration	<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>A LEAN MIXTURE CAN BE CAUSED BY: 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>A RICH MIXTURE CAN BE CAUSED BY: 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>

SYMPTOM	PROBABLE CAUSE	
Inconsistent Engine Idle Speed	Incorrect throttle linkage adjustment to carburetor. Governor not adjusted properly or faulty. Binding or sticking throttle linkage. Sticking carburetor throttle shaft.	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).
Surging Above Idle Speed	Clogged main jets. Improper size main jets. Low fuel level or float setting. Low fuel pump pressure or volume.	Clogged fuel filter or fuel pump filter screen. Distributor vacuum passage Clogged. Defective spark valve or gasket.
Reduced Power Output	Float setting too high or too low. Fuel pump pressure too high or too low. Improper size or obstructed main jets. Restricted air bleeds.	Restriction in main fuel passages. Excessive dirt in air cleaner. Throttle plate not fully open. Faulty choke operation. Improper throttle linkage or governor adjustment.

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 within the recommended maintenance interval. When in doubt, install a new filter.

Pressure Tests

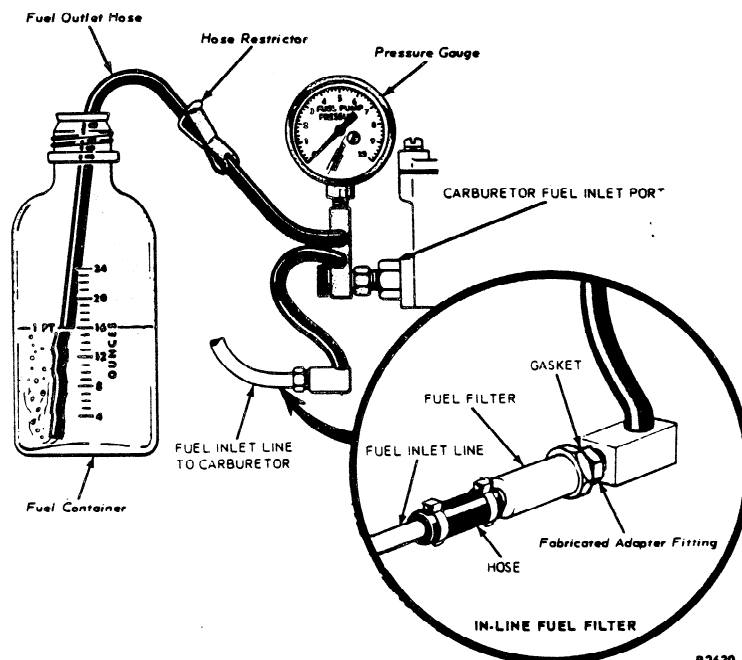
Refer to the fuel pump specification and note the fuel pump pressure and capacity (Volume) design tolerances.

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 Part 8).

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

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



B2630-B

FIG. 3 Typical Fuel Pump Pressure and Capacity Test Equipment

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.

REMOVAL AND INSTALLATION**FUEL PUMP ASSEMBLY****Removal**

1. Disconnect the inlet and outlet lines at the fuel pump.
2. Remove the pump attaching screws, then remove the pump and the gasket. Discard the gasket.

Installation

1. Remove all the gasket material from the mounting pad and pump flange. Apply oil-resistant sealer to both sides of a new gasket and to the threads on the attaching bolts.

2. Position the new gasket on the pump in position against the mounting pad. Make sure the rocker arm is riding on the camshaft eccentric. (Turn the engine over until the fuel pump eccentric is on the low side of the stroke.)
3. Press the pump tight against the pad, install the attaching screws and alternately torque them to specifications.
4. Connect the fuel inlet and outlet lines.
5. Operate the engine and check for leaks.

**BENDIX ZENITH CARBURETOR
DESCRIPTION AND OPERATION**

The Bendix Zenith carburetor is a single barrel downdraft type which is designated as either a 28 or 228 series.

These carburetors are of the "balanced" design in that all air for fuel bowl ventilation and idling must enter through the air cleaner. For this reason any restriction in the air cleaner will have a minimum effect upon the fuel-air mixture ratio. These models include single idle, main, accelerating and power jets. The accelerating pump is operated mechanically by throttle movement through a link connected to the throttle lever. The power jet is operated by engine manifold vacuum.

The basic difference between the 28 and 228 Series is in the idle system. The 28 series has a single idle discharge plug in line with the closed throttle plate. The idle needle valve is located in the air intake body (see Figure 7). The 228 Series includes a two-hole idle system with one hole located above the closed throttle plate and the other below the plate with the idle needle valve located in the throttle body (see Figure 8).

These carburetors have three main assemblies — the air intake assembly, the fuel bowl, and the throttle body.

The main components contained in the air intake assembly are the choke plate, the float assembly, vacuum cylinder assembly and, on the 28 series only, the idle adjusting needle.

The fuel bowl contains the accelerating pump and rod assembly, the power jet valve assembly and all of the jets.

The major parts in the throttle body are the throttle plate, throttle shaft, throttle stop screw and, on the 228 series only, the idle needle valve.

FUEL INLET

As fuel under pressure is supplied to the carburetor through the fuel inlet fitting (a fuel filter element is used on some models), fuel needle valve and seat into the fuel bowl, the float rises and shuts off the fuel supply at the fuel valve needle and seat when the fuel reaches a given level in the fuel bowl regardless of engine speed and load.

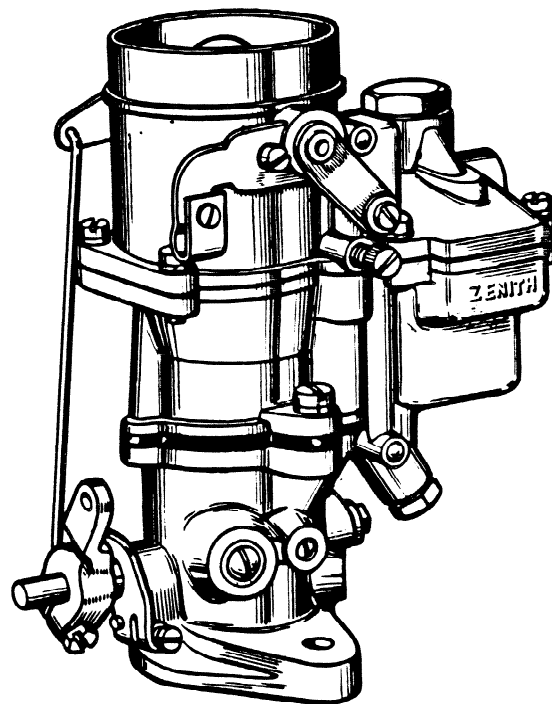


FIG. 4 Bendix Zenith One-Barrel Carburetor

CHOKE

The choke system is required for starting cold engines. Since a cold manifold will vaporize only a fraction of the gasoline, it is necessary to supply a richer mixture so that sufficient gasoline will be vaporized for a combustible mixture.

The choke system consists of a choke shaft and lever assembly with a choke plate located in the air intake to the carburetor.

To avoid over-choking or flooding of the engine, the choke must be partially opened as soon as the engine begins to operate. This is assisted by a poppet valve located in the choke plate which opens automatically as soon as the engine starts to supply enough air for a running mixture. As the engine warms, the choke should be opened gradually until it reaches the fully open position.

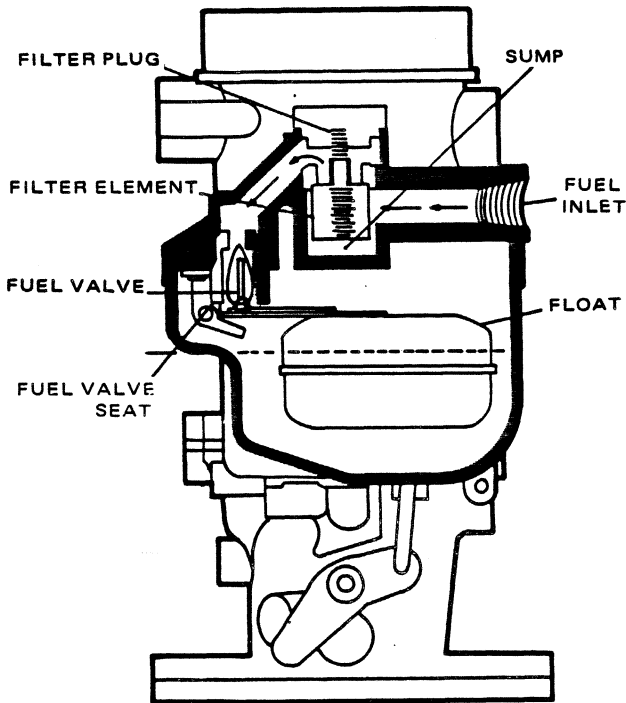


FIG. 5 Fuel System

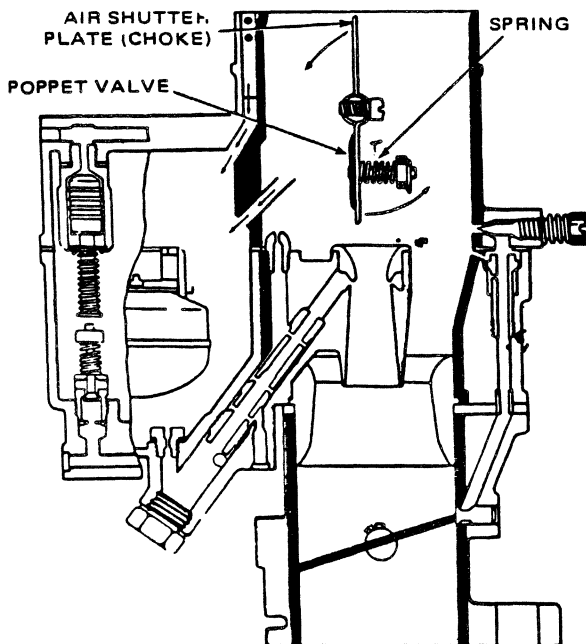


FIG. 6 Choke System

IDLE-FUEL SYSTEM

At idle and low speed operation, the engine does not draw sufficient air through the primary booster venturi to create a vacuum great enough to operate the main metering system; therefore, an idle fuel system is provided which is not dependent upon venturi vacuum to discharge fuel.

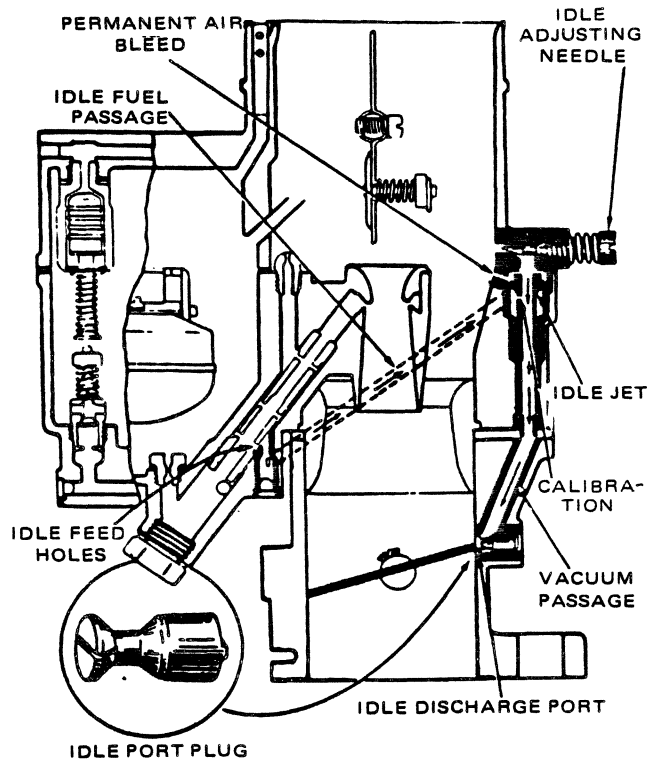


FIG. 7 Idle System (28 Series)

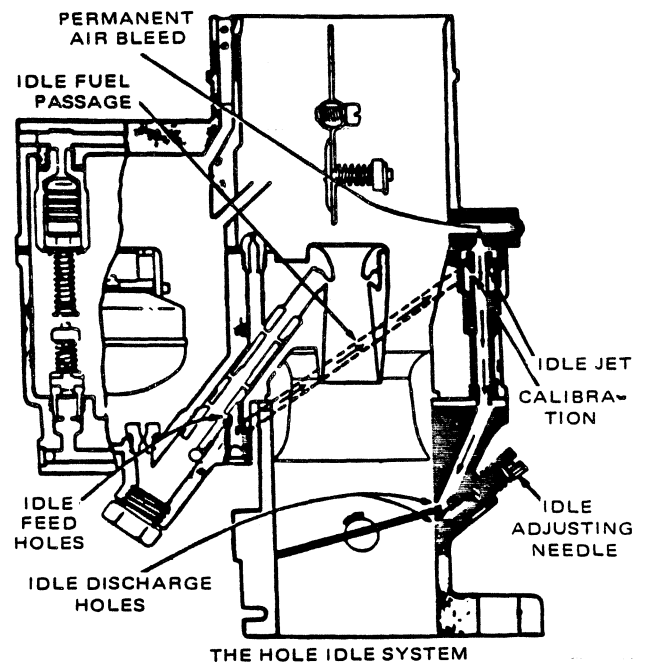


FIG. 8 Idle System (228 Series)

High manifold vacuum at idle creates a low pressure at the idle discharge port. The pressure in the fuel bowl is near atmospheric pressure. The difference in pressure between the fuel bowl and the idle discharge port forces fuel through the idle fuel system.

At idle speeds, the throttle plate is advanced slightly to expose about one-half of the area of the idle discharge port to engine suction (manifold vacuum). This suction is transmitted through a vacuum passage and the idle jet to the idle fuel passage. Fuel from the fuel bowl then flows through the main jet into the main discharge jet through the idle feed holes into the idle fuel passage and from here it is metered through the calibration of the idle jet.

As fuel leaves the idle jet and enters the vacuum passage leading to the discharge port, it is mixed with air admitted through the air intake through the permanent air bleed. This calibrated air bleed prevents the syphoning off of fuel into the intake manifold through the idle system if, for any reason, the idle air adjusting needle should be placed on its seat. An additional variable amount of air is admitted past the idle adjusting needle and seat to be mixed with the fuel-air mixture in the idle vacuum passage to be discharged into the engine manifold at the idle discharge port. Turning the idle adjusting needle IN (clockwise) increases the suction on the idle jet and causes a richer mixture, as well as a reduced volume of air admitted past the idle adjusting needle. Turning the idle needle OUT (counterclockwise) results in a leaner idle mixture. As the throttle plate is opened wider, the delivery of fuel-air through the high speed system supplements the idle system to increase the fuel-air supply. Although the delivery of fuel through the idle system diminishes as the throttle plate approaches the wide-open position, it continues to deliver a small amount of fuel-air to the engine.

NOTE: In the 228 series, the idle system operates in the same manner as in the 28 series except that the discharge of idle fuel-air mixture into the air stream is controlled directly by the idle adjusting needle located in the throttle body at the lower idle discharge hole. Turning the idle needle valve IN (clockwise) results in a leaner mixture of fuel-air since less of the fuel-air is discharged into the air system through the idle discharge hole.

In the curb idle position, additional air is admitted through the upper idle discharge hole to be mixed with the fuel-air in the vacuum passage and discharged through the lower idle discharge hole. As the throttle is opened slightly, the fuel-air is discharged through both the upper and lower idle discharge holes to increase the fuel-air supply to the engine.

MAIN FUEL SYSTEM

When the throttle plate is progressively opened, engine speed increases and the air passing through the booster venturi gradually creates sufficient vacuum to bring the main fuel system into operation and fuel will be discharged through the main discharge nozzle. The difference in pressure between the primary venturi and the fuel bowl causes fuel to flow through the primary stage main fuel system.

With the throttle plate opened to the cruising range, fuel from the fuel bowl is metered through the main jet to the base of the main discharge jet. To maintain the proper fuel-air ratio, a small amount of air is admitted through the well vent or high speed bleeder through a hole below the fuel

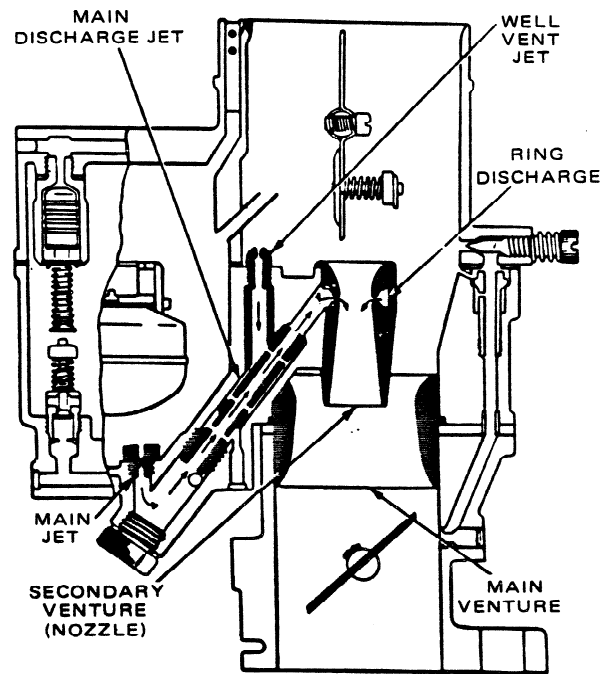


FIG. 9 Main Metering System

level. By introducing air into the discharge jet at a point below the fuel level, the surface tension of the fuel is reduced to help the fuel flow at low suction. This bleed also restricts the fuel flow through the main jet under high suction. A ring land in the main discharge jet just above the lower bleed holes separates the idle fuel supply from the high speed system. With the throttle plate advanced to a point just above the idle range, the air passing through the carburetor lowers the pressure at the discharge nozzle to cause the fuel to flow from the fuel bowl through the main jet into the main discharge jet. The air admitted through the bleed holes in the discharge jet and measured by the well

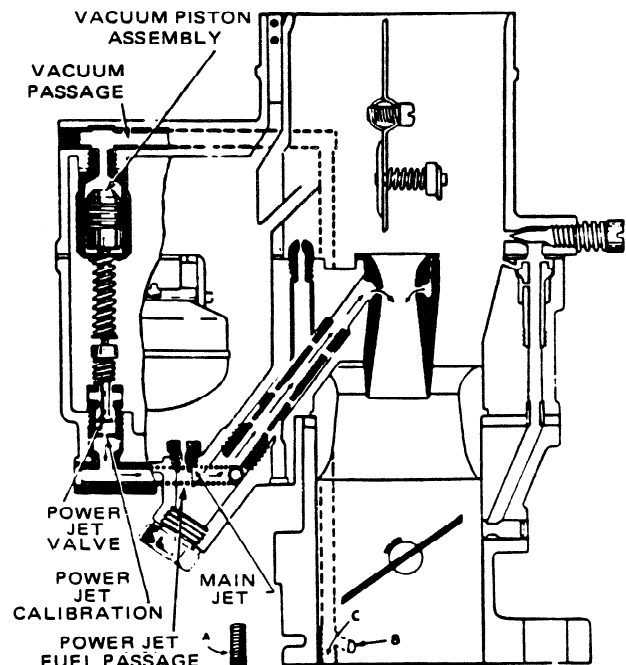


FIG. 10 Power System

vent is mixed with the fuel. This mixture of fuel-air from the main discharge jet passes through the discharge nozzle into the upper part of the secondary venturi and mixed with air passing through the secondary venturi. As it passes through the main venturi, this fuel-air mixture is further broken up or vaporized before it enters the intake manifold of the engine. With the throttle opened from $\frac{3}{4}$ to wide open position, the intake manifold vacuum drops below 6" of mercury which permits the springs to force the power valve piston downward to open the power jet valve. Fuel from the fuel bowl is then free to flow through the power jet valve (at a rate determined by the calibration of the bottom of the valve) into the main discharge jet where it is added to the fuel already being metered through the main jet and discharged into the air stream at the discharge nozzle. As the load decreases and the manifold vacuum builds up above 6", the vacuum piston is lifted to cut off the extra fuel supply.

ACCELERATOR PUMP SYSTEM

Upon acceleration, the air flow through the carburetor responds almost immediately to the increased throttle opening. There is, however, a brief interval before the fuel, which is heavier than air, can gain speed and maintain the desired balance of fuel and air. During this interval, the accelerating pump supplies fuel until the other fuel systems can once again provide the proper mixture.

When the throttle is opened suddenly, the pump lever attached to the throttle shaft moves the accelerator pump piston down to supply additional fuel instantly to counteract a momentary leaning out of the fuel-air mixture caused by the air rushing in through the air cleaner. As the pump piston moves down, the inlet pump check valve closes to trap fuel in the pump cylinder under pressure. The pressure built up in the pump cylinder then lifts the outlet ball check and weight above it to close the air inlet check valve. Fuel from the pump cylinder is then forced through the fuel channel and accelerating jet to be discharged into the air.

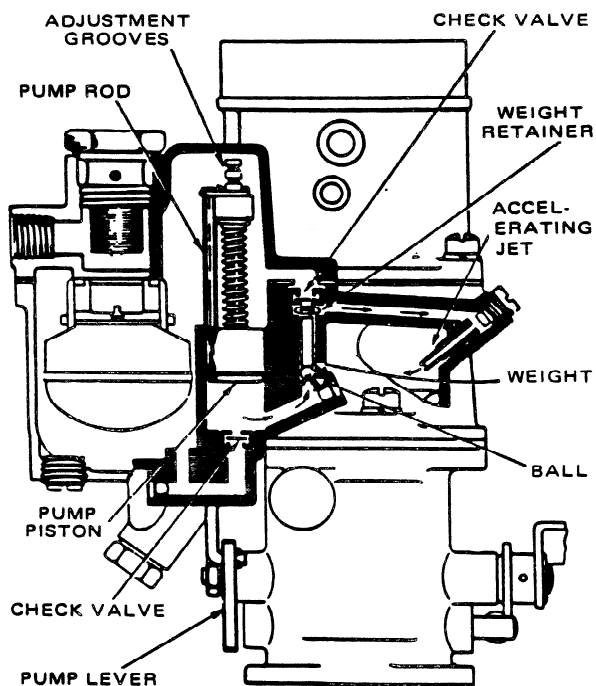


FIG. 11 Accelerating System

DISASSEMBLY

Use a separate container for the component parts of the various assemblies to facilitate cleaning, inspection and assembly.

The following is a step-by-step sequence of operations for completely overhauling the carburetor. However, certain components of the carburetor may be serviced without a complete disassembly of the entire unit. For a complete carburetor overhaul, follow all of the steps. To partially overhaul the carburetor or to install a new gasket kit, follow only the applicable steps.

Removal of Air Intake Body

1. Remove the large hex plug (3) and fiber washer (4) from the top of the air intake assembly (67) using a $13/16$ " wrench.
2. Remove the six screws (6) and lockwashers (7) which attach the air intake assembly to the fuel bowl assembly.
3. Raise the air intake assembly slightly and loosen the gasket from the fuel bowl and then lift air intake with gasket clear of the fuel bowl. Use care not to damage the float float (10).

Disassemble Air Intake Body

1. Invert air intake body and remove gasket (12) from air intake.
2. Press small screwdriver against float axle (11) to push axle through slotted side of hinge bracket and then remove float assembly (10) and fuel valve needle (part of 9).
3. Remove fuel valve seat (9) and fiber washer (8) from air intake, using C161-85 wrench or wide blade screwdriver.
4. Remove vacuum cylinder (63) with fiber washer (64), using C161-10 wrench.
5. Remove idle adjusting needle (66) and spring (65) from side of air intake body (28 Series only).
6. Mark choke bracket and choke lever positions to insure correct reassembly and then remove choke parts as follows:
 - a. If choke plate screw is riveted, file off the threaded end flat and remove screw (1) and choke plate (2). Remove choke spring (77) (28 Series only).
 - b. Pull out choke shaft and lever assembly (74).
 - c. Remove choke bracket screw (72) and choke bracket (69).

Separate Fuel Bowl and Throttle Body

1. Loosen main jet plug (26) or adjustable main jet (26) in fuel bowl assembly.
2. Remove accelerating pump link retainer (28) and pump link (27).
3. Remove the accelerating pump and rod assembly (13) from the pump cylinder.

NOTE: It may be necessary to file off any burrs or rough spots from the sides of the pump rod hole for the link before removing the assembly.

4. Remove the two screws (48) and lockwashers which attach the fuel bowl assembly to the throttle body assembly, using a screwdriver.
5. Separate the fuel bowl from the throttle body.
6. Remove the venturi (45) and gasket (44).

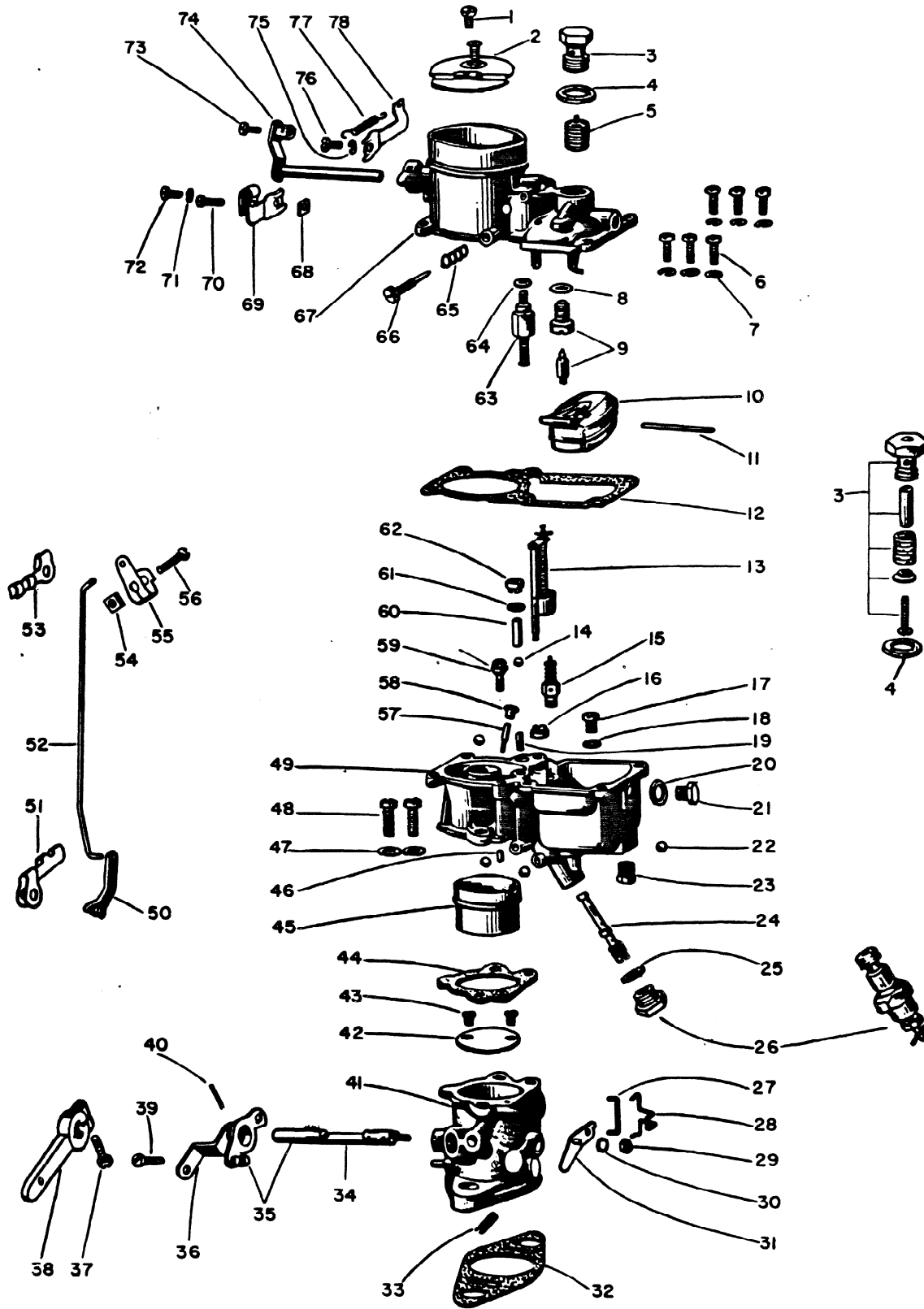


FIG. 12 Bendix Zenith One-Barrel Carburetor Assembly — Typical

Disassembly of Fuel Bowl

1. Remove the idle jet (59) from the top surface of the fuel bowl (49), using a screwdriver.
2. Remove well vent (19) from top surface of the fuel bowl, using C161-80 wrench.
3. Remove the main jet (17) and fiber washer (18) from inside bottom of fuel bowl, using a screwdriver.

NOTE: Those models which include an adjustable main jet do not have a main jet located inside of the fuel bowl.

4. Remove power jet valve assembly (15) from inside bottom of fuel bowl, using C161-9 wrench.
5. Remove main jet plug (26) and washer (25) or main jet adjustment (26), if used. Then remove main discharge jet (21), using C161-1 wrench.
6. Remove check valve from fuel bowl as follows:
 - a. Turn back "ears" of the pump check valve (16) located in pump cylinder with a small screwdriver. Turn fuel bowl over and allow check valve disc to fall out.
 - b. Insert tapered end of check valve tool C161-5 into check valve and screw down (counterclockwise) until tool is firmly fastened into check valve body. Then raise sliding weight up sharply against the stop bar a few times to remove check valve body.
 - c. Remove air vent check valve (62) from passage in top surface of fuel bowl by inserting the tapered thread end of check valve tool C161-5 into check valve and screw down (counterclockwise) until tool is firmly fastened to check valve. Then raise sliding weight up sharply against the stop bar a few times to remove check.
 - d. Turn the fuel bowl over and allow the ball, weight and retainer washer to fall into hand.

NOTE: DO NOT attempt to remove the channel bushing (46) or nozzle bushing as these parts are pressed in at the factory and need not be removed to service the carburetor.

7. Remove fuel bowl drain plug (23).
8. Remove the channel plugs as follows:
 - a. Remove the four lead channel plugs (22) and the accelerating jet channel plug (58) by first making a center punch mark in center of plugs.
 - b. Drill a #46 hole in center of plugs, being careful not to drill through the plugs into the casting.

NOTE: The accelerating jet channel plug is drilled at the factory in some cases to receive the plug extractor.

- c. Insert tapered thread end of plug extractor tool C161-21, into holes just drilled and screw down (counterclockwise) until tool is firmly fastened into plug. Then strike opposite end of tool sharply with light hammer to draw plugs out of casting.
- NOTE:** The threaded tip of the extractor tool can easily be broken off unless the casting and tool are held firmly and the extractor is driven away from the casting without tipping. For accelerating channel plug removal, use plug extractor C161-15.
- d. Remove corrosion, dirt and gum from the four passages, using a 1/8" drill with the cutting tip ground blunt to avoid damaging the casting.

Disassembly of Throttle Body

1. Remove pump lever assembly nut (29), lockwasher (30) and pump lever (31), using tool C161-25.
2. File riveted ends of throttle plate screws (43) flat and then remove the two throttle plate screws, throttle plate (42) and throttle shaft and lever assembly (35).

NOTE: Use caution to avoid scarring throttle body bore or throttle plate. DO NOT attempt to remove the idle port plug from the side of the throttle body.

3. Remove idle adjusting needle (66) and spring (65) from side of throttle body (228 Series only).

CLEANING

Clean all metal parts thoroughly in approved carburetor cleaner and rinse in cleaning solvent. Blow out passages and channels in the castings using compressed air. It is recommended to reverse the air flow through each passage to insure the removal of all particles of dirt. **NEVER USE A WIRE OR DRILL TO CLEAN OUT THE JETS.**

INSPECTION

Inspect all parts and replace any that are damaged or worn. Always use a Zenith Repair Kit. For correct Repair Kit, refer to Zenith Parts Catalog Specification Page.

ASSEMBLY

Assembly of Air Intake Body

1. Install choke bracket (78) in the same position on air intake as it was in before removal using screw (76) and lockwasher (75) (28 Series only).
 2. Place choke plate (2) in air intake assembly with poppet valve toward gasket surface. (Applies to units where choke plate includes poppet valve.)
 3. Insert choke shaft and lever assembly (74) and close choke. Spring of poppet valve should face air entrance.
 4. With choke plate closed, align hole in shaft with hole in choke plate. Lever should point toward bracket.
 5. Center choke plate in closed position and tighten choke plate screw (1).
- NOTE:** DO NOT attempt to rivet threaded end of screw.
6. Install idle adjusting needle (66) and spring (65) (28 Series only).
 7. Install vacuum cylinder assembly (63) with new fiber washer (64) in air intake assembly, using C161-10 wrench.
 8. Install new fuel valve seat (9) and fiber washer (8), using C161-85 wrench.
 9. Install fuel valve needle in seat, followed by float assembly (10) and float axle (11).

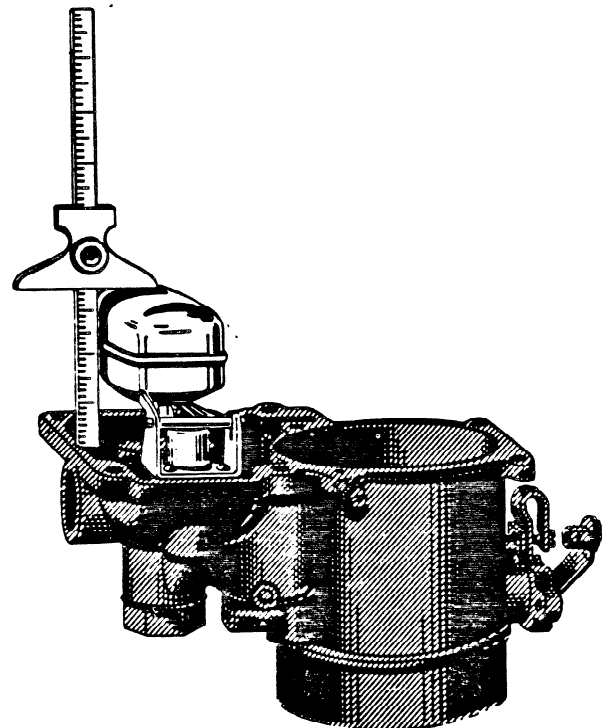


FIG. 13 Measuring Distance Between Float and Machined Surface of Air Intake

NOTE: Tapered end of float axle goes into float bracket on side opposite slot. Press float axle into center position from slotted side.

10. Invert air intake assembly. With float lever resting on fuel valve needle, measure distance from machined surface of air intake body to top center of float. This dimension should be 1-31/64". To increase or decrease distance between float and machined surface of air intake, use long-nosed pliers and bend float lever close to float body.

Assembly of Fuel Bowl

1. Drive each of the four lead ball plugs (22) into plug channels until plug is flush with surface of casting, using tool C161-19.

NOTE: Only one or two light blows are required to seal lead ball plug in channel. Avoid driving plugs in too deep which may block off fuel passages.

2. Install accelerating jet channel plug (58) and drive in place with light hammer.
3. Install new accelerating pump check valve (16) in bottom of pump cylinder, using tool C161-53, as follows:
 - a. Place check valve on formed end of tool and press firmly into counter-bore area.

NOTE: Both pump and air vent check valves are identical.

- b. Turn fuel bowl assembly upside down and start check valve tool into pump cylinder with guide bar in pump rod passage and press hard to start check valve into its seat.
 - c. Invert fuel bowl assembly, hold firmly in hand and drive check valve into its seat with a few sharp blows using a light hammer. Be sure that check valve bottoms completely.
4. Install idle jet (59) in top surface of fuel bowl (no gasket required).
5. Install pump refill check valve ball (14), weight (60), retainer washer (61) and air vent check valve (62) as follows:
 - a. Drop steel ball into vertical passage next to accelerating jet (57) in top surface of fuel bowl assembly.
 - b. Drop square weight (60) in on top of ball, then place brass retainer washer (61) in check valve counter-bore on top of weight.
 - c. Start air vent check valve (62) evenly into counter-bore on top of retainer washer with finger pressure. Flat head of valve must face top surface of fuel bowl casting.
 - d. Fit machined end of tool C161-5 into valve and lightly drive check valve into place as far as tool will permit.

NOTE: Check valve must seat evenly and must not be cocked at an angle.

6. Install main jet (17) with fiber washer (18) in bottom of fuel bowl and seat firmly with screwdriver.

NOTE: If carburetor includes an adjustable main jet, it will not have a main jet in the fuel bowl.

7. Install power jet valve assembly (15) using C161-9 wrench. No gasket required.
8. Install main discharge jet (24) in passage in outside bottom of fuel bowl, using C161-1 wrench.
9. Install main jet plug (26) with fiber washer (25) in passage at outside bottom of fuel bowl, using 1/2" wrench. Plug is not used with adjustable main jet.

NOTE: If carburetor includes an adjustable main jet (26), it should be installed at this time.

10. Install well vent jet (19) in top surface of fuel bowl assembly, using C161-80 wrench. No gasket is required.
11. Install accelerating pump piston and rod assembly (13) in pump cylinder.

NOTE: The hair pin cotter should be installed in the same groove it was in originally. The pump guide rod has three grooves at the upper end to determine the length of the pump stroke. When a half stroke is required, the hair pin cotter is installed in the uppermost groove; for three-quarters stroke, use the middle groove; for full stroke, use the bottom groove.

Check Pump Action

To check the action of the accelerating pump proceed as follows:

- a. Fill carburetor fuel bowl with gasoline.
- b. Force pump piston downward in pump cylinder and note if air vent check valve (62) leaks.
- c. Repeat this operation noting if pump check valve (16) leaks allowing gasoline to be forced back into the fuel bowl through channel leading from bottom of pump cylinder to fuel bowl.
- d. Again repeat operation and observe the discharge of fuel at the accelerating jet (57).

NOTE: Always make this check to insure that the accelerating pump is functioning properly.

Assembly of Throttle Body

NOTE: If the fit of the throttle shaft is sloppy in the throttle body, it will be necessary to either replace the throttle body and shaft assembly or install new throttle shaft bushings to return the fit to factory specifications. A poorly fitting throttle shaft upsets the idle of the engine. DO NOT attempt to replace the throttle shaft bushings in the field unless the following tools are available: counterbore reamer, C161-73-3; shaft line reamer, C161-71-3; and bushing driver, C161-72-3. The long shaft bushing is C9-56; the short shaft bushing is C9-55.

1. The following procedure should be followed when installing new throttle shaft bushings:
 - a. Place a suitable centering cone in the bed of the drill press. With one throttle shaft hole on the centering cone, bring the spindle down until the counterbore reamer just contacts the opposite shaft hole boss.
 - b. With the casting still in place as described above, set the stop on the press to the length of the bushing.

NOTE: Check to make sure that proper length bushing is being used for the particular shaft hole being counterbored.

 - c. The shaft hole is then counterbored to accommodate the bushing.
 - d. Drive proper shaft bushing into place, using bushing driver.
 - e. Ream the bushing with the shaft line reamer with the opposite shaft hole serving as a "pilot" to align the reamer in the bushing.
 - f. Turn the casting over and prepare the opposite hole to take the other bushing. It will be necessary to reset the stop on the spindle as described above. Then counter-bore the hole as above.
 - g. Drive the second shaft bushing into position with bushing driver.
 - h. Line ream the second bushing, using the opposite side bushing to "pilot" the reamer.

NOTE: A lathe may be used in place of the drill press in performing the counterbore and line ream operations.

2. Install throttle shaft and lever assembly (35) and throttle plate (42) in throttle body (41).
3. Back out throttle stop screw (39) and place throttle body assembly on bench with mounting flange side up.
4. Starting with throttle shaft facing downward, rotate shaft so that threaded ends of hole face the idle port plug.

5. Insert the throttle plate in the throttle shaft (short side first). Center throttle plate and then rotate shaft counterclockwise to close.
6. Turn the throttle body over and start the screws (13) into shaft leaving screws loose. Make sure beveled sides of plate are next to throttle body bore. Tap the plate lightly to center it and then tighten the screws.

NOTE: DO NOT attempt to rivet threaded ends of screws. The edges of the throttle plate are beveled so that they will fit flush against the sides of the throttle body bore when the throttle plate is closed.

7. Install idle adjusting needle (66) and spring (65) (228 Series only).

Assembly of Throttle Body, Fuel Bowl and Air Intake

1. Place venturi (45) in position in fuel bowl assembly.
NOTE: The notch in the venturi fits over the discharge arm of the fuel bowl.
2. Place throttle body to fuel bowl gasket (44) in position around venturi.
NOTE: One hole in the gasket is reinforced with a metal ring. The idle channel bushing in the fuel bowl assembly should pass through this ring.
3. Install pump lever (31), lockwasher (30) and nut (29) using C161-25 wrench.

NOTE: Pump lever should be mounted on throttle shaft so that pump link hole is under pump rod, and lever is pointing upward when throttle is closed.

4. Assemble the throttle body to the fuel bowl assembly with two screws (48) and lockwashers (47).
5. Install pump lever link (27), inserting long end of link into pump rod and install pump link retainer (28). Short end of link is installed in pump lever; long end in pump rod.
6. Place air intake gasket (12) on fuel bowl and assemble air intake assembly to fuel bowl assembly with six screws (6) and lockwashers (7). Tighten screws evenly and securely.
7. Install large hex plug (3) in top of fuel bowl cover. Tighten with 13/16" open end wrench.
8. Hold throttle lever in a closed position and turn throttle stop screw IN just to the point of contact with throttle body stop, then turn screw IN 1½ additional turns as a preliminary adjustment.
9. Check power jet vacuum passage in face of mounting flange for 1/8" x 40 threaded hollow vacuum passage screw (33). The screw should be in this passage if a speed governor is used on the engine. Always use a slotted type gasket (32) when screw is used. The screw should not be used, if no speed governor is used.
Assembly is now completed.

HOLLEY 1940 ONE-BARREL CARBURETOR

DESCRIPTION AND OPERATION

The Holley 1940 one-barrel carburetor used on the 300 CID engines includes four basic fuel metering systems. The idle system provides a reasonable rich mixture for smooth idle and a transfer system that operates during low speeds. The main metering system provides the most economical mixture for normal cruising conditions. The accelerator pump system mechanically provides additional fuel during acceleration. The power enrichment system provides a richer mixture when high power output is desired. In addition to these four basic systems, there is a fuel inlet system that constantly supplies the fuel to the metering systems.

The choke system supplies a rich mixture to start the engine when cold and a slightly richer than normal mixture for cold engine operation. The 1940 carburetor is equipped with a hand choke located on the dash.

FUEL INLET SYSTEM (FIG. 14)

All fuel enters the fuel bowl through the fuel inlet fitting in the carburetor body. The "viton" tipped fuel inlet needle seats directly in the fuel inlet fitting. The needle is retained by a cap that permits the fuel to flow out of holes in the side of the cap. The design of the fuel bowl eliminates the need for a fuel baffle. The fuel inlet needle is controlled by a dual lung nitrophyl (a closed cellular buoyant material which cannot collapse or leak) float and a stainless steel float lever which is hinged by a stainless steel float shaft.

The fuel inlet system must constantly maintain the specified level of fuel as the basic fuel metering systems are calibrated to deliver the proper mixture only when the fuel is at this level. When the fuel level in the bowl drops, the float also drops permitting additional fuel to flow past the fuel inlet needle into the bowl.

The float chamber is vented internally into the air horn. At idle speed the float may be vented externally to the fuel canister.

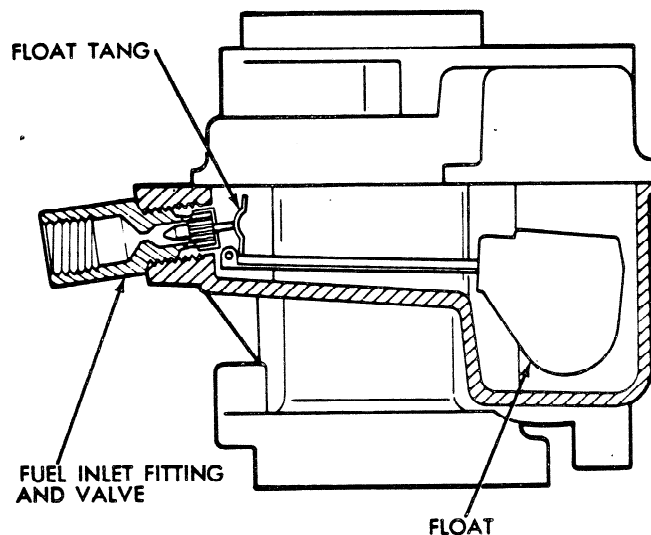


FIG. 14 Fuel Inlet System, Model 1940

IDLE SYSTEM (FIG. 15)

Fuel used during curb and low speed operation flows through the main jet into the main well.

An angular connecting idle well intersects the main well. An idle tube is installed in the idle well. Fuel travels into the idle well and through the restriction into the idle tube. This metered fuel mixes with air which enters through the idle air bleed located in the fuel bowl cover.

At curb idle the air and fuel mixture flows down the idle channel and is further mixed or broken up by air entering the idle channel through the transfer slot which is above the throttle valve at curb idle.

During low speed operation the throttle valve moves, exposing the transfer slot to manifold vacuum and fuel begins to flow through the transfer slot as well as the idle port. As the throttle valve is opened further and engine speed increases, the air flow through the carburetor also increases. This increased air flow creates a vacuum or depression in the venturi and booster nozzle and the main metering system begins to discharge air and fuel.

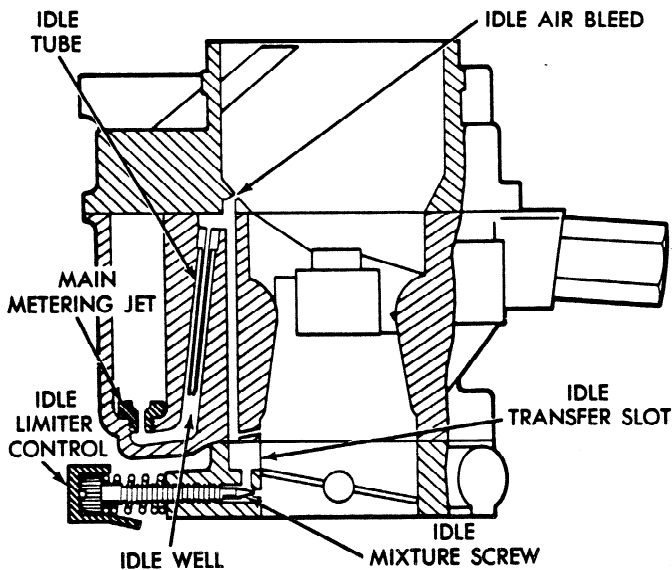


FIG. 15 Idle System, Model 1940

MAIN METERING SYSTEM (FIG. 16)

As the engine approaches cruising speed, the increased air flow through the venturi creates a greater vacuum (low pressure area) in the venturi of the carburetor. Near atmospheric pressure present in the bowl above the fuel causes the fuel to flow to the lower pressure area created by the venturi and is magnified by the dual booster venturi.

Fuel flows through the main jet into the main well; air enters through the main well air bleed and into the main well through holes in the main well tube. The mixture of air and fuel being lighter than raw fuel responds faster to changes in venturi vacuum and is also more readily vaporized when discharged into the venturi.

The main discharge nozzle passage is a part of the dual booster venturi, which is an integral part of the main body casting. Distribution tabs in the main venturi provide the proper distribution of the air-fuel mixture between cylinders for specific engine applications.

The main metering system is calibrated to deliver a lean mixture for best overall economy. When additional power is required, a vacuum-operated power system enriches the air-fuel mixture.

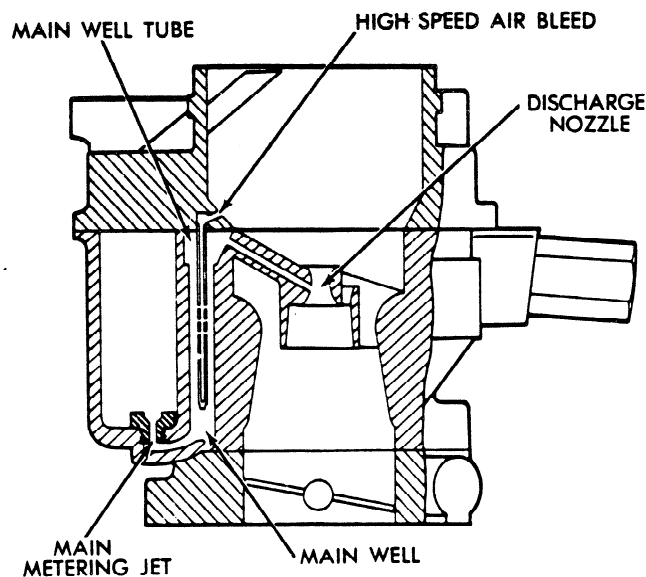


FIG. 16 Main Metering System, Model 1940

POWER ENRICHMENT SYSTEM MODEL 1940 (FIG. 17)

The power enrichment system consists of a power valve installed near the center of the carburetor body and a vacuum piston installed in the bowl cover. A vacuum passage leads from the top of the piston down to the manifold flange.

When the manifold vacuum is high, the vacuum piston is raised to the top of its cylinder and the spring on the piston is compressed.

When the manifold vacuum drops to a predetermined level, the spring overcomes the vacuum and pushes the piston stem down. The piston stem in turn pushes the power valve down, opening the power valve and permitting fuel to flow through the power valve, through the power valve channel restriction and into the main well located near the power valve.

The power valve originally used in the model 1940 is a three-piece valve sold as an assembly. Later model 1940 carburetors used a one-piece, two-stage power valve (Figure 17).

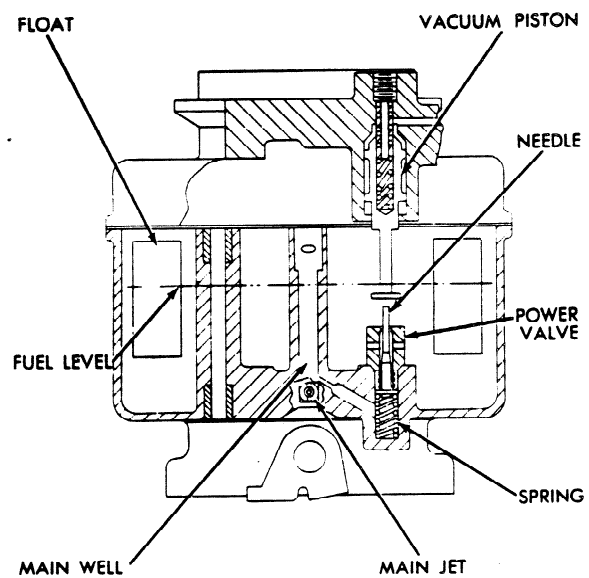


FIG. 17 Power Enrichment System

ACCELERATOR PUMP SYSTEM (FIG. 18)

When the throttle plates are opened suddenly, the air flow through the carburetor increases almost immediately; however, there is a brief time interval or lag before the fuel can overcome its inertia and attain required flow to maintain the desired air-fuel ratio.

The piston type accelerating pump system mechanically supplies the fuel necessary to overcome this deficiency for a short period of time.

Fuel enters the pump cylinder from the fuel bowl through the pump cup stem clearance hole when the pump is lifted to a refill position. The fuel level is above the normal position of the pump piston. This is known as a wet pump system.

As the throttle lever is moved, the pump link operating through a system of levers and a drive spring, pushes the pump piston down seating the pump cup against the face of the stem. Fuel is forced through a passage around the pump discharge jet which is drilled in the main body.

When the pump is not in operation, vapors or bubbles forming in the pump cylinder can escape through the stem clearance hole of the floating piston cup and past the pump stem.

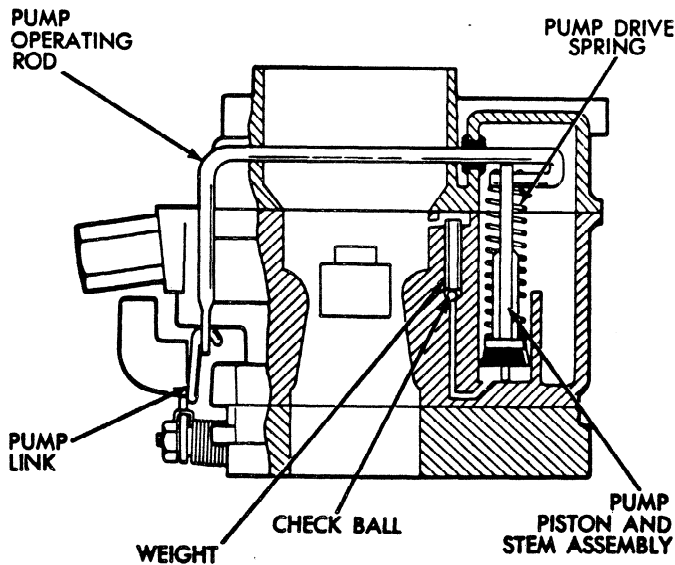


FIG. 18 Accelerator Pump System

ADJUSTMENTS

REPLACING IDLE MIXTURE SCREW

Reinstall the idle mixture screw and turn screw lightly against its seat with the fingers. Back off the exact number of turns recorded during disassembly. With the idle speed screw backed off and throttle plate completely closed, check the PUMP PISTON STROKE ADJUSTMENT (distance from the vacuum passage casting to the center of the hole in pump operating rod).

IDLE SPEED ADJUSTMENT

A stop screw controls the engine idle speed. Run the engine until normal operating temperature has been reached. Turn the idle stop screw "in" to increase the engine speed and "out" to decrease the engine speed.

CARBURETOR IDLE MIXTURE ADJUSTMENT (ON ENGINE)

CAUTION: Idle speed and fuel mixture adjustments must be made with the ENGINE AT NORMAL OPERATING TEMPERATURE and engine air cleaner in place.

1. Connect tachometer to engine. Tachometer must be 1%-2% accurate and have expanded scale of 1-1000 or 400-800 RPM.
2. Be sure engine is thoroughly warmed up. Adjust "idle speed" screw to specified RPM per idle speed adjustment.

Turn the mixture adjusting needle in until the engine begins to run rough from the lean mixture. Slowly turn the needle out until the engine begins to "roll" from the rich mixture. Then slowly turn the needle in until the engine runs smoothly. Always favor a slightly rich mixture rather than a lean setting.

It may be necessary to reset the idle speed stop screw after the correct idle mixture is obtained.

DISASSEMBLY

The model 1940 carburetor is assembled of three major sub-assemblies. These assemblies are the air horn or bowl cover, carburetor body assembly and throttle body assembly. Servicing of the carburetor can be simplified if these sub-assemblies are disassembled and kept together in their respective groups.

THE FOLLOWING PROCEDURES APPLY TO THE MODEL 1940

1. Remove nut and lockwasher retaining the pump rocker arm and pump link.
2. Remove the bowl cover screws.
NOTE: The position of the link in the rocker arm slots and the position of the throttle return spring or the positive throttle return spring on some model applications for proper reassembly (Figure 19).
3. Separate the bowl cover from the carburetor body. Do not pry. Tap gently from side to side with a plastic hammer or screwdriver handle.
4. Remove the accelerating pump operating rod retainer screw and retainer.
5. Rotate the pump operating rod and disconnect the pump drive spring and accelerating pump assembly (Figure 20). Set the pump assembly aside. Do not immerse in cleaner. A new pump cup is in the kit.
6. Rotate the pump operating rod and remove the rod and grommet from the bowl cover (Figure 21).
7. With a bearing scraper or a scraper ground from an old triangle file remove all the staking from the vacuum piston retainer (Figure 22).
8. With a suitable puller or long nosed pliers and support, remove the vacuum piston assembly (Figure 23).
9. Remove bowl vent valve from rod if so equipped. The rod cannot be removed.
10. Remove hot idle compensator valve cover, valve and gasket from cover, if so equipped.

This normally completes disassembly of the bowl cover. If the carburetor is equipped with a mechanical power valve modulator rod it cannot be removed.

CAUTION: Unless the choke valve is bent or damaged DO NOT REMOVE the choke valve screws, valve or shaft for normal service.

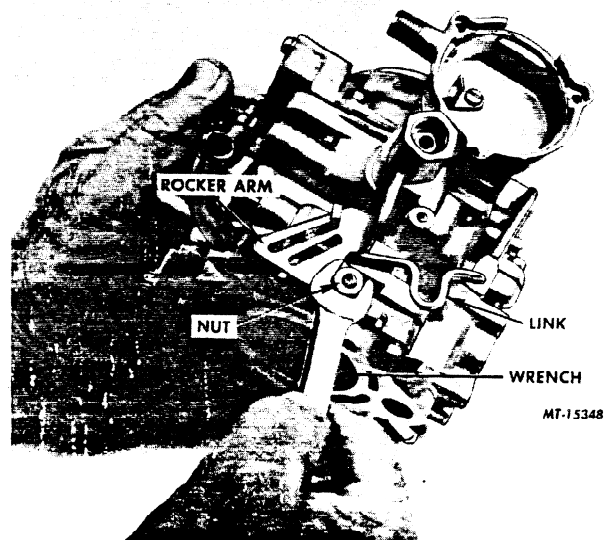


FIG. 19 Remove or Install Accelerator Pump Rocker Arm

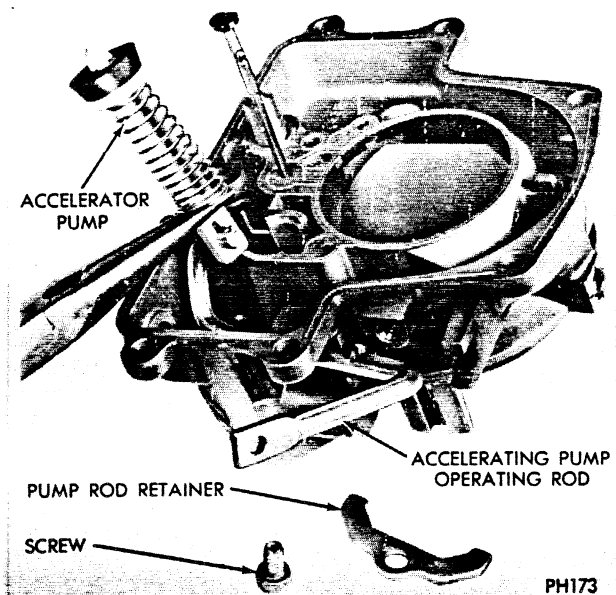


FIG. 20 Remove or Install Accelerator Pump Assembly

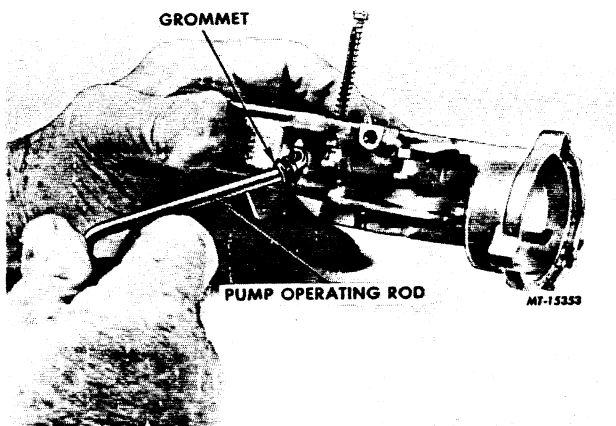


FIG. 21 Remove or Install Accelerator Pump Operating Rod and Grommet

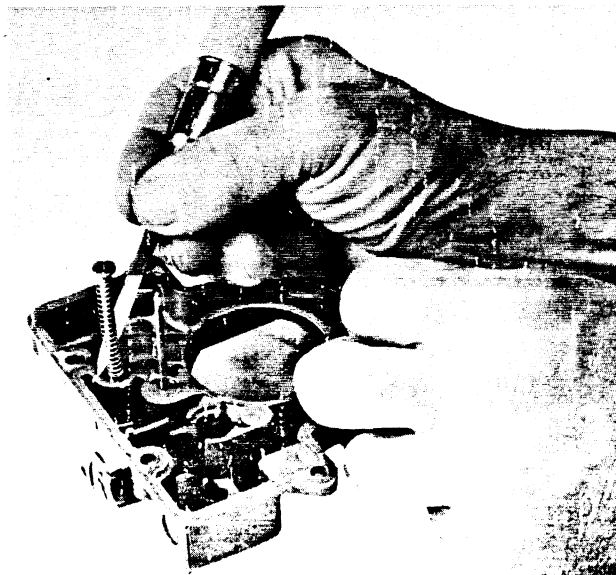


FIG. 22 Remove Staking from Vacuum Piston Retainer

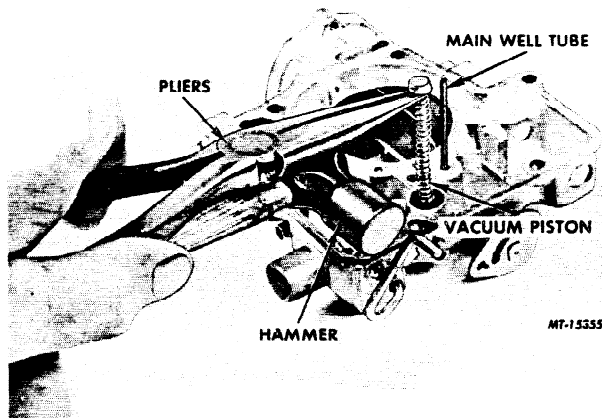


FIG. 23 Removing the Vacuum Piston Assembly

CARBURETOR BODY DISASSEMBLY

1. Turn the carburetor body upside down and remove the pump discharge ball and weight (Figure 24). Save the old ball in case the seat needs staking (Figure 32).
2. Remove the fuel inlet valve and fitting assembly; remove gasket. Remove spring float shaft retainer, float shaft and float (Figure 25).

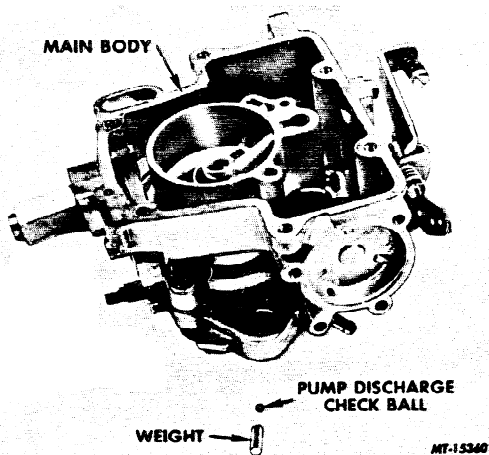


FIG. 24 Remove or Install the Pump Discharge Ball and Weight

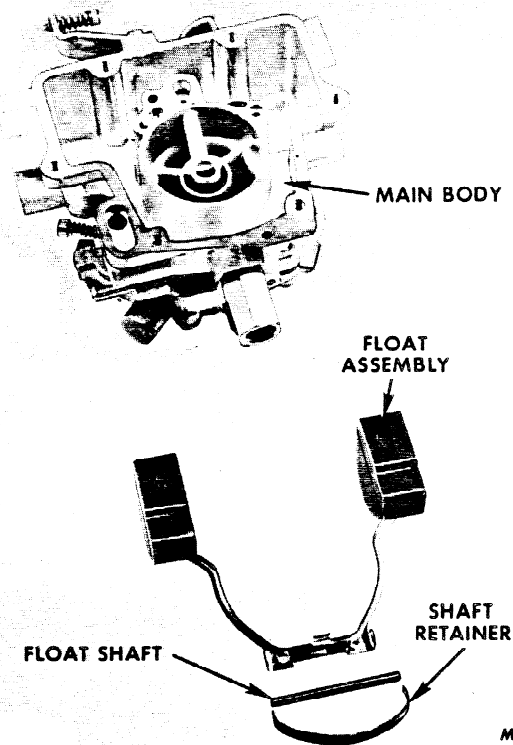


FIG. 25 Remove or Install the Float Assembly

3. Remove the main jet with a jet wrench. A 3/8" wide square point screwdriver may be used (Figure 26).
4. Remove the power valve assembly with a proper socket or a 3/8" wide screwdriver blade with a 1/16" x 3/8" deep slot sawed in the center of the blade. The slot will clear the power valve stem and prevent damage (Figure 27).

This completes the disassembly of the carburetor body. Remove the three carburetor body to throttle body screws. Tap gently and separate the throttle body from the main body (Figure 28).

THROTTLE BODY DISASSEMBLY

1. Gently turn the idle mixture screw clockwise until it seats. Record the starting position of the slot and the exact number of turns required to seat the screw. This procedure is necessary to reinstall it in the same position after cleaning:
2. Remove the curb idle screw and spring, low idle screw and spring and fast idle screw and spring. Certain applications may not have all of these screws (Figure 29).
3. Carefully inspect the throttle valve for nicks or burrs and the throttle shaft for wear. **Do not remove the throttle valve.** If damage or wear is evident, the throttle body or carburetor must be replaced. If the idle mixture screw is bent or grooved it must also be replaced. Correct idle adjustment cannot be achieved with a grooved or damaged idle mixture needle or screw.

CLEANING

Carburetor cleaning is thoroughly covered in a previous section. During cleaning the bowl cover should be placed on top of the other parts in the basket with the main well tube projecting upward and protected. It is a part of the bowl cover and cannot be replaced. Blow out passages as shown (Figure 30).

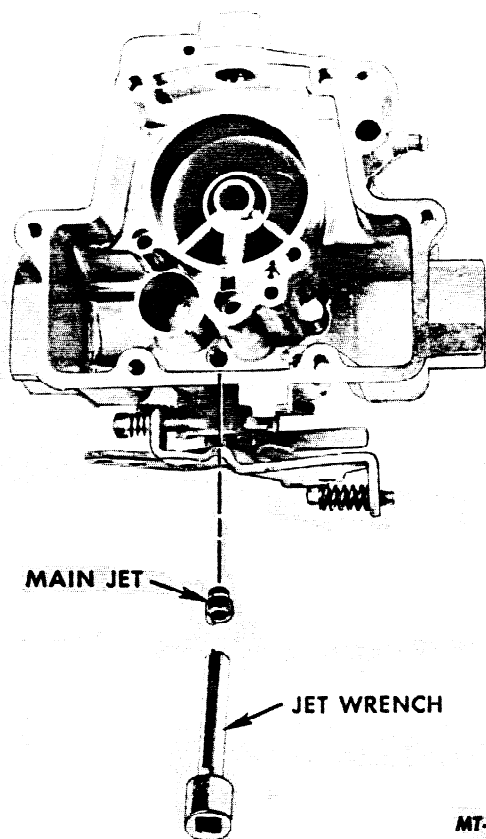


FIG. 26 Remove or Install Main Jet

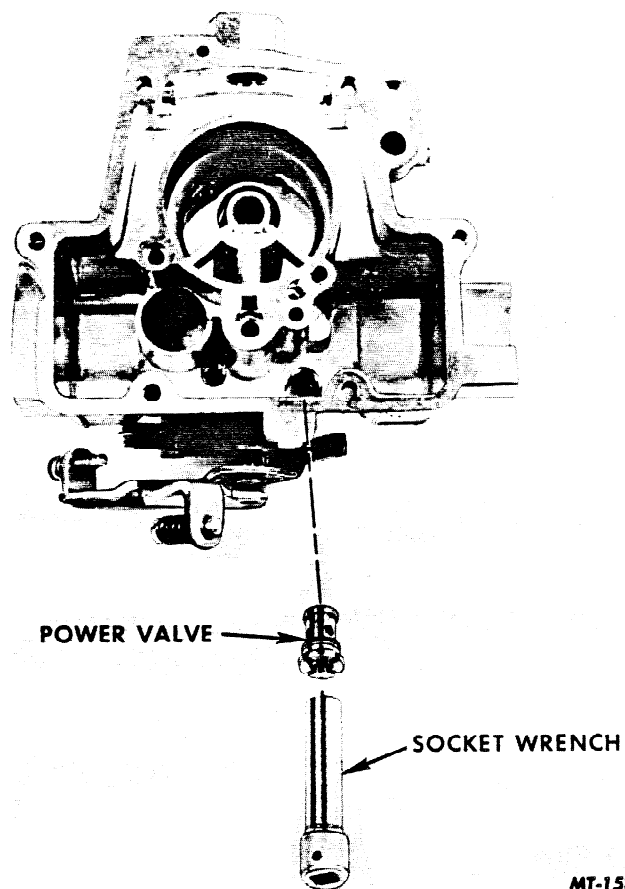


FIG. 27 Remove or Install Power Valve

ASSEMBLY

Except for the following vacuum piston staking operation (Figure 31), and testing the pump discharge valve (Figure 32), reassembly is the reverse of disassembly. Follow Figures No. 29 back to No. 1.

NOTE: Before installing the vacuum piston assembly, be sure to remove all previous staking from the retainer recess. Install the piston in the vacuum cylinder and stake lightly with a suitable tool.

Test the pump discharge valve prior to assembly by filling the pump cylinder with clean fuel. Hold the pump discharge ball and weight down with a small punch or drift and operate the pump plunger by hand. If the valve and seat are leaking fuel will rise around the valve weight and spill over (Figure 32).

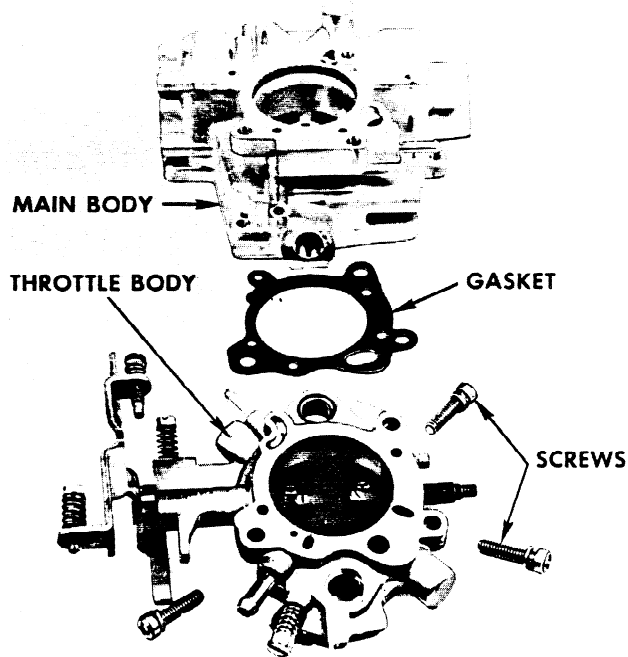


FIG. 28 Separate Throttle Body from Main Body

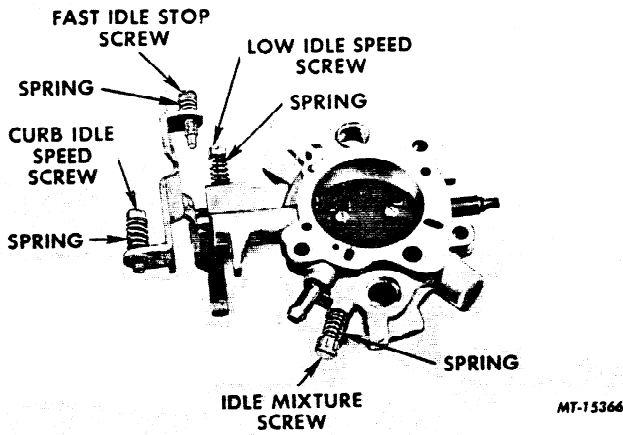


FIG. 29 Throttle Body and Idle Adjustment Screws

ADJUSTMENTS DURING ASSEMBLY

Assemble the throttle body, and assemble the throttle body to the main body. Use a new gasket and torque the screws to 30 in-lbs. in three even steps. Install the main jet and power valve with the proper tools.

If the valve is leaking remove the hexagon weight and lightly stake the seat with the old ball using a suitable punch or drift. Throw the old ball valve away and install the new ball from the kit, at the proper time during reassembly.

Install the float shaft in the float lever and insert assembly in the float shaft cradle. Insert the retaining spring.

Install a new gasket on the new fuel inlet valve (needle and seat).

Hold the retaining spring with the fingers and invert the bowl. A straight edge placed across the surface of the bowl should just touch the toes of the float. (The portion of the float hangs farthest from the fuel inlet.) If necessary bend the float hang to obtain this adjustment (Figure 33). Complete the reassembly.

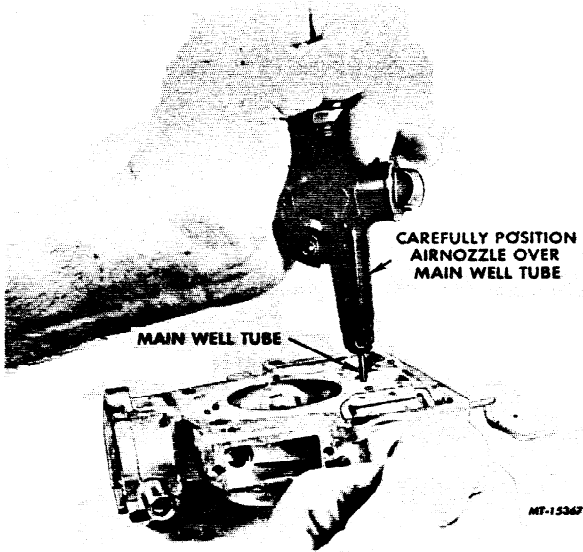


FIG. 30 Blowing Out Main Well Tube

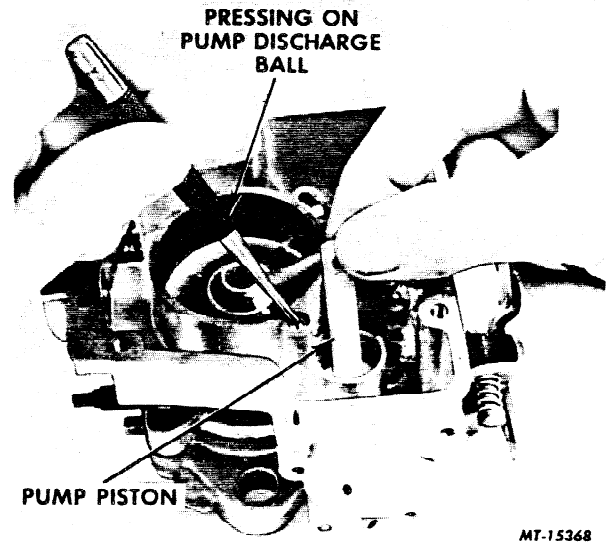


FIG. 32 Testing the Accelerator Pump System

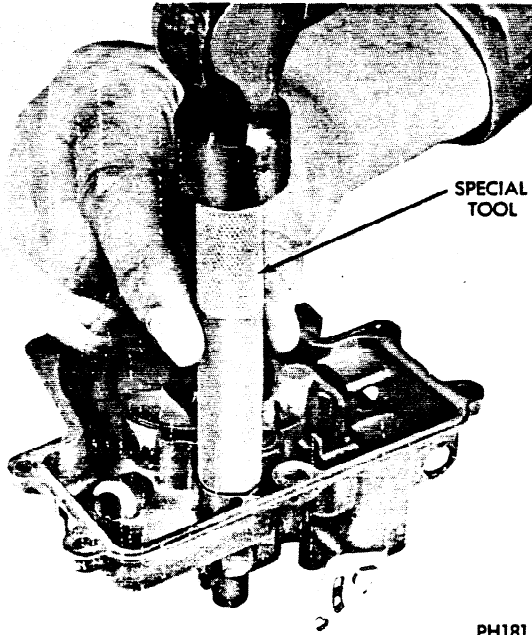


FIG. 31 Staking the Vacuum Piston

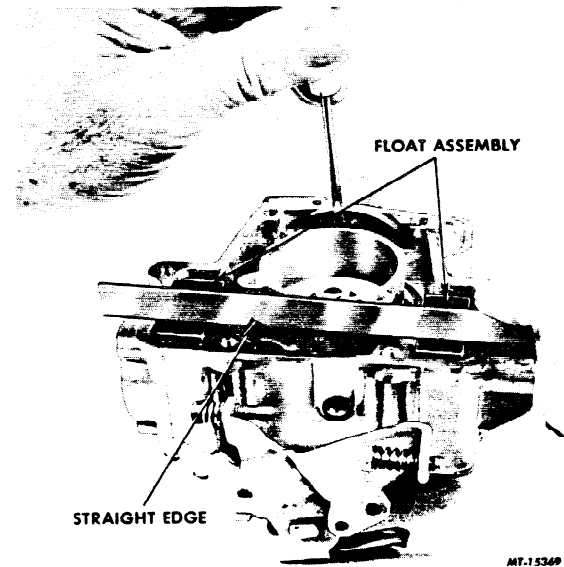


FIG. 33 Testing Dry Float Adjustment

HOLLEY MODEL 1904 ONE-BARREL CARBURETOR DESCRIPTION

The Holley model 1904 single-barrel carburetor (Figure 34) is used on the 300 CID engines. It consists of two main assemblies, the main body and the throttle body.

The main body contains the float, fuel-inlet valve, fuel bowl, the carburetor air inlet, the main and booster venturi, the choke plate, the main well body, the power fuel assembly, and the accelerating pump assembly. The main well body contains the majority of the fuel passages and the fuel metering parts.

The throttle body houses the throttle plate, the idle discharge ports, the idle speed screw, and the idle fuel mixture adjustment needle.

OPERATION

The carburetor has four fuel metering systems to provide the correct fuel-air mixture for all phases of engine operation. The four systems are: the idle fuel system, the main fuel system, the accelerating system, and the power fuel system. In addition, a fuel inlet system regulates the fuel supply to the various systems, and a manual choke provides an enriched mixture to aid in starting and running a cold engine.

FUEL INLET SYSTEM

Fuel under pressure from the fuel pump enters the float chamber through the fuel inlet needle valve and seat assembly (Figure 35).

Movement of the needle valve in relation to the seat is controlled by the float and lever assembly which rises and falls with the fuel level. As the fuel level drops, the float lowers, opening the needle valve to admit fuel. When the fuel in the float chamber reaches a pre-set level, the float moves the needle valve to a position where it restricts the

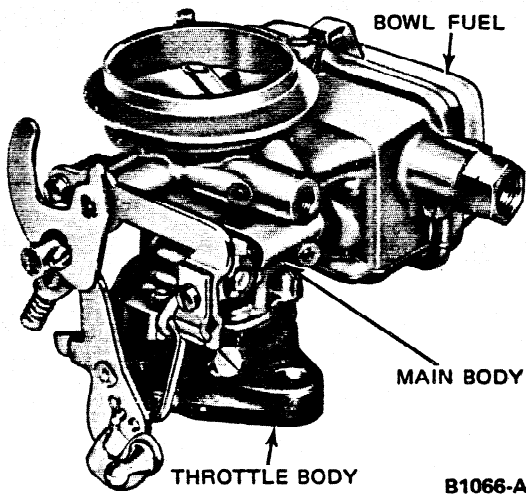


FIG. 34 Holley Single-Barrel Carburetor

flow of fuel into the float bowl. Changes in the fuel level cause a corresponding movement of the float which opens or closes the needle valve to maintain the pre-set fuel level. This level must be maintained because the carburetor is calibrated to deliver the proper mixture only when the fuel is at this level.

A spring and pin are located in the hollow needle valve to cushion the valve against vibrations. A clip, to assure reaction of the valve to any float movement, is attached to the valve and float.

IDLE FUEL SYSTEM

During idle, fuel passes through the main jet into the bottom of the main well (Figure 36). High manifold vacuum acting through the idle passages draws fuel from the main well through a short horizontal passage into the idle well.

The fuel is metered through a calibrated restriction, at the top of the idle well, on its way into the idle channel. Air is introduced through an idle air bleed at the top of the idle channel. The air bleed also acts as a vent to prevent siphoning at high speeds or when the engine is stopped. The fuel-air mixture travels down the idle channel past two idle transfer holes in the throttle body and is discharged through the idle discharge hole below the closed throttle plate. As the throttle plate is moved past the two transfer holes, during off idle, each hole begins to discharge fuel as it is exposed to manifold vacuum. The transfer holes act as additional air bleeds at idle.

Fuel discharge at idle is controlled by an idle adjusting needle which seats in the discharge hole.

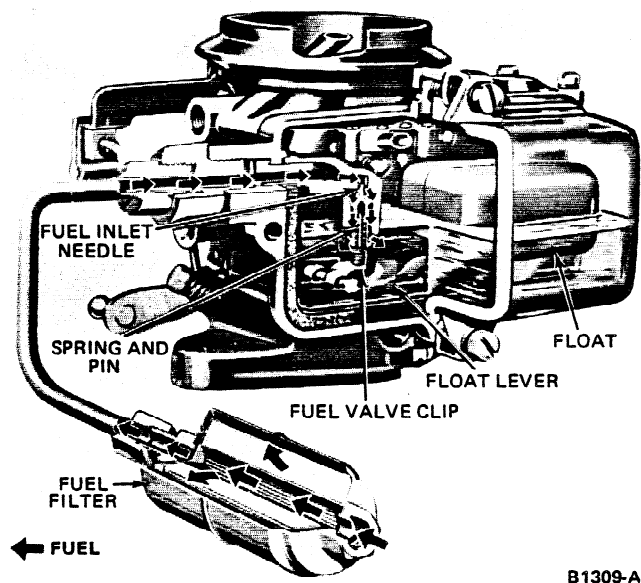


FIG. 35 Fuel Inlet System

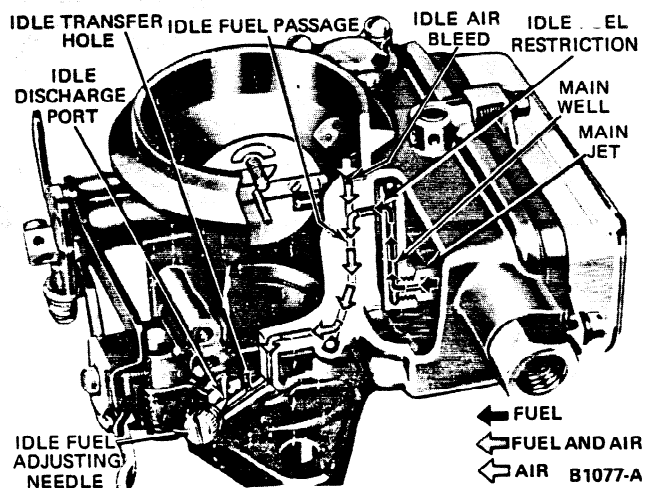


FIG. 36 Idle Fuel System

MAIN FUEL SYSTEM

The velocity of air flow through the carburetor increases as the throttle plate opens. When this causes a great enough pressure drop in the venturi, the main metering system starts flowing. Fuel from the idle system tapers off as the main system begins discharging fuel. At this time, there is a definite blend of the idle and main systems.

Fuel passes through the main jet into the bottom of the main well and flows up the main well (Figure 37). Filtered air from the carburetor air inlet passes through the high speed air bleed into the air bleed well and enters the fuel in the main well through three short horizontal air passages. This mixture of fuel and air, being lighter than raw fuel, responds faster to any change in venturi pressure and also vaporizes more readily when it is discharged. The fuel continues up the main well and flows into the main discharge nozzle where it is sprayed onto the open choke plate and the walls of the booster venturi. Here, the mixture is vaporized and mixed with the air stream passing through the booster venturi. It then passes the throttle plate into the intake manifold.

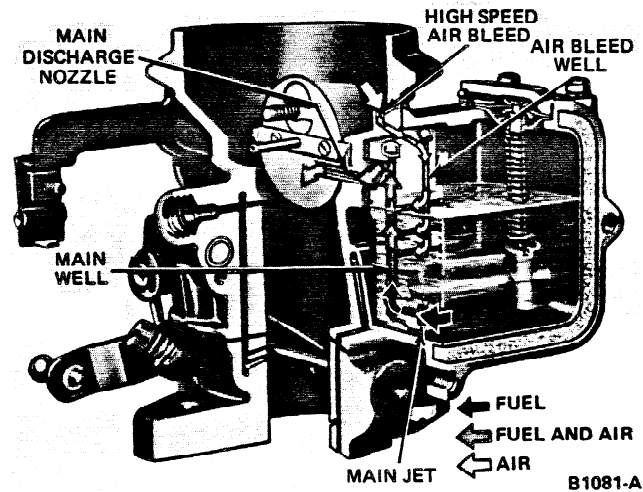


FIG. 37 Main Fuel System

ACCELERATING SYSTEM

During periods of sudden acceleration, the air flow through the carburetor responds very quickly to a sudden throttle opening. However, there is a brief interval before the heavier fuel-air mixture in the narrow passages can gain speed and maintain the desired balance of fuel and air. The accelerating system (Figure 38) operates during this interval to supply fuel until the other systems can provide the proper mixture.

When the throttle is suddenly opened, the diaphragm, which is connected by linkage to the throttle, forces fuel from the pump chamber into the pump discharge passage. The fuel under pressure forces the pump discharge ball check valve and weight up. The fuel then passes into the pump discharge nozzle where it is sprayed into the air stream of the venturi. The discharge nozzle is vented to prevent siphoning at high engine speeds.

When the throttle is closed, the pump return spring forces the pump diaphragm toward the back of the pump chamber, drawing fuel into the chamber through the pump inlet. A ball check valve in the pump inlet opens to admit fuel from the float chamber and closes when the pump is operated to prevent a reverse flow of fuel. The outlet ball check valve prevents air from entering when the diaphragm draws fuel into the pump chamber.

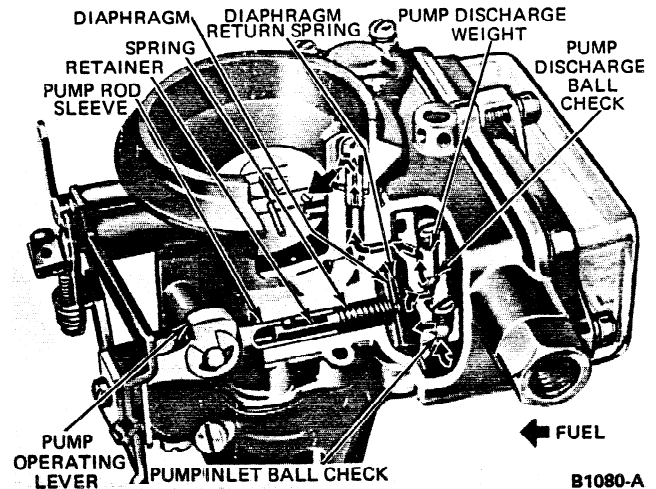


FIG. 38 Accelerating System

POWER FUEL SYSTEM

The power fuel system (Figure 39) operates when additional fuel is required for a richer mixture during high speeds, heavy loads, and for low speeds at full throttle.

Manifold vacuum is transmitted from below the throttle plate through the vacuum passage to the vacuum chamber on top of the diaphragm. At idle and normal speeds the manifold vacuum is great enough to hold the diaphragm up against the tension of the diaphragm spring. This raises the diaphragm stem clear of the power valve. The power valve is held closed by the tension of its spring.

When high power places a greater load on the engine, manifold vacuum is reduced. When the vacuum drops below 7-6 inches of mercury, the diaphragm can no longer overcome the tension of the diaphragm spring and the diaphragm stem is forced down on the power valve. This depresses the pin in the center of the power valve, opening the valve. Fuel from the float chamber flows into the valve and passes through a restriction into a horizontal passage which leads to the main well where it is added to the fuel from the main fuel system.

ADJUSTMENTS

IDLE FUEL MIXTURE ADJUSTMENT

The idle fuel mixture is controlled by the idle mixture adjustment needle (Figure 40). Turn the screw "in" to lean the mixture, and "out" to enrich the mixture. Make the initial mixture adjustment by turning the needle "in" until it lightly touches the seat. Then back off the screw one turn. **Do not turn the needle against the seat tight enough to groove the point. If the needle is damaged, it must be replaced before proper mixture adjustment can be obtained.**

Run the engine for 20 minutes at fast idle speed to bring it to normal operating temperature.

Turn the mixture adjusting needle in until the engine begins to run rough from the lean mixture. Slowly turn the needle out until the engine begins to "roll" from the rich

mixture. Then slowly turn the needle in until the engine runs smoothly. Always favor a slightly rich mixture rather than a lean setting.

It may be necessary to reset the idle speed stop screw after the correct idle mixture is obtained.

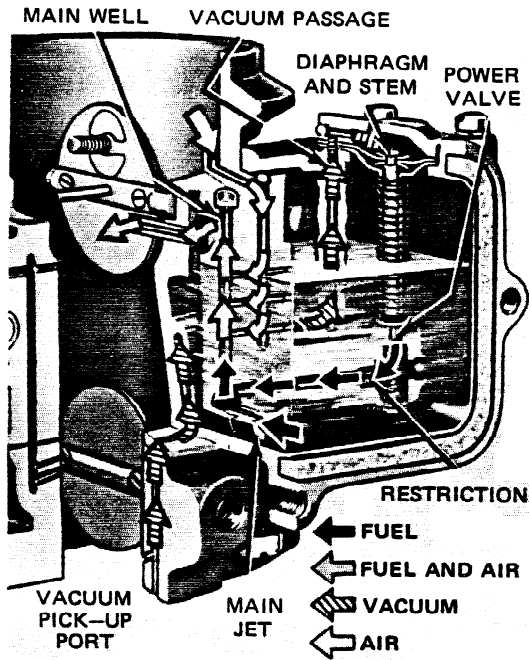


FIG. 39 Power Fuel System

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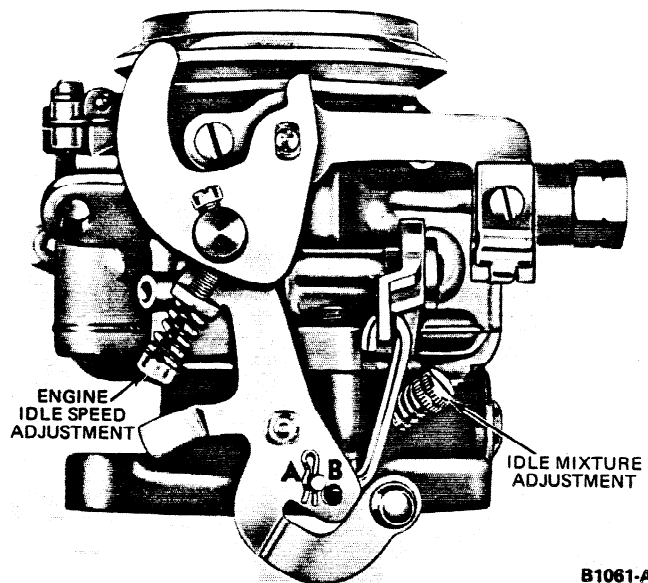
IDLE SPEED ADJUSTMENT

A stop screw controls the engine idle speed. Run the engine until normal operating temperature has been reached. Turn the idle stop screw "in" to increase the engine speed and "out" to decrease the engine speed.

ADJUSTING THE ACCELERATING PUMP STROKE AND CHECKING THE PUMP

The quantity of fuel discharged by the accelerating pump is controlled by changing the position of the pump link in the throttle lever holes. The inner hole is for average or hot weather operation, and the outer hole is for cold weather operation.

To check the accelerating pump, remove the air cleaner, then operate the throttle and observe the fuel flow from the



B1061-A

FIG. 40 Idle Fuel Mixture Adjustment

discharge outlet. If the system is in good condition, a quick steady stream will flow from the outlet when the throttle is opened.

CHECKING AND ADJUSTING FUEL LEVEL

To check the fuel level, remove the power valve diaphragm cover and valve assembly. Place the 6" depth gauge in this opening and crank the engine. Measure the distance from the machined surface to the exact fuel surface.

If the fuel level is not to specifications, remove the fuel bowl and carefully bend the tab on the float to correct the fuel level setting.

REMOVAL

Remove the air cleaner. Disconnect the accelerator rod, choke wire, fuel line, and the distributor vacuum line. Remove the carburetor hold-down nuts, then remove the carburetor and gasket from the manifold.

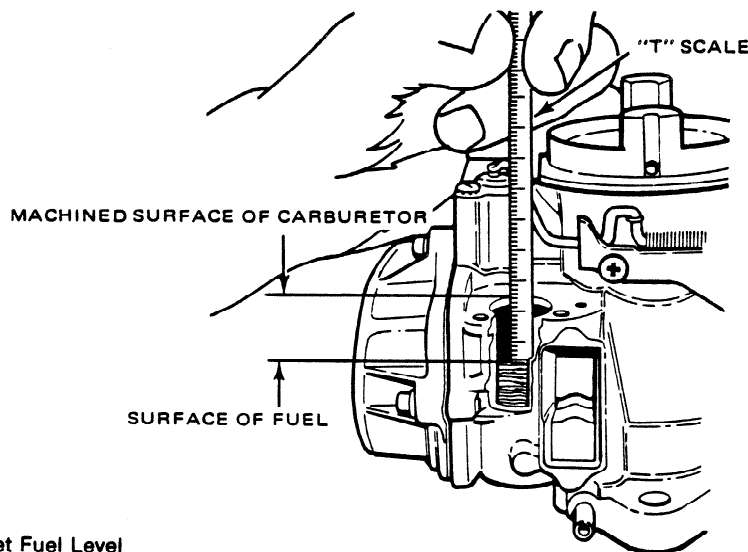


FIG. 41 Testing Wet Fuel Level

DISASSEMBLY

Use a separate container for the component parts of the sub-assemblies to facilitate cleaning, inspection, and assembly.

1. Remove the accelerator pump link cotter pin and slide the upper end of the link out of the pump operating lever. Remove the two throttle body screws and lock washers. Separate the throttle body and main body, and remove the gasket.
2. Remove the fuel inlet fitting with a box wrench, and remove the gasket. Remove the four float bowl retainer screws, lockwashers, and clamps. Remove the retainer, retainer gasket, float bowl, and bowl gasket.
3. Remove the fuel inlet seat screw and gasket located in the fuel inlet opening. Remove the fuel inlet needle valve and float assembly, and the gasket from inside the main body. Remove the float shaft, releasing the float. Slide the fuel inlet needle assembly off the float lever tab. Remove the wire clip, spring, and plunger from the fuel inlet needle. Remove the three power valve diaphragm screws and lockwashers, then lift the power valve diaphragm and stem assembly out of the main body. Separate the cover from the diaphragm and stem assembly.
4. Remove the five main well screws and lock washers, then remove the main well. Remove the pump return spring from the metal disc on the accelerating pump piston, then remove the spacer gasket. Pull the accelerating pump diaphragm out of the main body. Remove the pump operating lever retainer, then slide the lever off the stud. Remove the choke bracket screw and lockwasher, the choke plate screw and lockwasher, and the choke shaft locating screw and lockwasher. Slide the choke shaft and lever assembly out of the main body, then remove the choke bracket. Slide the main discharge nozzle out of the main body, then remove the choke plate and valve assembly. Invert the main body and remove the distributor passage ball retainer and the distributor passage ball.
5. Remove the main jet, the pump inlet check valve retainer, and the pump discharge valve retainer from the main well body. Invert the body, allowing the pump inlet check ball, pump outlet check ball weight and check ball to fall out into the hand.
6. Press the pump rod sleeve toward the diaphragm until the pump rod sleeve retainer ball drops out. Remove the pump rod sleeve and spring.
7. Remove the idle adjusting needle and spring. Remove the pump link cotter pin and link.

On carburetors equipped with a dashpot, remove the dashpot lever.

At times it may be necessary to remove the throttle plate and shaft to accomplish a thorough cleaning job. If this is done, be sure to mark the throttle plate before removal so it can be installed in exactly the same position. Throttle plates and shafts cannot be interchanged between carburetors, nor are they serviced as separate parts.

CLEANING AND INSPECTION

Many carburetor troubles are the result of deposits accumulating in the carburetor. A thorough cleaning must be performed to assure satisfactory carburetor performance.

CLEANING

Soak all castings and metal parts in a cleaning solution to soften and loosen all foreign deposits. If a commercial carburetor cleaning solvent is not available, lacquer thinner or denatured alcohol may be used.

INSPECTION

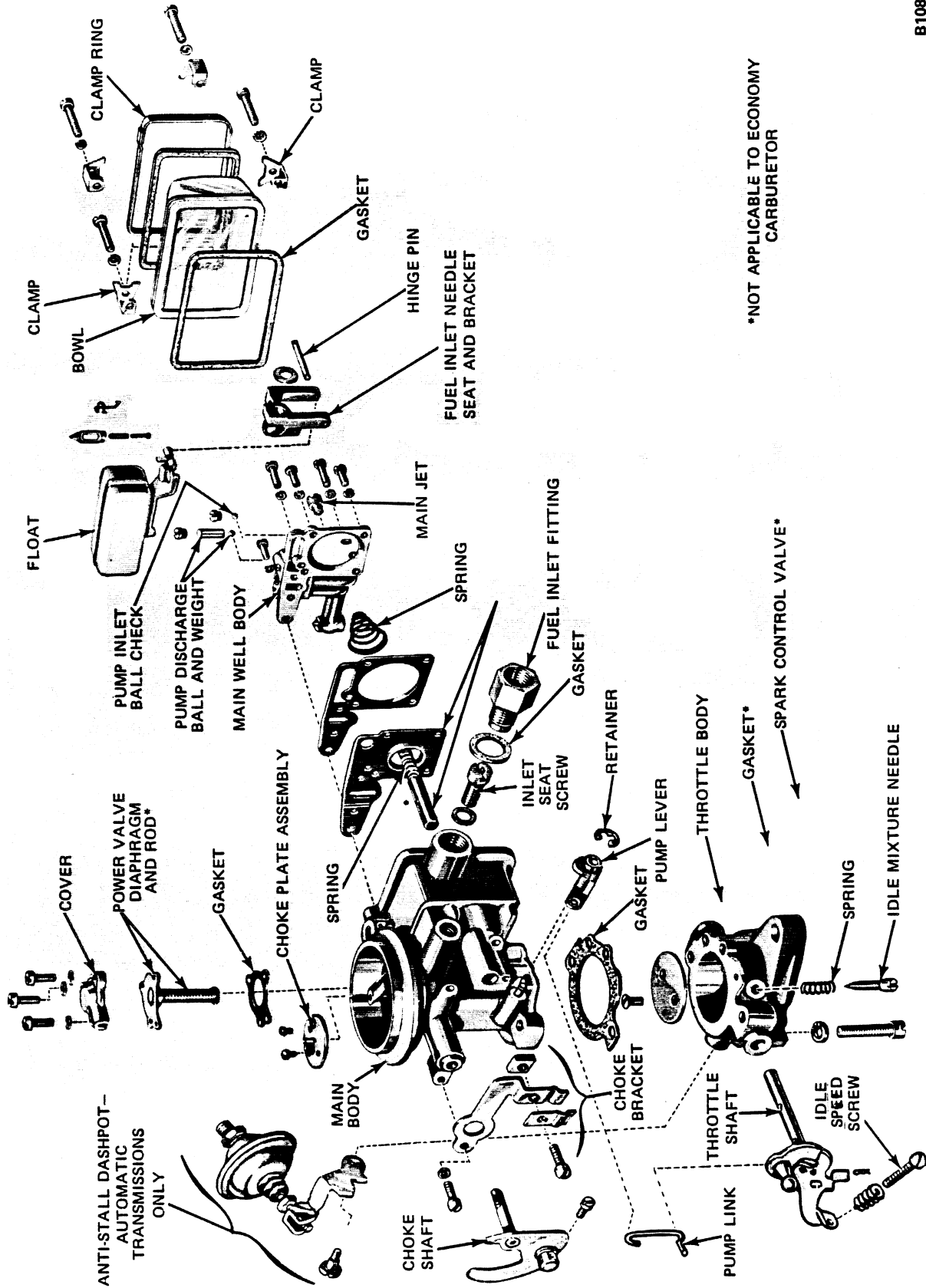
Replace the float if it leaks or if the assembly is damaged in any way. Replace the main body if the protective plating is damaged exposing bare metal to corrosion. Check the action of the poppet valve in the choke plate, and free it up if necessary. Replace the choke lever and shaft assembly if the threads in the shaft are stripped or if it is not securely riveted to the lever.

ASSEMBLY

Always install new gaskets when rebuilding the carburetor. A carburetor overhaul kit is available for service. A disassembled view of the carburetor is shown in Figure 42.

1. Install the pump link in the throttle lever, then secure it with a cotter pin. Install the idle adjusting needle and spring. Turn the needle in gently with the fingers until it seats, then back it off 1½ turns for a preliminary idle adjustment. **To avoid grooving the tip of the needle, do not force the needle against its seat.**
2. Install the distributor passage ball and ball retainer. Place the choke bracket in position on the main body and install the choke bracket screw and lockwasher. Insert the choke plate and valve assembly into the main body. The poppet valve stem should be pointing down. Install the main discharge nozzle. Slide the choke shaft in position and install, but do not tighten, the choke plate screw. Close the choke plate and hold the main body up to the light. Little or no light should show between the choke plate and the walls of the bore. Make sure the choke plate does not bind, then tighten the choke plate screw. Install the choke shaft locating screw and lockwasher.
3. Place the pump operating lever on the stud in the main body, and fit the pump operating lever retainer on the stud. Place the spring on the pump diaphragm rod, and press the pump rod sleeve into the rod to compress the spring. Drop the pump rod sleeve retainer ball into the hole in the sleeve. **Be sure the main discharge nozzle gasket is in place in the main body,** then position the pump assembly in the main body. Place the main well spacer gasket over the pump assembly.
4. Insert the pump inlet check ball, and the pump outlet check ball in the main well body. **The pump inlet check ball is slightly larger than the pump outlet check ball. Be sure they are installed in their proper chamber.** Seat the check balls with one gentle tap of a light hammer and a soft brass drift. Be sure the check balls move freely in their chambers, then install the pump inlet check ball retainer, and the outlet check ball weight and retainer. Install the main jet in the main well body.
5. Seat the large end of the pump return spring in the metal disc on the accelerating pump diaphragm. Position the main well body screws and lock washers in the body. The two long screws are placed in the center top and center bottom holes; the short screws are used in the three remaining holes. Insert the power valve end of the main well body into the main body, then press the main well body into position against the spacer gasket as follows:
 - Apply pressure with the index finger against the protruding end of the pump rod sleeve, to fully compress the pump return spring, as the thumb presses the main well body into position. This will prevent the pump return spring pressure from disturbing the alignment of the holes in the diaphragm, spacer gasket, and main body. Before releasing the pump rod sleeve, tighten the five main well body screws.
6. Position the power valve gasket, power valve diaphragm stem assembly, and the power valve body cover in the main body. Install the three power valve body cover screws and lockwashers.

B1084-B



*NOT APPLICABLE TO ECONOMY CARBURETOR

FIG. 42 Holley Single-Barrel Carburetor

7. Place the fuel needle plunger, and insert the hollow fuel inlet needle into the fuel inlet needle seat. Guide the needle into the inlet needle seat, and position the float lever bracket arms. Install the fuel inlet needle seat on the fuel inlet fitting boss in the main body. Place the seat screw through the inlet seat screw which rides into the fuel bowl. Set the float and fuel inlet assembly into position. Insert the carburetor hinge bracket to prevent the seat screw is tightened. Then remove the gauge. Invert the main body assembly on the float with a 6" steel rule on the float arm to bring the float setting within limits. This should provide the fuel level. Install a new float bowl gasket over the bowl. Place the retainer on the bowl, and set the bowl into position. Install the

- lockwashers. Tighten the two end screws, alternating the screws. Install the gasket (approximately 8-10 lbs) and overtighten these screws. Install the dashpot if so equipped.
11. Place a new throttle body gasket with the corresponding holes in the body. Insert the two throttle body lockwashers through the throttle body to maintain gasket alignment. Insert the throttle body. Invert the carburetor, and two throttle body screws evenly. Insert the pump link through the throttle end operating lever, and install the throttle pin

INSTALLATION

If the carburetor to intake manifold gasket is available, install a new one. Place the carburetor on the manifold and secure it with the lockwashers and nuts evenly. Connect the choke cable to the throttle linkage on the carburetor, and adjust if necessary. Connect the distributor vacuum line to the carburetor and tighten the clamp. Be sure the distributor gasket is properly seated. Adjust idle fuel mixture and speed, and set the fuel level, and adjust it if necessary.

Part 4 Charging System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
DESCRIPTION AND OPERATION		On-Vehicle Test	4-03
Alternator	4-01	Bench Test	4-06
DIAGNOSIS AND TESTING		ADJUSTMENTS	
MOTOROLA	4-02	Belt Adjustments	4-07
DIAGNOSIS AND TESTING		REMOVAL AND INSTALLATION	4-08
FORD ALTERNATOR	4-03	OVERHAUL	4-08

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.

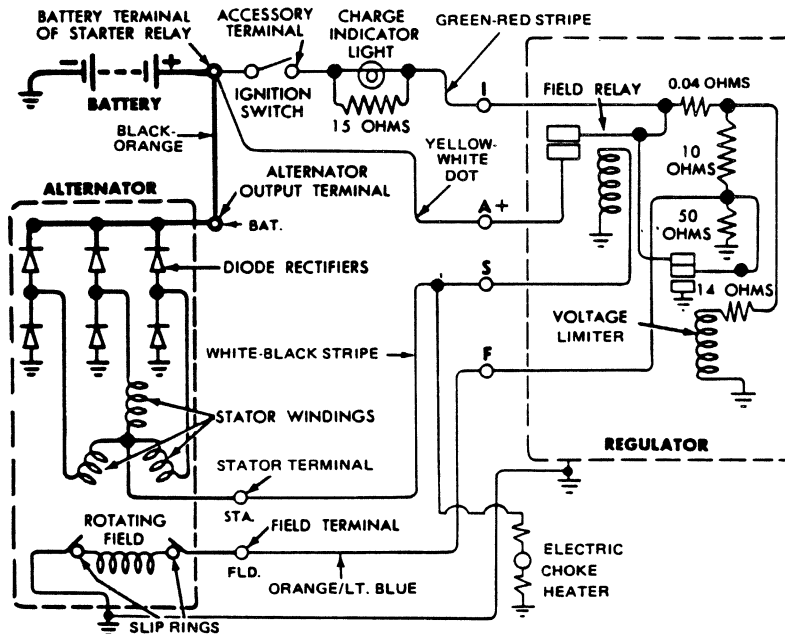
The alternator produces power in the form of alternating current. The alternating current is rectified to direct current by six diodes. The alternator regulator automatically adjusts the alternator field current to maintain the alternator output voltage within prescribed limits to correctly charge the 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 300 Engines use 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

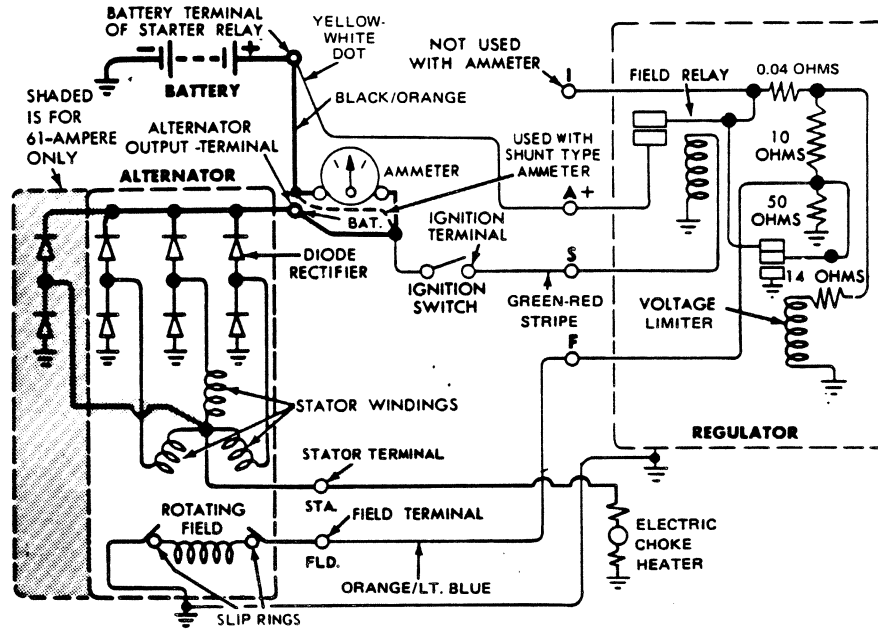


FIG. 2 Alternator Charging System — Ammeter

J1205-J

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 no charge, alternator warning light 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 the 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.

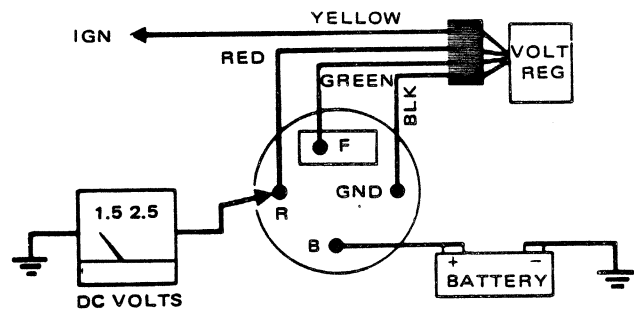


FIG. 3 Ignition On — Engine Not Running

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.

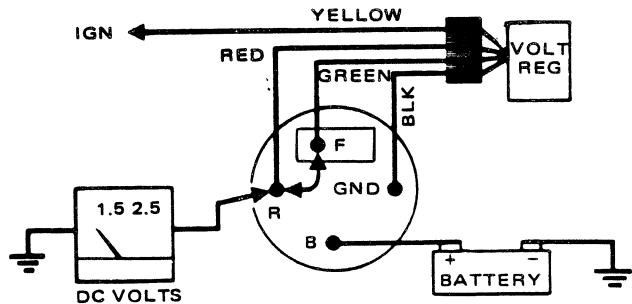


FIG. 4 Ignition On — Engine Not Running

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.

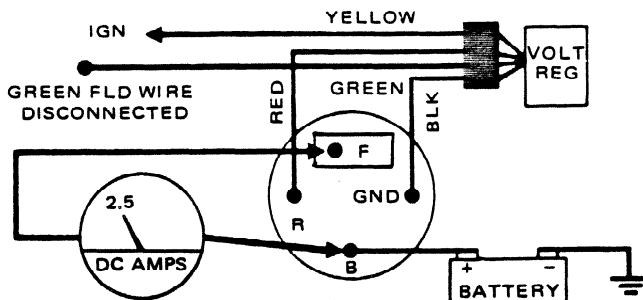


FIG. 5 Field Draw Test — Ignition Off

TEST 4 — IGNITION ON — ENGINE RUNNING AT FAST IDLE

(Refer to Figure 6)

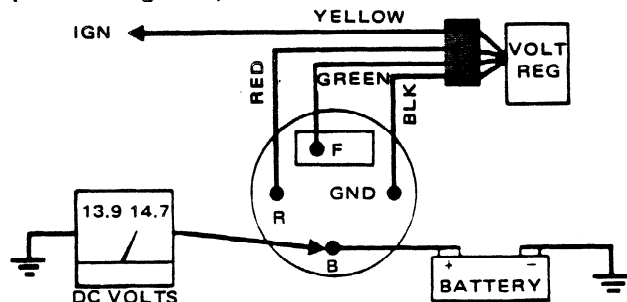


FIG. 6 Ignition On-Engine Running at Fast Idle

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.

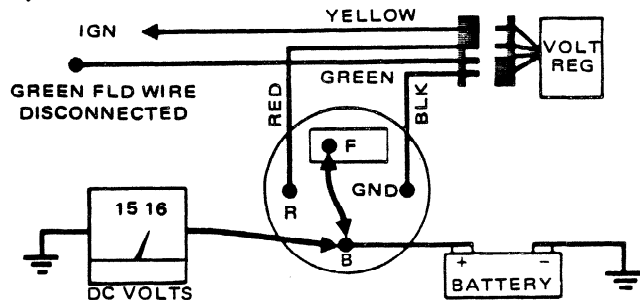


FIG. 7 Field Term Disconnected Volt Reg. Plug Disconnected Bat. Term. Shorted to Fld. Term. Ignition On — Engine Running at Idle

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.

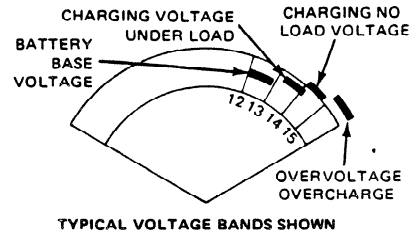
Voltmeter Test Procedure

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.

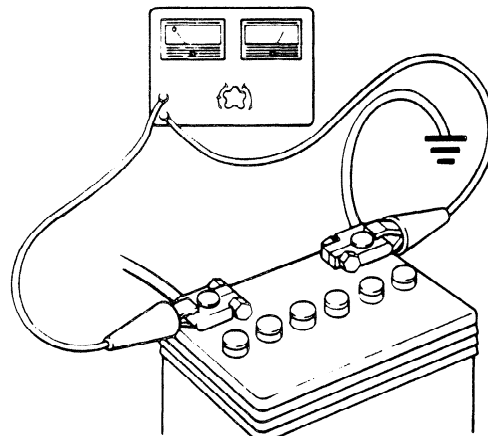


TYPICAL VOLTAGE BANDS SHOWN

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 alternator 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.**



VOLTMETER CONNECTIONS - TO BATTERY

K2628-A

FIG. 9 Voltmeter-to-Battery Connections

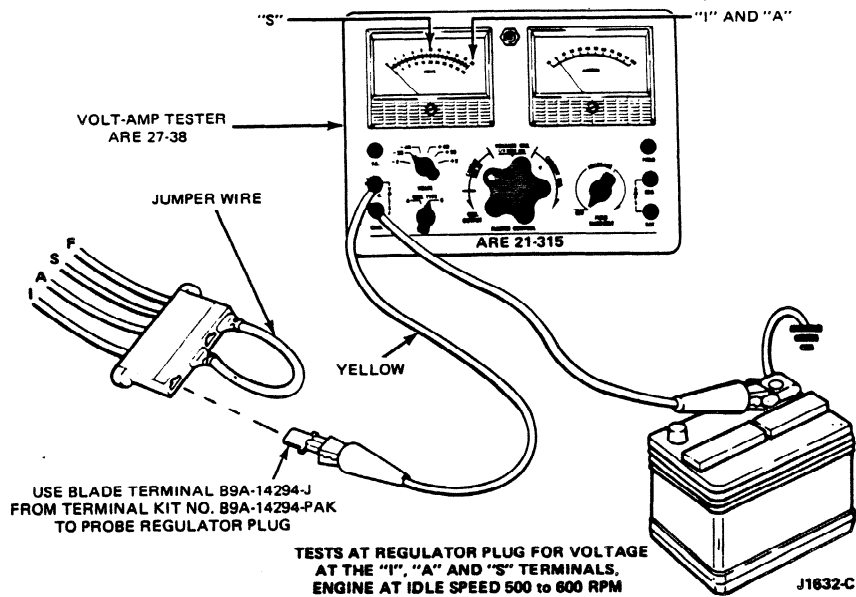


FIG. 10 Regulator Plug Voltage Tests

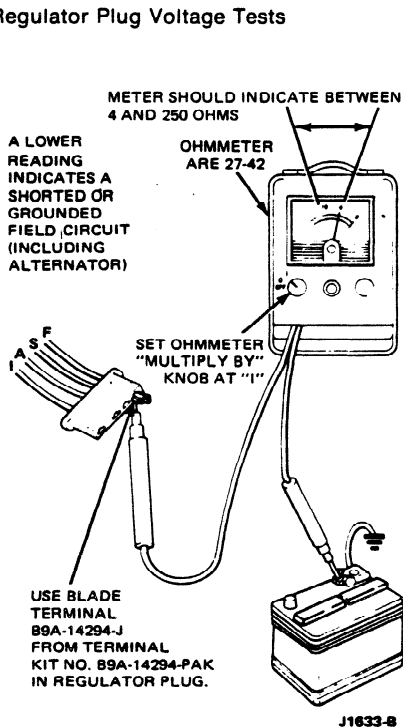


FIG. 11 Field Circuit Test

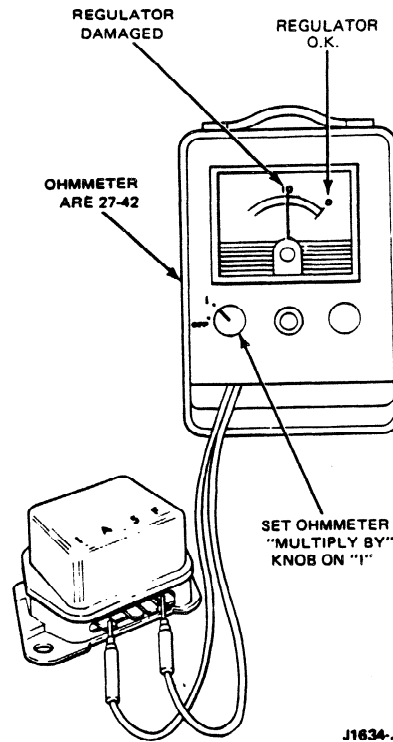


FIG. 12 Regulator Burned — Open Connector Wire Test

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.

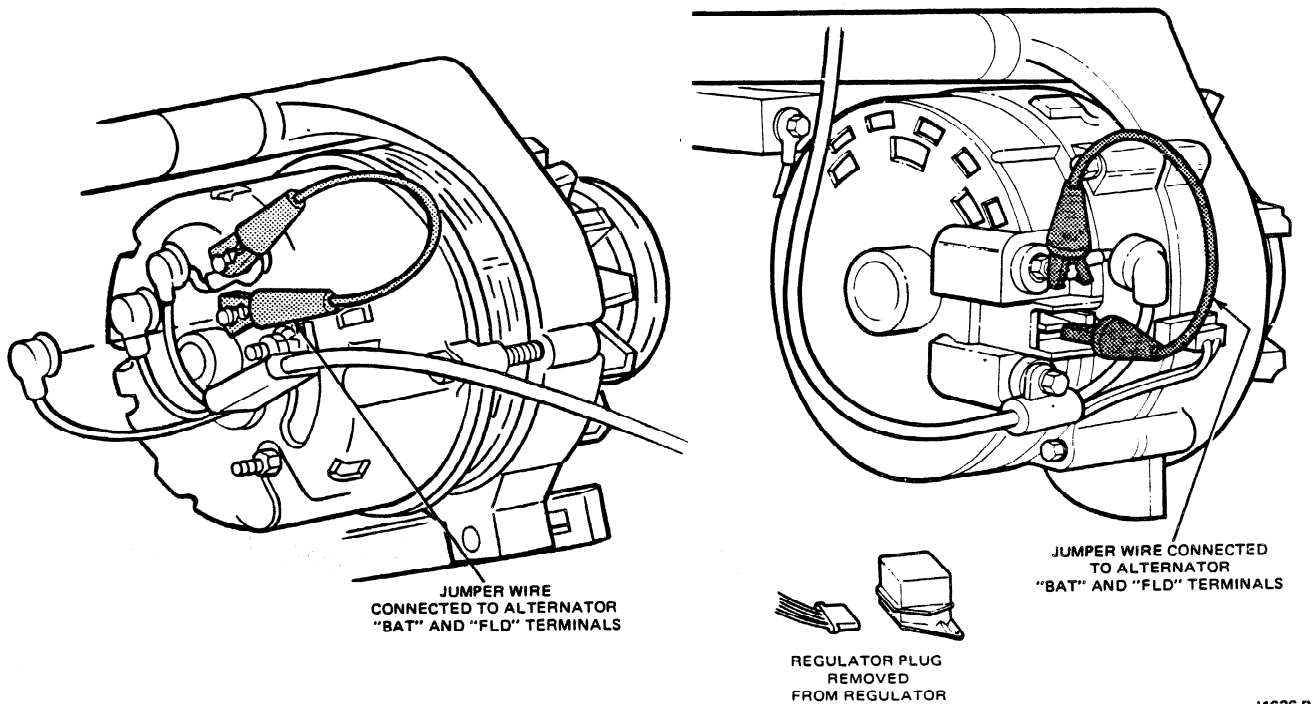


FIG. 13 Jumper Wire Connections

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 cable 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.

J1636-B

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.

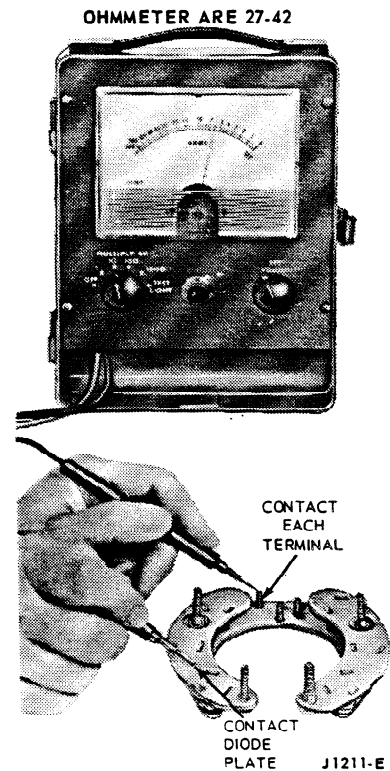


FIG. 14 Diode Test — Rear Terminal Alternator

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

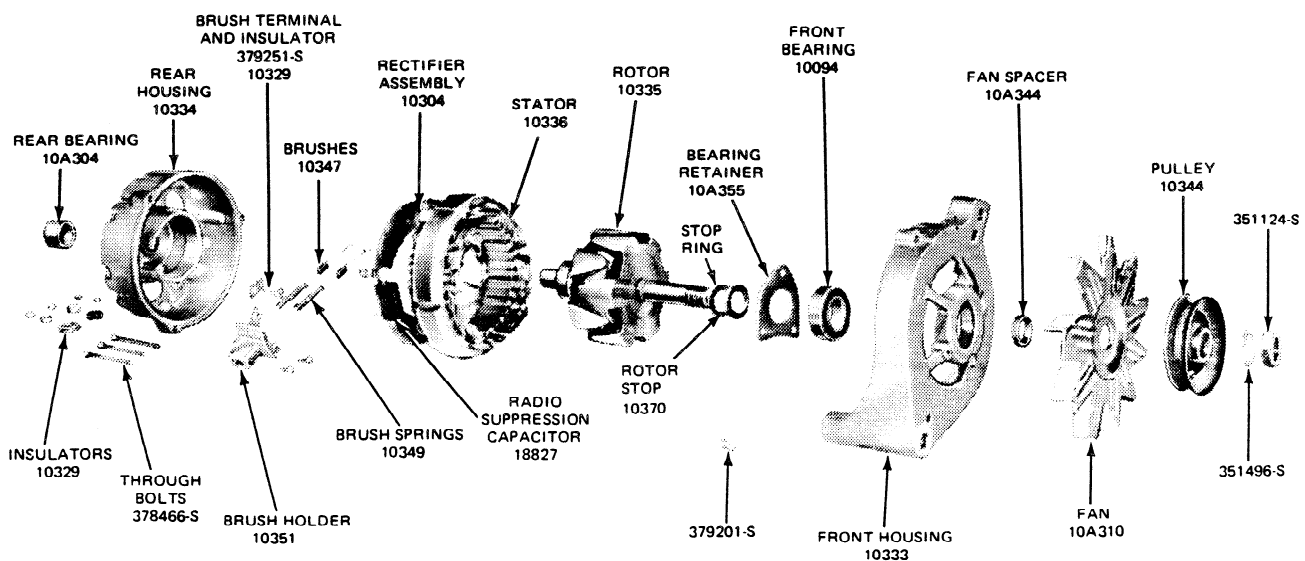
Figure 15 shows a disassembled view of the alternator.

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.

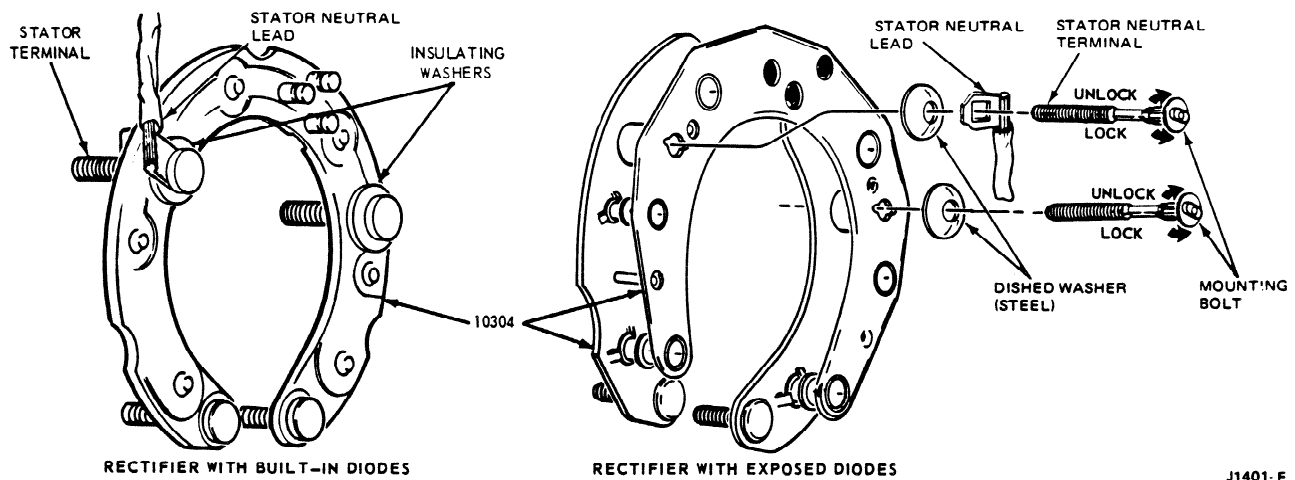
If the alternator rectifier has an exposed board, remove the screws from the rectifier by rotating the bolt heads 1/4 turn clockwise to unlock them and then remove the screws (Figure 16). Push the stator terminal straight out on a rectifier with the diodes built into the circuit board (Figure 16). Avoid 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).



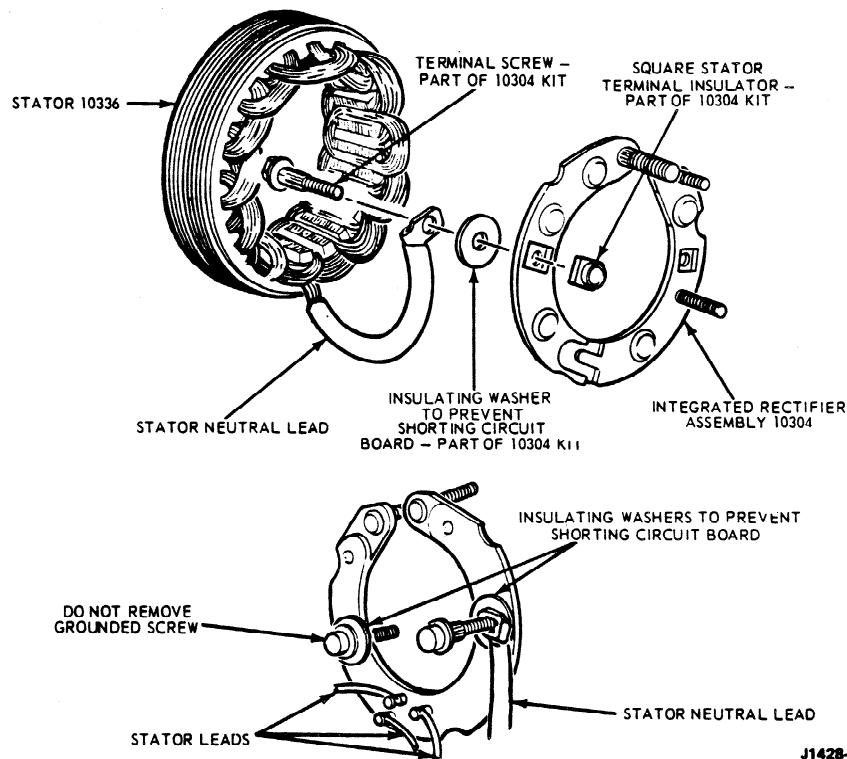
J1166-K

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).

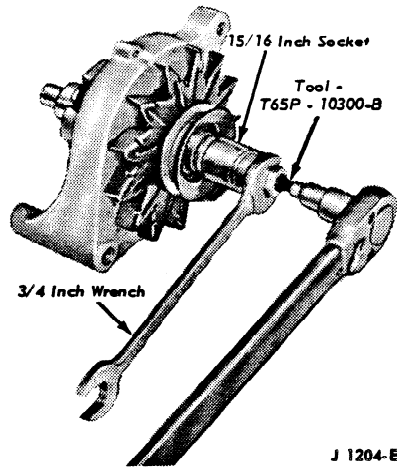


FIG. 18 Pulley Removal

J 1204-E

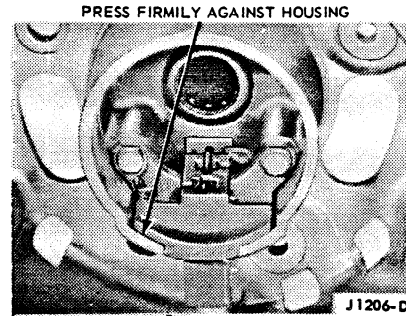


FIG. 20 Brush Lead Positions

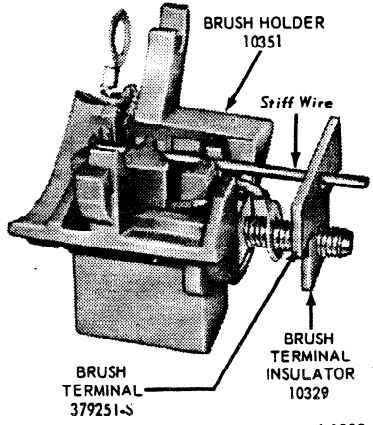


FIG. 19 Brush Holder Assembly

J 1203-C

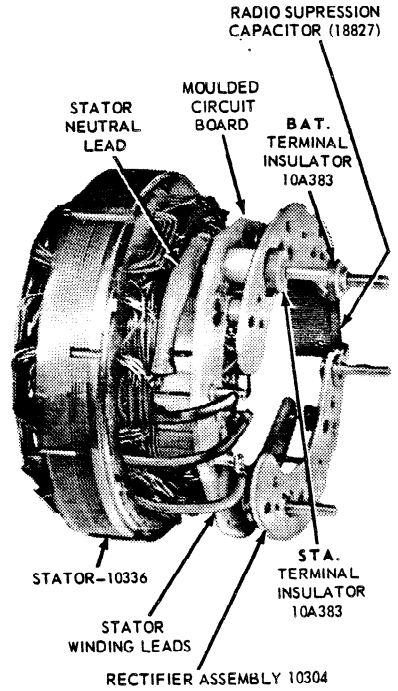


FIG. 21 Stator Lead Connections

J 1167-F

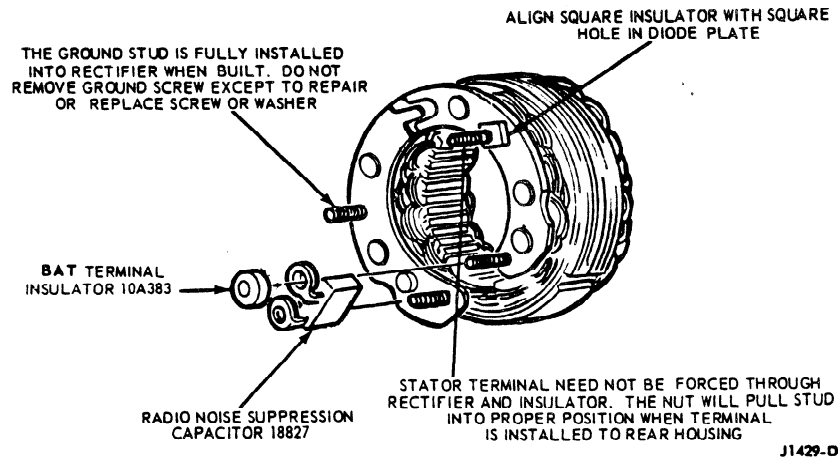


FIG. 22 Terminal Insulators — Fiber Glass Circuit Board

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 17).

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).

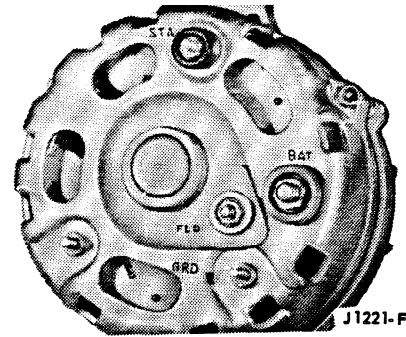


FIG. 23 Alternator Terminal Locations

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 dab of waterproof cement over the hole to seal it.

Part 5 Starting System

COMPONENT INDEX	Page	COMPONENT INDEX	Page
DESCRIPTION AND OPERATION	5-01	Disassembly	5-04
TESTING		Cleaning and Inspection	5-05
Booster Battery	5-02	Assembly	5-05
On-Vehicle Testing	5-02	Starter Drive Replacement	5-06
Bench Tests	5-03	Brush Replacement	5-06
REMOVAL AND INSTALLATION	5-04	Armature Replacement	5-06
OVERHAUL	5-04	Starter Terminal	5-07

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, relay contacts, or partially broken cables will result in slower than normal cranking speeds, and may even prevent the starter from cranking the engine.

POSITIVE ENGAGEMENT STARTER

The starter used on these engines is the positive engagement starter. The starting system includes the starter motor with an integral positive-engagement drive, the battery, a

remote control starter switch, the starter relay, and heavy circuit wiring.

Turning the ignition key to the START position or pressing the start button actuates the starter relay through the starter control circuit. The starter relay then connects the battery to the starter.

When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts (Figure 1). When the starter is first connected to the battery, a large current flows through the grounded field coil, actuating a movable pole shoe. The pole shoe is attached to the starter drive plunger lever and thus the drive is forced into engagement with the flywheel.

When the movable pole shoe is fully seated, it opens the field coil grounding contacts and the starter is then in normal operation. A holding coil is used to maintain the movable pole shoe in the fully seated position during the time that the starter is turning the engine.

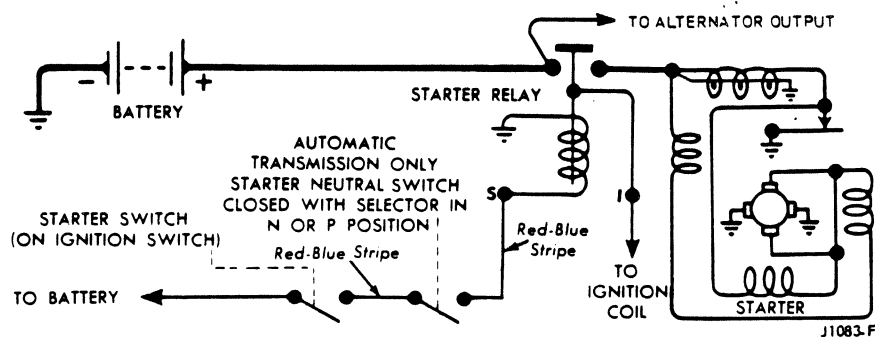


FIG. 1 Starting Circuit Positive Engagement

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 the 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 Drive and Starter Test

Flood the engine by pumping the throttle eight to ten times. Turn the ignition key to start and hold it in the start position. The engine should fire immediately, but should not start and run. The starter should continue to crank the engine. This indicates a normal, acceptable starter drive. If the engine stops turning and the starter spins at high speed, the drive is not operating properly and should be replaced. Whenever possible, remove the plunger cover to observe if the plunger pole is operating while the starter is on the vehicle. Do not damage the exposed switch during starter removal or installation.

Alternate Starter Drive Test

1. Pull the push-on connector from the ignition coil primary terminal. Place the connector loosely on the coil terminal.
2. Connect a remote control starter switch to the starter relay.
3. Turn the ignition switch key to the ON position and depress the remote control starter switch. As soon as the engine begins to run, pull the push-on connector from the coil terminal while holding the remote control switch in the start position. Pulling the wire off the coil kills the ignition, and the dead engine should now be cranked by the starter.
4. Observe to see if the starter begins to crank the dead engine and if it continues to crank the engine until the remote control switch is released. If the starter does not crank the dead engine, the drive assembly is slipping.

5. Repeat the test at least three times in succession to detect intermittent operation.

Starter Cranking Circuit Test

Excessive resistance in the starter circuit can be determined from the results of this test. Make the test connections as shown in Figure 3. Crank the engine with the ignition OFF. This is accomplished by disconnecting a high tension lead from the ignition coil and by connecting a jumper from the battery terminal of the starter relay to 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. With the voltmeter negative lead connected to the starter terminal and the positive lead connected to the battery positive terminal (Figure 2, connection (1)) . . . 0.5 volt.
2. With the voltmeter negative lead connected to the battery terminal of the starter relay and the positive lead connected to the positive terminal of the battery (Figure 2, connection (2)) . . . 0.1 volt.

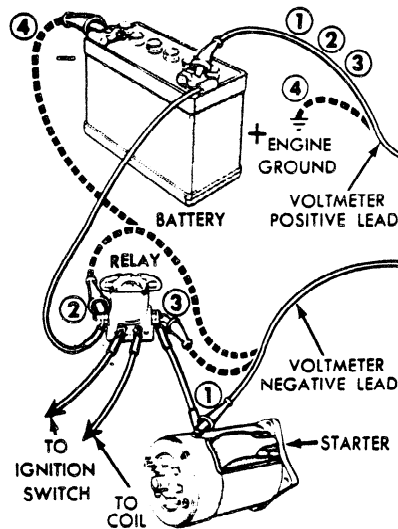


FIG. 2 Starting Cranking Circuit Test

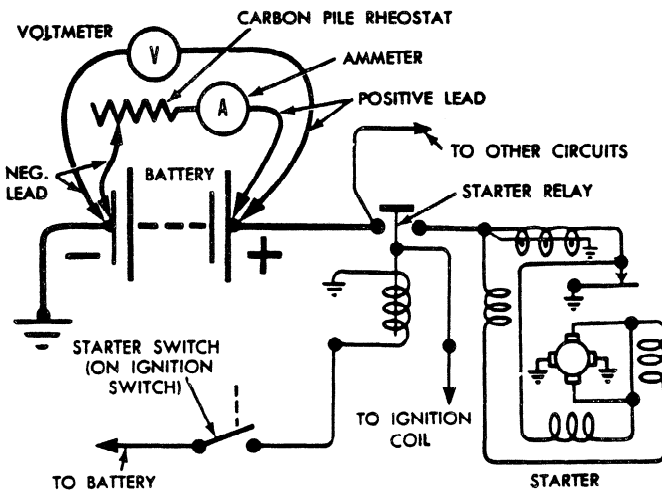
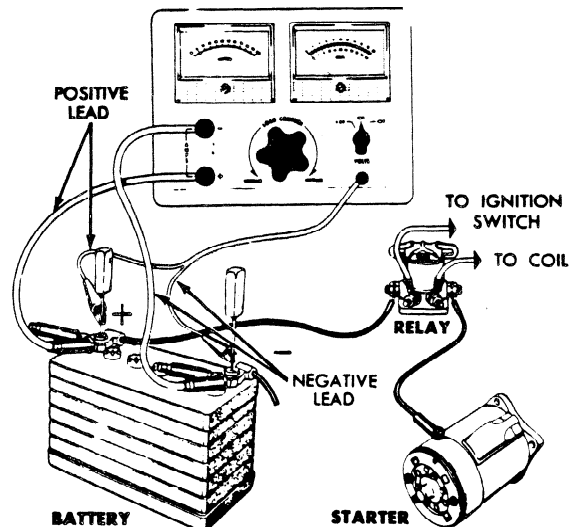


FIG. 3 Starter Load Test



3. With the voltmeter negative lead connected to the starter terminal of the starter relay and the positive lead connected to the positive terminal of the battery (Figure 2, connection (3)) . . . 0.3 volt.
4. With the voltmeter negative lead connected to the negative terminal of the battery and the positive lead connected to the engine ground (Figure 2, connection (4)) . . . 0.1 volt.

Starter Load Test

Connect the test equipment as shown in Figure 3. 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 relay to the ignition switch terminal of the relay.

Stop cranking the engine. Then 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.

BENCH TESTS

Starter No-Load Test

The starter no-load test will uncover open or shorted windings, rubbing armature, and bent armature shaft. The starter can be tested, at no-load, on the test bench only.

Make the test connections as shown in Figure 4. 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.

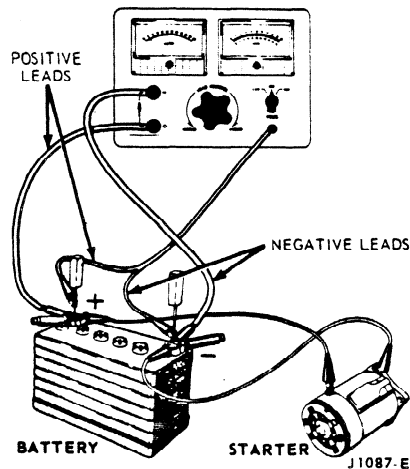


FIG. 4 Starter No-Load Test on Test Bench

Disconnect the starter from the battery. Then, 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.

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 winding, passes under a brush.

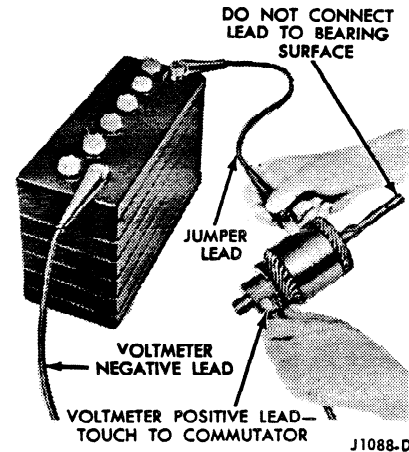


FIG. 5 Armature Grounded Circuit Test

Armature and Field Grounded Circuit Test

This test will determine if the winding insulation has been damaged, 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 5. If the voltmeter indicates any voltage, the windings are grounded.

Grounded field windings can be detected by making the connections as shown in Figure 6. If the voltmeter indicates any voltage, the field windings are grounded.

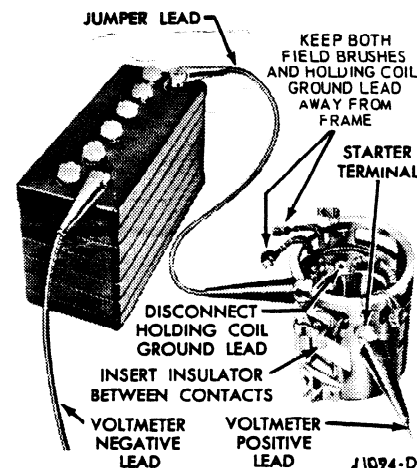


FIG. 6 Field Grounded Circuit Test

REMOVAL AND INSTALLATION

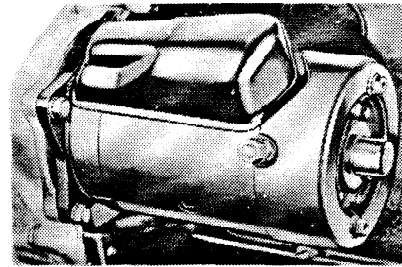
STARTER

Removal

1. Raise the engine on a hoist.
2. Disconnect the starter cable at the starter terminal.
3. Remove the starter mounting bolts. Remove the starter assembly (Figure 7).

Installation

1. Position the starter assembly to the flywheel housing, and start the mounting bolts.
2. Snug all bolts while holding the starter squarely against its mounting surface and fully insert into the pilot hole. Torque the bolts to specification.



J 1085-B

FIG. 7 Starter Mounting

OVERHAUL

STARTER

Use the following procedures when it becomes necessary to completely overhaul the starter. Figure 8 illustrates a partially disassembled starter.

Disassembly

1. Loosen the brush cover band retaining screw and remove the brush cover band and the starter drive plunger lever cover. Observe the lead positions for assembly and then remove the commutator brushes from the brush holders.
2. Remove the through bolts, starter drive end housing, and the starter drive plunger lever return spring.
3. Remove the pivot pin retaining the starter gear plunger lever and remove the lever and the armature.
4. Remove the stop ring retainer. Remove and discard the stop ring retaining the starter drive gear to the end of the armature shaft, and remove the starter drive gear assembly.
5. Remove the brush end plate.
6. Remove the two screws retaining the ground brushes to the frame.
7. On the field coil that operates the starter drive gear actuating lever, bend the tab up on the field coil retaining sleeve and remove the sleeve.
8. Remove the three coil-retaining screws, using Tool 10044-A and an arbor press (Figure 9). The arbor press prevents the wrench from slipping out of the screw. Unsolder the field coil leads from the terminal screw,

and remove the pole shoes and coils from the frame. Use a 300-watt solder iron.

9. Cut (or unsolder) the insulated brush leads from the field coils, as close to the field connection point as possible.
10. Remove the starter terminal nut, washer, insulator and terminal from the starter frame. Remove any excess solder from the terminal slot.

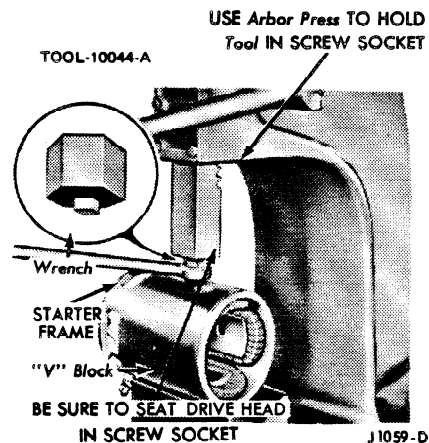


FIG. 9 Pole Shoe Screw Removal

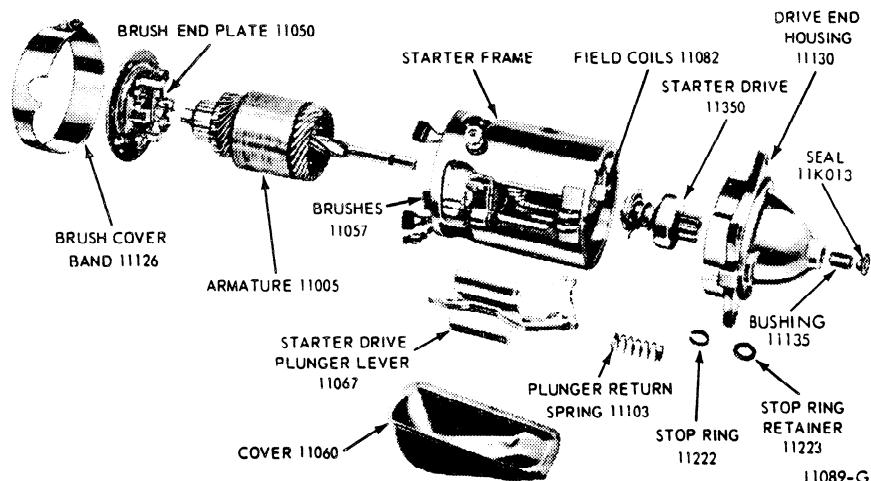


FIG. 8 Starter Disassembled

J 1089-G

Cleaning and Inspection

1. Use a brush or air to clean the field coils, armature, commutator, armature shaft, brush end plate, and drive 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. If the commutator is rough, or more than 0.005 inch out-of-round, turn it down.
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 (40 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 and a contact kit are 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 or that show evidence of inadequate engagement (Figure 11).

Assembly

1. Install the starter terminal, insulator, washers, and retaining nut in the frame (Figure 12). Be sure to position the slot in the screw perpendicular to the frame end surface.

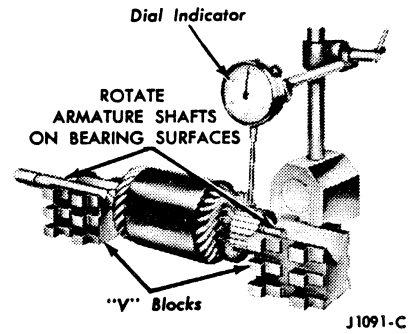


FIG. 10 Checking Commutator Runout

2. Position the coils and pole pieces, with the coil leads in the terminal screw slot, and then install the retaining screws (Figure 8). As the pole shoe screws are tightened, strike the frame several sharp blows with a soft-faced hammer to seat and align the pole shoes, then stake the screws.
3. Install the solenoid coil and retainer and bend the tabs to retain the coils to the frame.
4. Solder the field coils and solenoid wire to the starter terminal using rosin core solder. Use a 300-watt iron.
5. Check for continuity and grounds in the assembled coils.
6. Position the new insulated field brushes lead on the field coil terminal. Install the clip provided with the brushes to hold the brush lead to the terminal. Solder the lead, clip, and terminal together, using rosin core solder (Figure 12). Use a 300-watt iron.
7. Position the solenoid coil ground terminal over the nearest ground screw hole.
8. Position the ground brushes to the starter frame and install the retaining screws (Figure 12).

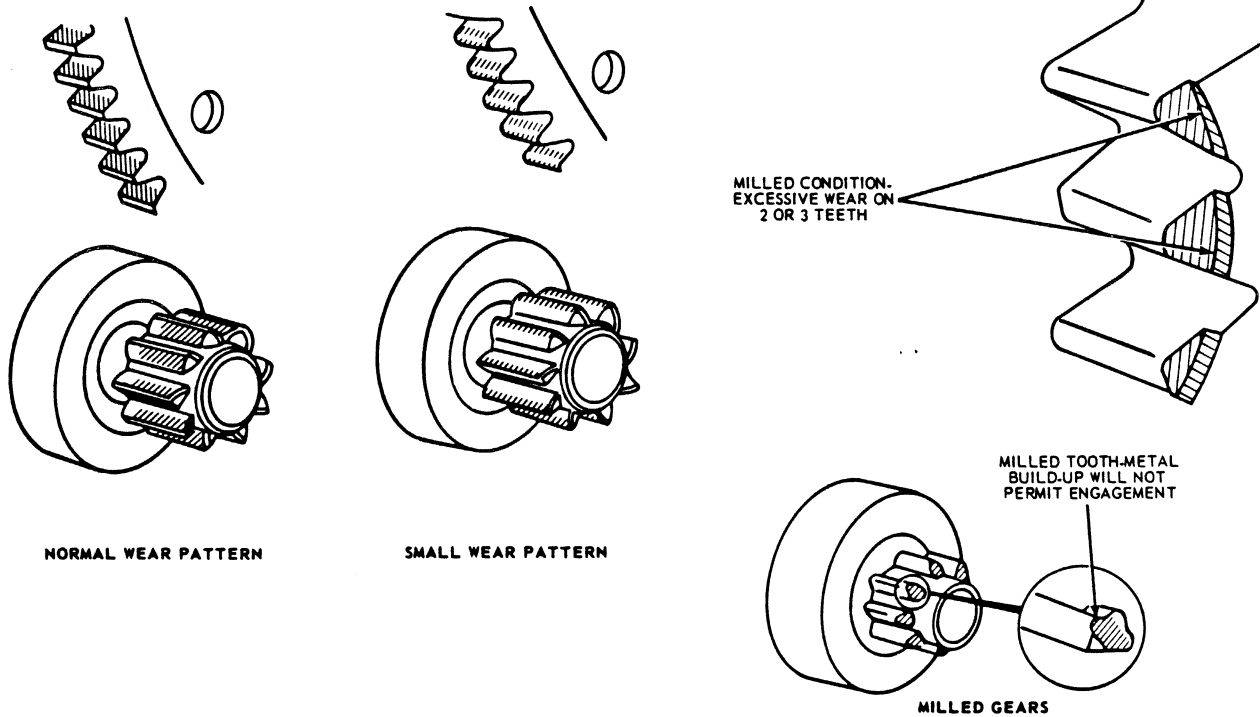
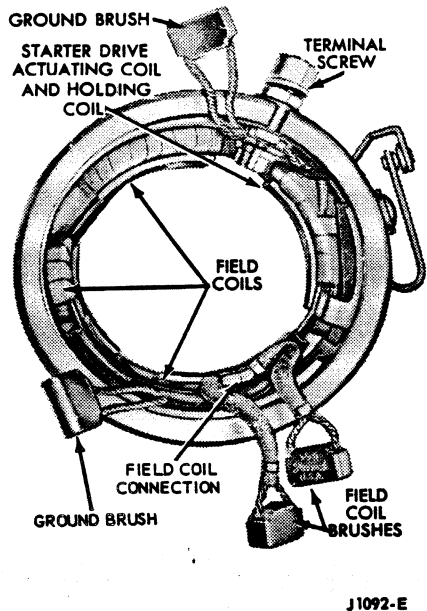


FIG. 11 Pinion and Ring Gear Wear Patterns



J1092-E

FIG. 12 Coil Assembly

9. Position the starter brush end plate to the frame with the end plate boss in the frame slot.
10. Apply a thin coating of Lubriplate 777 on the armature shaft splines. Install the starter motor drive gear assembly to the armature shaft and install a new retaining stop ring. Install a new stop retainer.
11. Position the fiber thrust washer on the commutator end of the armature shaft and position the armature in the starter frame.
12. Partially fill the drive end housing bearing bore with grease (approximately 1/4 full). Position the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.
13. Position the starter drive plunger lever return spring and the drive end housing to the frame and install and tighten the through bolts to specification (55-75 inch pounds). **Do not pinch the brush leads between the brush plate and the frame.** Be sure that the stop ring retainer is seated properly in the drive housing.
14. Install the brushes in the brush holders. **Be sure to center the brush springs on the brushes.**
15. Position the drive gear plunger lever cover on the starter and install the brush cover band with a gasket. Tighten the band retaining screw.
16. Check the starter no-load current draw.

Starter Drive Replacement

1. Loosen and remove the brush cover band and the starter drive plunger lever cover (Figure 8).
2. Loosen the through bolts enough to allow removal of the drive end housing and the starter drive plunger lever return spring.
3. Remove the pivot pin retaining the starter drive plunger lever and remove the lever.
4. Remove the drive gear stop ring retainer and stop ring from the end of the armature shaft and remove the drive gear assembly.
5. Apply a thin coating of Lubriplate 777 on the armature shaft splines. Install the drive gear assembly on the armature shaft and install a new stop ring.
6. Position the starter gear plunger lever on the starter frame and install the pivot pin. **Be sure that the plunger lever properly engages the starter drive assembly.**

7. Install a new stop-ring retainer. Partially fill the drive end housing bearing bore with grease (approximately 1/4 full). Position the starter drive plunger lever return spring and drive end housing to the starter frame, and then tighten the through bolts to specifications 55-75 inch pounds).
8. Position the starter drive plunger lever cover and the brush cover band, with its gasket, on the starter. Tighten the brush cover band retaining screw.

BRUSH REPLACEMENT

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

1. Loosen and remove the brush cover band, gasket, and starter drive plunger lever cover. Remove the brushes from their holders.
2. Remove the two through bolts from the starter frame.
3. Remove the drive end housing, and the plunger lever return spring.
4. Remove the starter drive plunger lever pivot pin and lever, and remove the armature.
5. Remove the brush end plate.
6. Remove the ground brush retaining screws from the frame and remove the brushes.
7. Cut the insulated brush leads from the field coils, as close to the field connection point as possible.
8. Clean and inspect the starter motor.
9. Replace the brush end plate if the insulator between the field brush holder and the end plate is cracked or broken.
10. 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 (Figure 12). Use a 300-watt iron.
11. Install the ground brush leads to the frame with the retaining screws.
12. Clean the commutator with 00 or 000 sandpaper.
13. Position the brush end plate to the starter frame, with the end plate boss in the frame slot.
13. Position the brush end plate to the starter frame, with the end plate boss in the frame slot.
14. Install the armature in the starter frame.
15. Install the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.
16. Partially fill the drive end housing bearing bore with grease (approximately 1/4 full). Position the return spring on the plunger lever, and the drive end housing to the starter frame. Install the through bolts and tighten to specified torque (55-75 inch pounds). Be sure that the stop ring retainer is seated properly in the drive end housing.
17. Install the commutator brushes in the brush holders. Center the brush springs on the brushes.
18. Position the plunger lever cover and the brush cover band, with its gasket on the starter. Tighten the band retaining screw.
19. Connect the starter to a battery to check its operation.

ARMATURE REPLACEMENT

1. Loosen the brush cover band retaining screw and remove the brush cover band, gasket, and the starter drive plunger lever cover. Remove the brushes from their holders.
2. Remove the through bolts, the drive end housing, and the drive plunger lever return spring.

3. Remove the pivot pin retaining the starter gear plunger lever, and remove the lever.
4. Remove the armature. If the starter drive gear assembly is being reused, remove the stop ring retainer and the stop ring from the end of the armature shaft, and remove the drive.
5. Place the drive gear assembly on the new armature with a new stop ring.
6. Install the armature in the starter frame.
7. Position the drive gear plunger lever to the frame and drive gear assembly and install the pivot pin.
8. Partially fill the drive end housing bearing bore with grease (approximately 1/4 full). Position the drive plunger lever return spring, the drive end housing and the front end plate to the starter frame, and then install and tighten the through bolts to specification. Be sure that the stop ring retainer is seated properly in the drive housing.
9. Place the brushes in their holders, and center the brush springs on the brushes.
10. Position the plunger lever cover and the brush cover band, with its gasket, and then tighten the retaining screw.
11. Connect the starter to a battery to check its operation.

STARTER TERMINAL

Removal

1. Loosen the brush cover band retaining screw and remove the brush cover band and the starter drive plunger lever cover. Observe the lead positions for assembly and then remove the commutator brushes from the brush holders.
2. Remove the through bolts, starter drive end housing, starter drive plunger lever return spring, and the brush end plate.

3. Remove the pivot pin retaining the starter gear plunger lever and remove the lever and the armature assembly.
4. Unsolder the field coil and solenoid wire leads from the terminal screw. Use a 300-watt soldering iron. Remove the starter terminal nut, washer, insulator and terminal from the starter frame.

Installation

1. Install the new starter terminal, insulator, washers, and retaining nut in the frame (Figure 8). Be sure to position the slot in the screw perpendicular to the frame end surface.
2. Solder the field coils and solenoid wire to the starter terminal using rosin core solder. Use a 300-watt iron.
3. Check for continuity and grounds in the assembled coils.
4. Position the starter brush end plate to the frame with the end plate boss in the frame slot.
5. Position the armature in the starter frame.
6. Position the starter drive gear plunger lever to the frame and starter drive assembly, and install the pivot pin.
7. Partially fill the drive end housing bearing bore with grease (approximately 1/4 full). Position the starter drive plunger lever return spring and the drive end housing to the frame and install and tighten the through bolts to specification (55-75 in-lbs). **Do not pinch the brush leads between the brush plate and the frame.** Be sure that the stop ring retainer is seated properly in the drive housing.
8. Install the brushes in the brush holders. **Be sure to center the brush springs on the brushes.**
9. Position the drive gear plunger lever cover on the starter and install the brush cover band with a gasket. Tighten the band retaining screw.
10. Check the starter no-load current draw.

Part 6 Governors

COMPONENT INDEX	Page	COMPONENT INDEX	Page
DESCRIPTION AND OPERATION	6-01	RPM Adjustments	6-02
TROUBLESHOOTING	6-01	No-Load Surge Adjustment	6-02
ADJUSTMENTS		REMOVAL AND INSTALLATION	6-04
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DESCRIPTION AND OPERATION

The 300 CID engine uses either a Velocity Governor or a Belt Driven Mechanical Governor.

VELOCITY GOVERNOR

The velocity governor (Figure 1) is a single unit mounted between the carburetor and the intake manifold. There is no provision for repair of this governor. It should be replaced when damaged.

The governor is operated by a combination of manifold vacuum and the air flow past the governor valves. The governor throttle valves are offset in the throttle bore so that the combined force of manifold vacuum and the fuel air flow through the bores has greater effect on the larger, upstream area of the valves. This forces the throttle valves to move toward the closed position restricting fuel-air flow. The closing action of the throttle valves is opposed by the control spring. The control spring is attached to the throttle valve shaft cam. The cam provides a balance between the closing action of the throttle valves and the action of the control spring at all engine speeds.

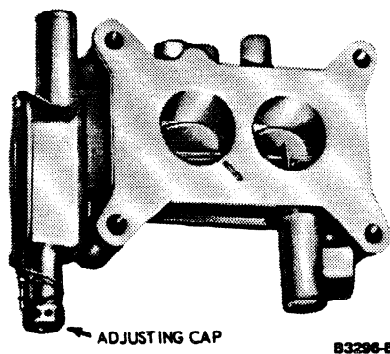


FIG. 1 Typical Velocity Governor

Under operating conditions, the governor throttle valves do not close, but remain open enough to allow the required quantity of the fuel-air mixture to flow into the manifold to maintain the governed engine speed.

To maintain the proper vacuum to the distributor, the governor has two interconnected vacuum transfer ports and a vacuum transfer plunger. When the governor throttle valves are forced toward the closed position, vacuum from the lower port is supplied to the distributor to maintain sufficient spark advance. When the governor throttle valves are

open wide enough, the plunger shuts off the bottom port and the top port supplies vacuum to the carburetor distributor vacuum passage for sufficient vacuum to the distributor.

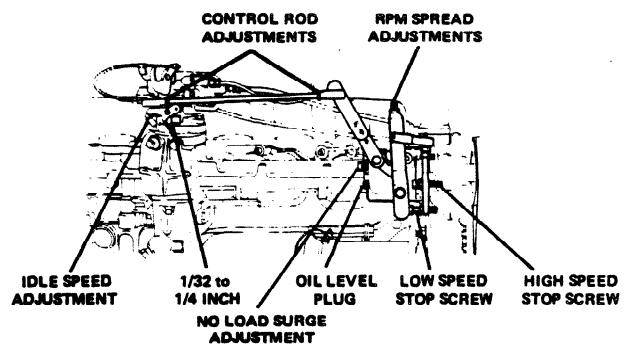


FIG. 2 Belt Driven Mechanical Governor

MECHANICAL GOVERNOR — BELT DRIVEN

Belt driven governors come in several versions. The constant speed type is adjusted to operate at one fixed speed. The governor spring is connected between the spring lever and the speed adjusting lever. Spring tension, thus engine rpm, are adjusted by the speed adjusting screw.

The governor throttle lever has a flexible knee-action lever which allows the engine to be idled at a lower speed for starting and for standby service.

The variable speed type allows engine governor operation from idle to a maximum setting. The variable speed lever is actuated by the throttle cable, which in turn adjusts the spring tension and engine speed.

The throttle is generally a solid arm, but in some cases may contain the flexible knee-action joint for special applications.

The belt driven governor must be driven by the engine at a fixed ratio. The governor pulley size and belt arrangement are determined by the engine application and the speed at which it is to be governed.

Slippage in either of these belts would permit the engine to run faster than the governor, thus permitting overspeed of the engine.

Tightening the drive belt too tight can cause early failure of the governor bearings. The belt tension should be set to specification with a belt tension gauge.

TROUBLESHOOTING MECHANICAL GOVERNOR

To troubleshoot a governor with a full load surge, first increase the spread between full and no-load. If this does not help, shorten the throttle rod 2 or three turns. Then check for an excessively rich or lean fuel/air mixture at the carburetor. Also look for vacuum leaks.

There are two other conditions that can cause this problem which should be checked. They are excessively loose throttle rod ball joints or throttle rod binding or rubbing.

No-load surge at maximum rpm can be eliminated with the surge adjustment screw providing the no-load and full load spread is properly set.

Engine overspeed on accelerating can be caused by excessive friction in the carburetor linkage, throttle shaft

and/or accelerator pump, if so equipped. The throttle rod may also be bending or rubbing, or the drive belt(s) may be slipping. These should be checked before making the adjustments.

If the engine overspeeds on removal of the load, try backing out the no-load surge adjustment screw 1 or 2 turns. If that doesn't correct the problem, shorten the throttle rod 2 or 3 turns. Also check for an excessive amount of oil in the governor.

When the governor does not respond to load changes, adjust the throttle rod to the proper length. If problems still exist, back out the no load screw and adjust it per instructions.

Look for bent or fractured flyweights in the governor possibly caused by insufficient lubrication or overspeeding.

ADJUSTMENTS MECHANICAL GOVERNOR

PRELIMINARY CHECKS

Three preliminary checks must be made on the mechanical governor before attempting any repair adjustments. These are the governor oil level, drive belt tension and the throttle control rod length.

OIL LEVEL

Remove the oil plug. If oil drips out the level is full. If oil doesn't drip out, remove the oil fill plug and add 10W-30 or 10W-40 engine oil into the fill hole until it starts dripping out the oil level hole. Install the oil level and oil fill plugs.

BELT TENSION

Belt tension should be checked on a cold belt only.

1. Install the belt tension tool on the drive belt and check the tension.
2. If adjustment is required, loosen the governor adjusting bolts and move the governor until the correct tension is obtained.
3. Remove the gauge. Tighten the governor adjusting bolts. Install the tension gauge and recheck the belt tension.

THROTTLE CONTROL ROD

1. Manually move the governor throttle lever to the maximum open throttle with spring tension on the governor.
2. Check the gap between the carburetor throttle shaft lever and its maximum open position stop. It should be 1/32 to 1/4 inch wide.
3. If adjustment is necessary, loosen the control rod ball joint lock nuts, remove the rod from the carburetor throttle lever and adjust the length of the rod with the ball joints.
4. Install the throttle control rod on the carburetor throttle lever and recheck the gap. Tighten the lock nuts.

RPM ADJUSTMENT

Attach a tachometer to the engine, then run the engine until it reaches normal operating temperature.

Disengage engine load and loosen the locknut on the governor high speed stop screw. The location of this screw

will vary from governor to governor. Slowly pull the throttle to the desired maximum engine speed and adjust the high speed stop screw to maintain this speed.

Proper governor operation requires a difference between full-load and no-load governed speed. This is called spread or sensitivity. Too small an rpm spread between the two speeds will cause governor hunting and surging. Too large a spread will cause low response to a load.

The normal rpm speed is 5 to 10 percent. This means if the desired full-load rpm is 2000 rpm, the no-load rpm can be 2100 to 2200 rpm.

Another type of spread adjustment is the eye bolt type. Adjustment is made with the eye bolt that attaches the spring to the variable speed lever.

To increase the spread, loosen the lock nut and turn the adjusting nut counterclockwise until the engine speed decreases approximately 150 rpm; then tighten the locknut.

Recheck governor operation under full load and no-load conditions.

To decrease the spread, loosen the locknut and turn the adjusting nut clockwise until engine speed increases approximately 150 rpm. Tighten the locknut.

Recheck governor operation under full load and no-load conditions.

The low speed adjustment is made with the low speed adjustment screw, if the governor is so equipped, or with the carburetor idle speed adjustment screw.

Move the hand throttle or variable speed lever to the closed position. Turn the adjustment screw in or out until you can maintain the desired speed.

NO LOAD SURGE ADJUSTMENT

One other adjustment that you may need to make is the no-load surge adjustment. It is set at the factory and rarely requires changing. If necessary, this adjustment can be used to prevent hunting and surging at no-load speeds, provided the rpm spread adjustment is set properly.

To make the adjustment, increase the engine speed with the hand throttle to 75 rpm lower than the maximum no-load desired control rpm. Then loosen the no-load surge adjustment screw locknut and turn the screw inward until rpm increases to the desired control rpm.

CAUTION: Do not turn the screw all the way. It will interfere with proper governor operation and prevent the governor from returning the engine to idle speed.

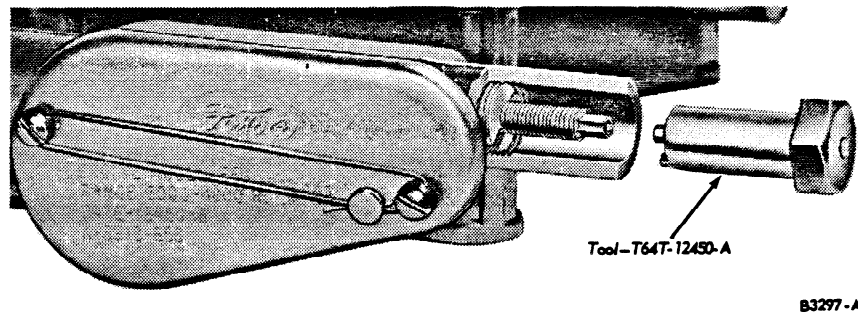


FIG. 3 Altitude Compensation Adjustment

VELOCITY GOVERNOR RPM ADJUSTMENT

Adjustment of the velocity governor is made with a tachometer attached and the engine at normal operating temperature.

Operate the engine at wide open throttle and check the rpm.

If adjustment is required or desired, remove the governor seal.

To increase the rpm, turn the cap counterclockwise.

When the adjustment is complete, stop the engine, seal the cap and remove the tachometer.

ALTITUDE COMPENSATOR

The characteristic of velocity-type governor is that the regulated engine speed increases in direct proportion to any increase in the altitude at which the engine is operated. This also causes a proportionate increase in the spread between full load and no load setting. A normal seal level no load setting of 3000 engine rpm becomes 3300 engine rpm at 5000 feet above sea level. The 300 engine rpm spread at sea level becomes a 500 engine rpm spread at 5000 feet above sea level.

The altitude compensating governor can be adjusted to compensate for variations due to altitude. With the exception to the altitude compensating adjustment (Figure 3), the description and operation of this governor is the same on the conventional velocity governor.

Varying Altitude Adjustment

On units equipped with an Altitude Compensating governor, the Varying Altitude Adjustment is made on engines that are operating at or near sea level and altitudes above 2000 feet. First make the no load adjustment as previously explained. Then, using the adjusting cap only, adjust the no load speed for the anticipated altitude by turning the adjustment cap 1/4 turn in the clockwise direction for each 1000 foot difference between the altitude. The adjustment is made and the maximum anticipated operating altitude.

Constant Altitude Adjustment

The Constant Altitude Adjustment is made on engines that are going to be operated at a constant altitude above 2000 feet. Cut the governor seal wire and remove the adjusting cap. Do not rotate the adjusting cap during removal.

Use a mirror and a light to observe the position of the slots in the adjusting bushing. Hold the tool in the proper position to engage the adjusting bushing slots and carefully insert the hex-shaped center post of the tool in the hex-head of the adjusting of the adjusting screw. Push the tool inward

until the tangs on the tool engage the slots in the adjusting bushing. If the tool will not engage in the adjusting bushing slots, note the position of the tool and rotate the tool slightly in either direction until engagement is achieved. If it is necessary to rotate the tool more than 1/6 turn (1 flat of the hex head) to accomplish engagement, rotate the tool back to its insertion position and pull the tool out. Rotate the tool 1/6 turn in the direction required to achieve engagement and re-insert it.

ADJUSTMENT TABLE

The altitude adjustment table specifies the amount from the factory setting that the tool should be rotated to adjust the velocity governor for altitude operation. For an increase in the average altitude of operation, rotate the tool the specified amount in the counterclockwise direction.

Remove the tool and install the adjusting cap. Do not turn the adjusting cap. Install the tachometer and check and adjust the no load setting of the governor with the adjusting cap. If the altitude adjustment was done properly, the no load and full load spread will be within specifications. Seal the adjusting cap to the governor body.

Trouble shooting is using the proper adjusting procedure. If the governor cannot be adjusted it will have to be replaced.

However, be sure the proper governor has been installed for the engine application and rpm it is to operate at.

Average Operating Altitude — Feet	Amount of ^① Tool Rotation
2000	1/3 turn (120°)
3000	1/2 turn (180°)
4000	2/3 turn (240°)
5000	5/6 turn (300°)
6000	1 turn (360°)

① 60° or 1/6 turn rotation is equivalent to one flat of the tool hex head.

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FIG. 4 Altitude Adjustment Table

REMOVAL AND INSTALLATION**VELOCITY GOVERNOR****Removal**

1. Remove the air cleaner.
2. Cut the governor seal wire.
3. Remove the carburetor to governor vacuum line.
4. Remove the carburetor and gasket.
5. Remove the governor, spacer (if so equipped) and gaskets. Discard the gaskets.

Installation

1. Position a new gasket over the studs on the intake manifold.
 2. Install the governor and gasket.
 3. Install the spacer and gasket (if so equipped).
 4. Install the carburetor.
 5. Install the governor to carburetor vacuum line.
 6. Install a new governor wire and seal.
 7. Install the air cleaner.
-

Part 7 Cooling

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

DESCRIPTION AND OPERATION

The cooling system has two stages of operation and uses one thermostat. In stage one the coolant flow is restricted for minimum circulation through the engine. In the second stage the thermostat opens and permits coolant flow through the radiator to maintain proper operating temperatures.

COOLANT

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 radiator cap to avoid injury from escaping steam or hot water.

When the cooling system is drained, fill the radiator with specified coolant. In production, the cooling system is filled with a 45-55 (50-50 for Canada and export) solution of Ford Permanent Antifreeze and water which prevents corrosion, keeps the cooling system clean, provides anti-freeze protection to -20 (-35 for Canada and export) degrees F in winter and provides for higher summer operation temperatures.

For the most effective cooling system operation, this mixture strength should be maintained all year round and in all climates.

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.

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.

7. 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.
8. 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.
9. 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.
10. If pressure drops, check for leaks at engine to radiator hoses, by-pass hose, thermostat housing gasket, etc.

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

1. Install the belt tension tool on the drive belt (Figure 1) and check the tension.
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.

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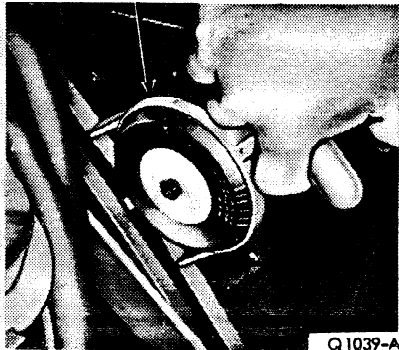


FIG. 1 Belt Tensioning

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.

Any leaks which are found must be corrected and the system re-checked.

11. If the system holds pressure, remove the radiator cap to release the pressure; then, reinstall the cap.
12. 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.

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 radiator so that the coolant level is below the thermostat.
2. Remove the water outlet housing retaining bolts. Bend the radiator 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 to the head 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 head. Install and torque the retaining bolts to specifications. Install the water bypass line and tighten hose connections.
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.

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 SPECIFICATIONS

Bore and Stroke	4.00 x 3.98
Firing Order	1-5-3-6-2-4
Idle Speed (rpm)	500-550

CYLINDER HEAD

Gasket Surface Flatness	0.006 inch in any 6 inches or 0.007 inch overall
Valve Guide Bore Diameter	0.3433-0.3443
Valve Seat Width —	
Intake	0.060-0.080
Exhaust	0.070-0.090
Valve Seat Angle	45°
Valve Seat Runout	0.0015-0.002
Rocker Arm Stud Bore Dia.-Std.	0.3685-0.3695

VALVE MECHANISM

Valve Stem Diameter — Standard	
Intake and Exhaust	0.3416-0.3423
Valve Stem Diameter — .003 Oversize	
Intake and Exhaust	0.3446-0.3453
Valve Stem Diameter — .015 Oversize	
Intake and Exhaust	0.3566-0.3573
Valve Stem Diameter — .030 Oversize	
Intake and Exhaust	0.3716-0.3723
Valve Face Angle	44°
Valve Stem to Valve Guide Clearance	
Intake and Exhaust	0.0010-0.0027
Wear Limit	0.0055
Valve Head Diameter	
Intake	1.772-1.790
Exhaust	1.551-1.569
Valve Face Runout	0.0020
Valve Spring Assembled Height	
Intake	1-11/16-1-23/32
Exhaust	1-9/16-1-19/32
Valve Spring Free Length — Approximate	
Intake	1.99
Exhaust	1.87
Valve Out of Square — Maximum	5/64 (0.078)
Valve Spring Pressure — Lbs. @ Specified Length	
Intake	76-84 @ 1.70
Wear Limit	68 @ 1.70
Intake	187-207 @ 1.300
Wear Limit	168 @ 1.300
Exhaust	77-85 @ 1.580
Wear Limit	68 @ 1.69
Exhaust	182-202 @ 1.180
Wear Limit	164.0 @ 1.180
Hydraulic Valve Lifter Leak Down Rate — Seconds	10-100
Valve Push Rod Runout — Maximum	0.025
Valve Tappet Diameter — Standard	0.8740-0.8745
Valve Tappet to Tappet Bore Clearance0007-.0027
Wear Limit	0.0050
Leak Down Rate	5.50 seconds max. ect.
Valve Rocker Arm Stud	
Standard	0.3717
.006 Oversize	0.3777
.010 Oversize	0.3817
.015 Oversize	0.3867

VALVE MECHANISM (Cont'd)

Collapsed Tappet Gap	
Allowable	0.100-0.200
Desired	125-.175
Valve Spring Assembled Height (Pad to Retainer)	
Intake	1-11/16-1-23/32
Exhaust	1-9/16-1-19/32

CAMSHAFT AND TIMING GEARS

Camshaft Journal Diameter — Standard	2.017-2.018
Camshaft Journal Runout	0.008
Camshaft Journal to Bearing Clearance	0.001-0.003
Wear Limit	0.006
Camshaft Journal Out-of-Round	0.0005
Camshaft End Play	0.001-0.007
Wear Limit	0.009
Camshaft Gear to Crankshaft	
Gear Backlash	0.002-0.004
Camshaft Lobe Lift	
Intake	0.249
Exhaust	0.249
Maximum Allowable Lobe Lift Loss	0.005
Assembled Gear Face Runout — Maximum	0.006
Inside Diameter	2.0190-2.0200
Location in Relation to Front Face of Block Cam Bearing Bore Face — No. 1 Bearing Only — Below	0.030-0.050

FLYWHEEL

Flywheel Clutch Face Runout — Maximum	0.010
Assembled Flywheel O.D. Runout	0.007

CRANKSHAFT

Main Bearing Journal Diameter	2.3982-2.3990
Main Bearing Journal Runout	0.002
Wear Limit	0.005
Connecting Rod and Main Bearing Journals	
Out-of-Round — Maximum	0.0006/inch
Connecting Rod and Main Bearing Journals	
Taper — Maximum	0.0006/inch
Thrust Bearing Journal Length	1.199-1.201
Main Bearing Journal Thrust Face Runout	0.001
Connecting Rod Journal Diameter	2.1228-2.1236
Crankshaft Free End Play	0.004-0.008
Wear Limit	0.012
Assembled Gear Face Runout	0.003
Main Bearings to Journal Clearance	
Desired	0.0008-0.0026
Allowable	0.0009-0.0028
Crankshaft to Rear Face of Block Runout	
TIR Max.	0.005
Flywheel Ring Gear Lateral Runout	
Standard Transmission	0.040
Automatic Transmission	0.060

CONNECTING ROD

Piston Pin Bushing ID — Standard	0.9104-0.9112
Bearing Bore Diameter	2.2750-0.0006
Bearing Bore Out-of-Round	2.2758
Bearing Taper	0.0004
Connecting Rod Length —	
Center to Center	6.2082-6.2112
Twist Total Difference — Maximum*	0.024
Bend Total Difference — Maximum *	0.012
Connecting Rod Assembly — Assembled to	
Crankshaft Side Clearance	0.006-0.003
Wear Limit	0.018
*Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.	
Connecting Rod Bearings to Crankshaft Clearance	
Desired	0.0008-0.0015
Allowable	0.0009-0.0027

PISTON

Piston Diameter	
Coded Red	3.9984-3.9990
Coded Blue	3.9996-4.0002
0.003 Oversize	4.0008-4.0014
Piston Pin Bore Diameter	0.9753-0.9756
Piston to Bore Clearance*	0.0014-0.0022
*Measured 90° to pin centerline and at pin centerline height.	
Piston Pin Diameter — Standard	0.9750-0.9753
Piston Pin Length	3.150-3.170
Piston Pin to Piston Clearance	0.0002-0.0004
Wear Limit	0.0008
Piston Ring Groove Width Compression	
Top	0.0800-0.0810
Bottom	0.0800-0.0810
Oil	0.1880-0.1890
Piston Pin to Connecting Rod Bushing Clearance	Interference Fit

PISTON RINGS

Compression Ring Width	
Top	0.0774-0.0781
Bottom	0.0770-0.0780
Compression Ring Side Clearance	
Top	0.0019-0.0036
Bottom	0.0025-0.0045
Compression Ring Side Clearance — Wear Limit	0.0060
Oil Ring Side Clearance	Snug
Compression Ring — Standard Bore —	
Ring Gap Width	
Top	0.010-0.020
Bottom	0.010-0.020
Oil Ring — Standard Bore —	
Ring Gap Width	0.015-0.055

CYLINDER BLOCK

Cylinder Bore Diameter	4.0000-4.0048
Cylinder Bore Out-of-Round	
Maximum	0.0015
Wear Limit	0.0050
Cylinder Bore Taper	0.001
Wear Limit	0.010
Main Bearing Bore Diameter	2.5902-2.5910
Head Gasket Surface Flatness	0.003 inch in any 6 inches or 0.007 inch overall
Cylinder Tappet Bore Diameter	0.8752-0.8767
Distributor Shaft Bearing Bore Diameter	0.5155-0.5165
Cylinder Bore Surface Finish RMS	15-35

OIL PUMP

Oil Pressure — Hot @ 2000 rpm	35-60
Relief Valve Spring Tension —	
Lbs. @ Specified Length	20.6-22.6 @ 2.490
Relief Valve Clearance	0.0015-0.0029
Drive Shaft to Housing Bearing Clearance	0.0015-0.0029
Rotor Assembly End Clearance —	
Pump Assembled	0.0011-0.0040
Outer Race to Housing — Radial Clearance	0.001-0.013
Oil Capacity (Qts.) (Add 1 qt. for filter change)	6

IGNITION SYSTEM

Ignition Timing — B.T.D.C. — Recommended	6°
Breaker Arm Spring Tension (Ounces)	17-21
Contact Spacing	0.024-0.026
Contact Dwell at Idle Speed	33-38°
Shaft End Play Clearance	0.003-0.010
Condenser	
Capacity (Microfarads)	0.21-0.25
Maximum Leakage (Megohms)	5
Maximum Series Resistance (Ohms)	1
Coil	
Primary Resistance (Ohms)	1.40-1.54 (75°F.)
Secondary Resistance (Ohms)	8000-8800 (75°F.)
Amperage Draw	
Engine Stopped	4.5
Engine Idling	2.5
Primary Circuit Resistor (Ohms)	1.30-1.40 (75°F.)
Spark Plugs	
Size	18 mm
Gap (Inches)	0.028-0.032
Torque (ft.-lbs.)	15-20

FUEL PUMP — MECHANICAL

Static Pressure (psi)*	4.0-6.0
Eccentric Total Lift (Inch)	290-310
Volume Flow — Minimum*	1 Pt. in 20 seconds
Inside diameter of smallest passage in test flow circuit must not be less than 0.220 inch.)	

*(On engine, with temperatures normalized, and at normal idle speed, in neutral.)

DISTRIBUTOR ADVANCE CHARACTERISTICS

CENTRIFUGAL ADVANCE. Set the test stand to 0° at 250 rpm and 0 inches of vacuum.

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
600	¾-1¾	0
800	4-5	0
1200	8¾-9¾	0
1600	10¼-11¾	0
2000	12½-14	0

Maximum Advance Limit16°

VACUUM ADVANCE. Set the test stand to 0° at 1000 rpm and 0 inches of vacuum.

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
1000	1-4	8
1000	4-7	10
1000	6½-8½	14

Maximum Advance Limit8½°

CARBURETOR SPECIFICATIONS

	C5JZ B	C8JJ A	D0JJ A	D0PF G	D0PF J	D3JL B	D4JL B	D7JL A	D7JL B
Carburetor Size									
Throttle Bore Dia.	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16
Venturi Dia.	1-3/8	1-3/8	1-3/8	1-11/32	1-11/32	1-3/8	1-3/8	1-11/32	1-11/32
Air Flow (CEM) c3''Hg	215	215	215	212	212	210	210	210	210
Fuel System									
Fuel Level (Wet)	11/16	11/16	11/16	N/A	N/A	11/16	11/32	N/A	N/A
Fuel Setting (Dry)	13/64	13/64	13/64	①	①	13/64	13/64	①	①
Main Metering System									
Main Jet	#63	#71	#73	#68	#68	#73	#73	#683	#683
Power Valve Timing	4-8	7-5	4-8	7.5-5.5	7-5	4-8	7-5	7.5-5.5	7.5-5.5
Accelerator Pump System									
Capacity — cc/10 Strokes	3-6	3-6	3-6	17-21cc	17-21	3-7cc	3-7cc	17-21	17-21
Pump Rod Location	#1	②	#1	#2	#2	#1	②	#2	#2
Idle Speed									
Curb Idle RPM	550	550	550- 575	550- 575	550- 575	550- 575	550- 575	550- 575	550- 575
Fast Idle RPM	1500	1500	1500	1500	1500	1500	1500	1500	1500
Holley List #	3206	4271	4689	4526-1	6844	4528-1	7075	7937	7931
Carburetor Model	1904	1904	1904	1940	1940	1904	1904	1940	1940

① Refer to Shop Manual for float setting procedure.

② Vacuum operated accelerator pump.

THERMOSTAT

Begins to Open (°F)	157-164
Fully Open (°F)	186

TORQUE LIMITS — FOOT-POUNDS

Main Bearing Cap Bolts — Oiled Threads	60-70
Cylinder Head Bolts — Oiled Threads	
Step 1	50-55
Step 2	60-65
Step 3	70-85
Oil Pan to Cylinder Block	10-15
Manifold to Cylinder Head	23-28
Exhaust Pipe to Manifold	25-35
Flywheel to Crankshaft	75-85
Oil Pump to Cylinder Block	12-15
Oil Pump to Cover Plate	9-15
Cylinder Front Cover	15-20
Water Outlet Housing	12-15
Valve Rocker Arm Cover	4-7
Damper or Pulley to Crankshaft	130-150
Connecting Rod Nuts	40-45
Camshaft Thrust Plate to Block	19-21
Valve Rocker Arm Stud Adjusting Nut*	4.5-15
*With tappet on camshaft base circle, turn adjusting nut counterclockwise.	
Valve Push Rod Chamber Cover	1.0-1.5
Water Pump to Cylinder Block	15-20
Oil Pick-Up Tube to Oil Pump	12-15

TORQUE LIMITS FOR VARIOUS SIZE BOLTS

CAUTION: In the event that any of the torque limits below are in disagreement with any of those listed above, the above limits prevail.

Size (inches)	Torque (Ft.-Lbs.)
1/4-20	6-9
1/4-28	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	45-57
7-16-20	40-60
1/2-14	60-70
1/2-20	70-80
9/16-18	85-120

BELT TENSION

Belt Tension — All Except Governor	
New	140
Used	110
Governor	
New	70
Used	50
A used belt is one that has been in operation for 10 minutes or more.	

Part 9 Basic Engine Changes

ADJUSTMENTS

VALVE CLEARANCE (1978/)

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 it is not compensated for, the hydraulic valve lifter will cease to function and the valve will be held closed.

The positive stop rocker arm stud eliminates the necessity of adjusting the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened properly.

With the crankshaft in the positions designated in the following procedure Steps 3, 4 and 5, remove and inspect the stud nut for conditions shown in Fig. 1. Install and turn the stud nut clockwise until it contacts the stop. Tighten the nut to specifications.

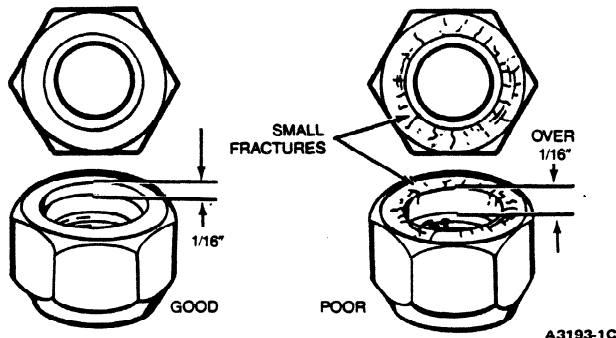


FIG. 1 Inspection of Rocker Arm Stud Nut

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.**
2. Make two chalk marks on the crankshaft damper (Fig. 2). Space the marks approximately 120 degrees apart so that, with the timing mark, the damper is divided into three equal parts (120 degrees is one-third of the distance around the damper circumference).
3. Rotate the crankshaft until No. 1 piston is on TDC at the end of the compression stroke. **Check the breakaway torque (torque required to turn nut in a counterclockwise direction) of each stud nut.** Replace the stud nut if the breakaway torque does not meet specifications. If, after replacing the stud nut, the breakaway torque still is not within specifications, replace the stud.
4. With No. 1 piston on TDC at the end of the compression stroke, install and tighten the nut to specifications.

Then slowly supply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed using Tool T70P-6513-A or equivalent (Fig. 3).

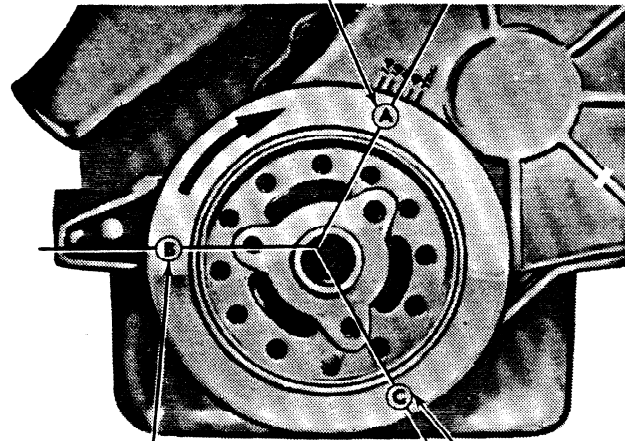
Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install a shorter push rod.

If the clearance is greater than specifications, install a longer push rod.

5. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, one-third turn at a time, in the direction of rotation, while adjusting the valves in the firing order sequence. 1-5-3-6-2-4.

STEP 1 – SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE ADJUST NO. 1 INTAKE AND EXHAUST
STEP 4 – ADJUST NO. 6 INTAKE AND EXHAUST



STEP 2 – ADJUST NO. 5 INTAKE AND EXHAUST
STEP 5 – ADJUST NO. 2 INTAKE AND EXHAUST

STEP 3 – ADJUST NO. 3 INTAKE AND EXHAUST
STEP 6 – ADJUST NO. 4 INTAKE AND EXHAUST

FIG. 2 4.9L (300 CID) Six Valve Clearance

A2925-1A

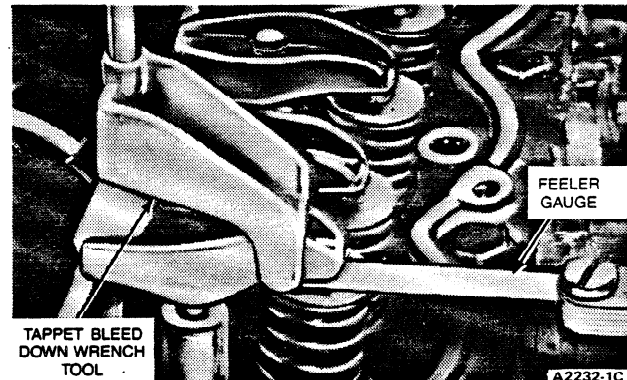


FIG. 3 Valve Clearance Check

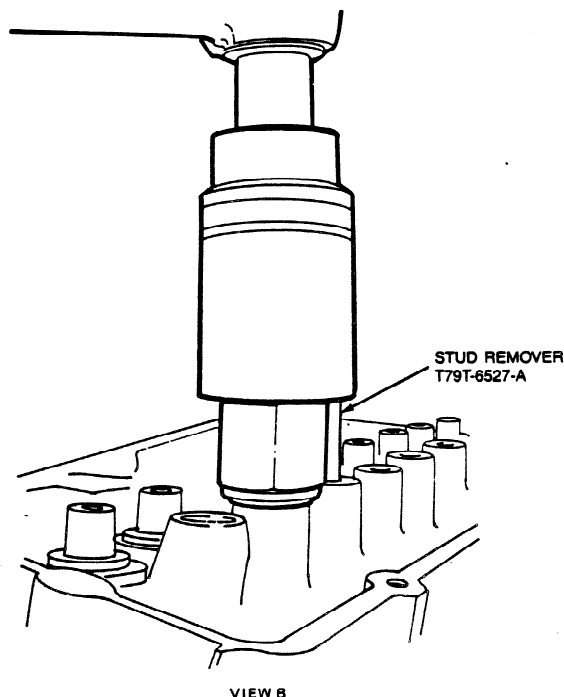
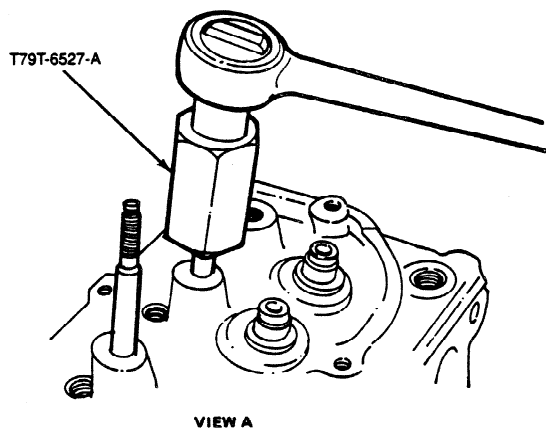
ROCKER ARM STUD REPLACEMENT — 4.9L (300 CID) I-6

If it is necessary to remove a rocker arm stud, Tool T79T-6527-A (Fig. 4) is available. A 0.006 inch oversize reamer T62F-6A527-B3 and a 0.015 inch oversize reamer T62F-6A527-B5 are available. For 0.010 inch oversize studs, use reamer T66P-6527-B. To press in replacement studs, use stud replacer T79T-6527-B for 4.9L (300 CID) I-6 (Fig. 6).

Rocker arm studs that are broken or have damaged threads may be replaced with standard studs. Loose studs in the head may be replaced with 0.006, 0.010 or 0.015 inch oversize studs which are available for service.

Standard and oversize studs can be identified by measuring the stud diameter within 1-1/8 inch from the pilot end of the stud. The stud diameters are:

0.006 oversize . . . 0.3774-0.7781
 0.010 oversize . . . 0.3814-0.3821
 0.015 oversize . . . 0.3864-0.3871



A4873-2B

FIG. 4 Removing Rocker Arm Stud — 4.9L (300 CID)

When going from a standard size rocker arm stud to a 0.010 or 0.015 inch oversize stud, always use the 0.006 inch oversize reamer before finish reaming with the 0.010 or 0.015 inch oversize reamer.

1. Position the sleeve of the rocker arm stud remover over the stud with the bearing end down. Thread the puller into the sleeve and over the stud until it is fully bottomed. Hold the sleeve with a wrench; then, rotate the puller clockwise to remove the stud (Fig. 4).

If the rocker arm stud was broken off flush with the stud boss, use an easy-out to remove the broken stud following the instructions of the tool manufacturer.

2. If a loose rocker arm stud is being replaced, ream the stud bore using the proper reamer (or reamers in sequence) for the selected oversize stud (Fig. 5). **Make sure the metal particles do not enter the valve area.**
3. Coat the end of the stud with Ford Polyethylene Grease (DOAZ-19584-A) or equivalent. Align the stud with the stud bore; then, tap the sliding driver until it bottoms (Fig. 6). When the driver contacts the stud boss, the stud is installed to its correct height.

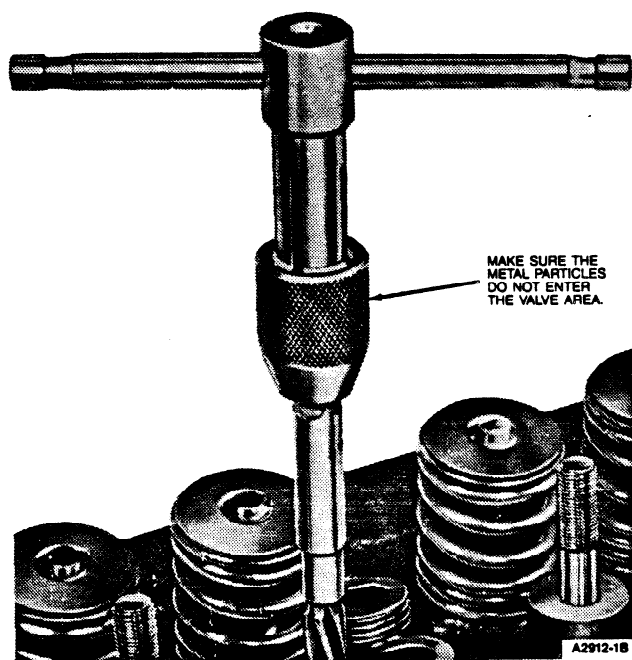


FIG. 5 Reaming Rocker Arm Stud — 4.9L (300 CID)

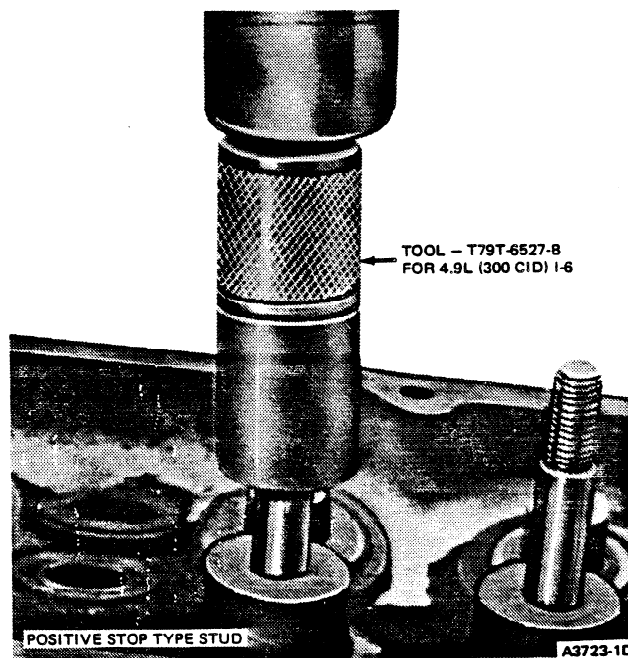


FIG. 6 Installing Rocker Arm Stud — 4.9L (300 CID)

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric MM.	Fractions	Decimal In.	Metric MM.
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:
LENGTH			ACCELERATION		
Inch	25.4	millimetres (mm)	Foot/sec ²	0.304 8	metre/sec ² (m/s ²)
Foot	0.304 8	metres (m)	Inch/sec ²	0.025 4	metre/sec ²
Yard	0.914 4	metres			
Mile	1.609	kilometres (km)	TORQUE		
			Pound-inch	0.112 98	newton-metres (N-m)
AREA			Pound-foot	1.355 8	newton-metres
Inch ²	645.2	millimetres ² (mm ²)	Horsepower	0.746	kilowatts (kW)
Foot ²	6.45	centimetres ² (cm ²)			
Yard ²	0.092 9	metres ² (m ²)	PRESSURE OR STRESS		
	0.836 1	metres ²	Inches of water	0.249 1	kilopascals (kPa)
			Pounds/sq. in.	6.895	kilopascals
VOLUME					
Inch ³	16 387.	mm ³	ENERGY OR WORK		
	16.387	cm ³	BTU	1 055.	joules (J)
Quart	0.016 4	litres (l)	Foot-pound	1.355 8	joules
Gallon	0.946 4	litres	Kilowatt-hour	3 600 000.	joules (J = one W's)
Yard ³	3.785 4	litres		or 3.6 x 10 ⁶	
	0.764 6	metres ³ (m ³)			
			LIGHT		
MASS			Foot candle	1.076 4	lumens/metre ² (lm/m ²)
Pound	0.453 6	kilograms (kg)			
Ton	907.18	kilograms (kg)	FUEL PERFORMANCE		
Ton	0.907	tonne (t)	Miles/gal	0.425 1	kilometres/litre (km/l)
			Gal/mile	2.352 7	litres/kilometre (l/km)
FORCE					
Kilogram	9.807	newtons (N)	VELOCITY		
Ounce	0.278 0	newtons	Miles/hour	1.609 3	kilometres/hr. (km/h)
Pound	4.448	newtons			
TEMPERATURE					
Degree Fahrenheit	(°F-32) ÷ 1.8	degree Celsius			