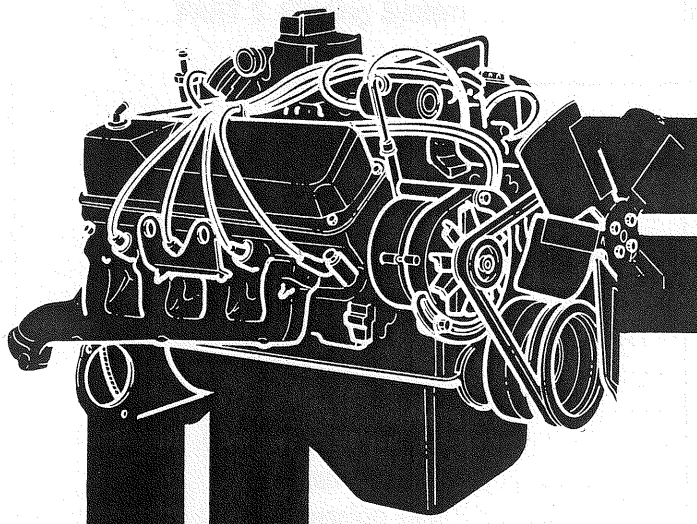
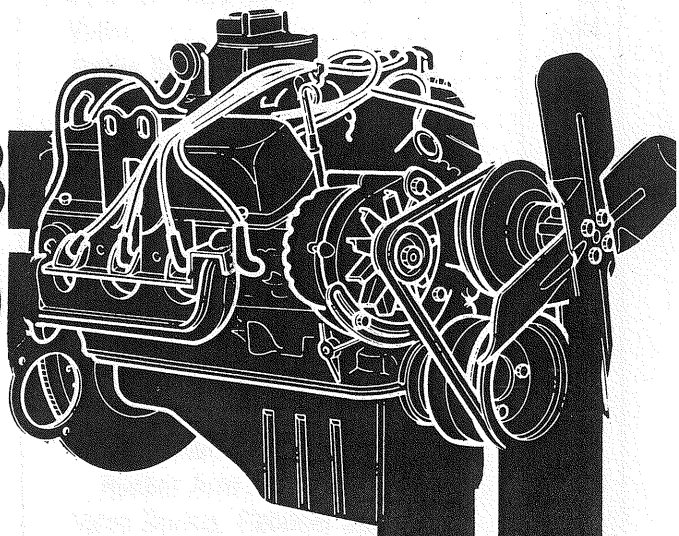
Ford

Power Products

SERVICE MANUAL



CSG-850 (302 CID)



WSG-858 (351 CID)

INDUSTRIAL AND MARINE ENGINES

IEO
REV JULY 79 194-209

IDENTIFICATION INDUSTRIAL AND IRRIGATION

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

MARINE

If this tag is destroyed or painted over, it will be very difficult to distinguish between various levels of engines; that is, for example, to distinguish between the standard output and low output or even standard rotation versus reverse rotation.

To identify Ford engines by the Marine Manufacturer serial or model number designation refer to your Parts and Service News.

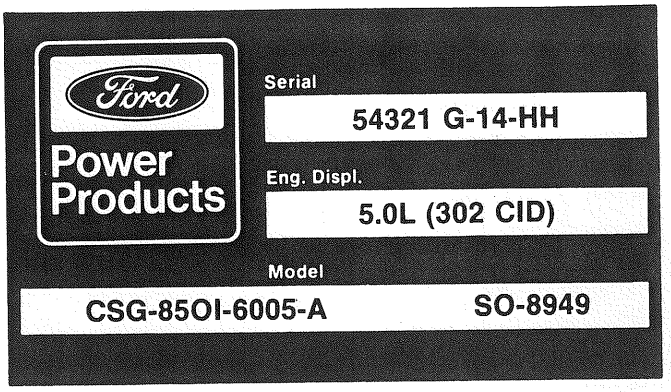


FIG. 1 Identification Decal — Industrial — Typical

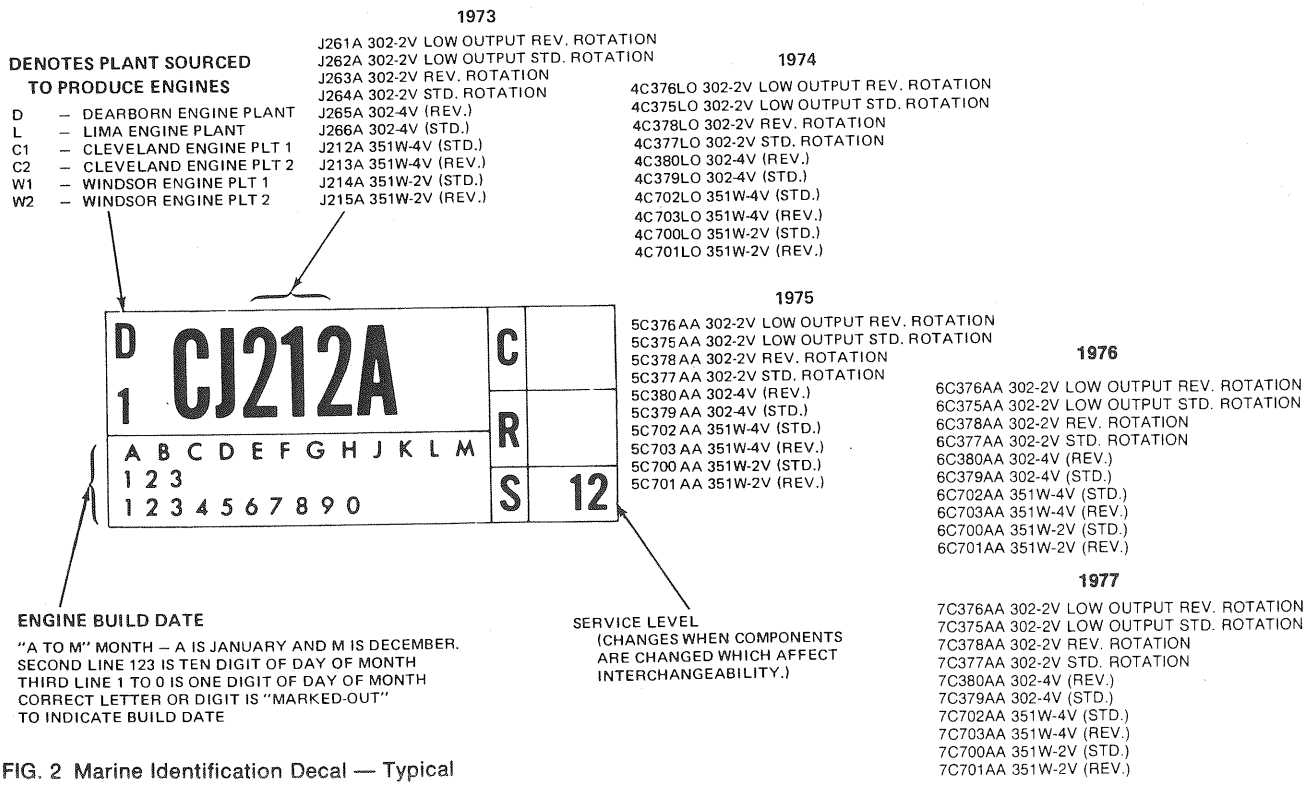


FIG. 2 Marine Identification Decal — Typical

DESCRIPTION AND OPERATION

The Ford 5.0L and 5.8L 8-cylinder gasoline engines are available as engine assemblies and are available in industrial or marine versions. In addition, optional equipment is available to custom tailor each engine to individual requirements.

The Ford 5.0L 8-cylinder engine (Figure 3) and the Ford 5.8L 8-cylinder engine (Figure 4) are designed by Ford Motor Company to incorporate many features for smooth, powerful operation, long life and service. The cylinder block is cast iron for maximum strength and rigidity. They have five main bearings and full-length, full-circle water jackets. These full-length, full-circle water jackets help eliminate hot spots and provide more uniform cylinder wall expansion under heavy-duty operation. The cylinders are numbered from front to rear, on the right bank 1, 2, 3, 4 and on the left bank 5, 6, 7, 8. The firing order is 1-5-4-2-6-3-7-8 for the 5.0L engine and 1-3-7-2-6-5-4-8 for the 5.8L engine. (All marine engines are available in either standard or reverse rotation of the camshaft and crankshaft depending upon the engine installation. The firing order for the standard rotation is 1-3-7-2-6-5-4-8 and the reverse rotation is 1-8-4-5-6-2-7-3, except the 5.0L low output engine. The firing order for the 5.0L low output engine is 1-5-4-2-6-3-7-8 for the standard rotation and 1-8-7-3-6-2-4-5 for the reverse rotation.)

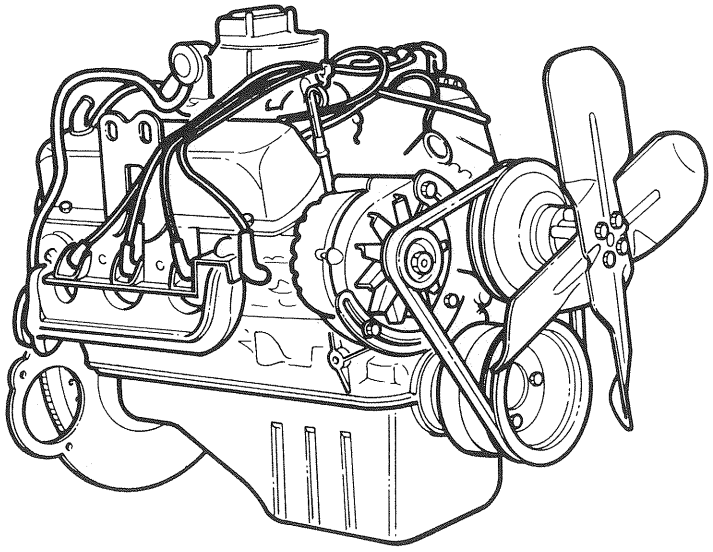


FIG. 3 CSG-850 Engine — Typical (Left 3/4 Front View)

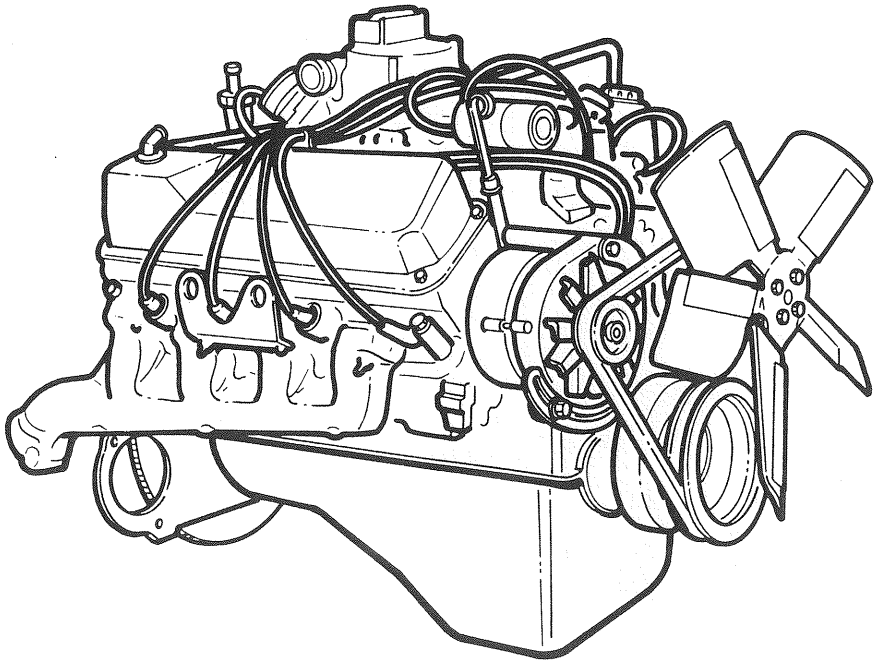


FIG. 4 WSG-858 Engine — Typical (Left 3/4 Front View)

CAMSHAFT IDENTIFICATION

Engine	Application	Rotation	Intake Lift	Exhaust Lift
CSG-850 (302)	Low Output	Standard	0.230	0.238
CSG-850 (302)	Low Output	Reverse	0.230	0.238
CSG-850 (302)	except Low Output	Standard	0.260	0.278
CSG-850 (302)	except Low Output	Reverse	0.260	0.278
CSG-850 (302-4V)		Standard	0.278	0.283
CSG-850 (302-4V)		Reverse	0.278	0.283
WSG-858 (351)		Standard	0.278	0.283
WSG-858 (351)		Reverse	0.278	0.283

FIG. 5 Marine Engine Camshaft Identification Chart

The crankshaft is carried in five replaceable copper-lead alloy main bearings. Crankshaft end thrust is controlled by the center bearing. (Marine engines use four crankshaft assemblies, two for the 302 including the 302 low output engine and two for the 351W. Standard or reverse rotation is the determining factor on which crankshaft is used. A different damper assembly is used for each crankshaft and can be identified by the part number stamped on the face of the damper and the direction of rotation as indicated by the timing marks on the damper.)

The camshaft is supported by five bearings pressed into the block. It is driven by a timing chain from the crankshaft. (There are six different camshafts available for marine engines, two for the 302 low output engine, depending upon standard or reverse rotation and four for the other engines depending upon whether a two or four venturi carburetor is used and whether the engine is standard or reverse rotation. The camshafts are identified as per the chart in Figure 5.)

Camshaft end play is controlled by a plate bolted to the front of the block. The distributor is driven by a gear at the front end of the camshaft. (Distributors used on marine engines may vary. The parts are not interchangeable between different makes of distributors, but complete distributors can be interchanged. The 302 marine engines use a Prestolite or Mallory distributor. The 351W marine engines use a Prestolite, GPD or Mallory distributor.)

The cylinder head assemblies contain the fuel intake and exhaust passages, the valves, and the valve rocker arm assemblies. Valve guides are an integral part of the head. Hard-faced intake and exhaust valve seat inserts are standard. The intake and exhaust valves are actuated through hydraulic-type valve lifters, tubular push rods and individual rocker arms. The large intake and exhaust valves are the free-turning type which rotate slightly each time the valve opens and closes. Rotation promotes self-cleaning and long life.

The self-adjusting valve lifters are housed in bores located in the cylinder block valve lifter chamber. The valve lifters operate directly on the camshaft, thereby transmitting the thrust of the camshaft lobes, by means of hydraulic pressure, to the push rods which actuate the valve train.

All marine engines use heavy duty valves and all have free rotating intake and exhaust valves, except the low output 302 engines. Free rotating valves rotate slightly each time the valve opens and closes.

On the low output 302 marine engines, the intake valves are free rotating while the exhaust valves are the positive rotating type. A positive rotating spring retainer produces a definite amount of rotation each time the valve opens and closes.

The low output 302 marine engines use the regular 302 cylinder head while all the other marine engines use a 351W engine cylinder head. The intake and exhaust valve parts of the 351W cylinder head are larger than those of the 302 head. Accordingly, the diameter of the intake and exhaust valves of all engines using the 351W head are larger and the length of the stems slightly longer. Valves with oversize stems are available for all marine engines.

The same spring is used for intake and exhaust valves of all marine engines except the low output 302 engine. These springs are identified by color coding. The color code for all springs other than those for the low output 302 is three green stripes. The intake valve spring for the low output 302 is light red while the exhaust valve spring is color coded purple.

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

The intake manifold has two sets of fuel passages, each with its own separate inlet connection to the carburetor. A heat crossover passage permits exhaust gases to circulate through the intake manifold, thereby providing the initial heat necessary to assist in vaporizing the incoming fuel charge.

Oil from the oil pan sump, located in the front of the oil pan, is forced through the pressure lubrication system by a rotor-type oil pump mounted in the front of the crankcase. A spring-loaded relief valve in the pump maintains the maximum pressure in the system. A full-flow filter is used which filters the entire output of the pump before the oil enters the engine. A valve integral with the filter permits oil flow if the filter ever becomes clogged. From the filter, the oil flows to an oil gallery and through passages to the various bearings and engine components.

The pistons have two compression rings and one oil control ring. The top compression ring is chrome-plated steel and the lower compression ring is phosphate-coated. The oil control ring consists of a serrated spring expander and two chrome-plated steel rails. The connecting rods are forged steel and use selective fit replaceable copper-lead alloy bearings.

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

The engine is equipped with a positive crankcase system that directs the crankcase vapors through an emission valve to the intake manifold, where they are mixed with the incoming fuel charge and burned in the cylinders.

Industrial and irrigation engines use a standard water pump. Marine engines use a different water pump depending upon whether the engine is standard or reverse rotation.

The reverse rotation engines use a bi-rotational water pump assembly. The bi-rotational pump only is identified by a number, D3JE-AA, on the housing.

Marine engines use Holley marine carburetors Model 4160 for four venturi applications and 2300 for two venturi applications.

DIAGNOSIS AND TESTING

CAMSHAFT LOBE LIFT

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

1. Remove the air cleaner. Remove valve rocker arm cover.
2. Remove the valve rocker arm assembly(ies) and install a solid, tappet-type push rod in the push rod bore of the camshaft lobe to be checked or use the adapter for ball end push rods shown in Figure 6.
3. Make sure the push rod is in the valve lifter socket. Install a dial indicator so that the actuating point of the indicator is in the push rod socket (or the indicator ball socket adapter is on the end of the push rod) and in the same plane as the push rod movement.
4. Connect an auxiliary starter switch in the starting circuit. Crank the engine with the ignition switch OFF. Bump the crankshaft over until the tappet or lifter is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position.
5. Zero the dial indicator. Continue to rotate the crankshaft slowly until the push rod is in the fully raised position.
6. Compare the total lift recorded on the indicator with 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 valve rocker arm assembly as detailed under Removal and Installation.
10. Install the valve rocker arm cover and the air cleaner.

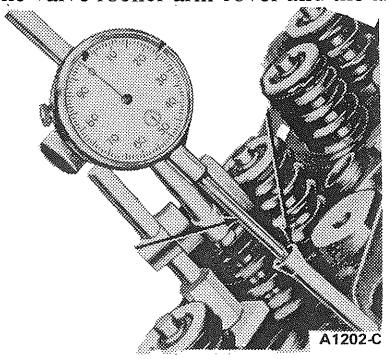


FIG. 6 Typical Camshaft Lobe Lift Hydraulic Valve Lifters — V-8 Engine

COMPRESSION TEST

COMPRESSION GAUGE CHECK

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

TEST CONCLUSION

The indicated compression pressures are considered normal if the lowest reading cylinder is within 75% of the highest. Refer to the following example and Figure 7.

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

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

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

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

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

CA1005-A

FIG. 7 Quick Reference Compression Pressure Limit Chart

EXAMPLE

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

HYDRAULIC VALVE LIFTER

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

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

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

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

1. Disassemble and clean the lifter to remove all traces of engine oil. Lifters cannot be checked with engine oil in them. Only the testing fluid can be used.
2. Place the valve lifter in the tester with the plunger facing upward. Pour hydraulic tester fluid into the cup to a level that will cover the valve lifter assembly. The fluid can be purchased from the manufacturer of the tester. Do not use kerosene, for it will not provide an accurate test.
3. Place a 5/16 inch steel ball in the plunger cup (Figure 8).
4. Adjust the length of the ram so that the pointer is 1/16 inch below the starting mark when the ram contacts the valve lifter plunger (Figure 9) to facilitate timing as the pointer passes the start timing mark.

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

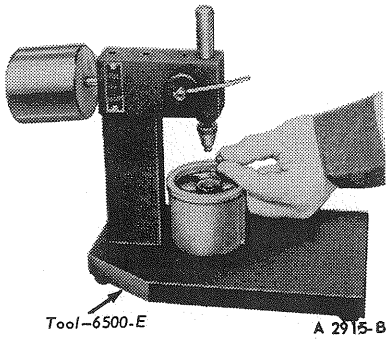


FIG. 8 Placing Steel Ball in Valve Lifter Plunger

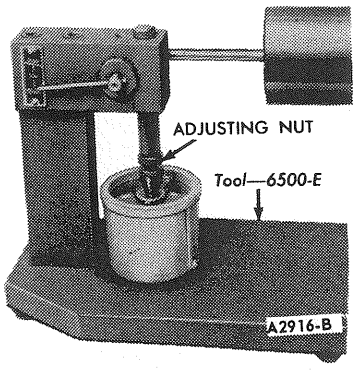


FIG. 9 Adjusting Ram Length

5. Work the valve lifter plunger up and down until the lifter fills with fluid and all traces of air bubbles have disappeared.
6. Allow the ram and weight to force the valve lifter plunger downward. Measure the exact time it takes for the pointer to travel from the start timing to the stop timing

marks on the tester.
7. A valve lifter that is satisfactory must have a leak-down rate (time in seconds) within the minimum and maximum limits specified.
8. If the valve lifter is not within specifications, replace it with a new lifter. It is not necessary to test a new lifter before installing it in the engine.

POSITIVE CLOSED-TYPE VENTILATION SYSTEM

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

AIR INTAKE TEST

This test is performed with the crankcase ventilation tester C8AZ-6B627-A (Figure 10) which is operated by the engine vacuum through oil fill opening. Follow the procedures described below to install the tester and check the crankcase ventilation system for faulty operation.

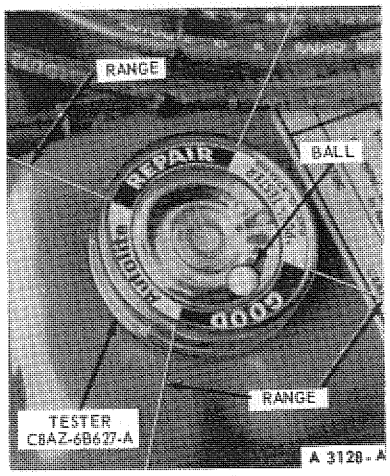


FIG. 10 Crankcase Ventilation System Tester

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

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

CRANKCASE VENTILATION REGULATOR VALVE TEST

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

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

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

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

CRANKSHAFT END PLAY

1. Force the crankshaft toward the rear of the engine.
2. Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Figure 11).
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 sufficiently to true up the surface if the mounting flange runout exceeds specifications. Replace it or reinstall it on the flywheel.

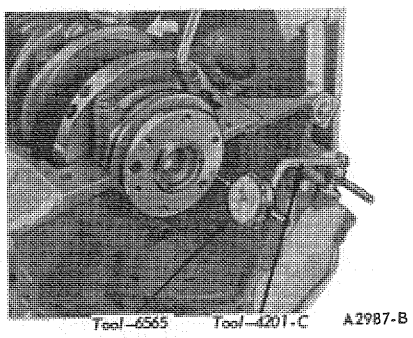


FIG. 11 Checking Crankshaft End Play

CAMSHAFT END PLAY

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

Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket attaching screw (Figure 12). 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.

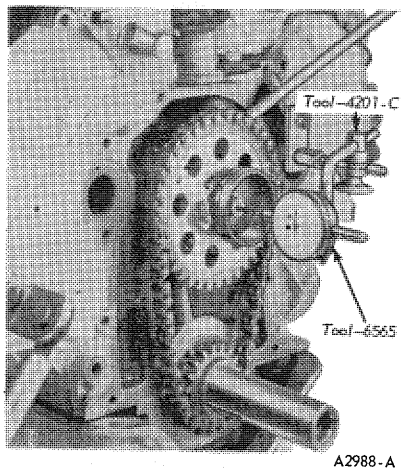


FIG. 12 Checking Camshaft End Play

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.

TIMING CHAIN DEFLECTION

1. Rotate the crankshaft in a counterclockwise position (as viewed from the front) to take up the slack on the left side of the chain.
2. Establish a reference point on the block and measure from this point to the chain.
3. Rotate the crankshaft in the opposite direction to take up the slack on the right of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

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

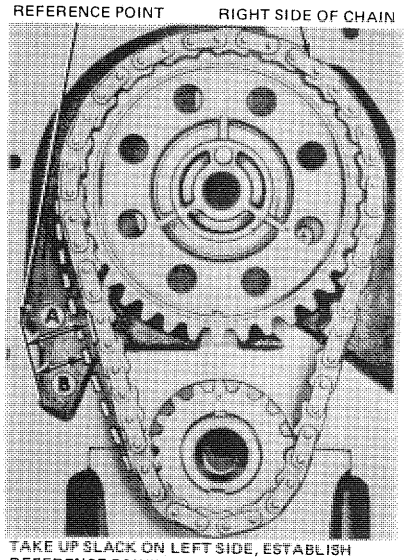


FIG. 13 Checking Timing Chain Deflection

CLEANING AND INSPECTION

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

INTAKE MANIFOLD

Cleaning

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

Inspection

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

EXHAUST MANIFOLDS

Cleaning

Remove all gasket material from the manifolds.

Inspection

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

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

VALVE ROCKER ARM ASSEMBLY

Cleaning

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

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

Inspection

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

Check the push rod end of the rocker arms for scratches or excessive wear.

PUSH RODS

Cleaning

Clean the push rods in a suitable solvent.

Inspection

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

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator (Figure 14).

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

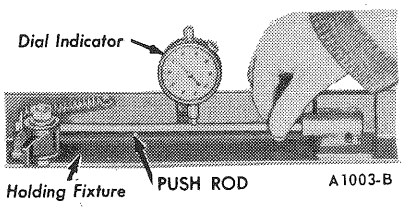


FIG. 14 Checking Push Rod Runout

CYLINDER HEADS

Cleaning

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

Inspection

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

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

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Figure 15) for conformance to specifications. If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.010 inch.**

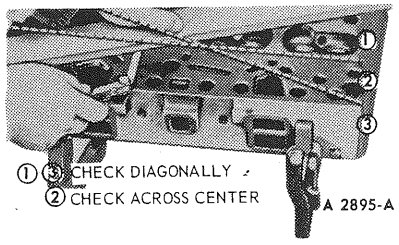


FIG. 15 Typical Cylinder Head Flatness

Check the valve seat runout with an accurate gauge (Figure 16). Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. Measure the valve seat width (Figure 30). Reface any valve seat whose width **is not within specifications.**

Inspect the valve face and the edge of the valve head for pits, grooves, scores or other damage. Inspect the stem for a bent condition and the end of the valve head for pits, grooves, scores or other wear. Inspect the stem for a bent condition and the end of the stem for grooves or scores.

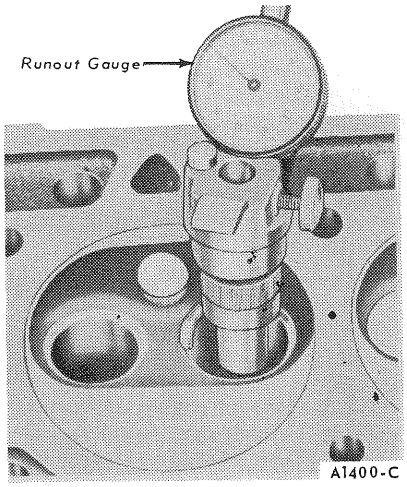


FIG. 16 Checking Valve Seat Runout

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

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

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Figure 17 or its equivalent. Use a flat end indicator point.

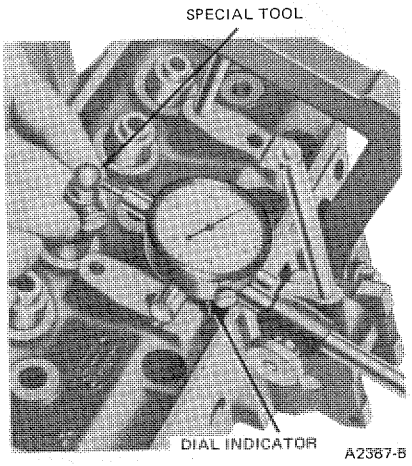


FIG. 17 Checking Valve Stem Clearance

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.

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

Check the springs for proper pressure (Figure 18) at the specified spring lengths (Tool 6513-DD). **Manually rotating the valve spring assemblies while installed in the engine must not be used to determine good and/or bad valve springs.** Weak valve springs cause poor engine performance. Replace any spring not within specifications.

Check each spring for squareness using a steel square and a flat surface (Figure 19). Stand the spring and square on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. The out-of-square limits are 5/64 inch.

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

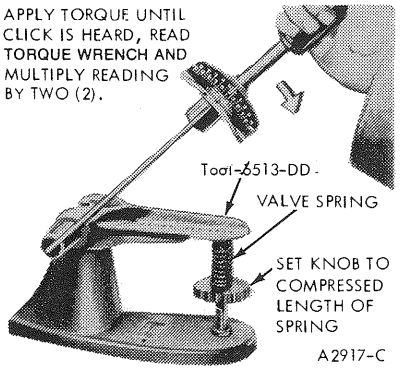


FIG. 18 Checking Valve Spring Pressure

HYDRAULIC VALVE LIFTERS

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

Cleaning

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

Inspection

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

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

CRANKSHAFT VIBRATION DAMPER AND SLEEVE

Cleaning

Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other inperfections 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.**

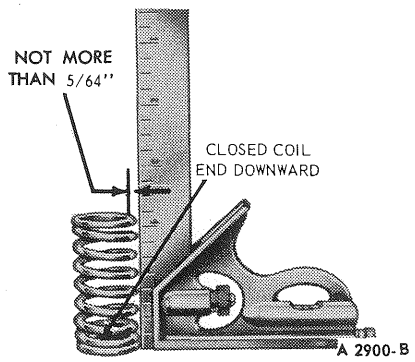


FIG. 19 Checking Valve Spring Squareness

Inspection

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

TIMING CHAIN AND SPROCKETS

Cleaning

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

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

Inspection

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

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

CAMSHAFT

Cleaning and Inspection

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

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

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

CRANKSHAFT

Cleaning

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

Inspection

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

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition (Figure 20).

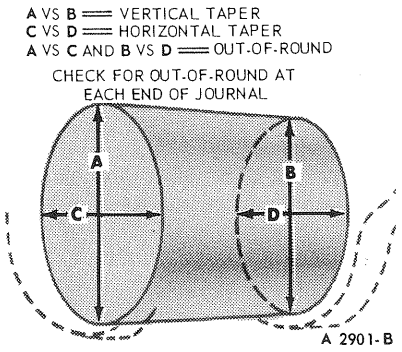


FIG. 20 Crankshaft Journal Measurement

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 21). Replace the bushing if it is worn or damaged or the ID is not within specifications.

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

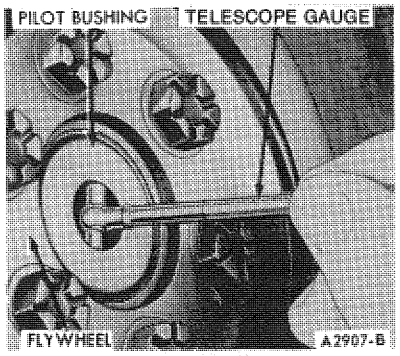


FIG. 21 Checking Clutch Pilot Bushing Wear

FLYWHEEL

Inspection

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

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

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

CONNECTING RODS

Cleaning

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

Inspection

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

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

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

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

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

PISTONS, PINS AND RINGS

Cleaning

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

Clean the ring grooves with a ring groove cleaner (Figure 22). Make sure the oil ring slots (or holes) are clean.

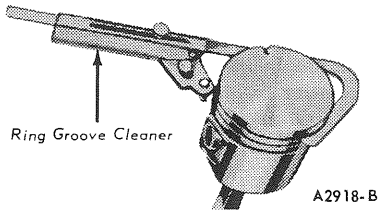


FIG. 22 Cleaning Piston Ring Grooves

Inspection

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

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

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

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

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

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

MAIN AND CONNECTING ROD BEARINGS

Cleaning

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

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in Figure 23. The copper-lead bearing base may be visible through the bearing overlay. This does not mean that the bearing is worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as detailed under Main and Connecting Rod Bearings.

CYLINDER BLOCK

Cleaning

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

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

Inspection

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

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

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

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Figure 24). **Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.**

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

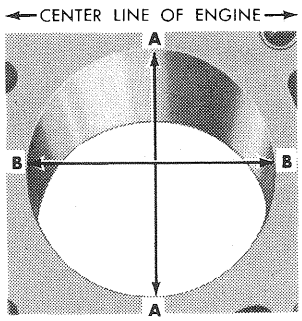


FIG. 24 Cylinder Bore Out-of-Round and Taper

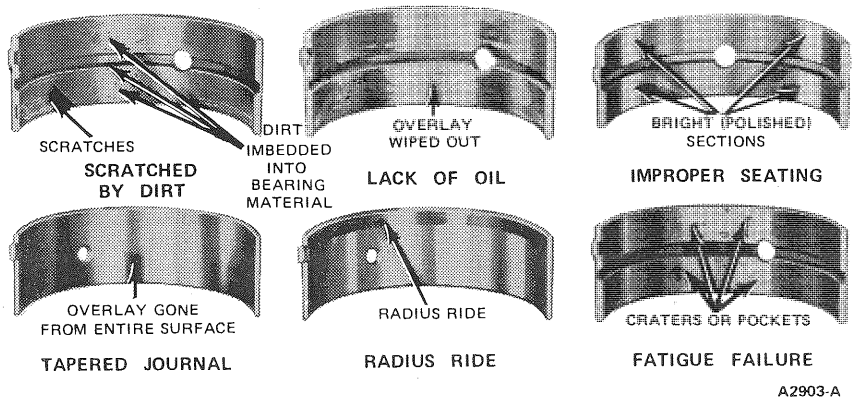


FIG. 23 Typical Bearing Failures

OIL PAN

Cleaning

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

Inspection

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

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

OIL PUMP

Cleaning

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

Inspection

Refer to the specifications for clearances and wear limits.

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

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

Measure the outer race to housing clearance (Figure 25). Then check the clearance between the outer race and the rotor lobes.

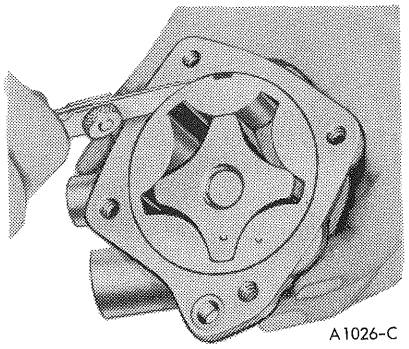


FIG. 25 Checking Outer Race to Housing Clearance

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 26). **The outer race, shaft and rotor are replaceable only as an assembly.** Check the drive shaft to housing bearing clearance by measuring the OD of the shaft and the ID of the housing bearing. Inspect the relief valve spring for a collapsed or worn condition. Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is worn or damaged, replace the spring. Check the relief valve piston for scores and free operation in the bore.

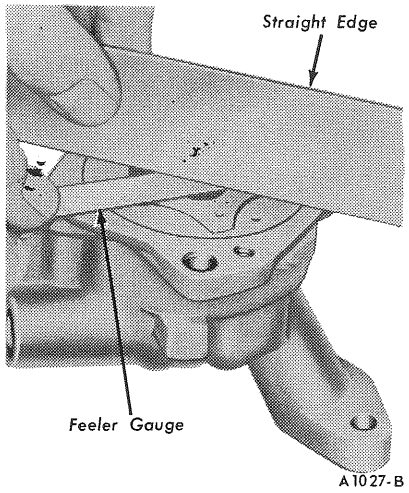


FIG. 26 Checking Rotor End Play

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

Cleaning

Do not attempt to clean the crankcase ventilation regulator valve (Figure 27); it should be replaced at the specified maintenance interval. The oil filler cap and oil separator should be cleaned at the proper maintenance interval. Remove the cap and the oil separator and wash them in a low-volatility, petroleum-base solvent. Shake the cap dry and install them. Clean the crankcase ventilation system connection(s) on the intake manifold by probing with a flexible wire or bottle brush. Clean the hoses, fittings, tubes and associated hardware with a low-volatility, petroleum-base solvent and dry with compressed air.

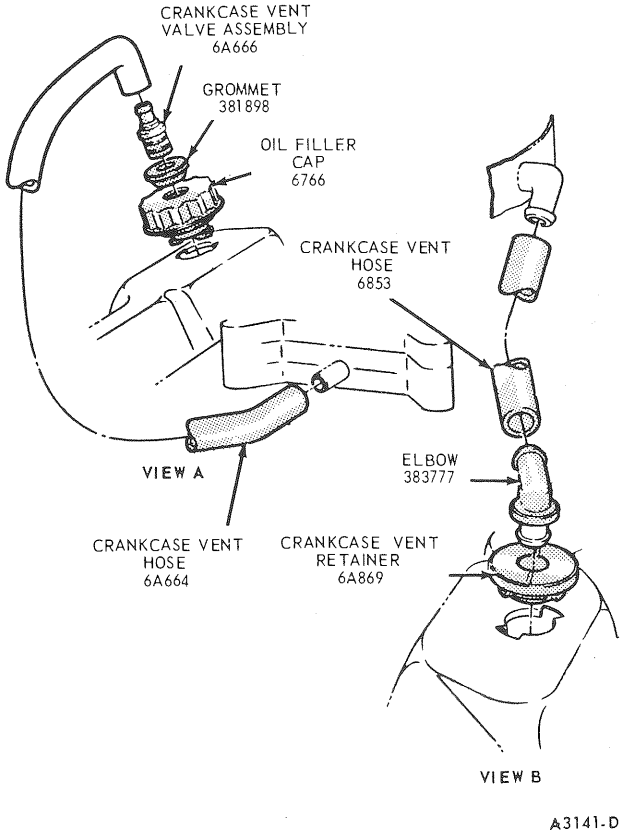


FIG. 27 Crankcase Ventilation System Regulator Valve Installed

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 28) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: a 0.003-inch OS reamer with a standard diameter pilot, a 0.015-inch OS reamer with a 0.003-inch OS pilot, and a 0.030-inch reamer with a 0.015-inch OS pilot.

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

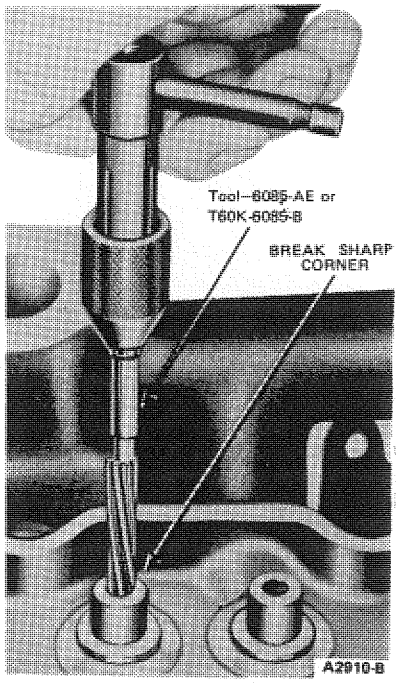


FIG. 28 Reaming Valve Guides

REFACING VALVE SEATS

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

Grind the valve seats of all engines to a true 45 degree angle (Figure 29). 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 30). Narrow the seat, if necessary, to bring it within specifications, and center it on the valve face.

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

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

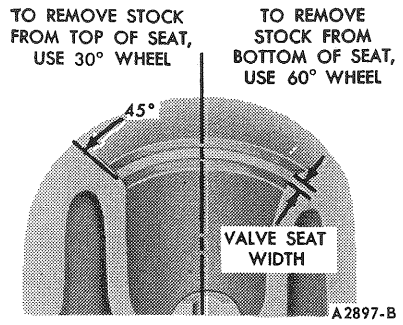


FIG. 29 Refacing Valve Seat

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.

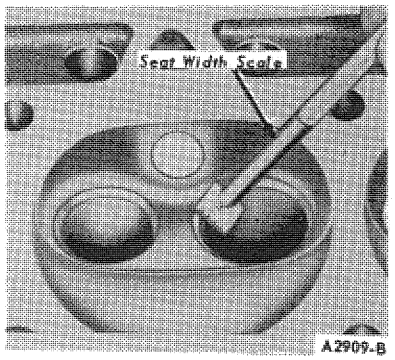


FIG. 30 Checking Valve Seat Width

VALVES

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

REFACING VALVES

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

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

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 1/32 inch thick after grinding (Figure 31), 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.

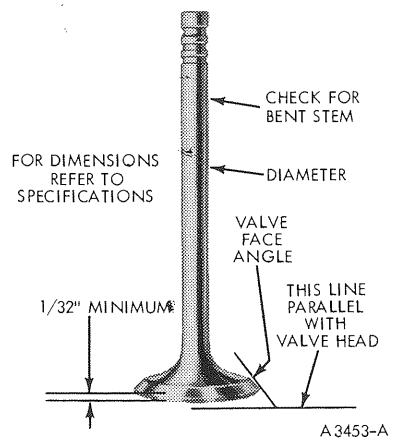


FIG. 31 Critical Valve Dimensions

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.**

REFINISHING JOURNALS

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

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

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

FITTING MAIN OR CONNECTING ROD BEARINGS WITH PLASTIGAGE

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear. **When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.** If the desired clearance cannot be obtained with a standard bearing, try a 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.
2. If fitting a main bearing in the chassis, **position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.**
3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center (Figure 32).
4. Install cap and torque bolts to specifications. Do not turn crankshaft while Plastigage is in place.
5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.
6. If clearance exceeds specified limits, on the connecting rod bearings, try a 0.002 inch undersize bearing in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.
7. After bearing has been fitted, remove Plastigage and apply light coat of engine oil to journal and bearings. Install bearing cap. Torque cap bolts to specifications.
8. Repeat procedure for remaining bearings that require replacement.

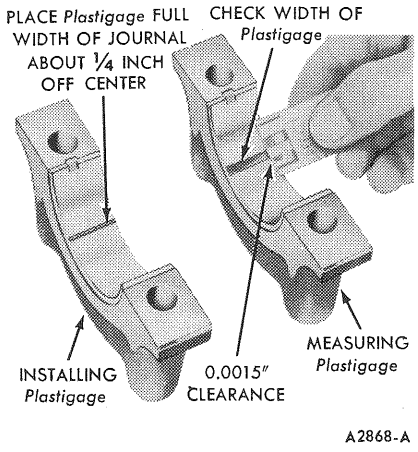


FIG. 32 Installing and Measuring Plastigage

PISTONS, PINS AND RINGS

FITTING PISTONS

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

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

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

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

1. Calculate the size piston to be used by taking a cylinder bore check. Follow the procedures outlined under Cleaning and Inspection.
2. Select the proper size piston to provide the desired clearance (refer to the specifications). The piston should be measured 2¼ inches below the dome and at 90° to the piston pin bore.
3. Make sure the piston and cylinder block are at room temperature (70 degrees F.). **After any refinishing operation allow the cylinder bore to cool, and make sure the piston and bore are clean and dry before the piston fit is checked.**

FITTING PISTON RINGS

1. Select the proper ring set for the size cylinder bore.
2. Position the ring in the cylinder bore in which it is going to be used.
3. Push the ring down into the bore area where normal ring wear is not encountered.
4. Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. **Use caution to avoid damage to the ring or cylinder bore.**
5. Measure the gap between the ends of the ring with a feeler gauge (Figure 33). 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 34). 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.**

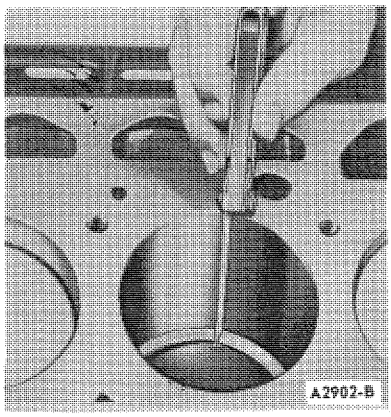


FIG. 33 Checking Piston Ring Gap

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.

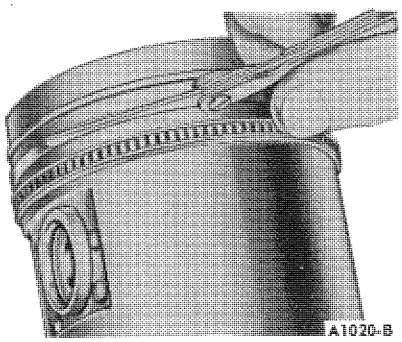


FIG. 34 Checking Piston Ring Slide Clearance

VALVE ROCKER ARM

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

PUSH RODS

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

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

CYLINDER BLOCK

REFINISHING CYLINDER WALLS

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

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

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

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

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

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

Use a motor-driven, spring pressure-type hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 15/32 RMS. When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. After the final operation in either of the two refinishing methods described and prior to checking the piston fit,

thoroughly clean and oil the cylinder walls. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

REPAIRING SAND HOLES OR POROUS ENGINE CASTINGS

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

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

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

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

ADJUSTMENTS

VALVE CLEARANCE

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

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

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

However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and torqued properly. On engines with positive step studs, each stud nut should be removed and inspected for conditions shown in Figure 37 when adjusting valve clearance.

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

5.0L V-8 Engine

1. Install an auxiliary starter switch. Crank the engine with the ignition switch OFF until the No. 1 piston is on TDC after the compression stroke.
2. With the crankshaft in the positions designated in Steps 3, 4 and 5, position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Figure 35). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge. The feeler gauge width must not exceed 3/8 inch.

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

   If the clearance is greater than specifications, install a longer push rod.
3. With the No. 1 piston on TDC at the end of the compression stroke, POSITION 1 in Figure 36, check the following valves:
   No. 1 Intake, No. 1 Exhaust
   No. 7 Intake, No. 5 Exhaust
   No. 8 Intake, No. 4 Exhaust
4. Rotate the crankshaft to POSITION 2 in Figure 36 and check the following valves:
   No. 5 Intake, No. 2 Exhaust
   No. 4 Intake, No. 6 Exhaust
5. Rotate the crankshaft to POSITION 3 in Figure 36 and check the following valves:
   No. 2 Intake, No. 7 Exhaust
   No. 3 Intake, No. 3 Exhaust
   No. 6 Intake, No. 8 Exhaust

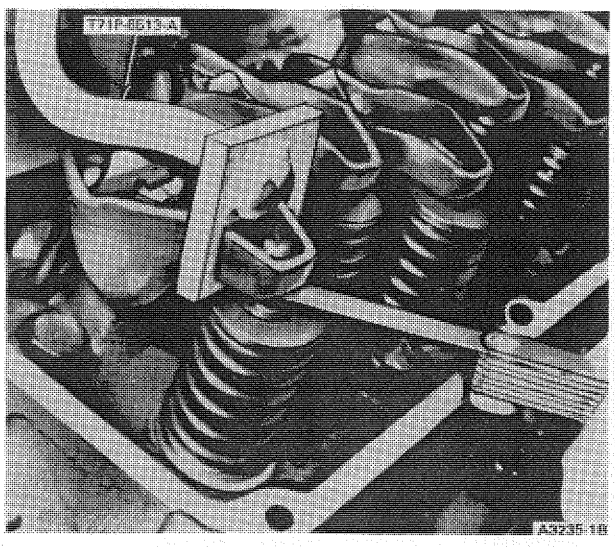


FIG. 35 Checking Valve Clearance Hydraulic Valve Lifters

5.8L V-8 Engine

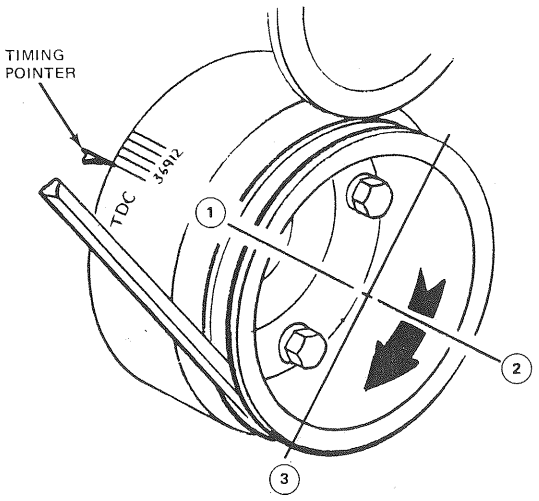
1. Install an auxiliary starter switch. Crank the engine with the ignition switch OFF.

2. Position the crankshaft as outlined in Figure 36. Position a hydraulic lifter compressor tool on the rocker arm and slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Figure 35). Hold the lifter in the fully collapsed position and insert a low-limit (see Specifications) clearance gauge between the valve stem and the rocker arm of the valve being checked. If the clearance is less than specified, install a 0.060 inch longer push rod. If the gauge enters, the old push rod may be used. If a high-limit gauge enters, the operating range of the lifter is excessive which indicates severe wear has occured at the push rod ends, rocker arm, or valve stem. In this case, it will be necessary to determine the area of discrepancy and the worn part(s) should be replaced. If all the valve train components except the push rod are within limits, install a 0.060 inch longer push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke, POSITION No. 1 in Figure 36, check the following valves:
   No. 1 Intake, No. 1 Exhaust
   No. 4 Intake, No. 3 Exhaust
   No. 8 Intake, No. 7 Exhaust

4. Rotate the crankshaft to POSITION No. 2 in Figure 36 and check the following valves:
   No. 3 Intake, No. 2 Exhaust
   No. 7 Intake, No. 6 Exhaust

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



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

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FIG. 36 Position of Crankshaft for Checking and Adjusting Valve Clearance

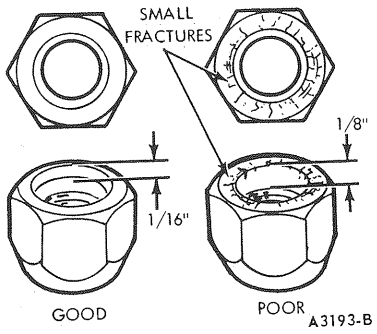


FIG. 37 Inspection of Rocker Arm Stud Nut

5. Rotate the crankshaft to POSITION No. 3 in Figure 36 and check the following valves:
   No. 2 Intake, No. 4 Exhaust
   No. 5 Intake, No. 5 Exhaust
   No. 6 Intake, No. 8 Exhaust

REMOVAL AND INSTALLATION

CRANKCASE VENTILATION SYSTEM

The positive closed-type crankcase ventilation system components are shown in Figure 38.

Removal

1. Remove ventilation system air intake hose from air cleaner and the right valve cover.
2. Remove air cleaner.
3. Disconnect the crankcase vent hose from the carburetor spacer.
4. Pull the regulator valve out of the oil filler cap in the left valve cover.

Installation

1. Insert the regulator valve into the oil filler cap on the left valve cover.
2. Connect the vent hose to the regulator valve; install the hose on the carburetor spacer.
3. Install the air cleaner.
4. Install the ventilation system air intake hose to the air cleaner and right valve cover fitting.
5. Start the engine and check for leaks.

VALVE ROCKER ARM COVER AND ROCKER ARM

Two types of rocker arm assemblies may be found on the engine. Prior to 1978, the cast rocker was used (Figure 39). Present engines use a stamped rocker (Figure 39A).

Removal

1. To remove a valve rocker arm from the right cylinder head, disconnect the automatic choke heat chamber air inlet hose from the inlet tube near the right valve rocker arm cover, if so equipped (302 only).
   Remove the air cleaner.
   Remove the automatic choke heat tube (302 only). Remove the crankcase ventilation fresh air tube from the valve rocker arm cover.
2. Disconnect the spark plug wires from the spark plugs using Tool No. T68P-6666-A. Do not pull on wire. Remove the wires from the bracket on the valve rocker arm cover(s) and position the wires out of the way.
3. On a left side rocker arm cover, remove the wire harness from the retaining clips. Remove the valve rocker arm cover attaching bolts and remove the cover.

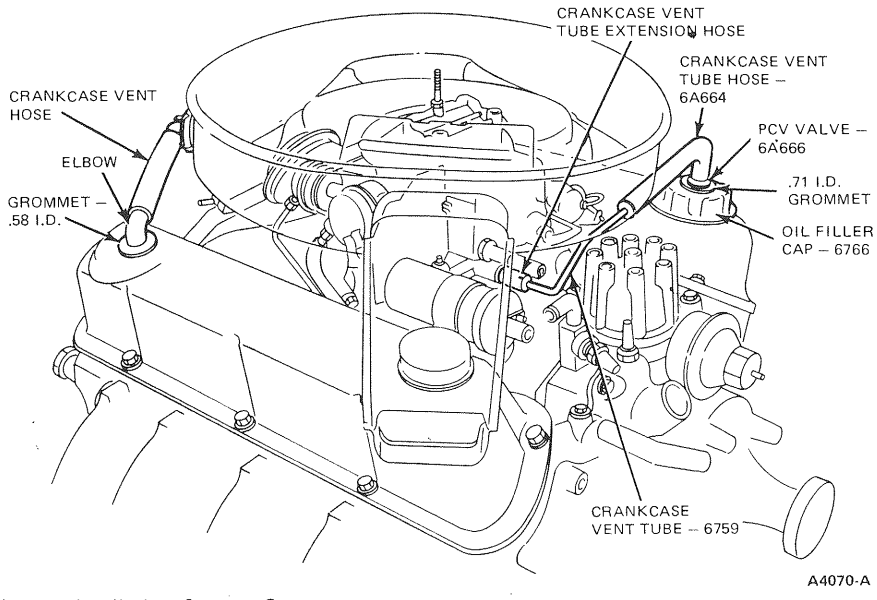


FIG. 38 Typical Crankcase Ventilation System Components

4. Remove the valve rocker arm attaching bolt or nut, fulcrum or fulcrum seat and rocker arm.

If removal of the rocker arm stud is necessary, refer to the procedure under Cylinder Head Repairs.

Installation

All rocker arms and fulcrum are to be lubricated with heavy SE engine oil before installation.

1. Apply Lubriplate, or equivalent, to the top of the valve stem and underside of the fulcrum or fulcrum seat.
2. Apply Lubriplate, or equivalent, to the top of the valve stem and underside of the fulcrum or fulcrum seat.
3. Install the rocker arm, fulcrum or fulcrum seat and attaching bolt or nut.
4. Clean the valve rocker arm cover(s) and the cylinder head gasket surface(s). Position the valve rocker cover gasket in each cover, making sure that the tabs engage the notches in the cover.
5. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts and wire loom clips on left hand cover. The cover is tightened in two steps. Torque the bolts to specifications.

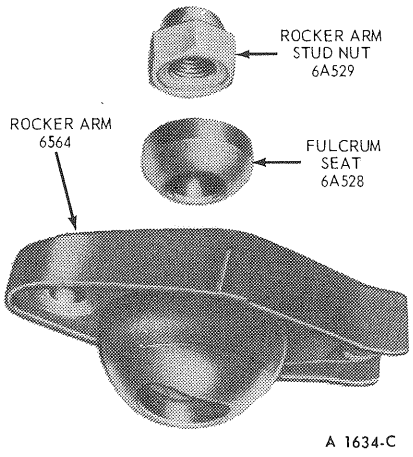


FIG. 39 Valve Rocker Arm Assembly

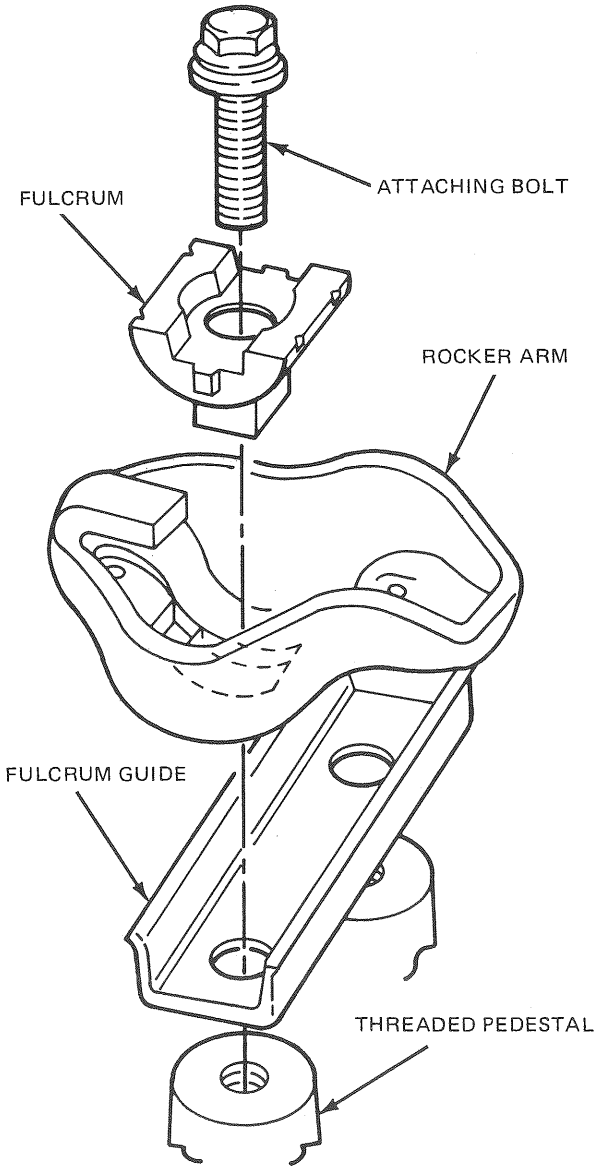


FIG. 39A Valve Rocker Arm Assembly (Stamped)

Two minutes later, torque the bolts to the same specifications.

Install the crankcase ventilation hoses in the covers. Install the automatic choke heat tube and connect the automatic choke heat chamber air inlet hose at the air cleaner.

6. Install the spark plug wires in the bracket on the valve rocker arm cover(s). Connect the spark plug wires. Install the air cleaner.
7. Install the Thermactor by-pass valve and air supply hoses.

VALVE SPRING, RETAINER AND STEM SEAL

Removal

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

1. Refer to Valve Rocker Arm Cover in this section for the cover removal and installation.
2. Remove the applicable spark plug and bring the piston to the top of the bore to prevent accidental loss of the valve into the cylinder.
3. Remove the valve rocker arms and push rods from the applicable cylinder. Remove the exhaust valve stem cap.
4. Install an air line with an adapter in spark plug hole and apply air pressure to the cylinder. Failure of the air pressure to hold the valve(s) in the closed position is an indication of valve seat damage and required removal of the cylinder head.
5. Install the stud nut and position the compressor tool as shown in Figure 40. Compress the valve spring and remove the retainer locks, spring retainer, sleeve and valve spring.
6. Remove and discard the valve stem seal (Figure 41).
7. **If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) 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.**
8. 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.**

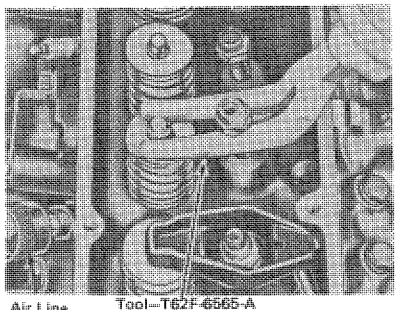


FIG. 40 Compressing Valve Spring — In Chassis

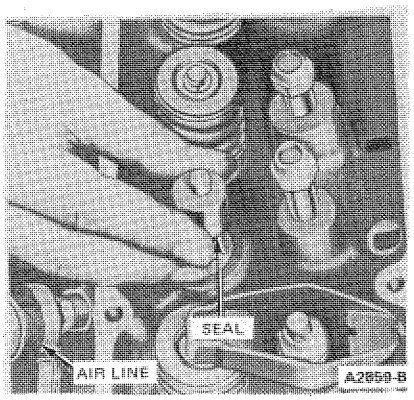


FIG. 41 Removing or Installing Valve Stem Seal

Installation

1. If the condition of the valve proved satisfactory, lubricate the valve stem with heavy engine oil SE. Hold the valve in the closed position and apply air pressure within the cylinder.
2. Install a new valve stem seal (Figure 41). Place the spring in position over the valve and install the valve spring retainer and sleeve. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut.
3. Lubricate the push rod ends with Lubriplate or equivalent and install the push rod. Apply Lubriplate or equivalent to the tip of the valve stem. Install the exhaust valve stem cap.
4. Apply Lubriplate or equivalent to the rocker arms and fulcrum seats. Install the valve rocker arm assemblies.
5. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
6. Clean and install the rocker arm cover.

INTAKE MANIFOLD

The intake manifold assembly is shown in Figure 42.

Removal

1. Drain cooling system. Remove air cleaner, including the crankcase ventilation hose.
2. Disconnect the throttle rod and choke cable from the carburetor. Remove the throttle retracting spring.
3. Disconnect the high-tension lead and wires from the coil.
4. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap using Tool No. T68P-6666-A. Remove the wires from the harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wires as an assembly.
5. Remove the carburetor fuel inlet line.
6. Disconnect the distributor vacuum hose from the distributor. Remove the distributor hold down bolt and remove the distributor.
7. Disconnect the radiator upper hose from the coolant outlet housing.
8. Loosen the clamp on the water pump by-pass hose at the coolant outlet housing and slide the hose off the outlet housing.
9. Disconnect the crankcase vent hose at the valve rocker arm cover.

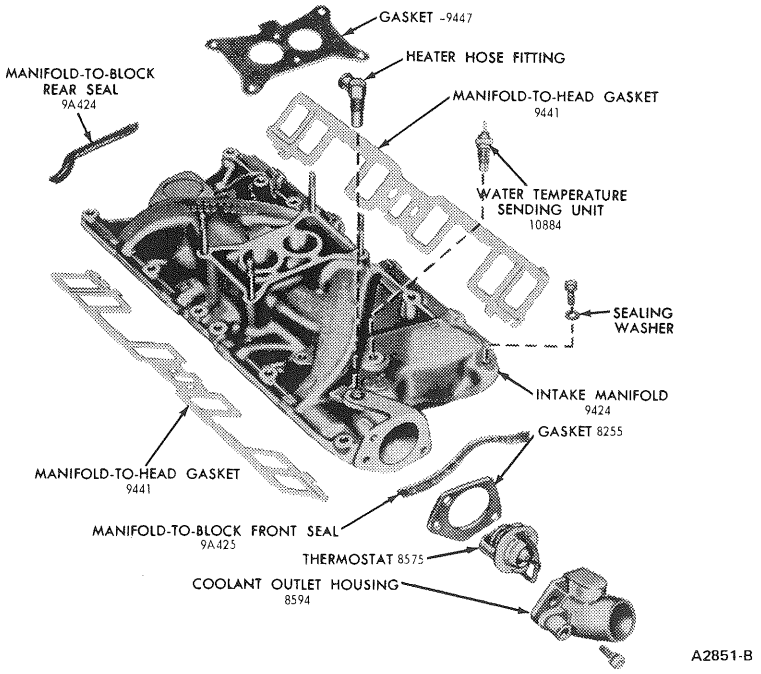


FIG. 42 Intake Manifold Assy.

10. Remove the intake manifold and carburetor as an assembly. **It may be necessary to pry the intake manifold away from the cylinder heads. Remove the intake manifold gaskets and seals. Discard the intake manifold attaching bolt sealing washers.**
11. If the manifold assembly is to be disassembled, identify all vacuum hoses before disconnecting them. Remove the coolant outlet housing gasket and thermostat. Remove the carburetor, spacer, gasket, vacuum fitting, accelerator retracting spring bracket and choke cable bracket.

Installation

1. If intake manifold assembly was disassembled, install the temperature sending unit (threads coated with electrical conductive sealer), ignition and coil, carburetor, spacer, gaskets, vacuum fittings, throttle retracting spring bracket and choke cable bracket. Install the coolant outlet housing.
2. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block using a solvent such as Ford Spot Remover (B7A-19521-A) or equivalent. Apply a 1/8 inch bead of RTV sealer, (C3AZ-19526-A or B) at the points shown in Figure 43.
3. Apply a 1/16 inch bead of RTV sealer to the outer end of each intake manifold seal for the full width of the seal (4 places). See Figure 43.

NOTE: This sealer sets-up in 15 minutes, so it is important that assembly be completed promptly. Do not drip any sealer into the engine valley. Position the seals on the cylinder block and new gaskets on the cylinder heads with the gaskets interlocked with the seal tabs. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

4. Carefully lower intake manifold into position on the cylinder block and cylinder heads. **After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and position the seals.**
5. Be sure the holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching nuts and bolts. Tighten the nuts and bolts in two steps (Figure 44 or Figure 15). Tighten all nuts and bolts in sequence to specifications.

TYPICAL SEALER APPLICATION AREAS FOR INTAKE MANIFOLD INSTALLATION

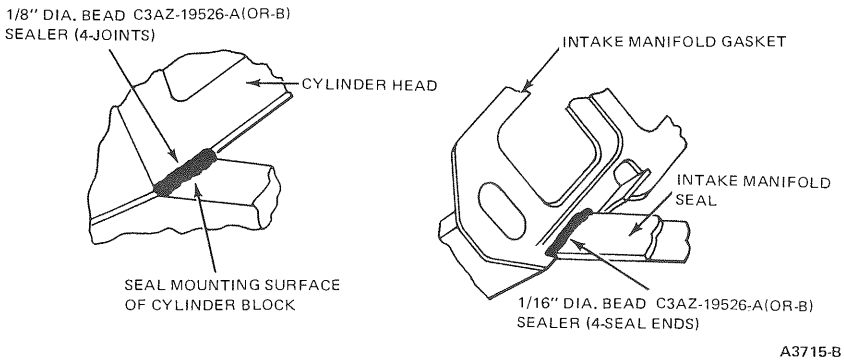


FIG. 43 RTV Sealer Installation Intake Manifold

After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature, then retighten the manifold nuts and bolts in sequence to specifications.

6. Install water pump by-pass hose on the coolant outlet housing. Slide the clamp into position and tighten the clamp.
7. Connect the radiator upper hose.
8. Install the carburetor fuel inlet line.
9. Rotate the crankshaft damper until the No. 1 piston is on TDC at the end of the compression stroke. Position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the holddown clamp.
10. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs.
11. Connect crankcase vent hose. Connect the high-tension lead and coil wires.
12. Connect the accelerator rod and retracting spring. Connect the choke cable.
13. Fill and bleed the cooling system.
14. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
15. Operate the engine at fast idle and check all hose connections and gaskets for leaks. Operate the engine until engine temperatures have stabilized and adjust the engine idle speed and idle fuel mixture. Retighten the intake manifold bolts to specifications.
16. Adjust the throttle linkage. Install the air cleaner and intake duct assembly, including the closed crankcase ventilation hose.

VALVE LIFTER

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve to rocker arm clearance or by worn rocker arms or push rods.

Removal

1. Remove the intake manifold and related parts following procedures given in Intake Manifold Removal.
2. Remove the valve rocker arm cover, then loosen the valve rocker arm bolt or nut and rotate the rocker arms to the side.
3. Remove the valve push rods in sequence so that they can be installed in their original positions.
4. Using Tool T70L-6500-A shown in Figure 46, remove the valve lifters and place them in a rack so that they can be installed in their original bores.

If necessary to disassemble a lifter, refer to Valve Lifter Disassembly and Assembly in this Part.

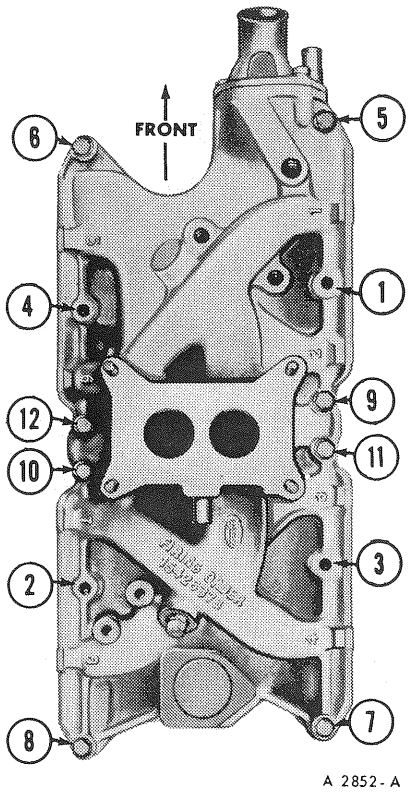


FIG. 44 Intake Manifold Bolts Tightening Sequence — 302 CID Engine

Installation

Valve lifters and bores are to be lubricated with heavy engine oil SE before installation.

1. Clean the external surfaces and install the valve lifters in the bores from which they were removed, using Tool T70L-6500-A. If a new lifter(s) is being installed, check the new lifter(s) for a free fit in the bore in which it is to be installed. Lubricate the lifter(s) and bore(s) with heavy engine oil before inserting the lifter.
2. Lubricate the ends of the push rods with Lubriplate or equivalent and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tip.
3. Lubricate the rocker arms and fulcrum seats with Lubriplate or equivalent and position the rocker arms over the push rods. Torque retaining bolts or nuts.
4. Install the valve rocker arm covers.
5. Install the intake manifold following instructions given under Intake Manifold Installation.

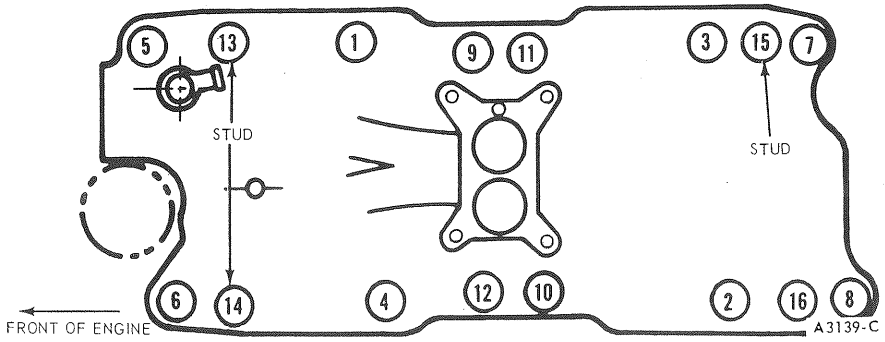


FIG. 45 Intake Manifold Bolt Tightening Sequence — 351W Engine

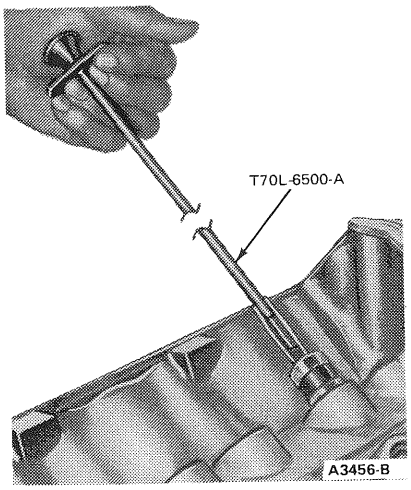


FIG. 46 Removing Valve Lifter

CYLINDER HEADS

If a cylinder is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly in this Part, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves and check all assembly clearances before assembling the new or used parts to the new cylinder head.

Removal

1. Remove the intake manifold and carburetor as an assembly, following the procedure under Intake Manifold Removal.
2. Remove the rocker arm cover(s).
3. If the right cylinder head is to be removed, loosen the alternator adjusting arm bolt and remove the alternator mounting bracket bolt and spacer. Swing the alternator down and out of the way.

Remove the air cleaner inlet duct from the right cylinder head assembly.

4. Loosen the rocker arm bolts or nuts so that the rocker arms can be rotated to the side. Remove the push rods in sequence (Figure 47) so that they may be installed in their original positions.
5. On 302 engines, remove the exhaust valve stem caps.
6. Install the cylinder head holding fixtures (Figure 48). Remove the cylinder head attaching bolts and lift the cylinder head off the block. Remove and discard the cylinder head gasket.

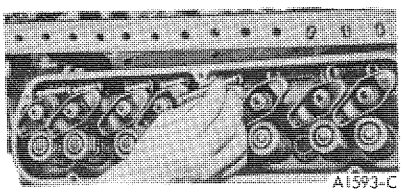


FIG. 47 Removing Valve Push Rods

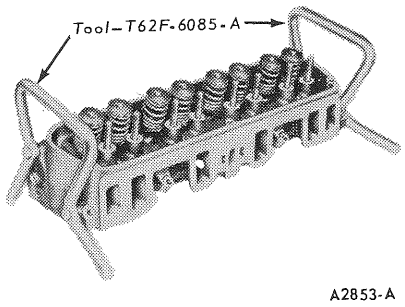


FIG. 48 Cylinder Head Holding Fixtures

Installation

1. Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces.
2. On 302 and 351 V-8 engines, a specially treated composition gasket is used. **Do not apply sealer to a composition gasket. Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts. Remove the holding fixtures.**
3. The cylinder head bolts are tightened in three progressive steps. Tighten all the bolts in sequence (Figure 49) to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retighten the bolts after extended operation. However, the bolts may be checked and retightened if desired.
4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods for straightness or check push rod runout with a dial indicator. If runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**
5. Lubricate the end of the push rods with Lubriplate or equivalent and install them in their original positions. Apply Lubriplate or equivalent to the valve stem tips. Install the exhaust valve stem cap on 302 engines.
6. Lubricate the rocker arms and fulcrum seats with Lubriplate or equivalent, then install the rocker arms.
7. Position a new gasket(s) on the exhaust pipe(s). Tighten the nuts to specifications.
8. If the right cylinder head was removed, swing the alternator into position and install the alternator attaching bolt, spacer, and air cleaner inlet duct on the right cylinder head. Adjust the drive belt tension to specifications.

If the left cylinder head was removed, install the accelerator shaft assembly at the front of the cylinder head.

9. Clean the valve rocker arm cover and cylinder head gasket surfaces. Place the new gaskets in the covers making sure that the tabs of the gasket engage the notches provided in the cover. Install the valve rocker arm cover(s).
10. Install the intake manifold and related parts, following the procedure under Intake Manifold Installation.

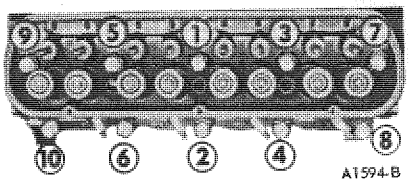


Fig. 49 Cylinder Head Bolt Tightening Sequence

EXHAUST MANIFOLDS

Removal

1. Remove air cleaner and intake duct assembly, including the crankcase ventilation hose.
2. Remove the oil dipstick tube bracket on right exhaust manifold.
3. Disconnect exhaust manifold(s) from inlet pipe(s).
4. Remove the exhaust manifold.

Installation

1. Clean the mating surfaces of the exhaust manifold(s) and cylinder head(s). Clean the mounting flange of the exhaust manifold(s).
2. Position the exhaust manifold(s) on the cylinder head(s) and install the attaching bolts and flat washers. Working from the center to the ends, tighten the bolts to specifications.
3. Place a new gasket(s) on the exhaust pipe(s). Position the exhaust pipe(s) into the manifold(s). Install and tighten the attaching nuts to specifications.
4. Position the oil dipstick tube bracket on the right exhaust manifold. Install and tighten attaching bolts to specifications.
5. Install air cleaner and intake duct assembly, including the crankcase ventilation hose.

WATER PUMP

Removal

1. Drain the cooling system.
   Remove the fan and spacer from the water pump shaft.
2. Remove the alternator drive belt.
   Remove all accessory brackets which attach to the water pump.
   Remove the water pump pulley.
3. Disconnect the radiator lower hose and water pump bypass hose at the water pump.
4. Remove the bolts that attach the pump to the cylinder front cover.
   Remove the pump and gasket.
   Discard the gasket.

Installation

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
2. Position a new gasket, coated on both sides with sealer, on the cylinder front cover; then install the pump.
3. Install the attaching bolts and torque them to specifications.
4. Connect the radiator hose, and water pump bypass hose at the water pump.
5. Install all the accessory brackets which attach to the water pump. Place the water pump pulley on the water pump shaft.
6. Install the alternator and drive belt.
7. Install the spacer or fan drive clutch and fan.
   Adjust the drive belts to the specified belt tension.
8. Fill and bleed the cooling system. Operate the engine until normal operating temperatures have been reached and check for leaks.

CYLINDER FRONT COVER AND TIMING CHAIN

Removal

1. Refer to Water Pump Removal. Perform all steps except removal of the pump. Leave it attached to the front cover.
2. Drain the crankcase.
3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper (Figure 50) and remove the vibration damper.
4. Disconnect the fuel pump outlet line from the fuel pump. Remove the fuel pump attaching bolts and lay the pump to one side with the flexible fuel line still attached.
5. Remove the oil level dipstick.
6. Remove the oil pan to cylinder front cover attaching bolts. Use a thin blade knife to cut the oil pan gasket flush with cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover and water pump as an assembly.

If a new cylinder front cover is to be installed, remove the water pump and dipstick tube from the old cylinder front cover and install them on the new cover.

7. Discard the cylinder front cover gasket. Remove the crankshaft front oil slinger.
8. Check the timing chain deflection.
9. Crank the engine until the timing marks on the sprockets are positioned as shown in Figure 51.
10. Remove the camshaft sprocket cap screw, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly (Figure 52).

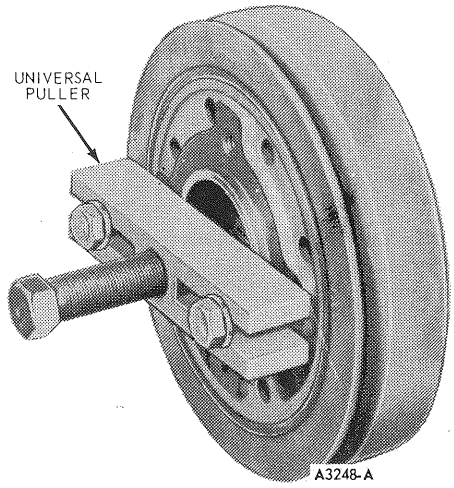


FIG. 50 Removing Crankshaft Vibration Damper

Installation

1. Position the sprockets and timing chain on the camshaft and crankshaft simultaneously (Figure 52). Be sure the timing marks on the sprockets are positioned as shown in Figure 51.
2. Install the fuel pump eccentric, washers and camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Install the crankshaft front oil slinger (Figure 53).
3. Clean the cylinder front cover, oil pan and the block gasket surfaces.
4. Install a new oil seal in the cylinder front cover following the procedures under Front Oil Seal Removal and Installation.

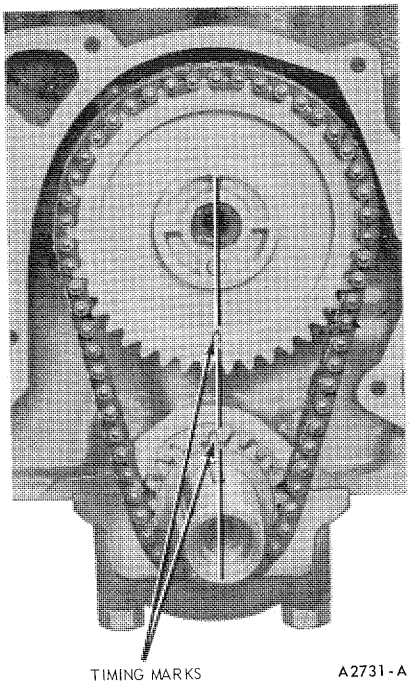


FIG. 51 Aligning Timing Marks

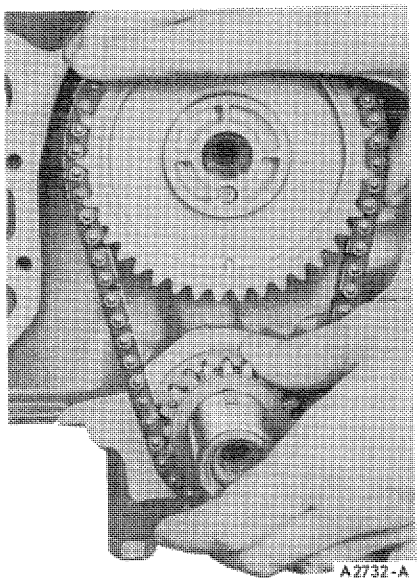


FIG. 52 Removing or Installing Timing Marks

5. Lubricate the timing chain with engine oil.
6. Coat the gasket surface of the oil pan with sealer, cut and position the required sections of a new gasket on the oil pan, apply sealer at the corners. Install pan seal as required.

Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

7. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible gasket mislocation.
8. Install the cylinder front cover to seal alignment tool into proper position.
9. It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the front attaching hole locations.
10. Coat the threads of the attaching screws with oil resistant sealer and install the screws. While pushing in on the alignment tool, tighten the oil pan to cover attaching screws to specifications (Figure 54). Tighten the cover to block attaching screws to specifications. Remove the pilot.

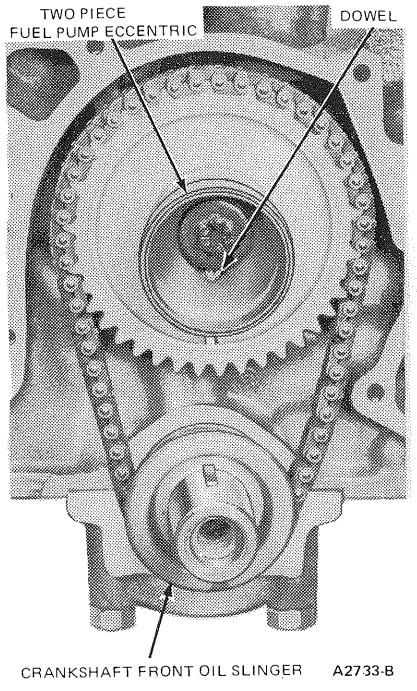


FIG. 53 Fuel Pump Eccentric and Front Oil Slinger Installed

11. Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.
12. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft (Figure 55). Install the cap screw and washer. Tighten the screw to specifications. Install the crankshaft pulley.
13. Install the fuel pump using a new gasket. Connect the fuel pump outlet line.
14. Install the oil level dipstick.
15. Refer to Water Pump Installation. Perform all the required steps except installation of the pump.
16. Fill the crankcase with the proper grade and quantity of engine oil.
17. Fill and bleed the cooling system.
18. Operate the engine at fast idle and check for coolant and oil leaks. Check and adjust the ignition timing.

FRONT OIL SEAL

1979 engines have the seal installed from the front. The front cover does not have to be removed to replace the seal.

Engines built prior to 1979 must use the following procedure.

Removal

1. Remove the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Removal.
2. Drive out the old seal with the pin punch. Clean out the recess in the cover.

Installation

1. Coat a new seal with grease, then install the seal in the cover. Drive the seal in until it is fully seated in the recess (Figure 56). Check the seal after installation to be sure the spring is properly positioned in the seal.
2. Replace the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Installation.

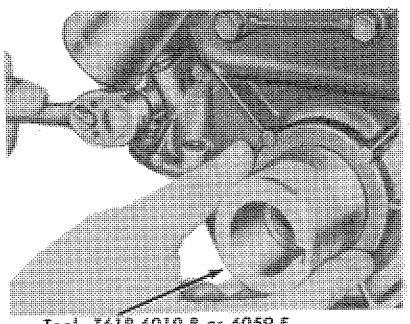


FIG. 54 Aligning Cylinder Front Cover

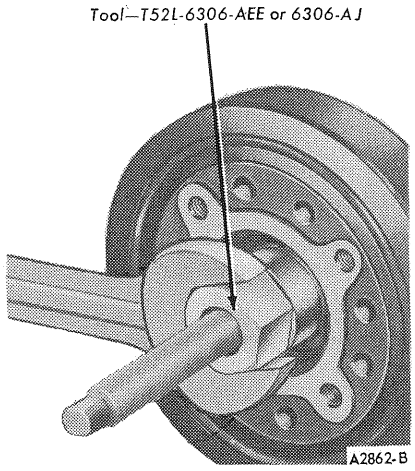


FIG. 55 Installing Cranksahft Vibration Damper

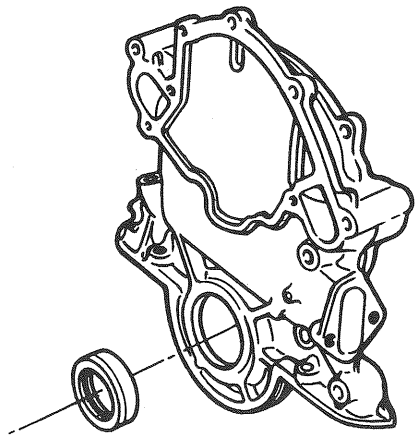


FIG. 56 Installing Crankshaft Front Oil Seal

CORE PLUGS

Removal

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

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

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

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

Installation

Cup Type

Cup-type core plugs (Figure 57) 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 install the plug in the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blow out. The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore. If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

Expansion-Type

Expansion-type core plugs (Figure 57) 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.

CAMSHAFT

The camshaft and related parts are shown in Figure 58.

Removal

1. Disconnect the upper and lower radiator hoses. Remove the radiator (if so equipped).
2. Remove the cylinder front cover and the timing chain following the procedure under Cylinder Front Cover and Timing Chain Removal.
3. Remove the intake manifold and related parts by following procedures under Intake Manifold Removal.
4. Remove the crankcase ventilation valve and tubes from the valve rocker arm covers. Remove the valve rocker arm covers. Loosen the valve rocker arm stud nuts and rotate the rocker arms to the side.
5. Remove the valve push rods and identify them so that they can be installed in their original positions.
6. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Figure 46).

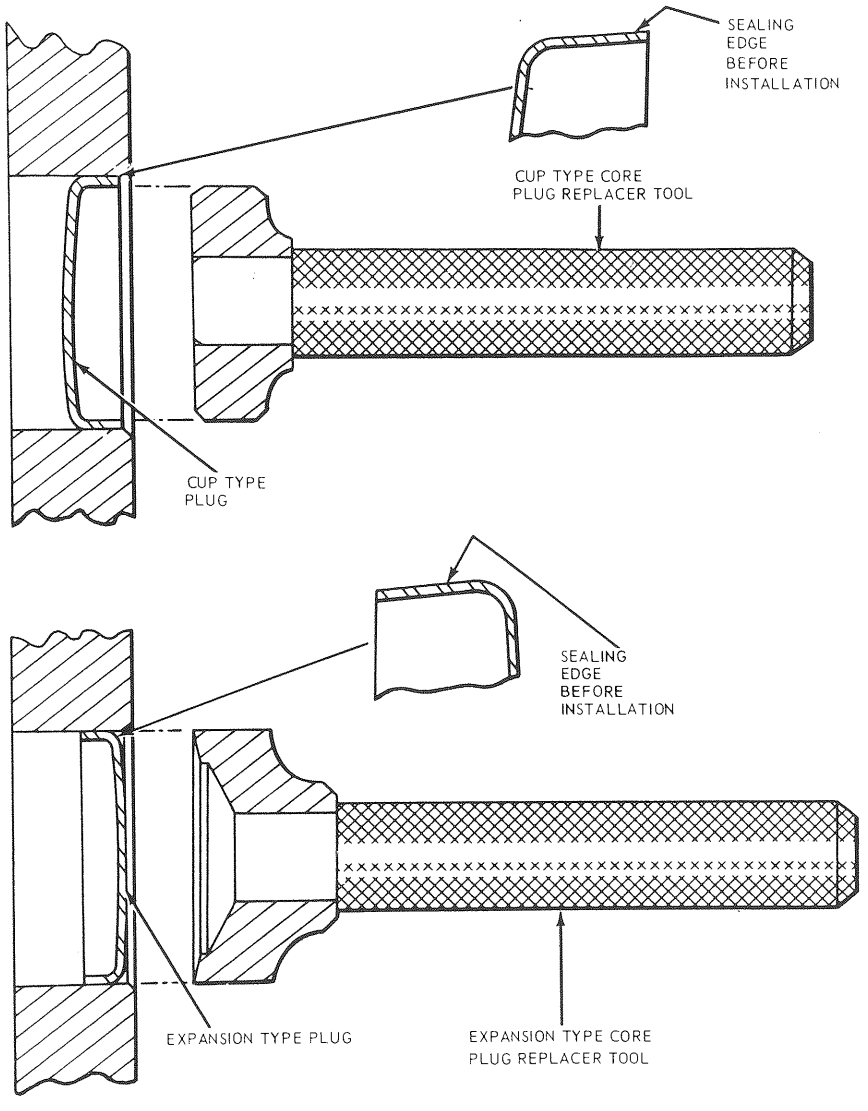


FIG. 57 Typical Core Plugs and Installation Tools

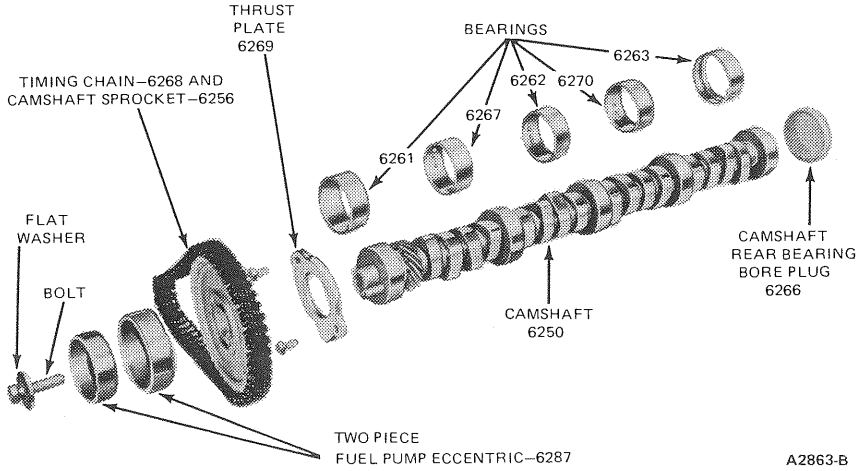


FIG. 58 Camshaft and Related Parts

If necessary to disassemble a lifter, refer to Valve Lifter Disassembly and Assembly.

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

7. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**

Installation

1. Oil the camshaft journals with heavy engine oil SE and apply Lubriplate or equivalent to the lobes. Carefully slide the camshaft through the bearings. Install camshaft thrust plate with groove towards the cylinder block. Check camshaft end play.
2. Lubricate the lifters and bores with heavy engine oil SE. Install the valve lifters in the bores from which they were removed.
3. Apply Lubriplate or equivalent to each end of the push rod and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tips. Lubricate the rocker arms and fulcrum seats with heavy engine oil SE. Position the rocker arms over the push rods.
4. Install the intake manifold and related parts by following procedures under Intake Manifold Installation.
5. Connect the throttle and retracting spring.
6. Position and connect the fuel line.
7. Replace the crankshaft front oil seal following procedures under Front Oil Seal Removal and Installation. Install the timing chain, cylinder front cover and related parts following procedures under Cylinder Front Cover and Timing Chain Installation.
8. Install the radiator and connect the upper and lower radiator hoses.
9. With No. 1 piston on TDC at the end of the compression stroke, position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.
10. If any valve train components have been replaced, perform a Valve Clearance Adjustment as outlined under Hydraulic Valve Lifters.
11. Clean the valve rocker arm covers and the cylinder head gasket surface. Position the valve rocker cover gasket in each cover, making sure that the tabs engage the notches in the cover.
12. Position the covers on the cylinder heads. Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.
13. Clean the install the crankcase ventilation system.
14. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs. Connect the high tension lead at the coil.
15. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil
16. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum line at the carburetor.
17. Operate the engine at fast idle and check all hoses connections and gaskets for leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture. Retorque intake manifold bolts and nuts.
18. Adjust the throttle linkage. Install the air cleaner and intake duct assembly.
19. Connect the automatic choke heat chamber air inlet hose.

CAMSHAFT REAR BEARING BORE PLUG

Removal

1. Remove the transmission, clutch pressure plate and disc.
2. Remove the flywheel attaching bolts and remove the flywheel. Remove the engine rear cover plate.
3. Remove the bore plug.

Installation

1. Install the bore plug.
2. Coat the flywheel attaching bolts with oil-resistant sealer. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install the torque the attaching bolts in sequence across from each other to specifications.

Install the clutch pressure plate, disc and the transmission.

CLUTCH PILOT BUSHING (IF SO EQUIPPED)

Removal

1. Remove the clutch pressure plate and disc.
2. Remove the pilot bushing.

Installation

1. A new clutch pilot bushing normally does not require lubrication. However, due to long storage periods, some of the lubricant pressed into the bushing in manufacture may be lost. It is therefore recommended that the new bushing be soaked in SAE-30 non-detergent engine oil for a minimum of one-half hour before installation. Wipe off all excess oil before installing. **Do not lubricate with grease of any kind.**
2. Install the pilot service bushing.
3. Install the clutch pressure plate, disc and the transmission.

OIL PUMP

Removal

1. Remove the oil pan and related parts as outlined under Oil Pan Removal.
2. Remove the oil pump inlet tube and screen assembly.
3. Remove the oil pump attaching bolts (Figure 59), and remove the oil pump gasket and intermediate drive shaft.

Installation

1. Prime the oil pump by the inlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.
2. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.
3. With the stop properly positioned, insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate drive shaft into a new position.** Tighten the oil pump attaching screws to specifications.
4. Clean and install the oil pump inlet tube and screen assembly.
5. Install the oil pan and related parts.

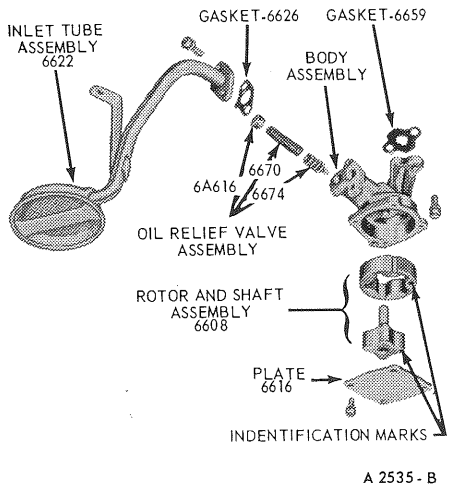


FIG. 59 Oil Pump and Inlet Tube Installed

CRANKSHAFT REAR OIL SEAL

Replacement of a crankshaft rear oil seal to correct for oil leaks requires replacement of both the upper and lower seals, as follows:

Removal

1. Remove the oil pan and oil pump.
2. Loosen all the main bearing cap bolts, thereby lowering the crankshaft slightly but not to exceed 1/32 inch.
3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal, install a small metal screw in one end of the seal and pull on the screw to remove the seal. **Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.**

Installation

1. Carefully clean the seal grooves in the cap and block with a brush and solvent.
2. Dip the seal halves in clean engine oil.
3. Carefully install the upper seal (cylinder block) into its groove with the lip of seal toward the FRONT of the engine (Figure 60) by rotating it on the seal journal of the crankshaft until the seal protrudes approximately 1/8 inch below the parting surface.

Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.

4. Tighten the remaining bearing cap bolts and torque to specifications.
5. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Figure 62). Allow the seal to protrude approximately 1/8 inch above the parting surface to mate with the upper seal when the cap is installed.
6. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove. Install the rear main bearing cap. Torque the cap bolts to specifications.**
7. Install the oil pump and oil pan. Install the oil level dipstick. Fill the crankcase with the proper amount and viscosity oil. Install the spark plugs.
10. Operate the engine and check for oil leaks.

MAIN BEARING

The main bearing inserts are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal in this section.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
4. Insert the upper bearing removal tool (Tool 6331) in the oil hole in the crankshaft.
5. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
6. Clean the crankshaft journal. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear.
7. If the rear main bearing is being replaced, remove and discard the rear oil seal from the bearing cap.
8. Remove the block half of the rear oil seal following the procedures given under Crankshaft Rear Oil Seal Removal.

Installation

1. If the rear main bearing is being replaced, clean the rear oil seal groove in the block with a brush and solvent.
2. Install the block half of the rear oil seal following the procedure given under Crankshaft Rear Oil Seal Installation.
3. To install an 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. With Tool 6331 positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.
4. Install the bearing cap.
5. Select fit the bearing for proper clearance, following the procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.
6. If the bearing is being replaced on journal number 1, 2 or 4, apply a coat of heavy engine oil SE to the journal and bearings and install the bearing cap. Tighten the cap bolts to specifications.
7. If the rear main bearing is to be replaced, remove the rear main oil seal retaining pin from the lower bearing cap seal groove. The pin is not used with the split, lip-type seal.

Clean the oil seal groove with a brush and solvent.

8. Install the lower seal in the rear main bearing cap with the undercut side of the seal toward the FRONT of the engine. Allow the seal to protrude approximately 1/8 inch above the parting surface to mate with the upper seal when the cap is installed.
9. Apply RTV sealer to the rear main bearing cap as shown in Figure 61. Lubricate the journal with heavy engine oil SE and install the rear main bearing cap. Tighten the cap bolts to specifications.
10. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with heavy engine oil SE and 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. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearin. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications (Figure 63).

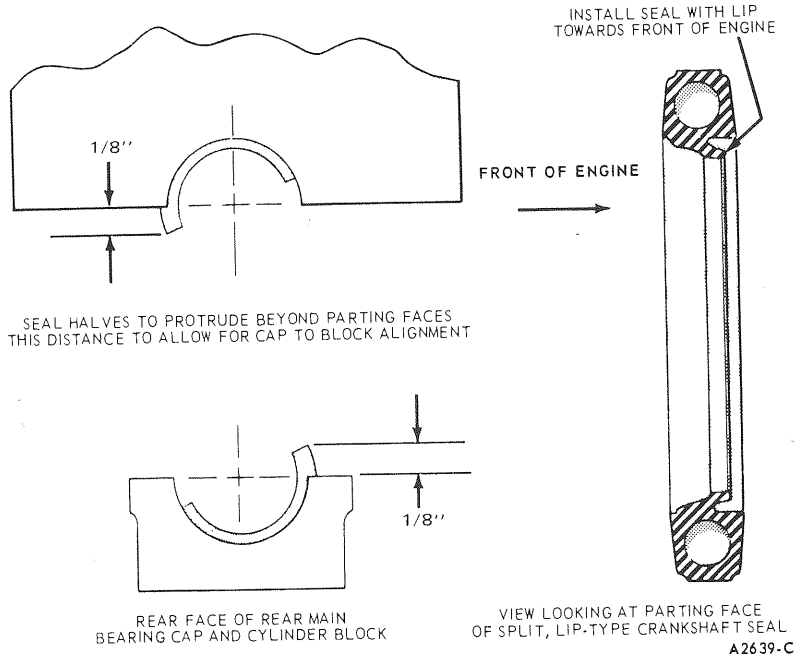


FIG. 60 Installing Crankshaft Rear Seal

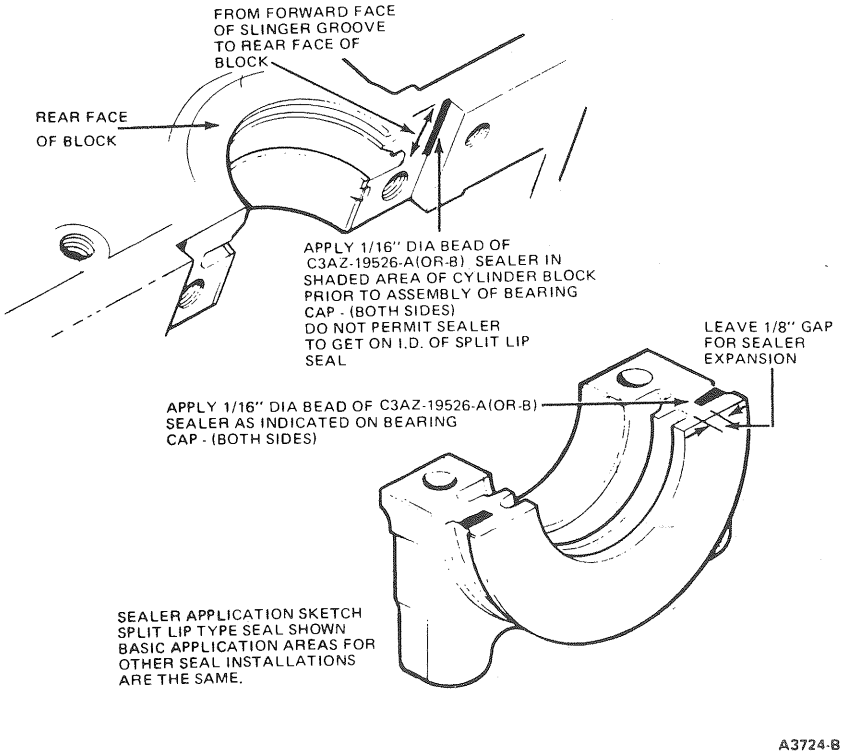


FIG. 61 Applying RTV Sealer to Main Bearing Cap and Block — Typical for 6 and 8-Cylinder Engines

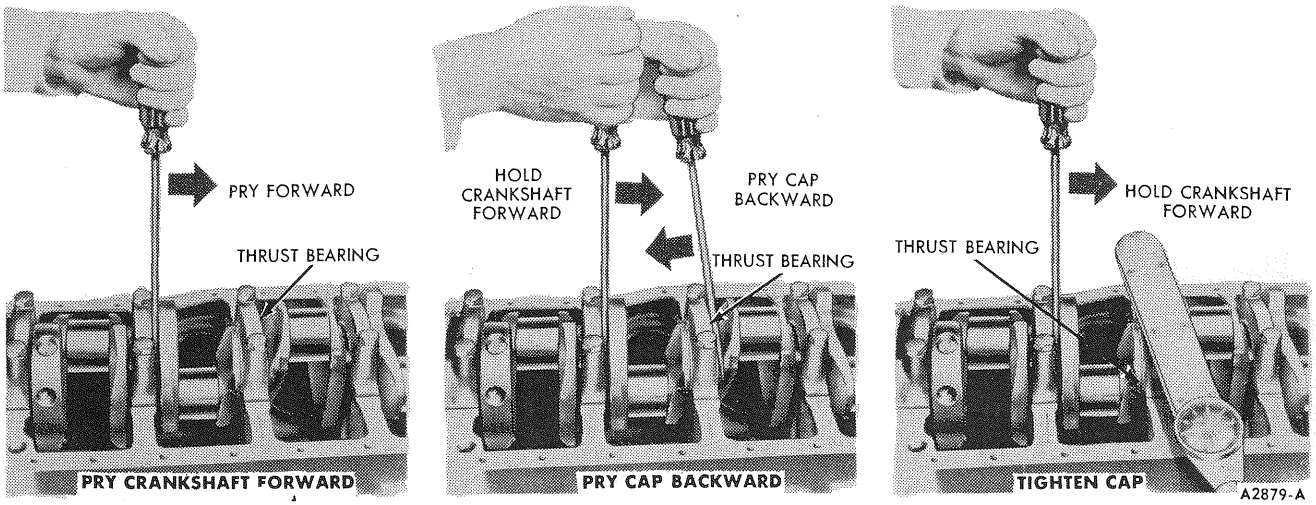


FIG. 62 Aligning Thrust Bearing

11. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
12. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts, following the procedure under Oil Pan Installation in this section. Install the oil level dipstick.
13. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

CONNECTING ROD BEARINGS

The connecting rod bearings are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. 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.

Installation

1. 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.
2. Clean the crankshaft journal.
3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.
4. Pull the connecting rod assembly down firmly on the crankshaft journal.
5. Select fit the bearing, following procedures under Fitting Main and Connecting Rod Bearings.
6. After the bearing has been fitted, clean and apply a coat of heavy engine oil SE to the journal and bearings. Install the connecting rod cap. Tighten the nuts to specifications.
7. Repeat the procedure for the remaining connecting rods that require new bearings.
8. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
9. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts, following the procedure under Oil Pan Installation in this section. Install the oil level dipstick.
10. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

PISTONS AND CONNECTING RODS

Removal

1. Drain the cooling system and crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following the procedures in this section.
2. Remove any ridges and/or deposits from the upper end of cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel, then place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. **Never cut into ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all connecting rod caps are marked so they can be installed in their original positions.
4. Turn the crankshaft until the connecting rod being removed is down.
5. Remove the connecting rod nuts and cap.
6. Push the connecting rod and piston assembly out 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.**
7. Remove the bearing inserts from the connecting rod and cap.
8. Install the cap on the connecting rod from which it was removed.

Installation

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow the instructions of the tool manufacturer.
2. Oil the piston rings, pistons and cylinder walls with heavy engine oil. **Be sure to install pistons in the same cylinders from which they were removed or to which they were fitted.** Connecting rod and bearing caps are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever 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.

When installing the piston and connecting rod assembly, the largest chamfer at the bearing end of the rod should be positioned towards the crank pin thrust face of the crankshaft.

3. Make sure that ring gaps are properly spaced around circumference of piston (Figure 63).
4. Install piston ring compressor on the piston and push the piston in with hammer handle until it is slightly below top of the cylinder (Figure 64). Be sure to guide connecting rods to avoid damaging the crankshaft journals. Install the piston with indentation notch in piston head toward the front of the engine.
5. Check the clearance of each bearing, following the procedure under Fitting Main and Connecting Rod Bearings.
6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
8. Install the connecting rod cap. Tighten the nuts to specifications.
9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each shaft journal (Figure 65).
10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen, and oil pan and block gasket surfaces.
11. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and the oil pan, following the procedure under Oil Pan Installation in this section.
12. Install the cylinder heads, following the steps under Cylinder Head Installation.
13. Install the intake manifold, following the steps under Intake Manifold Installation.
14. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.
15. Start the engine, then check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
16. Operate the engine at fast idle and check for oil and coolant leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture.
17. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

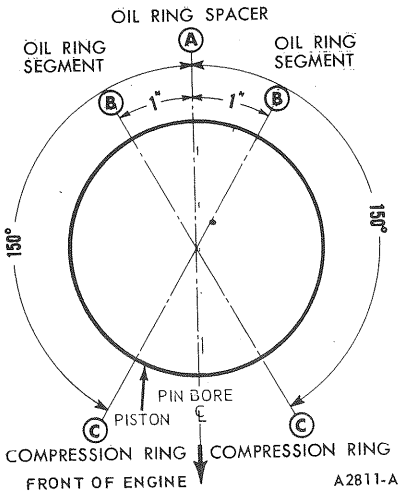


FIG. 63 Piston Ring Spacing

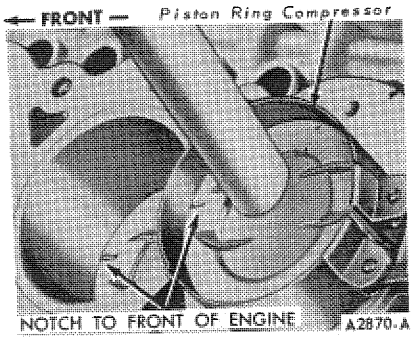


FIG. 64 Installing Piston

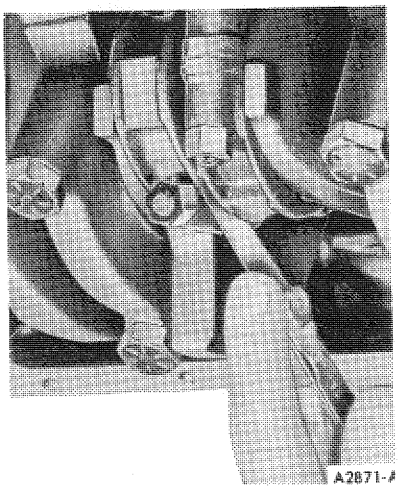


FIG. 65 Checking Connecting Rod Side Clearance

CRANKSHAFT

The crankshaft and related parts are shown in Figure 66.

Removal

1. With the engine placed in a work stand, disconnect the spark plug wires at the spark plugs by hand only and remove the wires from the ignition harness brackets on the valve rocker arm covers. Disconnect the coil to distributor high-tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the fuel pump and the oil filter. Slide the water pump by-pass hose clamp toward the water pump. Remove the alternator and mounting brackets.
3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the capscrew and washer from the end of the crankshaft. Install the puller on the crankshaft vibration damper (Figure 50) and remove the damper.
4. Remove the cylinder front cover and water pump as an assembly.
5. Remove the crankshaft front oil slinger. Check the timing chain deflection, then remove the timing chain and sprockets by following steps under Cylinder Front Cover and Timing Chain Removal.
6. Invert the engine on a work stand. Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.

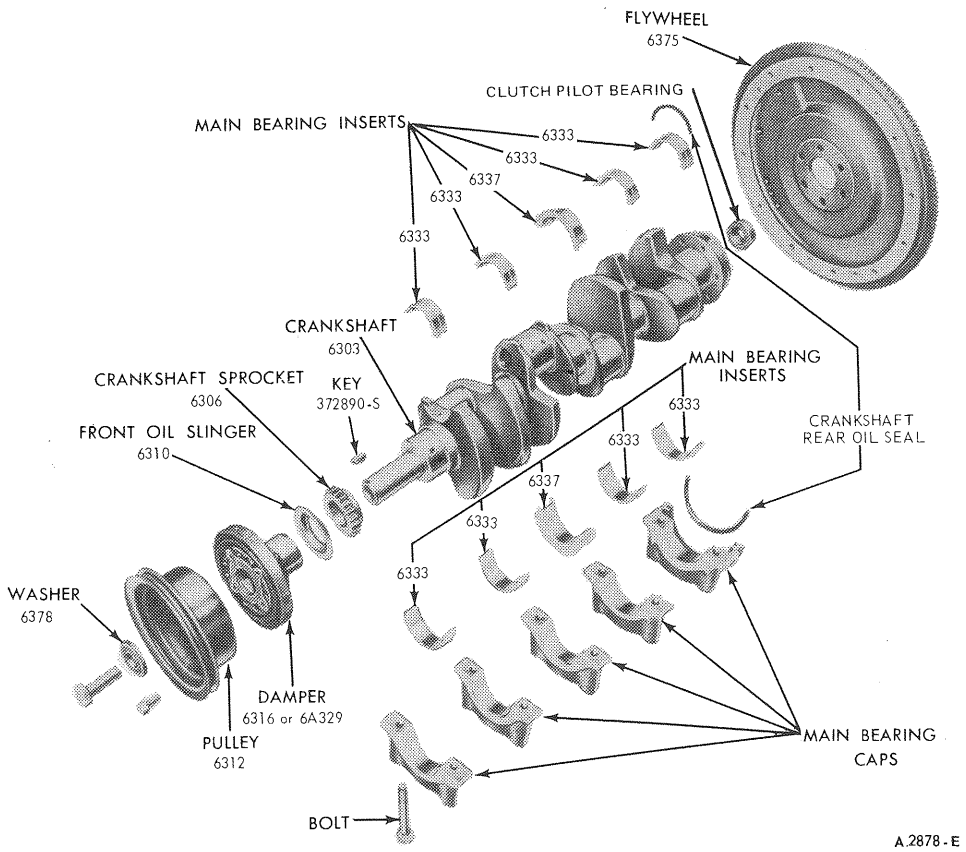


FIG. 66 Crankshaft and Related Parts

7. **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 down, then remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.
8. Remove the main bearing caps.
9. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Installation

1. Remove rear journal oil seal from the block and rear main bearing cap.
2. Remove the main bearing inserts from the block and bearing caps.
3. Remove the connecting rod bearing inserts from the connecting rods and caps.
4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.
5. Place the upper main bearing inserts in position in bores with tang fitting in the slot provided.
6. Install lower main bearing inserts in the bearing caps.
7. Clean the rear journal oil seal groove and the mating surfaces of the block and rear main bearing cap with Ford Spot Remover (B7A-19521-A). Remove the rear oil seal retainer pin from the rear main bearing cap seal groove. The pin is not used with the split, lip-type seal.
8. Dip the lip-type seal halves in clean engine oil. Install the seals in the bearing cap and block with the undercut side of the seal toward the FRONT of the engine.
9. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
10. Check the clearance of each main bearing by following the procedure under Fitting Main and Connecting Rod Bearings.
11. After the bearings have been fitted, check for special instructions in applying RTV sealer to the rear main bearing cap.
12. Apply heavy engine oil SE to the journals and bearings.
13. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original locations.** Tighten the bearing cap bolts to specifications.
14. Install the thrust bearing cap with the bolts finger-tight.
15. Pry the crankshaft forward against the thrust surface of the upper half of the bearing.
16. 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.
17. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specification.
18. Force the crankshaft toward the rear of the engine.
19. Check the crankshaft end play.
20. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing, following the procedure under Fitting Main and Connecting Rod Bearings.
21. After the connecting rod bearings have been fitted, apply a light coat of engine oil SE to the journals and bearings.

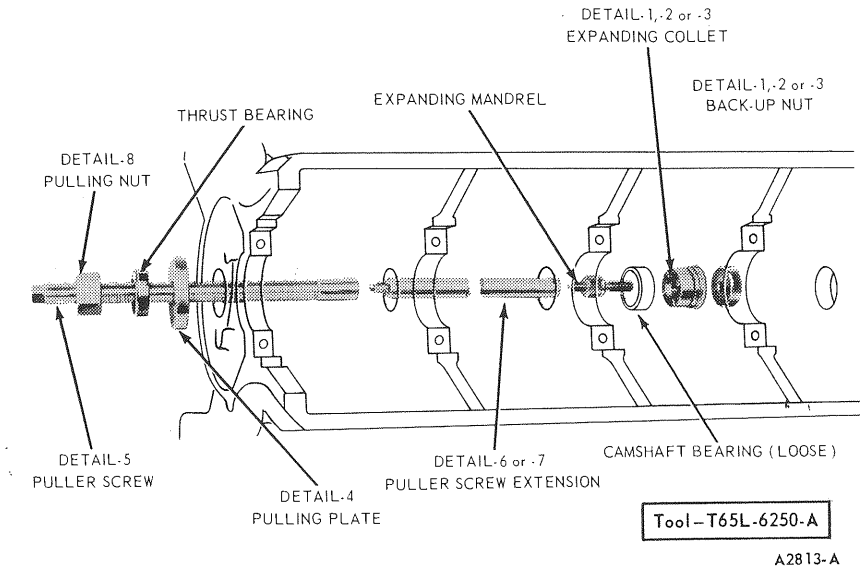


FIG. 67 Camshaft Bearing Replacement

22. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.
23. Install the connecting rod cap. Tighten the nuts to specifications.
24. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Figure 65).
25. Install the timing chain and sprockets, cylinder front cover and crankshaft pulley and adapter, following steps under Cylinder Front Cover and Timing Chain Installation.
26. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and tighten the bolts to specifications.

Use Tool 6392-N to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

27. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan by following the procedures under Oil Pan and Oil Pump Installation.
28. Install the oil filter, fuel pump and connect the fuel lines. Install the alternator, shield and mounting bracket.
29. Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high-tension lead.

CAMSHAFT BEARINGS

Camshaft bearings are available prefinished to size for standard and 0.015 inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

Removal

1. Remove the camshaft, flywheel, and crankshaft, following the appropriate procedures in this Section. Push the pistons to the top of the cylinders.
2. Remove the camshaft rear bearing bore plug. Remove camshaft bearings (Figure 67).
3. 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 back-up nut on the expanding mandrel until the collet fits the camshaft bearing.
4. 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.
5. Repeat the procedure for each bearing. 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 with the oil holes aligned and press them in place with the tool shown in Figure 67. 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. Be sure the front bearing is installed the specified distance below the front face of the cylinder block (Figure 68).**
2. Install a new rear bearing bore plug.
3. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures, except do not check connecting rod and main bearing clearnaces as a part of Camshaft Bearing Replacement.

OIL FILTER

SPIN-ON TYPE

The spin-on type oil filter assembly is shown in Figure 69.

Removal

1. Place a drip pan under the filter.
2. Unscrew the filter from the adapter fitting. Clean the adapter filter recess.

Installation

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

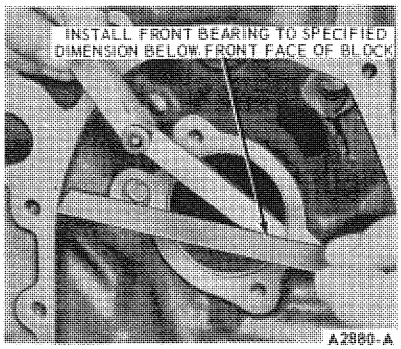


FIG. 68 Camshaft Front Bearing Replacement

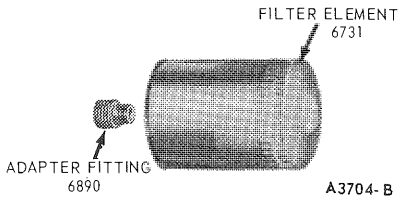


FIG. 69 Typical Oil Filter Assy. — Spin-On Type

DISASSEMBLY AND ASSEMBLY

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

Refer to Page 1-08 for the cleaning and inspection procedures.

VALVE LIFTER

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

Valve lifters should always be tested after assembly; refer to the test procedures covered on page 1-06.

Disassembly

Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so that they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.
2. Remove the push rod cup, metering valve (disc), plunger and spring.
3. Remove the plunger assembly, the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer, and the check valve disc from the plunger.

Assembly

Hydraulic valve lifter assembly is shown in Figure 70.

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).

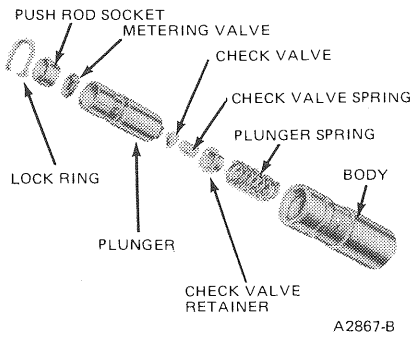


FIG. 70 Hydraulic Valve Lifter Assy.

3. Position the check valve retainer over the check valve and spring then push the retainer down into place on the plunger.
4. Place the plunger spring, and then the plunger (open end up) into the lifter body.
5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.
6. 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.
7. Use a hydraulic valve lifter leakdown tester to fill the lifters with test fluid.

CYLINDER HEADS

Disassembly

1. Remove the exhaust manifolds and spark pulgs.
2. Clean the carbon out of the cylinder head combustion chambers before removing the valves.
3. Compress the valve spring (Figure 71). Remove the spring retainer locks and release spring.

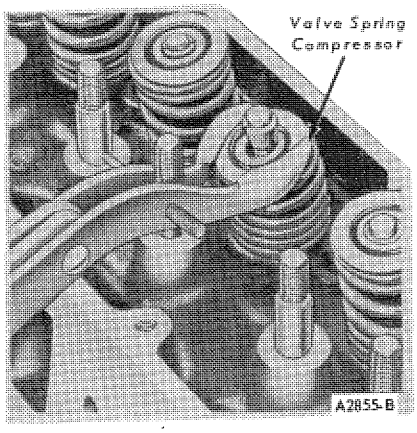


FIG. 71 Compressing Valve Spring on Bench

4. Remove the spring retainer, sleeve, spring, stem seal and valve. Discard the valve stem seals. Identify all valve parts.
5. Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.

Assembly

1. Install each valve (Figure 72) in the port from which it was removed or to which it was fitted. Install a new stem seal on each valve.
2. Install the valve spring over the valve, and then install the spring retainer and sleeve. Compress the spring (Figure 71) and install the retainer locks (Figure 72).
3. 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 73). Check the dividers against a scale. If the assembled height is greater than specifications, 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 height.

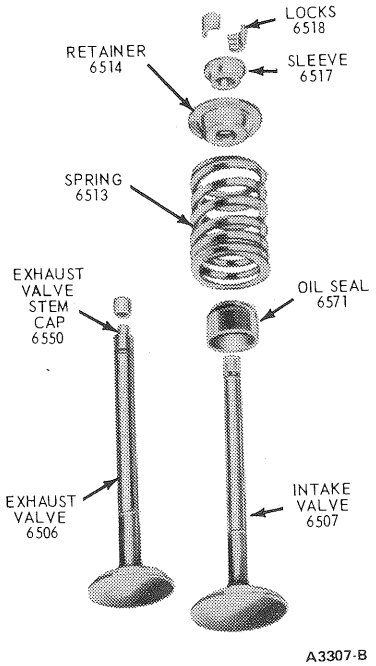


FIG. 72 Valve Assembly

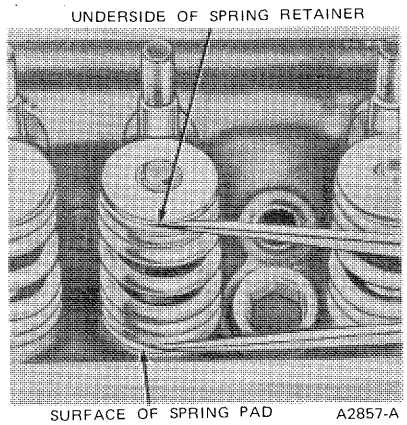


FIG. 73 Checking Valve Spring Assembled Height

Do not install the 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.

4. Install the exhaust manifolds and the spark plugs.

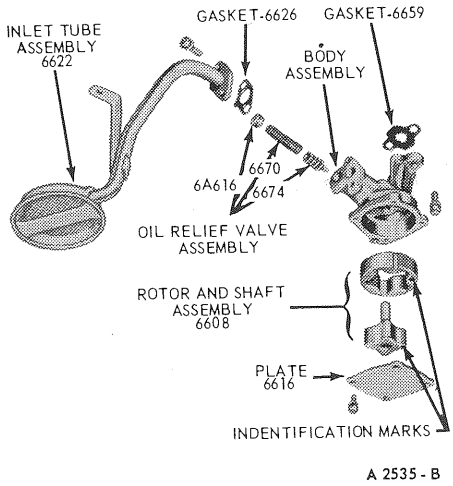


FIG. 74 Oil Pump — Disassembled

OIL PUMP

Disassembly

1. Remove the oil inlet tube from the oil pump and remove the gaskets.
2. Remove the cover attaching bolts, then remove the cover. Remove the inner rotor and shaft assembly: then, remove the outer race.
3. Drill a small hole and insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

Assembly

The oil pump assembly is shown in Figure 74.

1. Clean, inspect and oil all parts thoroughly.
2. Install the oil pressure relief valve plunger, spring and a new cap.

3. Install the outer race and the inner rotor and shaft assembly. **Be sure the dimple (identification mark) on the outer race is facing outward and on the same side as the identification mark on the rotor. The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.** Install the cover and tighten the cover attaching bolts to specifications.
4. Install the attaching bolts.

PISTONS AND CONNECTING RODS

Disassembly

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons to assure assembly with same rod and installation in the same cylinders from which they were removed.
3. Using an Arbor press and the tool shown in Figure 75, press the piston pin from the piston and connecting rod. Remove the piston rings.

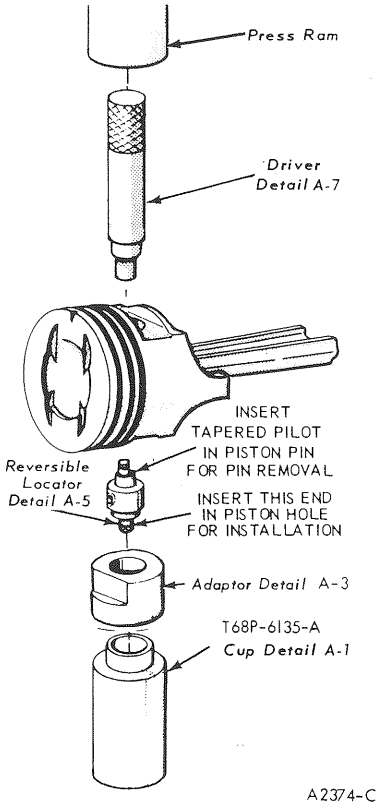


FIG. 75 Removing or Installing Piston Pin

Assembly

The piston, connecting rod and related parts are shown in Figure 76. 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 SE to all parts. **Assemble the piston to the connecting rod with the indentation in the piston positioned as shown in Figure 77.**

On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore towards the cranksahft cheek; facing towards front of engine on the right bank rods, and facing towards rear of engine on left bank rods.

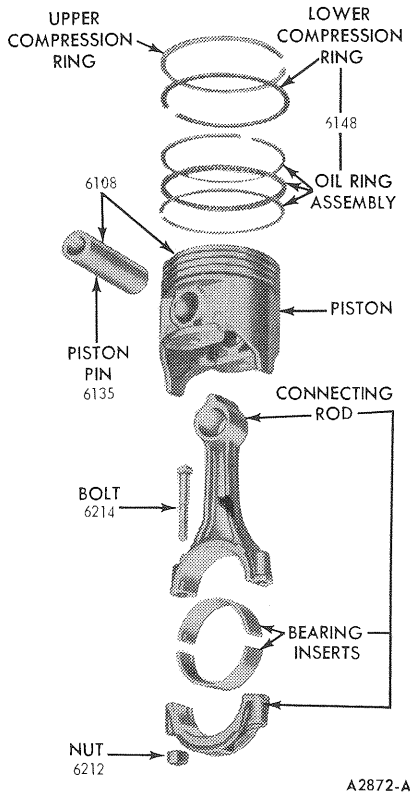


FIG. 76 Piston, Connecting Rod and Related Parts

2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an Arbor Press, press the piston pin through the piston and connecting rod until the pin is centered in the piston (Figure 77).
3. Check the end gap of all piston rings. It must be within specifications. Follow the instructions contained on 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 high steps, the piston should be replaced.**
5. Be sure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

CYLINDER ASSEMBLY

Disassembly

1. Mount the old engine in a work stand and remove all parts not furnished with the new cylinder assembly; following the procedures given in the Removal and Installation Section of this Part.
2. Remove the old cylinder assembly from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly in a work stand.
3. Transfer all serviceable parts removed from the old cylinder assembly, following the procedures given in the Removal and Installation Section of this Part.
4. Check all assembly clearances and correct as necessary.

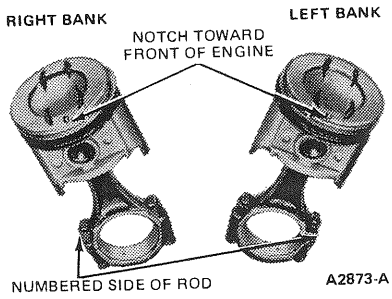


FIG. 77 Correct Piston and Rod Positions

CYLINDER BLOCK

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following the procedures given earlier in this part.

Disassembly

1. Completely disassemble the old engine, following the procedures given in the Removal and Installation Section of this Part.
2. Remember to ridge-ream the cylinder bores before removing piston assemblies.

Assembly

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

Part 2 Ignition System

IDENTIFICATION

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

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

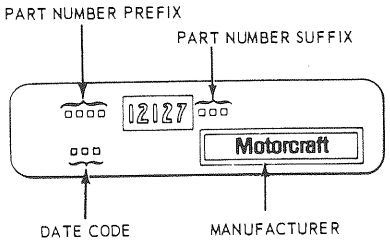


FIG. 1 Distributor Identification

DESCRIPTION AND OPERATION

The 302 and 351 engines use a conventional ignition system.

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

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

The distributor used on the 302 and 351 Industrial engines is the dual advance type (Figure 2) with two independently operated spark advance systems. **(Marine and Irrigation engines use a Prestolite distributor which is covered later in this section.)**

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

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

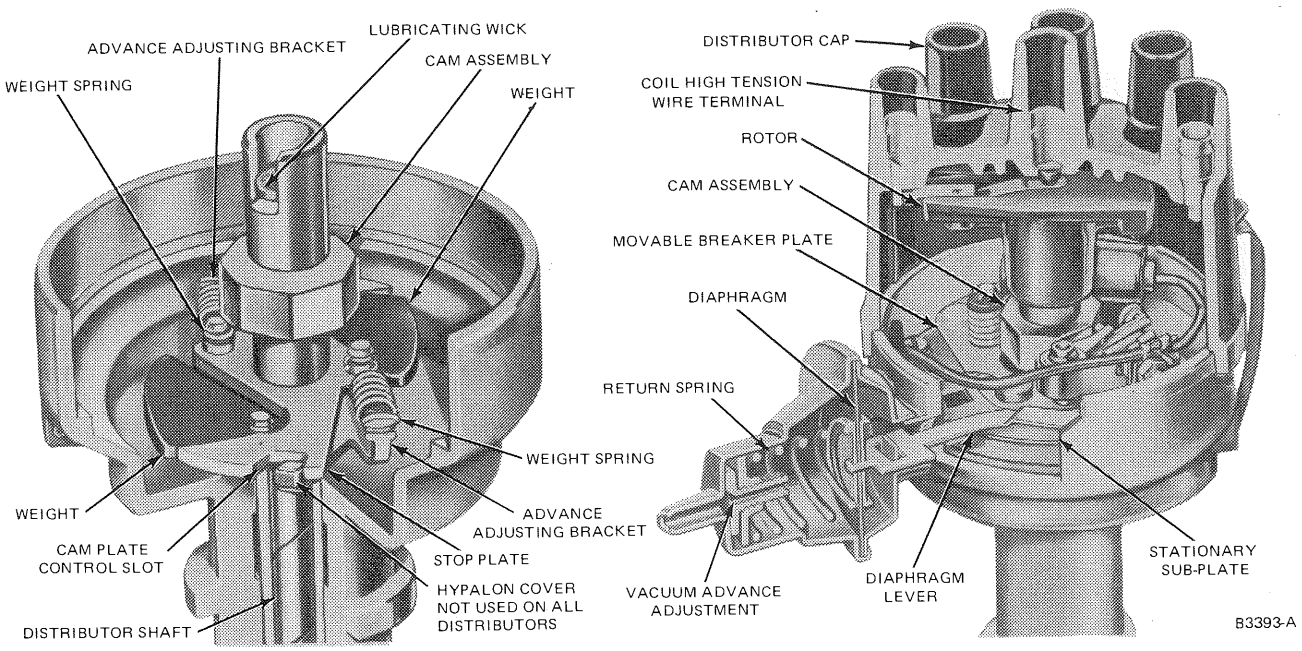


FIG. 2 Dual Advance Distributor

CIRCUIT OPERATION

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

The primary consists of the:

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

The secondary circuit consists of the:

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

When the breaker points are closed, current flows from the battery through the ignition switch to the primary windings in the coil, then to ground through the closed breaker points. When the breaker points open, the magnetic field built up in the primary windings of the coil moves through the secondary windings of the coil, producing high voltage. **High voltage is produced each time the breaker points open.** The high voltage flows through the coil high tension lead to the distributor cap where the rotor distributes it to one of the spark plug terminals in the distributor cap. This process is repeated for every power stroke of the engine.

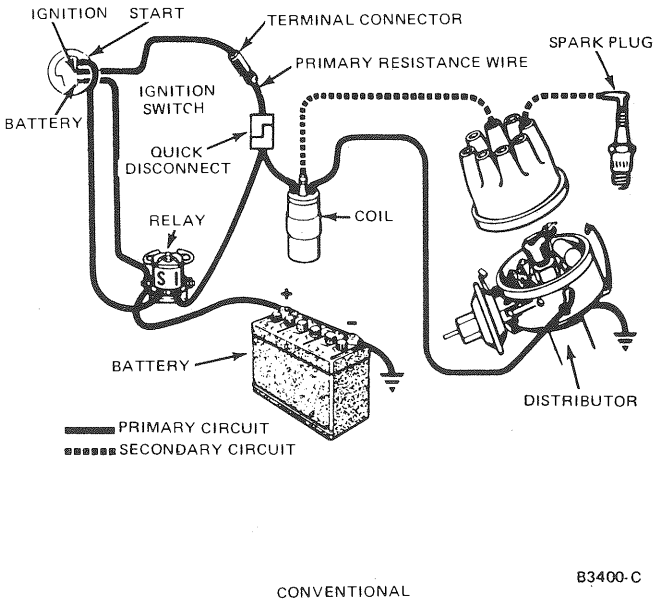


FIG. 3 Typical Ignition System Circuits

DIAGNOSIS AND TESTING

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

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

SPARK INTENSITY TESTS

Trouble Isolation

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

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

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

Primary Circuit

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

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

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

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

Secondary Circuit

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

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

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

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

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

IGNITION SYSTEM TESTS

Battery to Coil Voltmeter Test

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

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

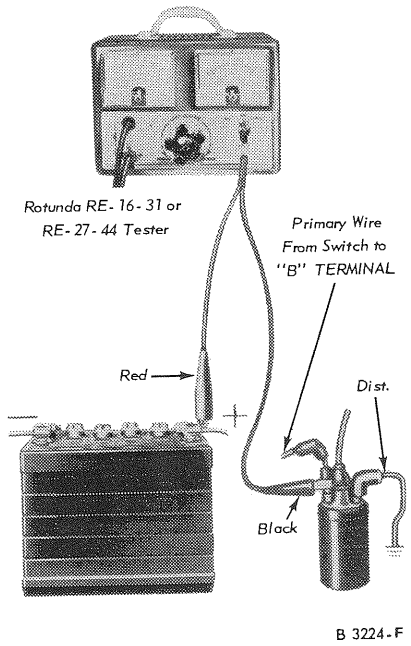


FIG. 4 Battery-to-Coil and Starting Ignition Circuit Test

Starting Ignition Circuit Voltmeter Test

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

Coil to Ground Voltmeter Test

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

Breaker Points Check

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

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

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

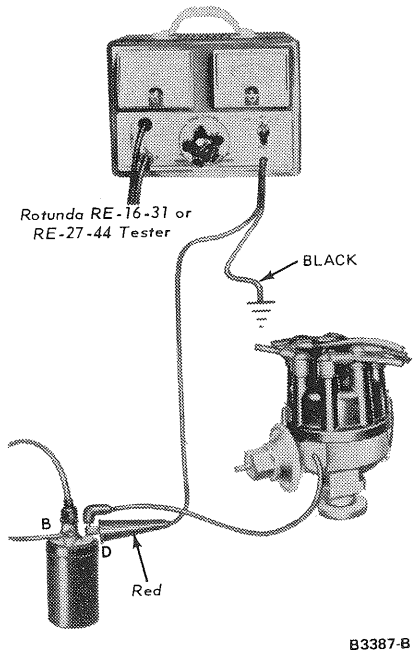


FIG. 5 Coil-to-Ground Test

Coil Test

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

Secondary (High Tension) Wires Resistance Test

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

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

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

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

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

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

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

Spark Plug Test

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

DISTRIBUTOR TESTS — ON VEHICLE

TEST CONNECTIONS

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

Dwell Angle Check

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

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

Dwell Angle Adjustment

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

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

DISTRIBUTOR TESTS — OFF VEHICLE

Distributor Shaft End Play

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

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

General Principles for Testing

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

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

Breaker Point Resistance

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

Insulation and Leakage

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

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

Mechanical Operation

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

Breaker Plate Wear

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

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

Distributor Spark Advance Test

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

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

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

ADJUSTMENTS (INDUSTRIAL ENGINES)

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

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

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

IGNITION TIMING

TIMING MARK LOCATIONS

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

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

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

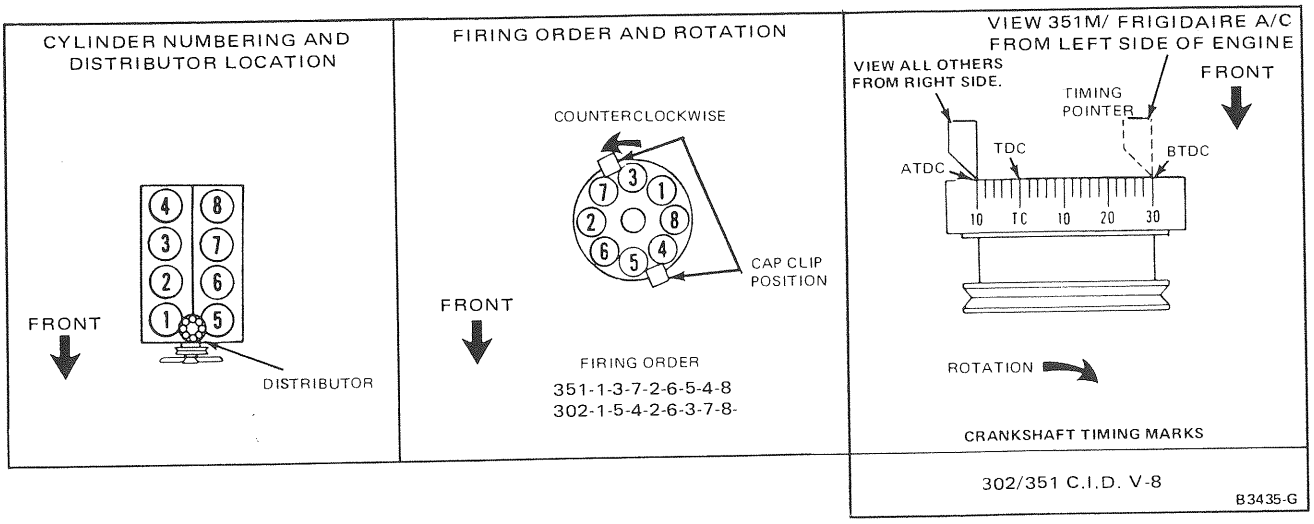


FIG. 6 Engine Timing and Cylinder Firing Order — Typical

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 intial ignition timing to specifications by rotating the distributor in the proper direction.
5. Check the centrifugal advance for proper operation by starting the engine and accelerating it to approximately 2000 rpm. If the ignition timing advances, the centrifugal advance mechanism is functioning properly. Note the engine speed when the advance begins and the amount of total advance. Stop the engine.
6. Unplug the vacuum line and connect it to the distributor vacuum advance unit. Start the engine and accelerate it to approximately 2000 rpm. Note the engine speed when the advance begins and the total amount of advance.

Advance of the ignition timing should begin sooner and advance farther than when checking the centrifugal advance alone. Stop the engine.

7. If the vacuum advance is not functioning properly, remove the distributor and check it on a distributor tester. Replace the diaphragm unit if the vacuum portion is out of calibration.

DUAL-ADVANCE DISTRIBUTOR

Adjust the centrifugal advance before adjusting the vacuum advance.

Centrifugal Advance

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

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

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

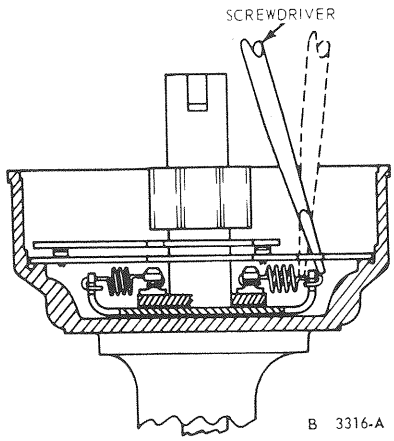


FIG. 7 Centrifugal Advance Adjustment

Vacuum Advance

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

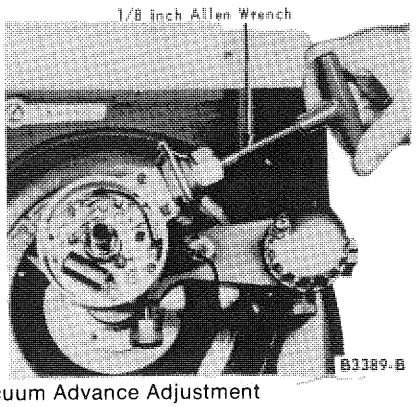


FIG. 8 Vacuum Advance Adjustment

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 8). Turn the wrench clockwise to increase the vacuum advance or counterclockwise to decrease it.
   Removal of a washer will increase advance.
5. After one vacuum setting has been adjusted, the others should be checked. Do not change the original rpm setting when going to a different vacuum setting. If the other settings are not within limits, there is incorrect spring tension, leakage in the vacuum chamber and/or line, or the wrong fiber stop has been installed in the vacuum chamber of the diaphragm housing.
   To check the diaphragm for leakage:
   Remove the vacuum line from the distributor. Adjust the vacuum pressure of a distributor tester to its maximum position. Hold your hand over the end of the tester's vacuum hose and note the maximum reading obtained. **Do not exceed 25 inches Hg.**
   If the maximum reading is 25 inches Hg or less, connect the tester's vacuum line to the vacuum fitting on the diaphragm to be tested without changing any of the adjustments. The maximum gauge reading should not be less than it was above. If it is less, the diaphragm is leaking and should be replaced.

BREAKER POINTS AND/OR CONDENSER

Breaker Point Alignment

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

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

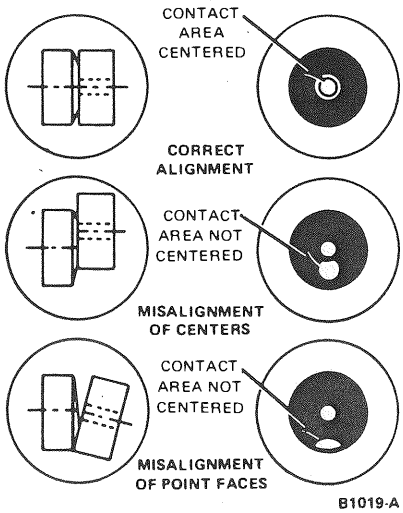


FIG. 9 Checking Breaker Point Alignment

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

1. With the ignition switch off, crank the engine by using an auxiliary starter switch.
2. Using the tool shown (Figure 10) 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.

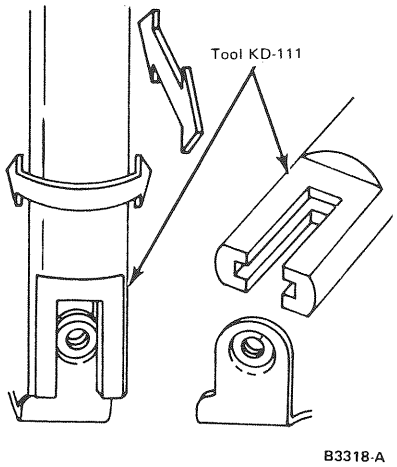


FIG. 10 Using Alignment Tool

Breaker Point Gap Adjustment

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

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

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

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 on the engine, place the rubbing block on the peak of the cam by proceeding as follows:
   Crank the engine with an auxiliary starter switch.
   Insert the correct thickness blade of a clean feeler gauge between the breaker points (Figure 11). Adjust the points to the correct gap and tighten the screws.

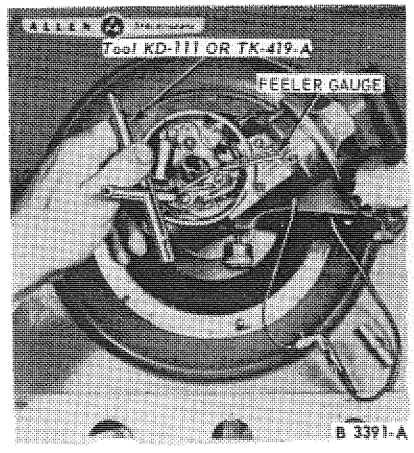


FIG. 11 Adjusting New Breaker Point Gap

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

Also, set the contact dwell to the low setting.

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

Breaker Point Spring Tension Adjustment

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

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

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

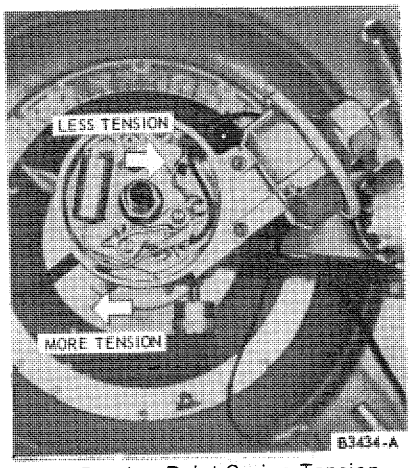


FIG. 12 Adjusting Breaker Point Spring Tension

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

   To adjust the spring tension see Figure 12.
4. Connect the primary lead wire and the condenser lead.

REMOVAL AND INSTALLATION (INDUSTRIAL ENGINES)

BREAKER POINTS AND/OR CONDENSER

Removal

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

Installation

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

VACUUM ADVANCE UNIT

Removal

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

Installation

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

SPARK PLUG WIRE

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

Removal

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

Installation

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

SPARK PLUGS

Removal

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

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.

Installation

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

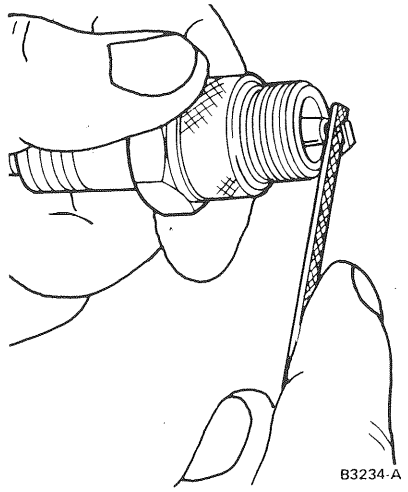


FIG. 13 Fling Spark Plug Electrode

DISTRIBUTOR

Removal

1. Remove the air cleaner. Disconnect the primary wire from the coil.

   Disconnect the vacuum advance line(s) 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.

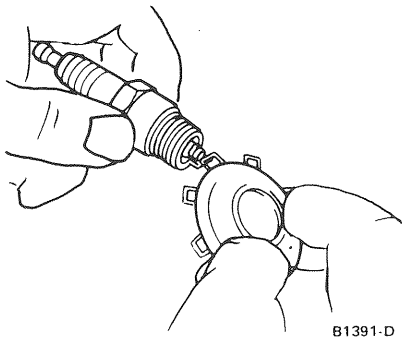


FIG. 14 Checking and Setting Spark Plug Gap

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

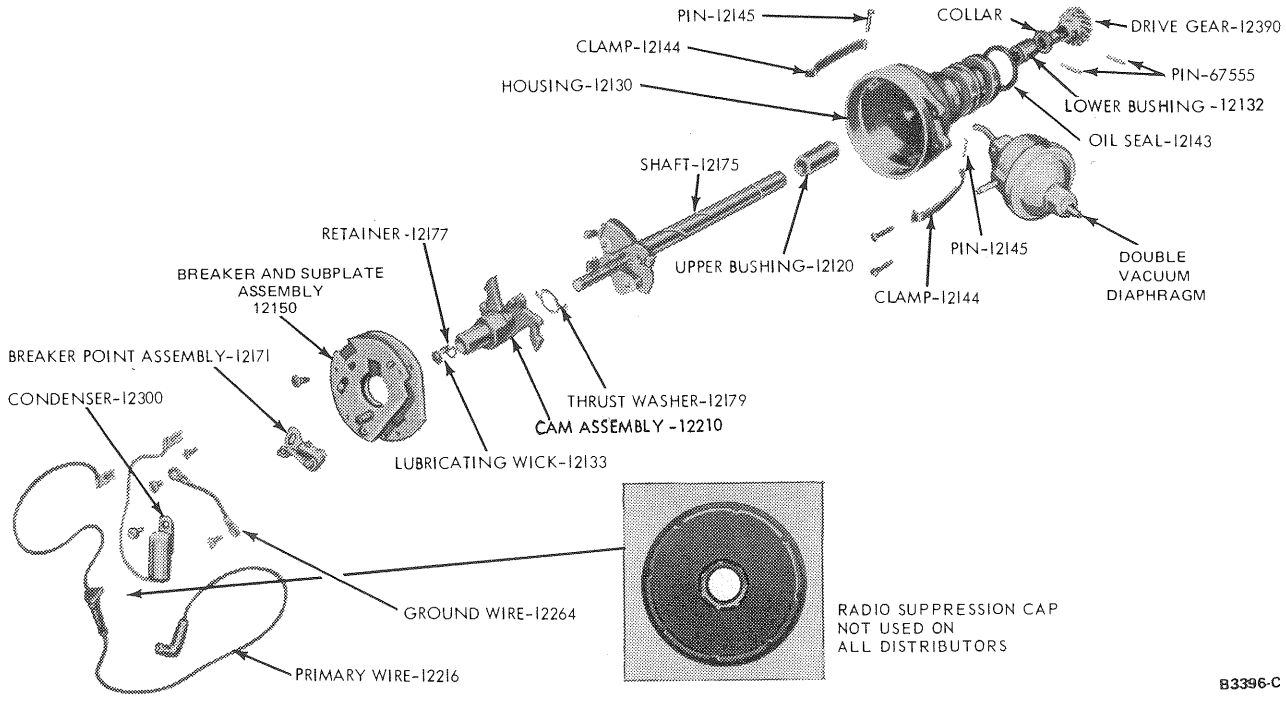


FIG. 15 Breaker Plate Installed

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

BREAKER PLATE AND SUB-PLATE

Refer to Figure 15 for the correct location of parts.

Removal

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

Installation

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

CLEANING AND INSPECTION

SPARK PLUGS

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

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

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

DISTRIBUTOR

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

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

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

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

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

Check the distributor base for cracks or other damage.

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

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

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

Distributor Cap

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

Rotor

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

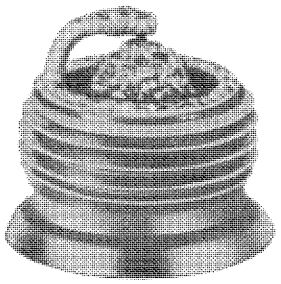
Secondary Wiring

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

Coil

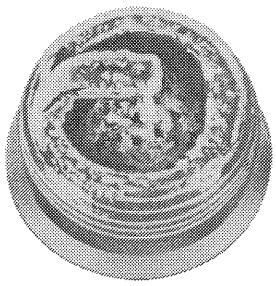
Wipe the coil with a damp cloth and check for any cracks or other defects.

GAP BRIDGED



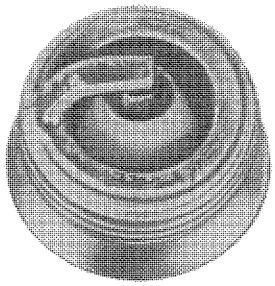
IDENTIFIED BY DEPOSIT BUILD-UP CLOSING GAP BETWEEN ELECTRODES. CAUSED BY OIL OR CARBON FOULING. REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE, THE PLUG CAN BE CLEANED.

OIL FOULED



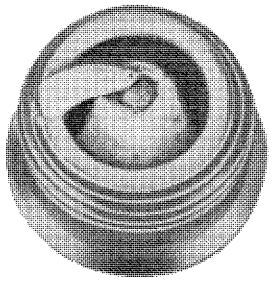
IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. REPLACE THE PLUG. IF ENGINE IS NOT REPAIRED, USE A HOTTER PLUG.

CARBON FOULED



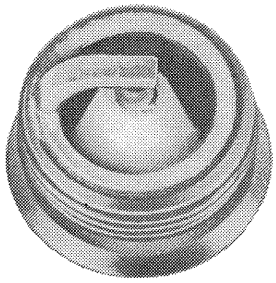
IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES. CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.

WORN



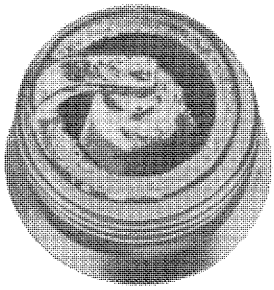
IDENTIFIED BY SEVERELY ERODED OR WORN ELECTRODES. CAUSED BY NORMAL WEAR. SHOULD BE REPLACED

NORMAL



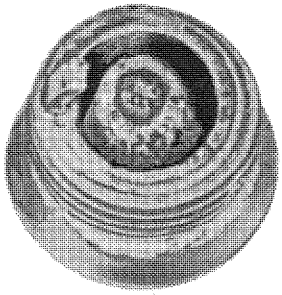
IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP.

LEAD FOULED



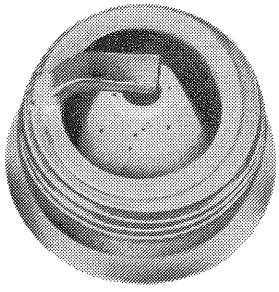
IDENTIFIED BY DARK GRAY, BLACK, YELLOW OR TAN DEPOSITS OR A FUSED GLAZED COATING ON THE INSULATOR TIP. CAUSED BY HIGHLY LEADED GASOLINE. REPLACE THE PLUG.

PRE-IGNITION



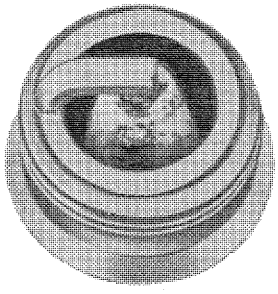
IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALLIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE. CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING. REPLACE THE PLUG.

OVERHEATING



IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLUISH-BURNT APPEARANCE OF ELECTRODES, CAUSED BY ENGINE OVERHEATING. WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.

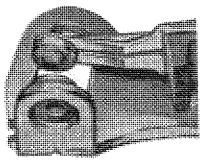
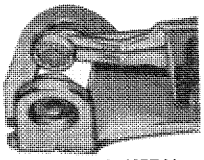
FUSED SPOT DEPOSIT



IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUBBLES OR BLISTERS. CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE. OTHERWISE REPLACE PLUG.

B3235-B

FIG. 16 Spark Plug Inspection

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

B1443-C

FIG. 17 Breaker Point Inspection

PRESTOLITE DISTRIBUTORS (MARINE ENGINES) DESCRIPTION AND OPERATION

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

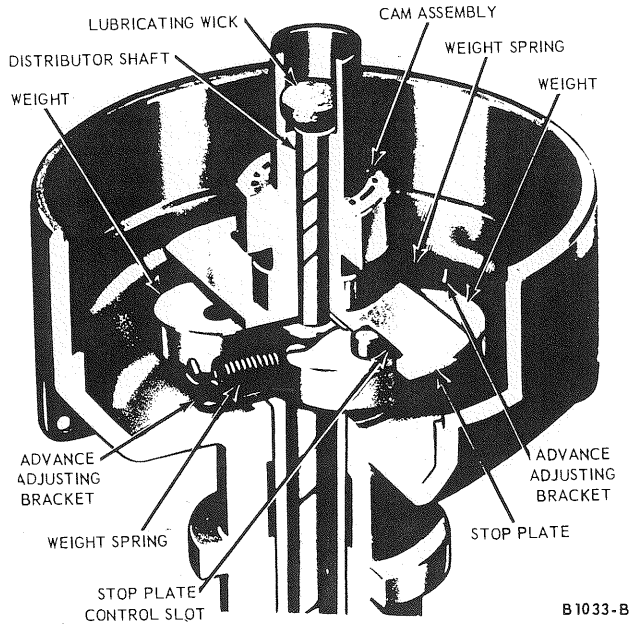


FIG. 18 Centrifugal Advance Mechanism

ADJUSTMENTS AND REPAIRS

BREAKER POINTS AND/OR CONDENSER

Removal

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

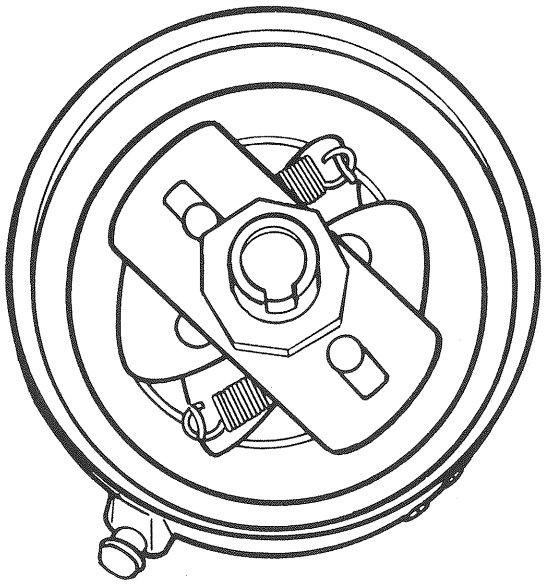


FIG. 19 Weights, Springs, and Cam Installed

Installation

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

BREAKER PLATE AND SUB-PLATE

Removal

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

Installation

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

CAM AND CENTRIFUGAL ADVANCE WEIGHTS

Removal

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

Installation

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

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

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

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

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

DISTRIBUTOR

Removal

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

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

Installation

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

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

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

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

MAJOR REPAIR OPERATIONS

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

BENCH DISASSEMBLY

Refer to Figure 20 for the location of parts.

CONVENTIONAL IGNITION SYSTEM DISTRIBUTOR

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

BENCH ASSEMBLY

ORIGINAL SHAFT AND GEAR

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

5. Place the collar in position on the shaft and align the holes in the collar and shaft, then install a new pin.
6. Check the shaft end play with a feeler gauge placed between the collar and the base of the distributor. If the end play is not within limits, replace the shaft and gear.
7. Press the gear on the shaft, using the marks made on the gear and shaft as guides to align the pin holes.
8. Remove the distributor from the press. Install the gear retaining pin.
9. Position the distributor in a vise. Fill the grooves in the weight pivot pins with distributor cam lubricant (C4AZ-19D530-A).
10. Position the weights in the distributor **(the marked weight is placed on the marked pivot pin)** and install the weight retainers.
11. Place the thrust washer on the shaft.
12. Fill the grooves in the upper portion of the distributor shaft with distributor cam lubricant (C4AZ-19D530-A).
13. Install the cam assembly. **Be sure that the marked spring bracket on the cam assembly is near the marked spring bracket on the stop plate.**

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

14. Install the weight springs. **Be sure that the marked spring is attached to the marked spring brackets.**
15. Place the breaker point and condenser plate in position and install the retaining screws.
16. Working from the inside of the distributor, push the primary wire through the opening in the distributor housing.
17. Place the breaker point assembly and the condenser in position and install the retaining screws.
18. Align and adjust the breaker point assembly.
19. Connect the primary wire and the condenser wire to the breaker point assembly.
20. Install the rotor and the distributor cap.
21. Check and adjust (if necessary) the centrifugal advance mechanism.

NEW SHAFT AND GEAR

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

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

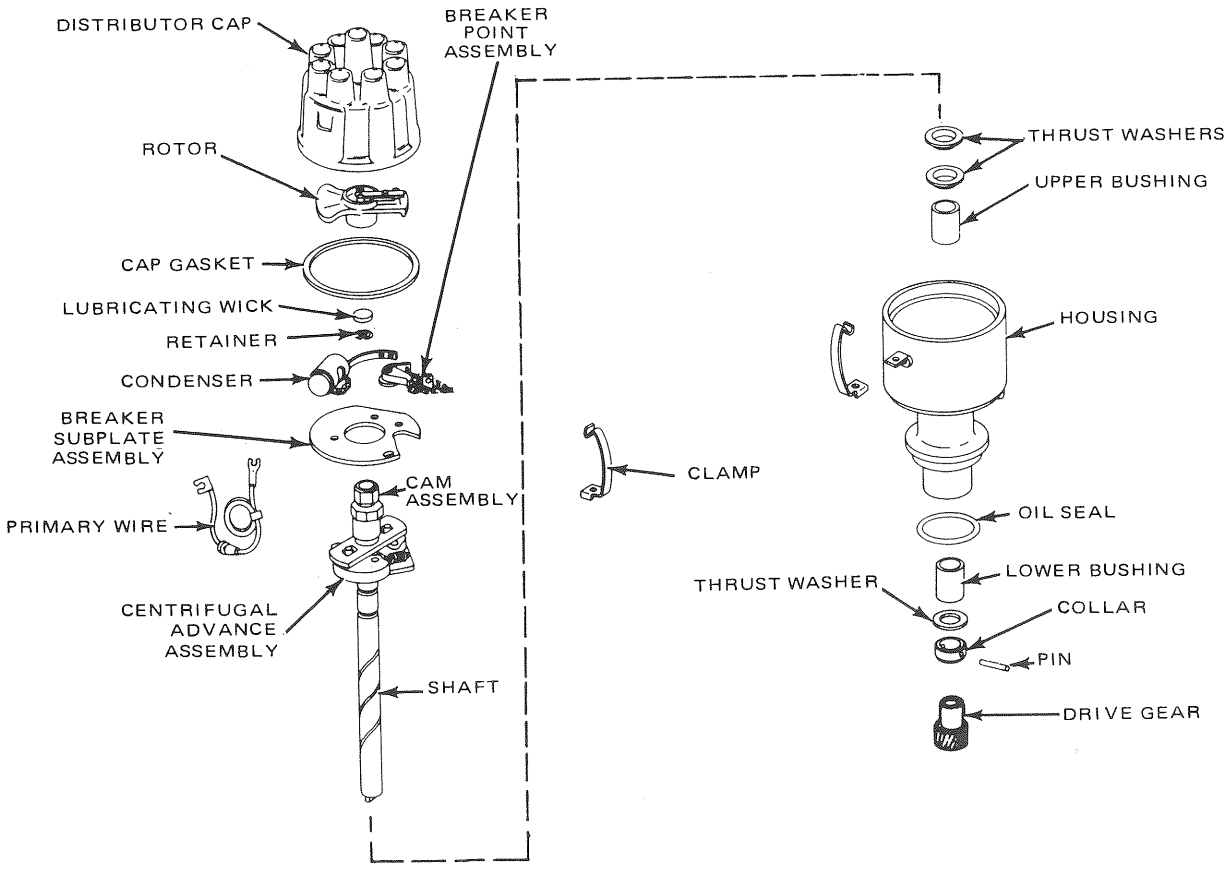


FIG. 20 Distributor Assembly (Conventional)

Part 3 — Fuel Systems 302 and 351W CID Engines

IDENTIFICATION

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

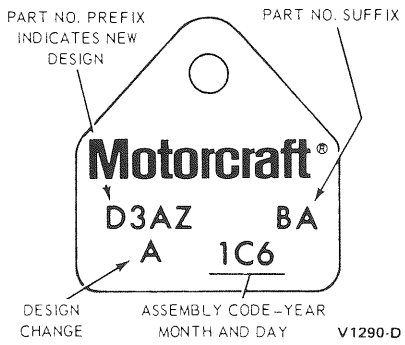
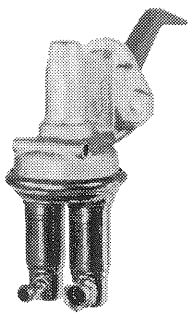


FIG. 1 Carburetor Identification — Typical

DESCRIPTION

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

The 302 and 351W engines use either a Holley Model 4160 or a Model 2300-2V carburetor.



302, 351-W CID V-8

FIG. 2 Mechanical Fuel Pump

DIAGNOSIS AND TESTING

GENERAL INFORMATION

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

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

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

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

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

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

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

SYMPTOM	PROBABLE CAUSE	
Poor Acceleration	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.	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.
	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.	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.
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 (if so equipped) within the recommended maintenance interval. When in doubt, install a new filter.

Pressure Tests

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

1. Remove the air cleaner assembly. Disconnect the fuel inlet line or the fuel filter at the carburetor. **Use care to prevent combustion due to fuel spillage.**
2. Connect a pressure gauge, a restrictor and a flexible hose (Figure 3) between the fuel filter and the carburetor. **Inside diameter of smallest passage in test flow circuit must not be smaller than .220.**
3. Position the flexible fuel outlet hose and the restrictor so the fuel can be discharged into a suitable graduated container (Figure 3).
4. Before taking a pressure reading operate the engine at the specified idle rpm and vent the system into the container by opening the hose restrictor momentarily.
5. Close the hose restrictor, allow the pressure to stabilize, and note the reading. (Refer to the Specifications in this Part.

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

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

Capacity (Volume) Test

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

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

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

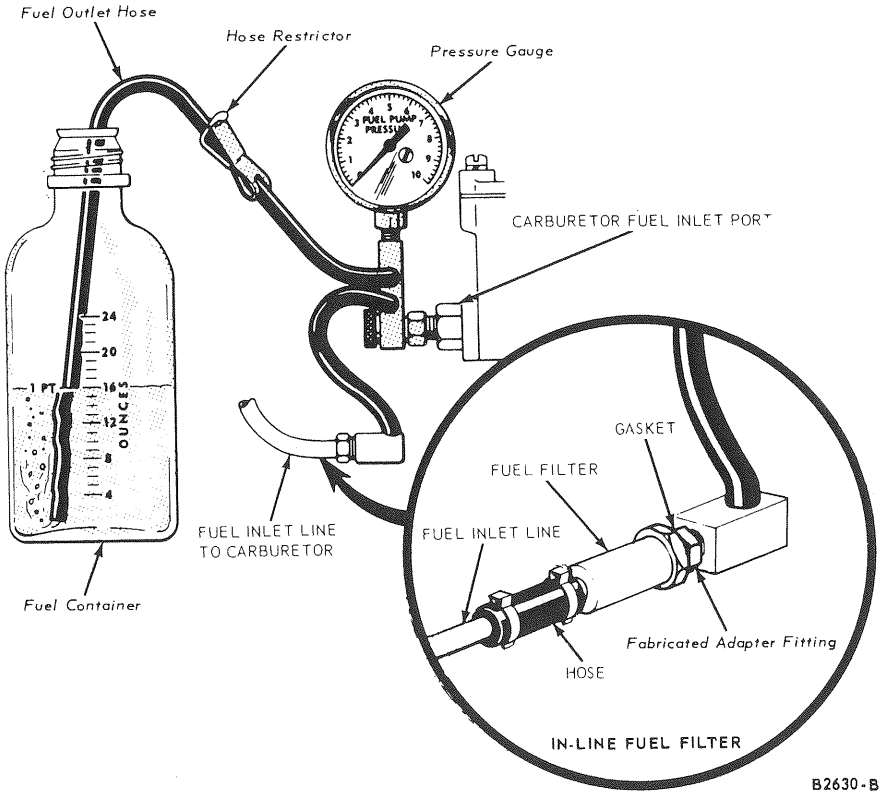


FIG. 3 Typical Fuel Pump Pressure and Capacity Test Equipment

MODEL 4160 CARBURETOR
PRIMARY SYSTEMS

FUEL INLET SYSTEM

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

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

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

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

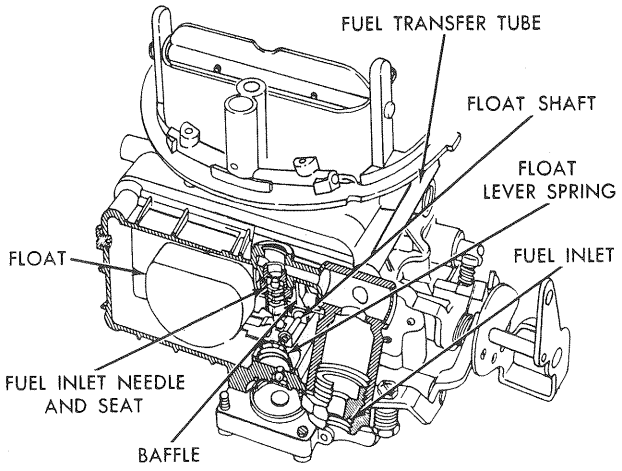


FIG. 4 Fuel Inlet System

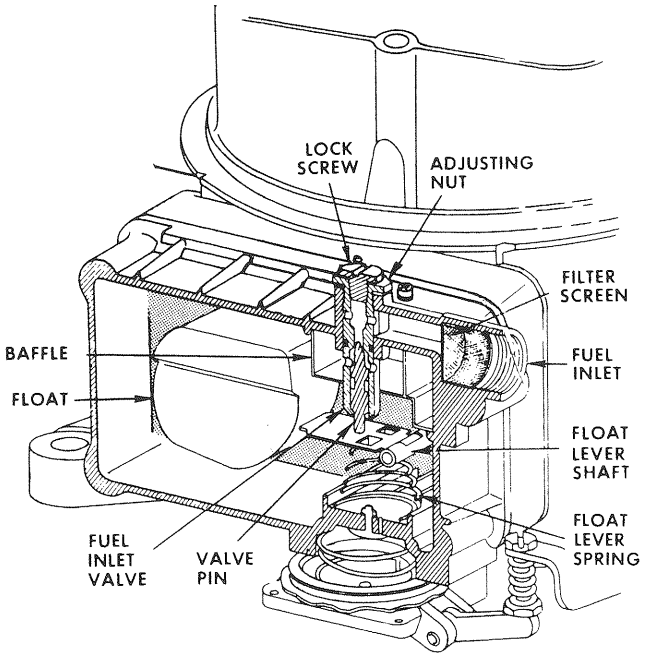


FIG. 5 Fuel Inlet System

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

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

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

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

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

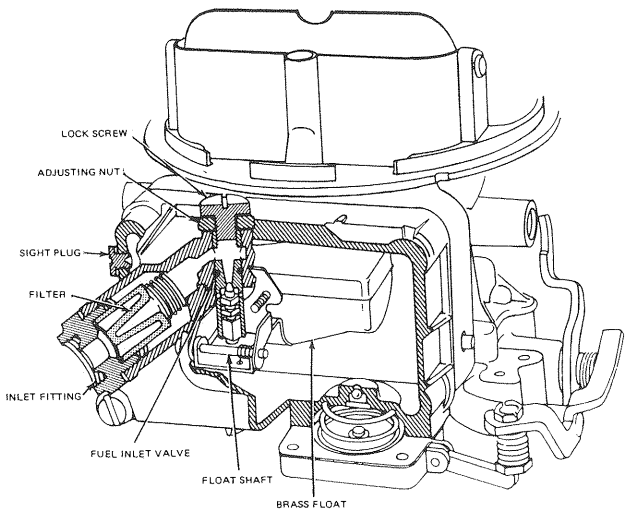


FIG. 6 Fuel Inlet System

IDLE SYSTEM

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

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

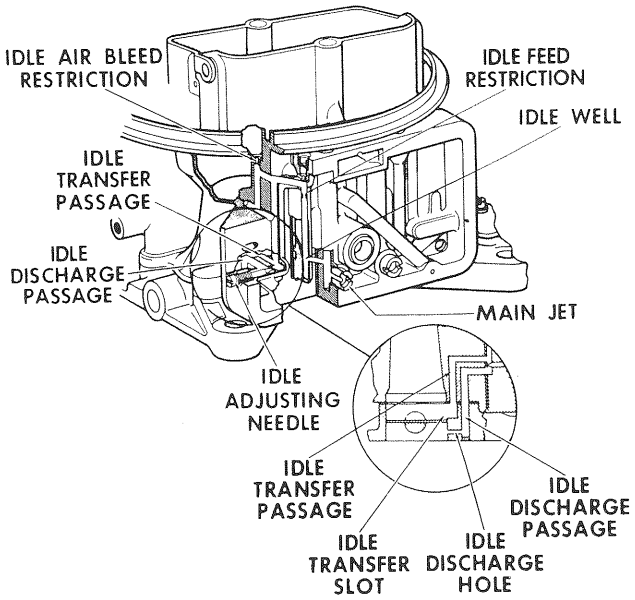


FIG. 7 Idle System Primary Side 4V

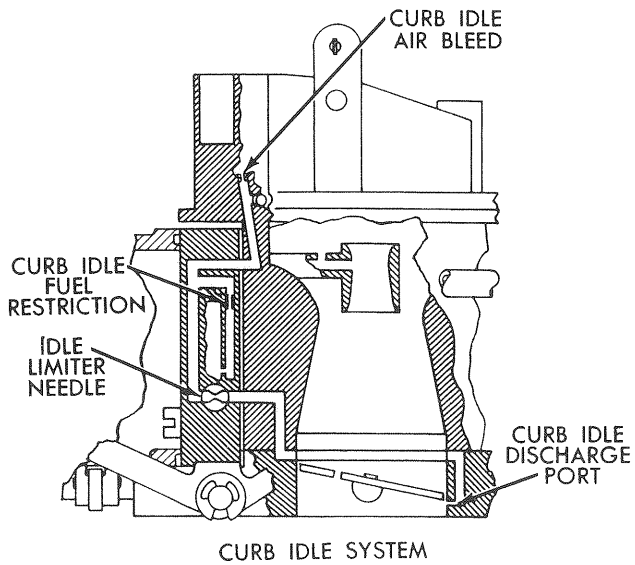


FIG. 8 Curb Idle System, Primary Idle Transfer System

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

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

MAIN METERING SYSTEM (PRIMARY)

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

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

This vacuum or pressure differential causes fuel to flow through the main metering jet into the main well. The fuel moves up the main well past one or more air bleed holes from the main airwell. These air bleed holes are supplied with the filtered air from the "high speed" air bleeds in the air horn. The mixture of fuel and air moves up the main well and through a channel to the main discharge nozzle in the booster venturi (Figures 9 and 10).

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

The booster venturi in the 4160 carburetor is not replaceable, although many carburetors use separate booster castings that are permanently installed in the main body casting.

POWER ENRICHMENT SYSTEM (PRIMARY)

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

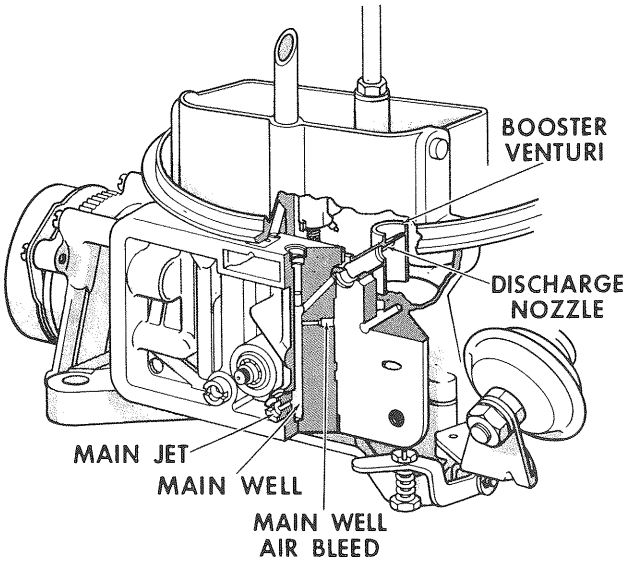


FIG. 9 Main Metering System

When manifold vacuum drops below the power valve's calibration, the power valve spring opens the valve to admit additional fuel. This fuel is metered by the power valve channel restrictions in the metering body. The fuel flows through the restrictions into the main well and is added to the fuel flowing from the main metering jets (Figure 11).

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

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

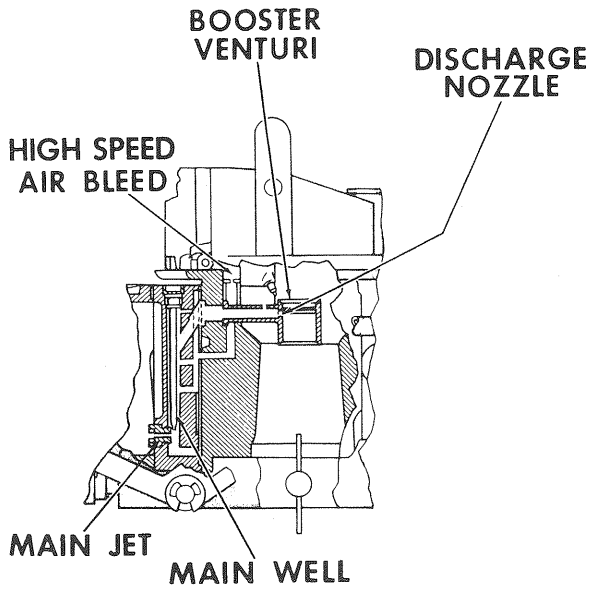


FIG. 10 Side View, Main Metering System

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

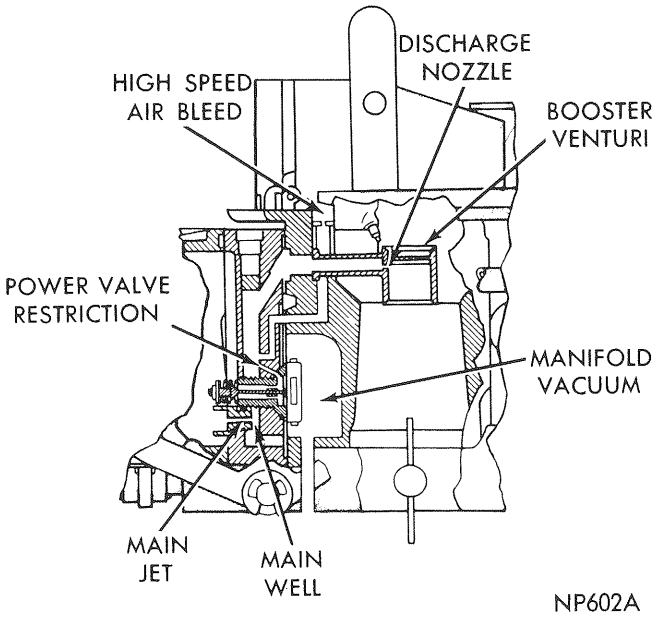


FIG. 11 Power Enrichment System

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

ACCELERATING PUMP SYSTEM

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

The diaphragm type pump is located in the bottom of the primary fuel bowl. Locating the pump in the bottom of the fuel bowl assures a more solid charge of fuel (fewer bubbles).

When the throttle is opened, the pump linkage, actuated by a cam on the throttle lever, forces the pump diaphragm up. As the diaphragm moves up, the pressure forces the pump inlet check ball or valve onto its seat, thereby preventing the fuel from flowing back into the fuel bowl (Figure 12).

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

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

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

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

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

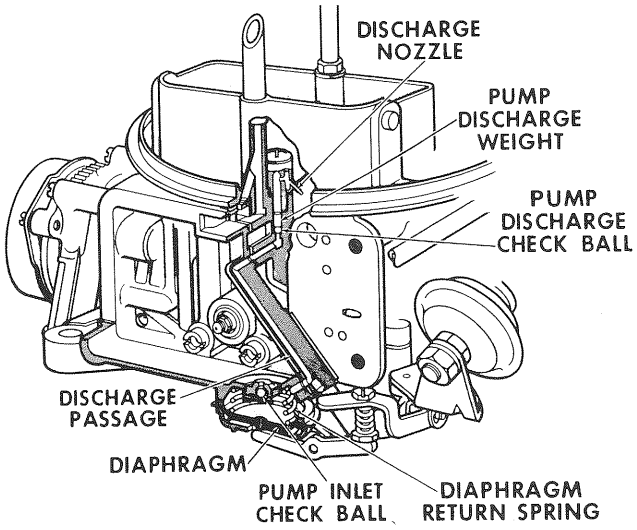


FIG. 12 Accelerator Pump System

CHOKE SYSTEMS

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

The integral choke has the bimetal assembly and vacuum piston housing mounted on the carburetor. In this model the heat required to operate the bimetal is supplied from an intake manifold cross-over tube or a heat stove mounted on or in the exhaust manifold (Figure 13).

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

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

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

Hand operated chokes are used on many special applications.

Integral Automatic Choke

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

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

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

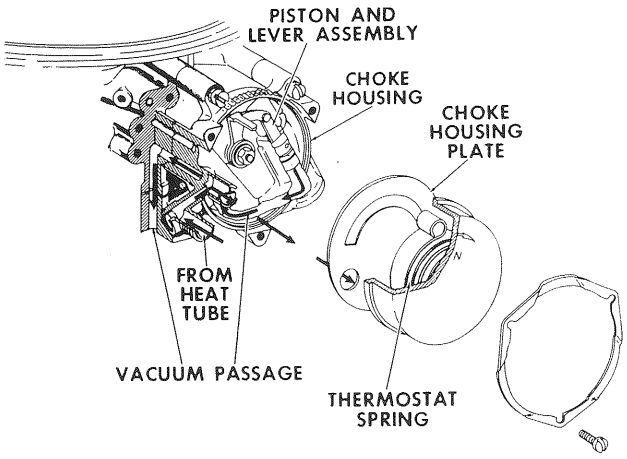


FIG. 13 Integral Automatic Choke

Electric Chokes

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

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

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

Hand Operated Chokes

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

SECONDARY SYSTEMS

VACUUM SYSTEMS SECONDARY OPERATION

At lower speeds the secondary throttle valves remain closed, allowing the engine to maintain proper air-fuel velocities and distribution for lower speed, light load operation. When engine demand increases to a point where additional breathing capacity is needed, the vacuum controlled secondary throttle valves begin to open automatically (Figure 14).

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

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

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

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

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

SECONDARY FUEL METERING SYSTEMS

FUEL INLET SYSTEMS

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

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

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

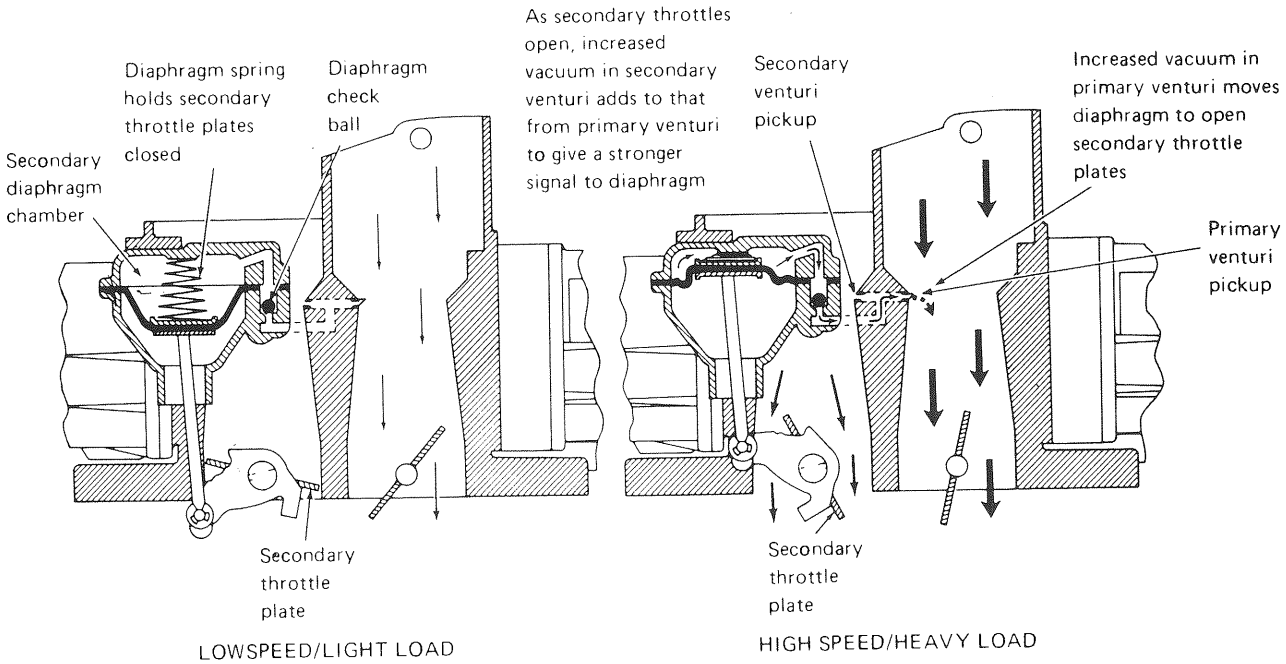


FIG. 14 Vacuum Operated

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

SECONDARY FUEL METERING SYSTEM — MODEL 4160 (Figure 15)

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

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

The air and fuel emulsion is discharged out of the secondary nozzles located in the booster venturi. The secondary transfer and main metering system are only operative when the secondary throttle valves are opened (Figures 16 and 17).

SERVICE PROCEDURES

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

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

All restrictions and channels should be blown out with air (See Figure 20).

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

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

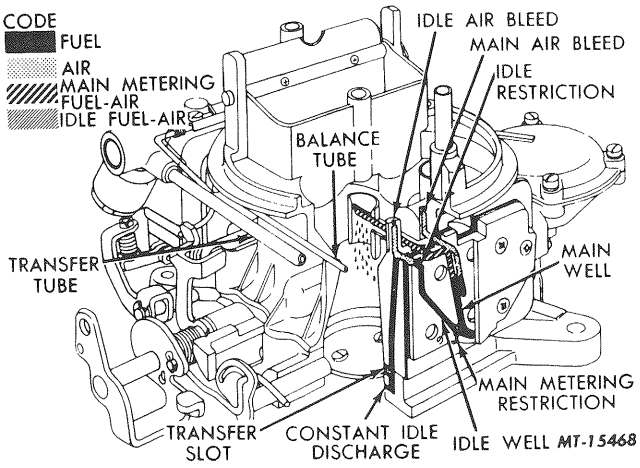


FIG. 15 Model 4160 Secondary System

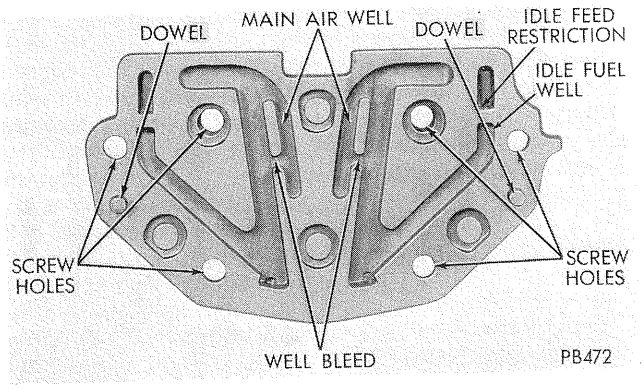


FIG. 16 Late Secondary Metering Body

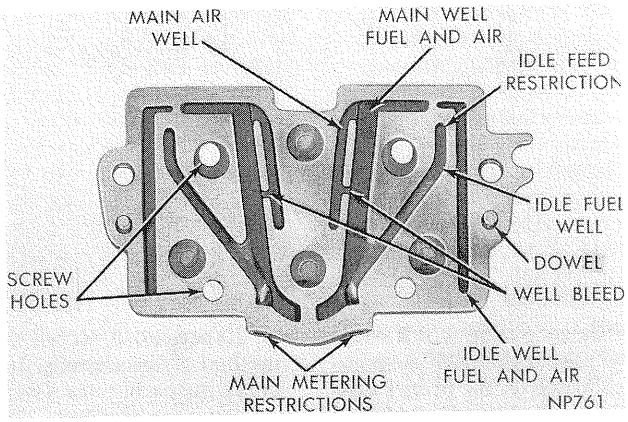


FIG. 17 Early Secondary Metering Body

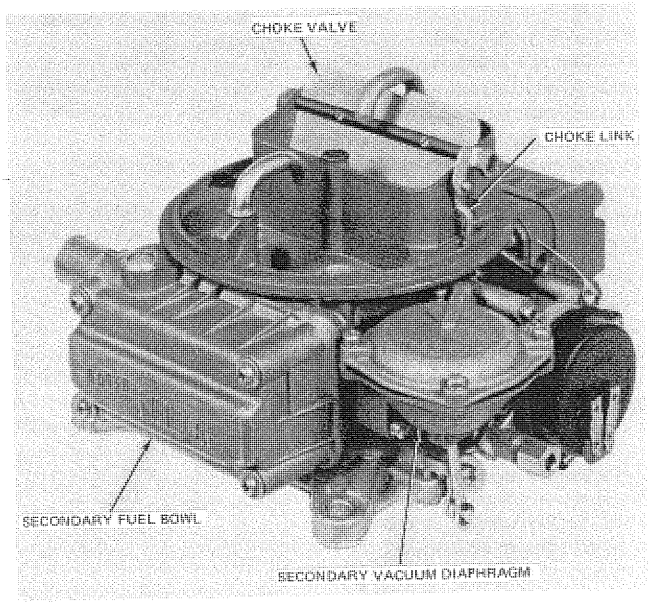


FIG. 18 Secondary Side Model 4160, Internal Fuel Inlet Needle and Seats

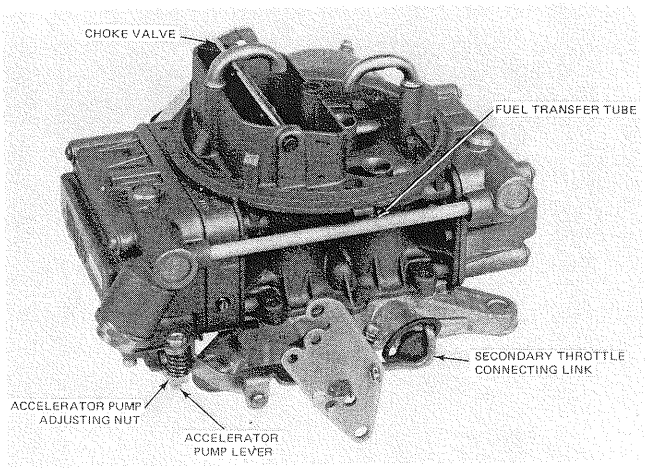


FIG. 19 Throttle Lever Side. Model 4160

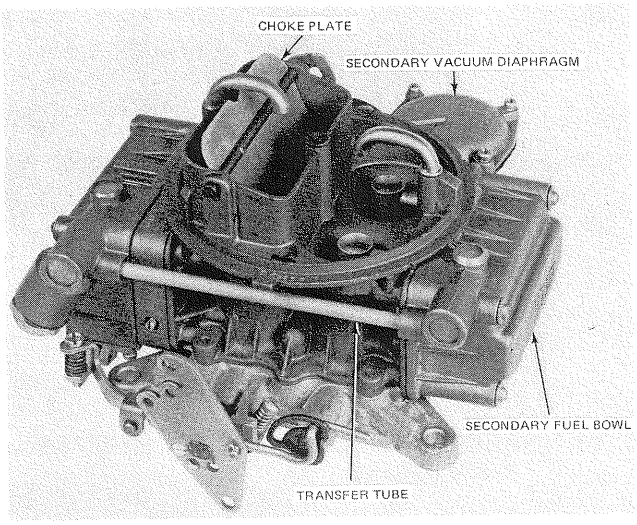


FIG. 21 Throttle Lever Side, Model 4160

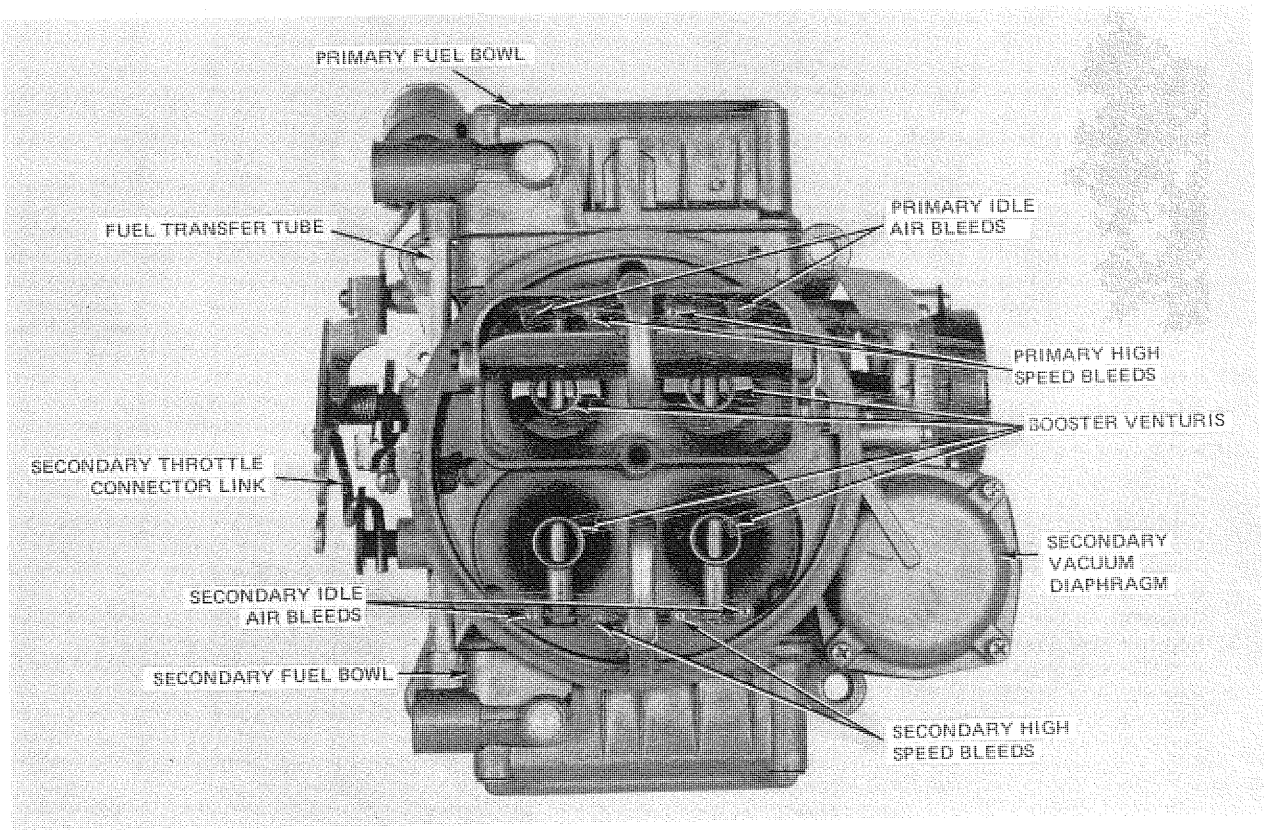


FIG. 20 Top View, Model 4160, showing Idle Air and High Speed Bleeds

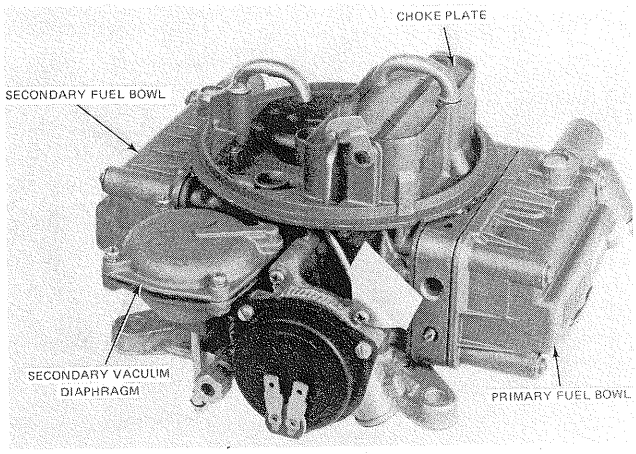


FIG. 22 Choke Housing Side Model 4160, Internally Adjusted Needle and Seat

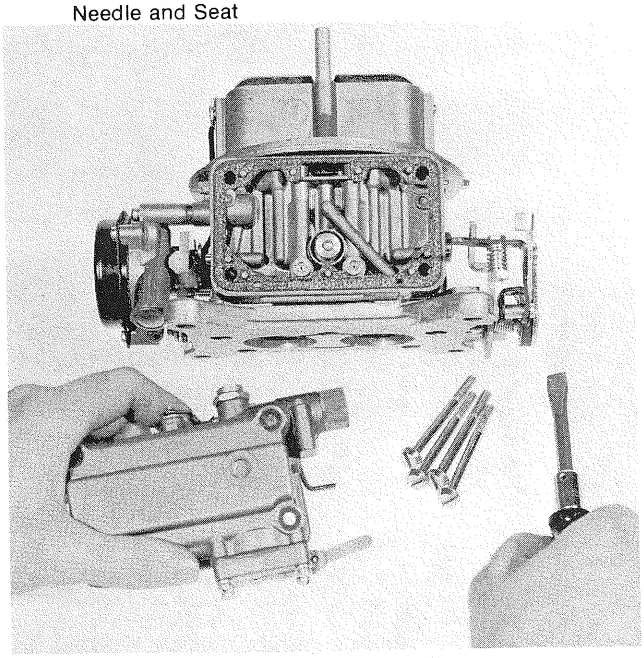


FIG. 23 Removal or Installation of Primary Fuel Bowl

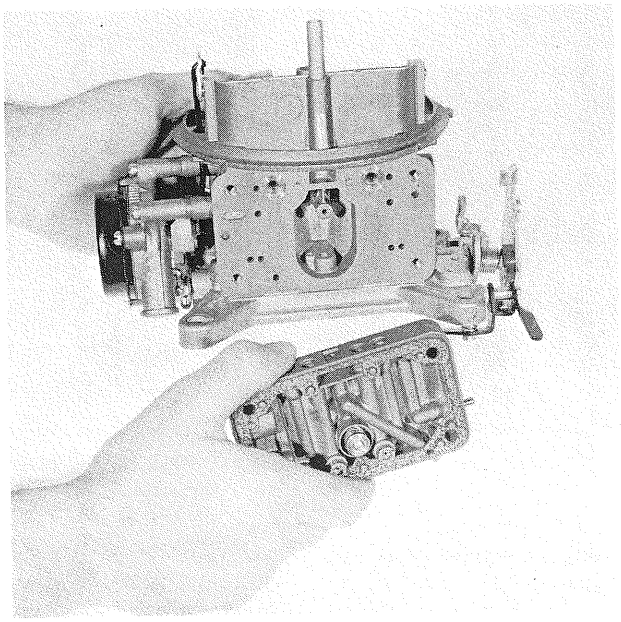


FIG. 24 Removal or Installation of Primary Metering Body

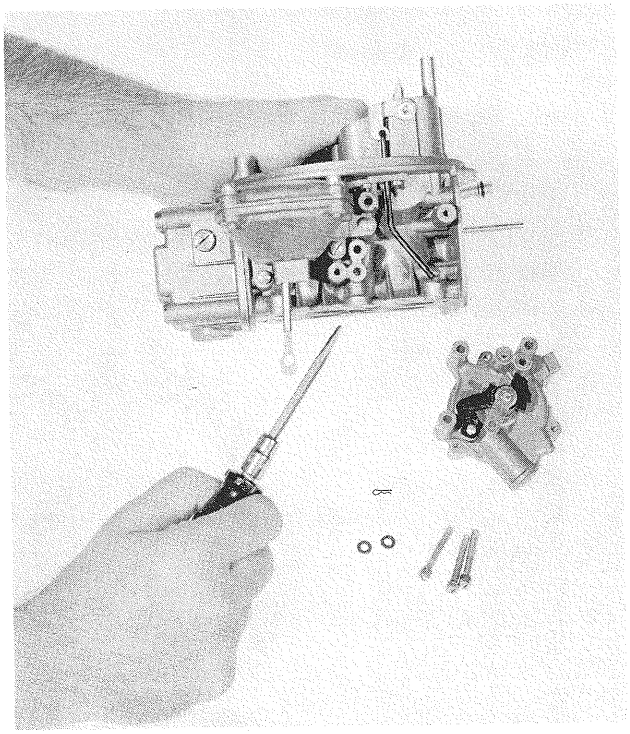


FIG. 25 Removal or Installation of Integral Automatic Choke

DISASSEMBLY MODEL 4160

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

1. Remove integral choke assembly and fast idle cam (if used) (Figure 25).
2. Remove choke fast idle lever screw and lever, remove "E" clip, fast idle cam and lever (if used).
3. Remove secondary vacuum diaphgram assembly from carburetor body (if used) (Figure 22).
4. Remove four fuel bowl screws and primary fuel bowl assembly by sliding straight off transfer tube (Figure 26).
5. Remove primary metering body by sliding straight off dowels or balance tube.
6. Remove power valve using 1" wrench or power valve socket. Remove power valve gasket and pump transfer tube with "O" rings (if used) from metering body (Figure 28).
7. Remove gasket and main metering jets using 3/8 inch wide screwdriver or proper jet socket (Figure 29).
8. Turn idle limiter caps "clockwise" to stops. Remove caps by prying off of idle mixture screws (if used). **(Be careful not to bend screws).** Count and record exact number of "clockwise" turns to seat each screw lightly. The same number of turns must be maintained from the seat upon reinstallation. Remove screws and gaskets from metering body. Remove vent baffle (Figure 29).

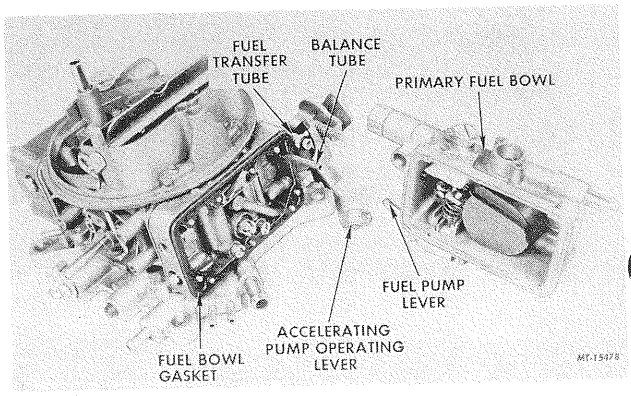


FIG. 26 Removal or Installation of Primary Fuel Bowl

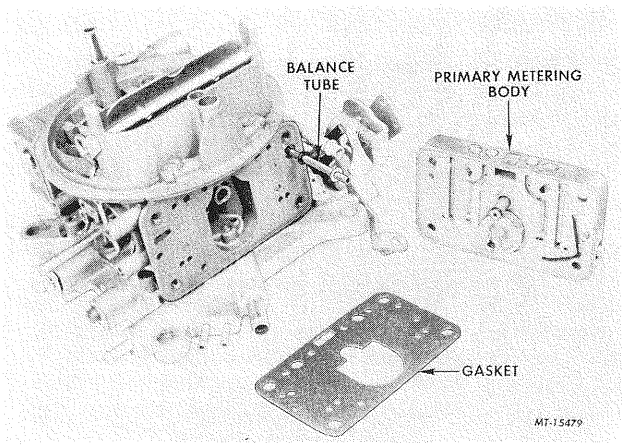


FIG. 27 Removal or Installation of Primary Metering Body (with Pump Transfer Tube)

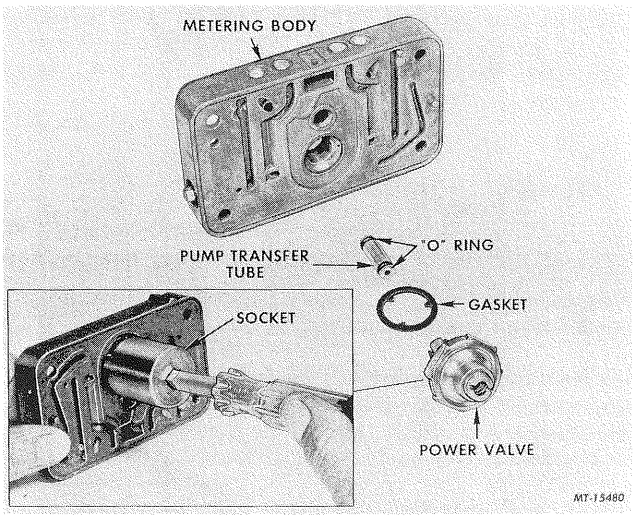


FIG. 28 Primary Metering Body with Acceleration Pump Transfer Tube (Disassembled View)

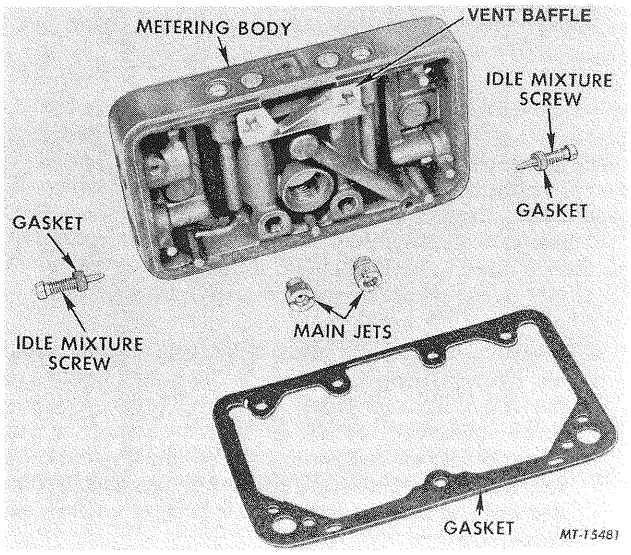


FIG. 29 Primary Metering Body, Fuel Bowl Side (Disassembled View)

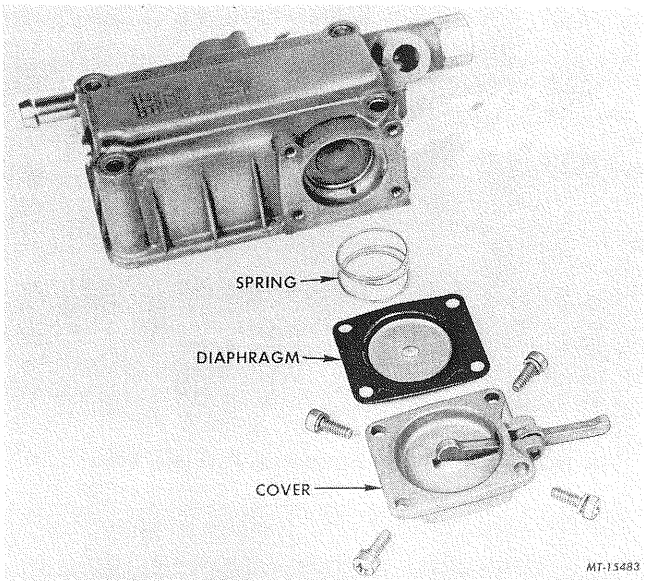


FIG. 30 Accelerator Pump, Disassembled Plastic Pump Inlet Valve

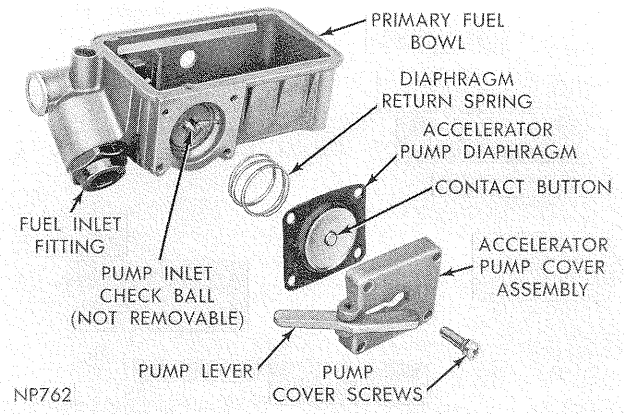


FIG. 31 Accelerator Pump, Disassembled Ball Check Valve

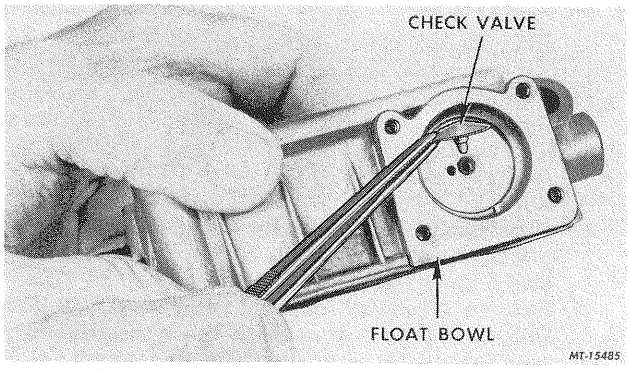


FIG. 32 Removal or Installation of the Plastic Pump Intake Check Valve

9. Remove screws attaching accelerator pump cover to fuel bowl. Remove cover and carefully remove pump diaphragm and spring (Figure 30 and 31).
10. Remove fuel inlet fitting with screen or filter and gasket (Figure 33).
11. Externally Adjustable Needle and Seat: Remove the fuel inlet baffle and remove the retainer, float assembly and float spring (if spring is used). Remove the adjustment lock screw. Turn the adjustment nut counterclockwise. Remove the locknut, gasket and fuel inlet needle and seat.

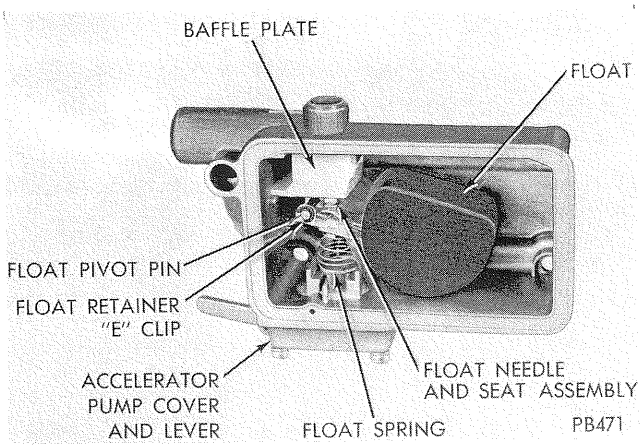


FIG. 33 Fuel Bowl Assembly Internal Fuel Inlet Valve

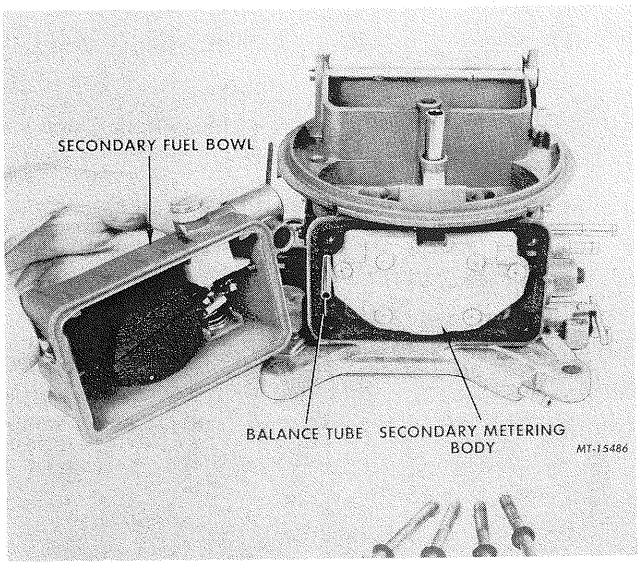


FIG. 34 Removal or Installation of Secondary Fuel Bowl (Model 4160)

12. Internal Needle and Seat: Remove float retainer "E" clip, then slide float and spring out of float chamber. Remove baffle, fuel inlet valve and seat. Discard gasket (Figure 33).
13. Remove the plastic accelerator pump inlet check valve (Figure 32). **THE BALL TYPE INLET CHECK VALVE IS NOT REMOVABLE.**
14. Remove secondary fuel bowl from carburetor body. **Disassembly of the secondary fuel bowl is similar to the primary bowl.** The fuel inlet baffles are not interchangeable (Figure 34).
15. Remove secondary metering body plate and gaskets from main body (Figure 35). **A clutch head screwdriver must be used. Do not attempt to make one from a regular screwdriver.** Remove balance tube washers and "O" ring.
16. Remove choke rod and seal (Figure 18). Unless the choke valve is bent or damaged, DO NOT remove. **The choke valve screws are staked to prevent loosening and care is necessary to avoid breaking or stripping the threads in the choke shaft. If necessary to remove valve, remove staking with a file before loosening screws.**
17. Remove pump discharge nozzle retaining screw, then lift out discharge nozzle. Remove gaskets from nozzle (top and bottom), invert carburetor and drop out pump discharge needle or check ball and weight from discharge passage.

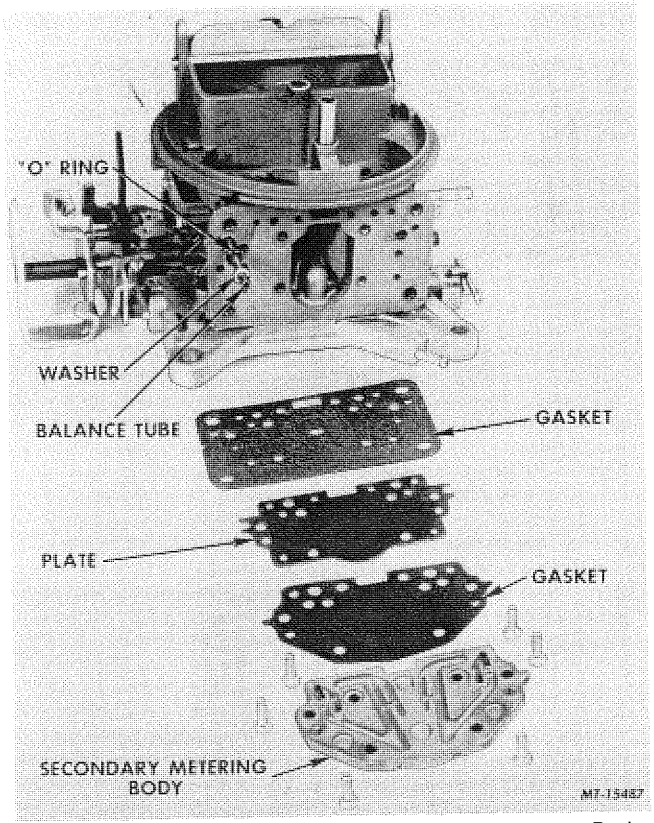


FIG. 35 Removal or Installation of Secondary Metering Body (Model 4160)

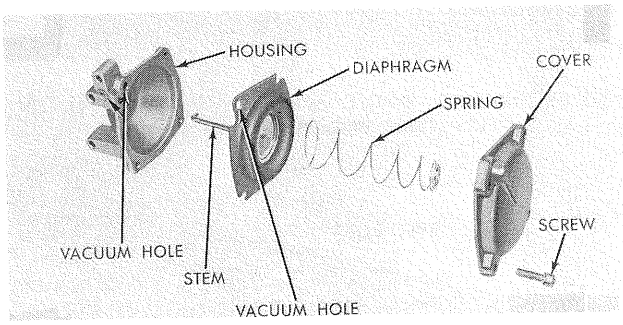


FIG. 36 Disassembly or Assembly of Secondary Vacuum Diaphragm

18. Invert carburetor and remove the throttle body attaching screws. Remove the throttle body and gasket. Remove accelerator pump operating lever, adjusting screw and spring, low idle speed screw and spring, curb idle speed screw and spring, and secondary connecting rod. **If the throttle valves are nicked or damaged, it will be necessary to install a new throttle body or obtain a new carburetor.**
19. Disassemble the secondary diaphragm. **Loosen four screws carefully and free up cover to prevent catching edges of diaphragm in cover screws (Figure 36).**

CLEANING

Carburetor parts cleaning is thoroughly covered in the introductory section.

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

Assembling Primary Metering Body

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

   Inspect mixture screws. If the tapered portion is grooved or ridged, a new mixture screw should be installed to insure ability to maintain the correct idle mixture. Turn screws in lightly against their seats. Back each screw out the exact number of turns recorded during disassembly (Figure 29).
2. Install a new gasket on power valve and install with proper wrench or socket. Torque to 100 in.-lbs. (Figure 28).
3. Install main metering jets using proper screwdriver or jet wrench (Figure 29).
4. Install fuel baffle (if used). Press metering body and fuel bowl gasket down firmly on the dowels (Figure 29). **Be sure you are using the correct metering body gasket and that bowl gasket is not covering the accelerator pump passage.**

ASSEMBLY FUEL BOWLS

FUEL BOWLS WITH INTERNALLY ADJUSTED FUEL INLET NEEDLE AND SEAT

1. Install plastic accelerator pump check valve in fuel bowl (Figure 32) (if used).
2. If ball type, check for proper ball clearance under retaining bar (Figure 37).
3. On primary fuel bowl only, install pump diaphragm return spring, diaphragm and pump cover. Be sure diaphragm is centered and contact button is toward pump lever in cover. Install four attaching screws and tighten evenly.
4. Externally Adjusted Fuel Inlet Needle and Seat: Apply lubricating oil or vaseline on a new "O" ring seal and slide it on the needle and seat assembly.
5. Install the fuel inlet needle and seat assembly through the top of the fuel bowl. Then install the adjusting nut gasket. Align the flats of the seat and the adjusting nut and install the nut. Install the lock screw and gasket. Invert the bowl and turn the adjusting nut until top of float is parallel to top of bowl. This preliminary adjustment will run the engine until the fuel level can be properly checked through the sight plug hole after the carburetor has been installed on the engine (Figure 38).
6. Slide the inlet baffle into the grooves (Figure 38).
7. Install float spring (if used) on float lever and then install the assembly on the float shaft. Be sure spring is properly located on fuel bowl floor. Install the float retainer.
8. Install new gasket on fuel inlet fitting, install screen or filter element. Tighten fitting securely.

FUEL BOWLS WITH INTERNALLY ADJUSTED FUEL INLET NEEDLE AND SEAT (Figure 33)

1. Install plastic accelerator pump check valve in fuel bowl (Figure 32) (if used).
2. If ball type, check for proper ball clearance under retaining bar (Figure 37).
3. On primary fuel bowl only, install pump diaphragm return spring, diaphragm and pump cover. Be sure diaphragm is centered and contact button is toward pump lever in cover. Install four attaching screws and tighten evenly.

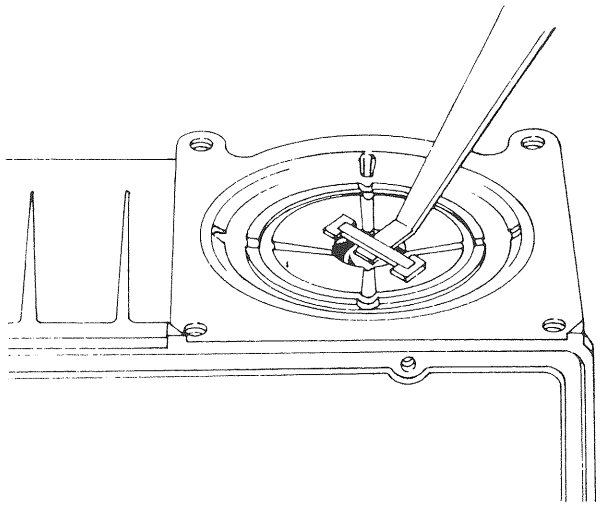


FIG. 37 Checking Pump Intake Ball Valve Clearance

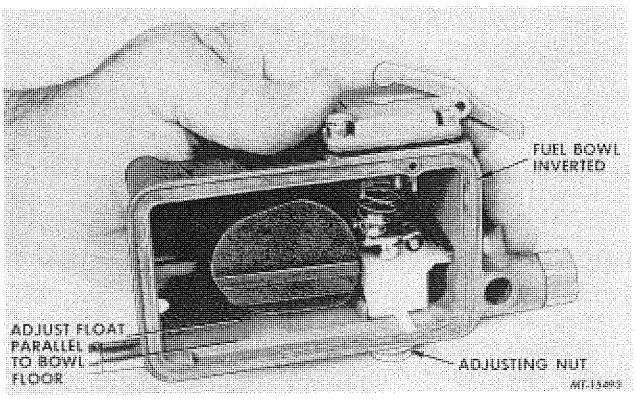


FIG. 38 Preliminary Float Adjustment Externally Adjustable Fuel Inlet Valve — Internally Adjusted Fuel Inlet is Similar

4. Install gasket on fuel inlet seat and install in fuel bowl.
5. Tighten securely with proper wrench.
6. Install fuel inlet needle.
7. Slide the inlet baffle into the grooves (Figure 38).
8. Install float spring (if used) on float lever and then install the assembly on the float shaft. Be sure spring is properly located on fuel bowl floor. Install the float retainer.
9. To adjust the dry float setting (internally adjusted needle and seat), adjust float parallel to bowl floor as illustrated in (Figure 38). If an adjustment is necessary, carefully bend float tang until proper adjustment has been obtained using care not to nick or damage portion of tang which contacts needle.

ASSEMBLING MAIN BODY

1. Place a new gasket on throttle body, then lower main body down on throttle body. **BE SURE THE GASKET FITS THE THROTTLE BODY AND MAIN BODY.**
2. Hold assembly together, invert assembly and install attaching screws. **Primary throttle bores must be on primary venturi side (choke side).** Install levers, springs and screws into throttle body. Torque attaching screws evenly in stages to 50 in.-lb. (Figure 39).
3. Install accelerator pump discharge needle or ball and weight (if used) in pump discharge passage under choke valve.
4. Install pump discharge nozzle gasket on nozzle screw, install nozzle, second gasket and install assembly in position. Tighten screw securely.

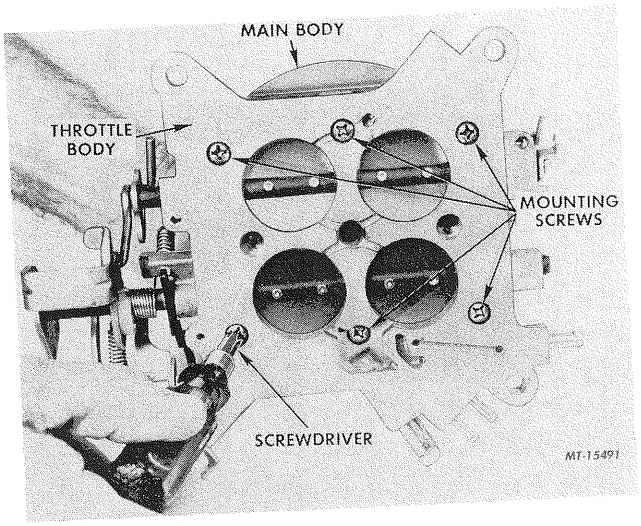


FIG. 39 Installing and Torquing Throttle Body Screws

MODEL 4160 ASSEMBLY

1. Install balance tube into main body. **Install new "O" rings and washers at each end. Be sure "O" rings and washers are seated in recesses on both primary and secondary side (Figure 40); otherwise fuel leakage will occur.**
2. Install a new secondary metering body (plate) to main body gasket followed by the metering body (plate) (Figure 35). Install six clutch head screws. Tighten evenly and securely with a proper clutch head screwdriver.
3. Position balance tube so that only 1" extends beyond the secondary metering body (Figure 40).
4. Adjust primary and secondary dry fuel levels to specification. (Primary at toe of float, secondary at heel of float.)

PRIMARY BOWL AND METERING BODY ASSEMBLY

1. If metering body and bowl gaskets were not installed previously under No. 4, describing assembly of primary metering body, do so now. Press gaskets down firmly on dowels, not only to hold them in place but to prevent bowl gasket from interfering with the float (Figures 27 and 29).
2. Install eight bowl screw gaskets on the screws, NOT IN THE RECESSES. **This prevents shearing off gasket fibers which could enter the fuel bowl and partially stop up a main metering jet.**

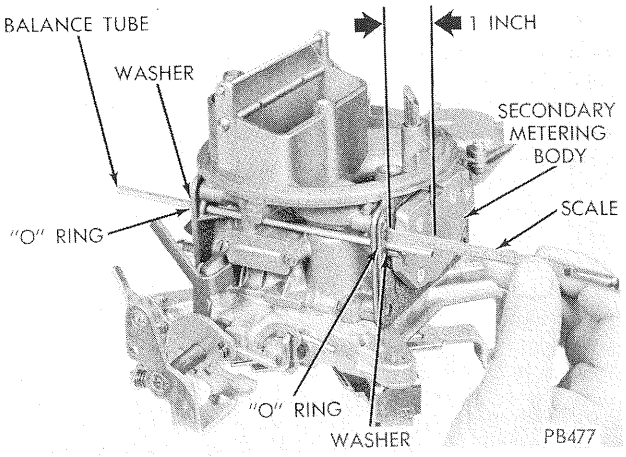


FIG. 40 Adjusting Balance Tube Model 4160

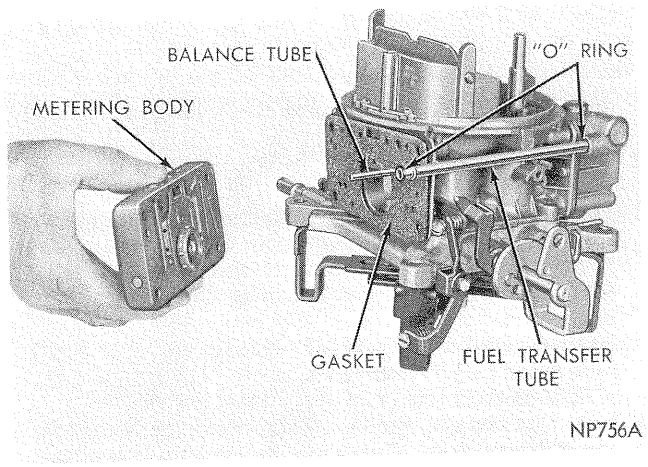


FIG. 41 Installing Primary Metering Body (Model 4160)

3. Carefully install primary metering body over balance tube (if used) and press firmly on dowels (Figure 41).
4. Install fuel bowl on metering body, positioning pump lever in proper position over pump operating lever. Carefully install four bowl screws and gaskets and torque all bowl screws evenly in stages.
5. Install a new "O" ring on the extreme end of each end of fuel transfer tube. Apply Vaseline lightly on "O" ring and install transfer tube into opening in primary fuel bowl. The "O" ring will roll into proper position as tube is installed (Figure 27).

The secondary metering body of the Model 4160 was installed under Step 2, Model 4160 assembly.

ASSEMBLING SECONDARY DIAPHRAGM (Figure 36)

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

CARBURETOR ADJUSTMENTS

FUEL LEVEL FLOAT ADJUSTMENT — DRY

The dry float adjustment is a preliminary fuel level adjustment only. The final adjustment (Fuel Level Float Adjustment — Wet) must be performed after the carburetor is installed on the engine.

With the fuel bowl and float assembly removed, adjust the float so that the float is parallel to the fuel bowl, with the top of the fuel bowl inverted (Figure 42).

FUEL LEVEL ADJUSTMENT — WET

The fuel pump pressure and volume must be to specifications prior to performing the following adjustments.

1. Operate the engine to normalize engine temperatures and place the engine on a flat surface, as near level as possible. Stop the engine and remove the air cleaner, if it was not previously removed.
2. Check the fuel level in each fuel bowl separately (Figure 43). **Place a suitable container below the fuel level sight plug in the fuel bowl to collect any spillover of fuel. Carefully remove the fuel level sight plug and gasket.**
3. If the fuel level is satisfactory, install the sight plug.
4. If the fuel level is too high, drain the fuel bowl and refill it. To drain the fuel bowl, loosen one lower retaining bolt from the fuel bowl and drain the fuel into a suitable container. Check the fuel level again before altering the float setting. **This will eliminate the possibility of foreign material causing a temporary flooding condition. Install the bolt and the fuel level sight plug, and start the engine to fill the fuel bowl. After the fuel level has stabilized, stop the engine and check the fuel level.**

If the fuel level is still too high, it should first be lowered below specifications and then raised until it is just at the lower edge of the sight plug opening. If the fuel level is too low, it is only necessary to raise it to the specified level. Follow the procedure under To Lower Fuel Level or To Raise Fuel Level, whichever is applicable.

To Lower Fuel Level

1. With the engine stopped, loosen the lock screw on top of the fuel bowl just enough to allow rotation of the adjusting nut underneath (Figure 43). **Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running because the pressure in the line will spray fuel out and present a fire hazard.**
2. Turn the adjusting nut approximately 1/2 turn in to lower the fuel level below specifications (1/6 turn of the adjusting nut, depending on the direction of rotation, will raise or lower the float assembly at the fuel level sight plug opening 3/64 inch).
3. Tighten the lock screw and install the fuel level sight plug. Start the engine. After the fuel level has stabilized, stop the engine and check the fuel level at the sight plug opening. The fuel level should be below specified limits. If it is not, repeat the previous steps, turning the adjusting nut an additional amount sufficient to lower the fuel below the specified level.
4. Loosen the lock screw and turn the adjusting nut out in increments of 1/6 turn or less until the correct fuel level is achieved. After each adjustment, tighten the lock screw, install the fuel level sight plug, and then start the engine and stabilize the fuel level. Check the fuel level at the sight plug opening. Install the sight plug and gasket.
5. Install the air cleaner if other carburetor adjustments are not required.

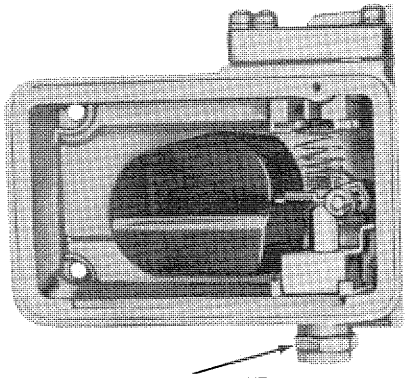


FIG. 42 Adjusting Float — Dry

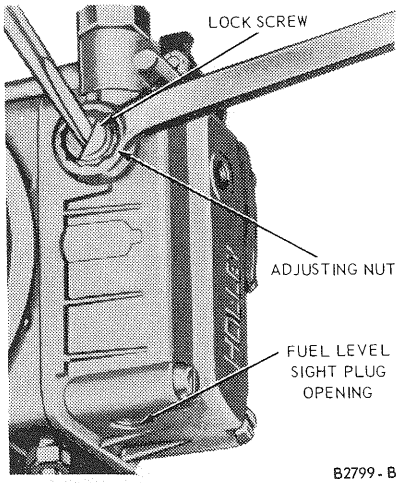


FIG. 43 Adjusting Fuel Level

To Raise Fuel Level

1. With the engine stopped, loosen the lock screw on top of the fuel bowl just enough to allow rotation of the adjusting nut underneath (Figure 43). **Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running because the pressure in the line will spray fuel out and present a fire hazard.**
2. Loosen the lock screw and turn the adjusting nut out in increments of 1/6 turn or less until the correct fuel level is achieved. After each adjustment, tighten the lock screw, install the fuel level sight plug, and then start the engine and stabilize the fuel level. Check the fuel level at the sight plug opening. Install the sight plug and gasket.
3. Install the air cleaner if other carburetor adjustments are not required.

CHECKING ACCELERATOR PUMP LEVER CLEARANCE (Figure 44)

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

ADJUSTING SECONDARY THROTTLE STOP (IF USED) (Figure 45)

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

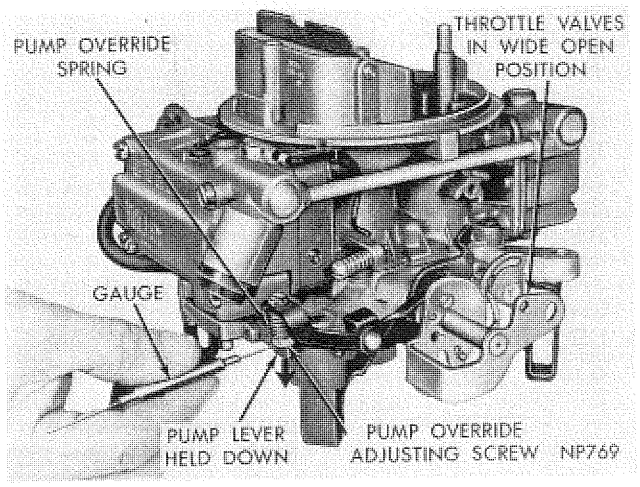


FIG. 44 Pump Override Screw Adjustment

INTEGRAL CHOKE ADJUSTMENTS

Choke Qualifying

Remove choke thermostat housing cover (plastic).

A paper clip (.030 to .036 dia.) must be bent as shown to provide an end no longer than 1/8 inch. The bent end of the clip should be inserted into the piston bore until the end of the bore slot is hooked as shown. Move the piston and levers (bimetal lever must be in contact with piston lever adjusting tab) in a choke closing direction until the edge of the piston slot engages the end of the paper clip. The resulting choke valve opening (clearance to the air horn wall) may then be adjusted by bending the piston lever adjusting tab.

CHOKE BIMETAL ADJUSTMENT (Figure 22)

Set choke bimetal cover to specifications.

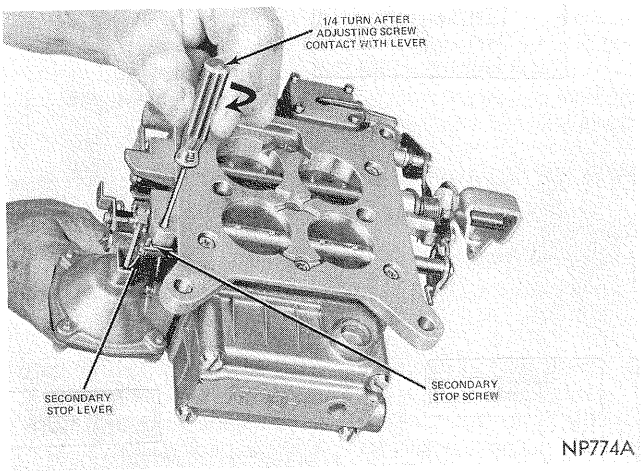


FIG. 45 Secondary Throttle Valve Adjustment

CHOKE UNLOADER ADJUSTMENT

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

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

IDLE ADJUSTMENT

Connect tachometer to engine; tachometer should have 1% to 2% accuracy and an expanded scale of 0-1000 RPM or 400-800 RPM.

1. Adjust idle mixture screws fully in until they are lightly seated. Back them out 1½ revolutions. This will provide sufficient adjustment to be able to start the engine.
2. Be sure the engine is thoroughly warmed up. Adjust the curb idle speed to specification by turning the throttle stop screw "in" to raise idle speed, or "out" to decrease idle speed.
3. Turn the idle mixture adjustment screws inward until the engine speed begins to drop due to a lean mixture. Next, turn the screws outward until the engine speed begins to drop due to an excessively rich mixture. Then turn the screws inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
4. Reset idle speed to specifications.
5. Recheck idle mixture adjustment and reset if necessary.

ERRATIC ENGINE IDLE

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

1. Recheck spark plugs and spark plug wires. Be sure all cylinders are firing.
2. Check for vacuum leaks (vacuum lines or manifold).

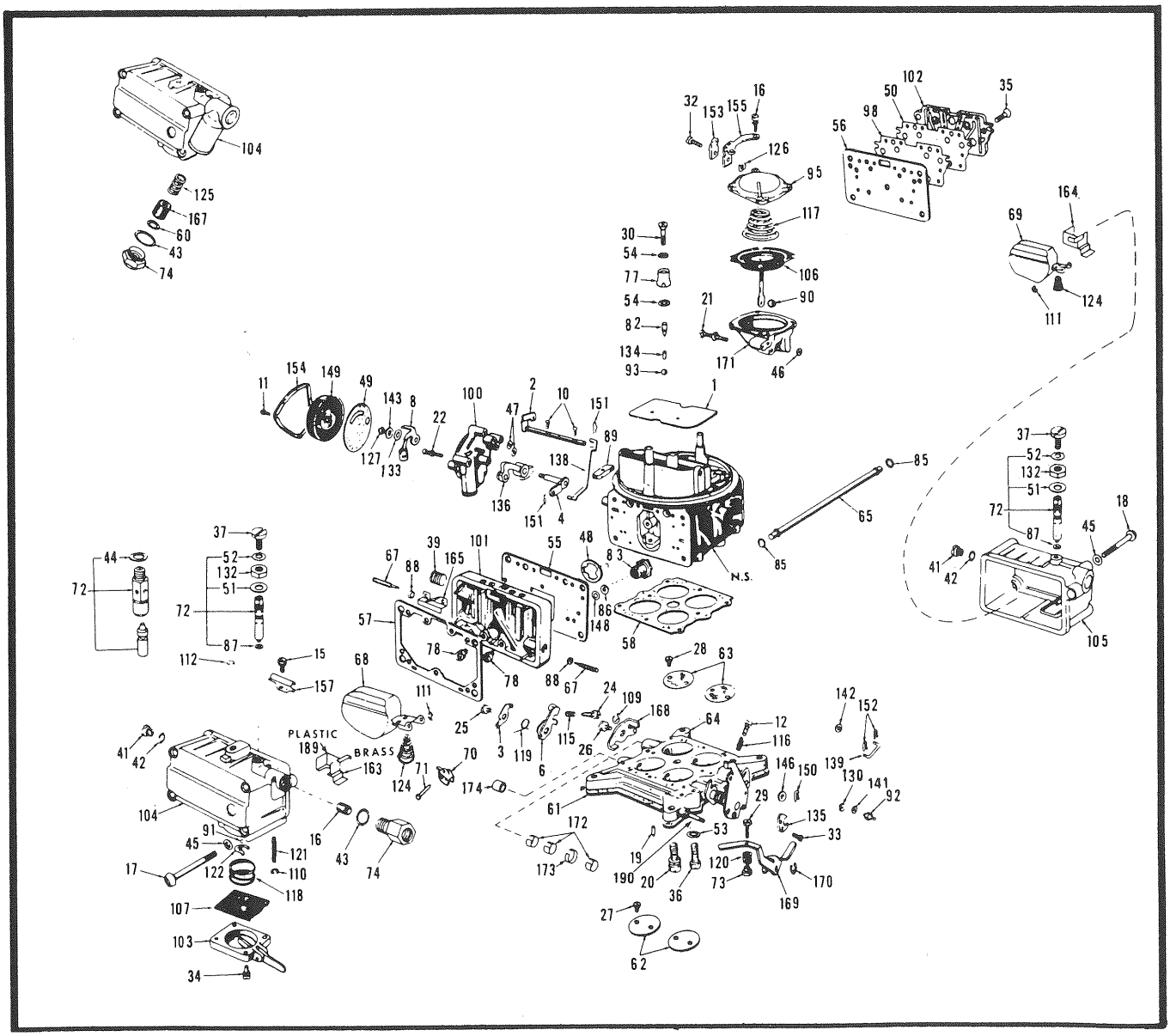


FIG. 47 Holley Model 4160 Carburetor

TYPICAL NOMENCLATURE

Index Number	Part Name	Index Number	Part Name	Index Number	Part Name
1	Choke Plate	52	Fuel Valve Seat Lock Screw Gasket	115	Fast Idle Cam Lever Screw Spring
3	Fast Idle Pick-up Lever	53	Throt. Body Screw Gasket	116	Throttle Stop Screw Spring
4	Choke Housing Shaft & Lever Assy.	54	Pump Discharge Nozzle Gasket	117	Secondary Diaphragm Spring
8	Choke Therm. Lev., Link & Piston Assembly	55	Metering Body Gasket — Primary	118	Diaphragm Return Spring
		58	Throttle Body Gasket	119	Fast Idle Cam Lever Spring
10	Choke Plate Screw	60	Fuel Inlet Filter Gasket	120	Pump Lev. Adj. Screw Spring
11	Therm. Housing Clamp Screw	61	Flange Gasket	122	Pump Inlet Check Ball Ret. Spring
12	Throttle Stop Screw	62	Throttle Plate — Primary	124	Float Spring — Pri. & Sec.
15	Air Vent Clamp Screw & L.W.	63	Throttle Plate — Secondary	127	Choke Thermostat Shaft Nut
16	Sec. Diaph. Assy. Cov. Scr. & L.W.	64	Throt. Body & Shaft Assembly	130	Throttle Lever Ball Nut
17	Fuel Bowl to Main Body Screw — Primary	65	Fuel Line Tube	132	Fuel Valve Seat Adj. Nut
		67	Idle Adjusting Needle	133	Choke Thermostat Lever Spacer
18	Fuel Bowl to Main Body Screw — Secondary	68	Float & Hinge Assy. — Primary	134	Pump Check Ball Weight
		69	Float & Hinge Assy. — Secondary	135	Pump Cam
19	Diaph. Lever Adjusting Screw	73	Pump Lever Adjusting Screw Fitting	138	Choke Rod
20	Throt. Body Screw & Lock Washer	74	Fuel Inlet Fitting	139	Throttle Connecting Rod
21	Diaph. Hsg. Assy. Scr. & L.W.	77	Pump Discharge Nozzle	141	Throttle Lev. Ball Nut Washer
22	Choke Housing Screw & L.W.	78	Main Jet — Primary	143	Choke Shaft Nut Lock Washer
24	Fast Idle Cam Lever Adj. Screw	82	Pump Discharge Needle Valve	146	Throt. Connector Pin Washer
26	Diaph. Lev. Assy. Scr. & L.W.	83	Power Valve Assy. — Primary	149	Therm. Hsg. Assy. — Complete
27	Throt. Plate Screw — Primary	85	Fuel Line Tube "O" Ring Seal	150	Throt. Connector Pin Retainer
28	Throt. Plate Screw — Secondary	87	Fuel Valve Seat "O" Ring Seal	151	Choke Rod Retainer
29	Pump Lever Adjusting Screw	88	Idle Needle Seal	152	Throt. Connecting Rod Cotter Pin
30	Pump Discharge Nozzle Screw	89	Choke Rod Seal	154	Thermostat Housing Clamp
33	Pump Cam Lock Screw	90	Diaph. Hsg. Check Ball — Sec.	157	Air Vent Rod Clamp
34	Fuel Pump Cov. Assy. Scr. & L.W.	91	Pump Inlet Check Ball	161	Filter Screen
35	Secondary Metering Body Screw	92	Throttle Lever Ball	163	Baffle Plate — Primary (Brass)
36	Throt. Body Screw — Special	93	Pump Discharge Check Ball	164	Baffle Plate — Secondary
37	Fuel Valve Seat Lock Screw	95	Sec. Diaphragm Housing Cover	165	Metering Body Vent Baffle
39	Spark Hole Plug	98	Secondary Metering Body Plate	168	Diaphragm Lever Assembly
41	Fuel Level Check Plug	100	Choke Hsg. & Plugs Assembly	169	Pump Operating Lever
42	Fuel Level Check Plug Gasket	101	Main Metering Body & Plugs Assy. — Primary	170	Pump Operating Lever Retainer
43	Fuel Inlet Fitting Gasket			171	Secondary Diaphragm Housing
44	Fuel Valve Seat Gasket	103	Fuel Pump Cover Assembly	172	Throt. Shaft Brg. Pri. & Sec. (Ribbon)
45	Fuel Bowl Screw Gasket	106	Secondary Diaph. & Rod Assy.	173	Throt. Shaft Brg. Pri. & Sec. (Ribbon)
46	Sec. Diaphragm Housing Gasket	107	Pump Diaphragm Assembly	174	Throt. Shaft Bearing — Pri. (Solid)
47	Choke Housing Gasket	109	Secondary Diaph. Link Retainer	189	Baffle Plate — Primary (Plastic)
49	Choke Thermostat Housing Gasket	110	Air Vent Rod Spring Retainer	*	Fuel Valve Clip
50	Sec. Metering Body Plate Gasket.	111	Float Retainer	190	Pump Oper. Lever Stud
51	Fuel Valve Seat Adj. Nut Gasket	112	Air Vent Valve Retainer		

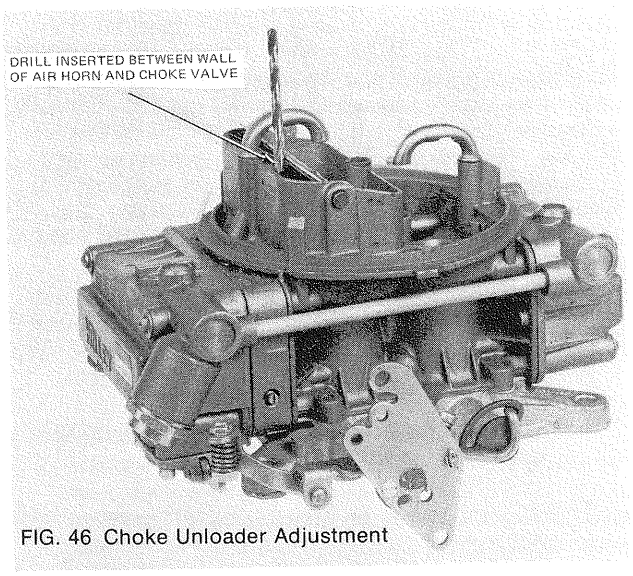


FIG. 46 Choke Unloader Adjustment

LOW IDLE SPEED ADJUSTMENT

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

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

FAST IDLE ADJUSTMENT (IF SO EQUIPPED)

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

IDLE ADJUSTMENT PROCEDURE WITH ANALYZER

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

MODEL 2300 2-V CARBURETOR

DESCRIPTION

CARBURETOR

The Model 2300 2-V carburetor used on the 302 and 351W CID engines (Figure 48) has four main assemblies. They are the main body, throttle body, metering block and the fuel bowl. The fuel passages are identified in Figure 49.

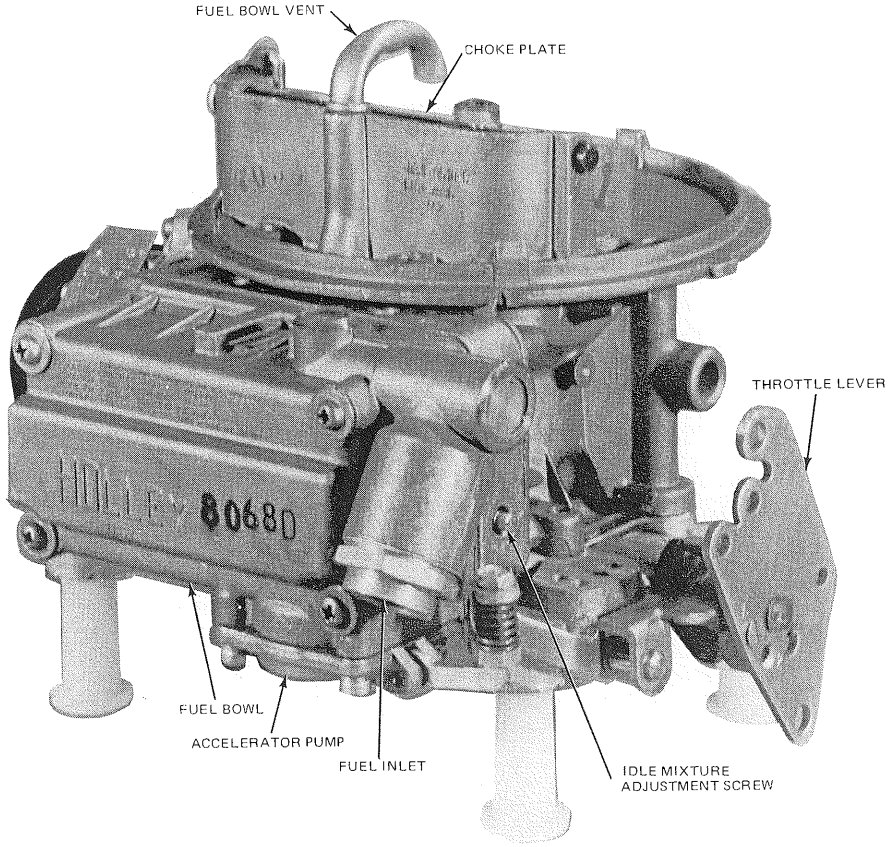


FIG. 48 Model 2300 2-V Carburetor — Left Front View

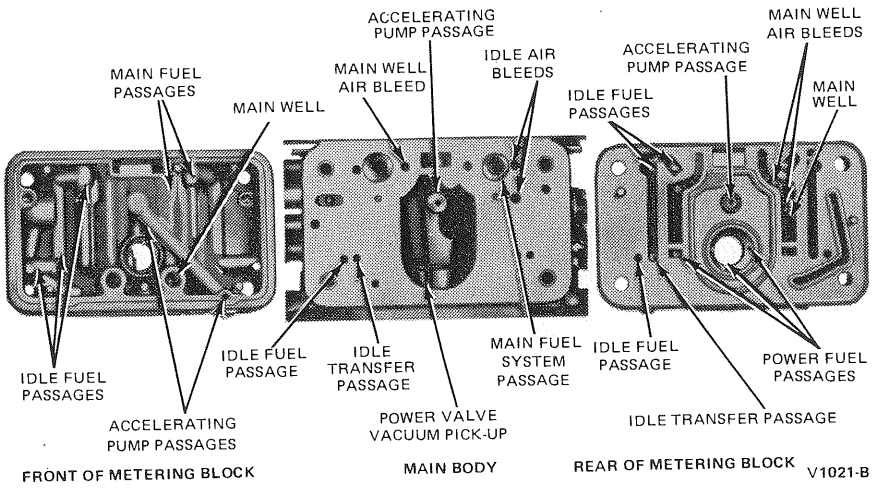


FIG. 49 Fuel Passage Identification

ADJUSTMENTS

IDLE MIXTURE ADJUSTMENT

Connect tachometer to engine; tachometer should have 1% to 2% accuracy and an expanded scale of 0-1000 RPM or 400-800 RPM.

1. Adjust idle mixture screws fully in until they are lightly seated. Back them out 1½ revolutions. This will provide sufficient adjustment to be able to start the engine.
2. Be sure the engine is thoroughly warmed up. Adjust the curb idle speed to specification by turning the throttle stop screw "in" to raise idle speed, or "out" to decrease idle speed.
3. Turn the idle mixture adjustment screws inward until the engine speed begins to drop due to a lean mixture. Next, turn the screws outward until the engine speed begins to drop due to an excessively rich mixture. Then turn the screws inward to a point between these two extremes to obtain maximum engine smoothness and RPM.
4. Reset idle speed to specifications.
5. Recheck idle mixture adjustment and reset if necessary.

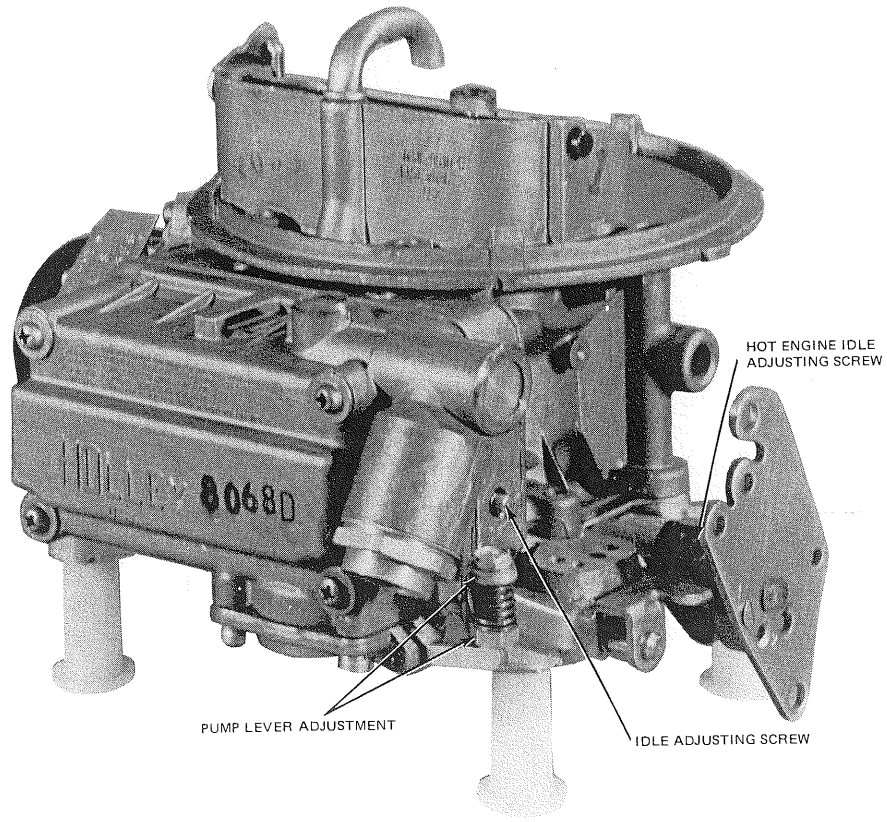


FIG. 50 Carburetor Adjustments

ERRATIC ENGINE IDLE

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

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

LOW IDLE SPEED ADJUSTMENT

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

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

ACCELERATING PUMP LEVER ADJUSTMENT

1. Using a feeler gauge and with the throttle plates in the wide open position, there should be .015 inch clearance between the accelerating pump operating lever adjustment screw head and the pump arm when the pump arm is depressed manually (Figure 51).
2. If adjustment is required, loosen the adjusting screw lock nut and turn the adjusting screw in to increase the clearance and out to decrease the clearance. **One half turn of the adjusting screw is equal to approximately 0.015 inch.** When the proper adjustment has been obtained hold the adjustment screw in position with a wrench and tighten the lock nut.
3. Perform an accelerating pump stroke adjustment, if required.

ACCELERATING PUMP STROKE ADJUSTMENT

The accelerating pump stroke has been set to help keep the exhaust emission level of the engine within the specified limits. The additional holes provided for pump stroke adjustment are for adjusting the stroke for specific engine applications. **The stroke should not be changed from the original setting.**

If the pump stroke has been changed from the specified setting, refer to the following instructions to correct the stroke to specifications.

If a change in the adjustment is required, make certain the proper hole (top or bottom) in plastic accelerating pump cam, located behind the throttle lever, is properly aligned (indexed) with the numbered hole (top or bottom) in the throttle lever before installing the retaining screw.

FUEL LEVEL FLOAT ADJUSTMENT — DRY

On the externally adjusted fuel inlet needle and seat, the dry float adjustment is a preliminary fuel level adjustment only. The final adjustment (Fuel Level Float Adjustment — Wet) must be performed after the carburetor is installed on the engine.

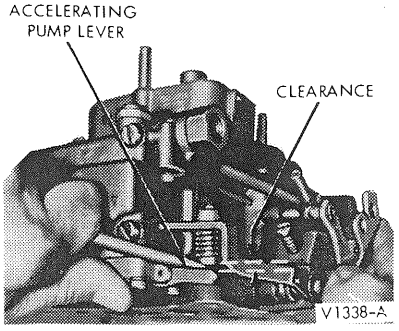


FIG. 51 Accelerating Pump Lever Clearance

On the internally adjusted fuel level, the dry adjustment is the only one made. With the fuel bowl and float assembly removed, adjust the float so that the float is parallel to the fuel bowl, with the top of the fuel bowl inverted (Figure 52).

On the externally adjusted fuel inlet needle and seat, turn the adjusting nut to make the adjustment.

On the internally adjusted fuel level, bend the float arm to make the adjustment.

With the fuel bowl and float assembly removed, adjust the float so that the float is parallel to the fuel bowl, with the top of the fuel bowl inverted (Figure 52).

FUEL LEVEL ADJUSTMENT — WET

The fuel pump pressure and volume must be to specifications prior to performing the following adjustments.

1. Operate the engine to normalize engine temperatures and place the engine on a flat surface, as near level as possible. Stop the engine and remove the air cleaner, if it was not previously removed.
2. Check the fuel level in each fuel bowl separately (Figure 53). **Place a suitable container below the fuel level sight plug in the fuel bowl to collect any spillover of fuel. Carefully remove the fuel level sight plug and gasket.**
3. If the fuel level is satisfactory, install the sight plug.
4. If the fuel level is too high, drain the fuel bowl and refill it. To drain the fuel bowl, loosen one lower retaining bolt from the fuel bowl and drain the fuel into a suitable container. Check the fuel level again before altering the float setting. **This will eliminate the possibility of foreign material causing a temporary flooding condition. Install the bolt and the fuel level sight plug, and start the engine to fill the fuel bowl. After the fuel level has stabilized, stop the engine and check the fuel level.**

If the fuel level is still too high, it should first be lowered below specifications and then raised until it is just at the lower edge of the sight plug opening. If the fuel level is too low, it is only necessary to raise it to the specified level. Follow the procedure under To Lower Fuel Level or To Raise Fuel Level, whichever is applicable.

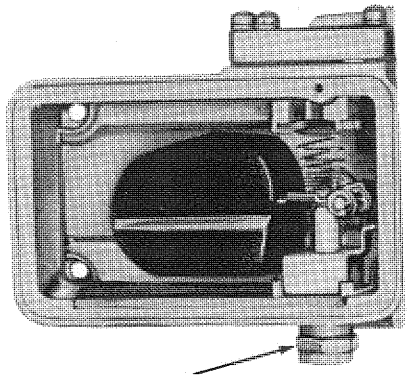


FIG. 52 Adjusting Float — Dry

To Lower Fuel Level

1. With the engine stopped, loosen the lock screw on top of the fuel bowl just enough to allow rotation of the adjusting nut underneath (Figure 53). **Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running because the pressure in the line will spray fuel out and present a fire hazard.**
2. Turn the adjusting nut approximately 1/2 turn in to lower the fuel level below specifications (1/6 turn of the adjusting nut, depending on the direction of rotation, will raise or lower the float assembly at the fuel level sight plug opening 3/64 inch).

3. Tighten the lock screw and install the fuel level sight plug. Start the engine. After the fuel level has stabilized, stop the engine and check the fuel level at the sight plug opening. The fuel level should be below specified limits. If it is not, repeat the previous steps, turning the adjusting nut an additional amount sufficient to lower the fuel below the specified level.
4. Loosen the lock screw and turn the adjusting nut out in increments of 1/6 turn or less until the correct fuel level is achieved. After each adjustment, tighten the lock screw, install the fuel level sight plug, and then start the engine and stabilize the fuel level. Check the fuel level at the sight plug opening. Install the sight plug and gasket.
5. Install the air cleaner if other carburetor adjustments are not required.

To Raise Fuel Level

1. With the engine stopped, loosen the lock screw on top of the fuel bowl just enough to allow rotation of the adjusting nut underneath (Figure 53). **Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running because the pressure in the line will spray fuel out and present a fire hazard.**
2. Loosen the lock screw and turn the adjusting nut out in increments of 1/6 turn or less until the correct fuel level is achieved. After each adjustment, tighten the lock screw, install the fuel level sight plug, and then start the engine and stabilize the fuel level. Check the fuel level at the sight plug opening. Install the sight plug and gasket.
3. Install the air cleaner if other carburetor adjustments are not required.

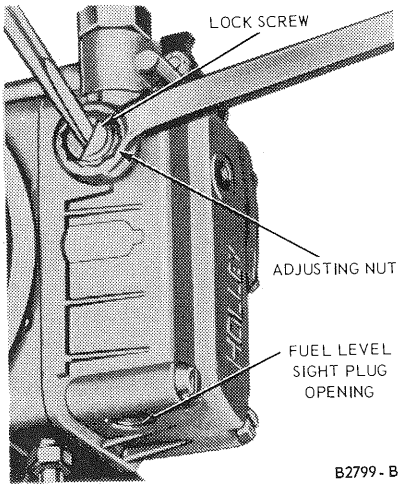


FIG. 53 Adjusting Fuel Level

REMOVAL AND INSTALLATION

CARBURETOR

Removal

1. Remove the air cleaner. Remove the throttle rod from the throttle lever. Disconnect the choke control cable, hand throttle control cable, the distributor vacuum hose and the fuel line.
2. Disconnect the governor throttle control lines or rod at the carburetor.
3. Remove the carburetor retaining nuts and lockwashers, then remove the carburetor. Remove the spacer from the manifold.

Installation

1. Be sure all old gasket material is removed from the manifold heat riser flange, then place the spacer in position on the manifold. Position the carburetor on the manifold and install the lockwashers and nuts. Tighten the nuts alternately to specification.
2. Connect the throttle rod. Connect the choke control cable. **Be sure the end of the choke cable is bent downward to prevent interference with the bottom of the air cleaner. This interference will restrict opening of the choke plate.** Connect the hand throttle control cable, the distributor vacuum hose, the fuel line, and the governor lines or control rod. Adjust the idle speed, the primary and secondary fuel level, and the idle fuel mixture.

FUEL BOWL AND GASKET AND METERING BLOCK AND GASKET

Removal

1. Remove the fuel inlet line and vacuum line.
2. Place a suitable container under the fuel bowl and drain the bowl by loosening one of the lower fuel bowl retaining screws. Remove the container.
3. Remove the four fuel bowl retaining screws.
4. Remove the fuel bowl, gasket and baffle, and metering block and gasket. Discard the gaskets.

Installation

1. If the fuel bowl or metering block is being replaced, transfer the parts.
2. Position the metering block gasket on the dowels on the back of the metering block.
3. Lay the metering block in place on the main body.
4. Position the baffle and fuel bowl gasket on the metering block.
5. Place the fuel bowl on the metering block. Use new compression gaskets on the bowl retaining screws; then install and tighten the screws.

POWER VALVE AND GASKET

Removal

1. Remove the fuel bowl and metering block.
2. Using a socket wrench, remove the power valve and gasket.
3. Discard the gasket.

Installation

1. Place a new gasket on the specified power valve.
2. Using a socket wrench, install the power valve and gasket.
3. Install the fuel bowl and metering block.

MAIN JET

1. Remove the fuel bowl and metering block.
2. Use a jet wrench to remove and install jets.
3. Install the fuel bowl and metering block.

ACCELERATING PUMP DIAPHRAGM

Removal

1. Remove the fuel bowl and metering block.
2. Remove the accelerating pump cover, diaphragm and spring.

Installation

1. Place the spring and diaphragm in the accelerating pump chamber. The diaphragm must be positioned so that the diaphragm disc protrudes from the fuel bowl.
2. Install the cover screws finger tight.
3. Make sure the diaphragm is centered; compress the diaphragm with the pump operating lever and tighten the cover screws.

FLOAT

Removal

1. Using needle nose pliers, remove the float retainer.
2. Slide the float off the shaft.
3. Remove the spring from the float.

Installation

1. Install the float spring on the float.
2. Slide the float on the shaft.
3. Install the float retainer.

FUEL INLET NEEDLE AND SEAT

Removal

The fuel inlet needle and seat assembly can be replaced without removing the fuel bowl.

1. Remove the air cleaner.
2. Remove the fuel level adjustment lock screw and gasket. Turn the adjusting nut out and remove the adjusting nut and gasket. Remove the fuel inlet needle and seal assembly (Figure 54). **Do not disassemble the fuel inlet needle and seat assembly. They are matched parts and are serviced as an assembly.**

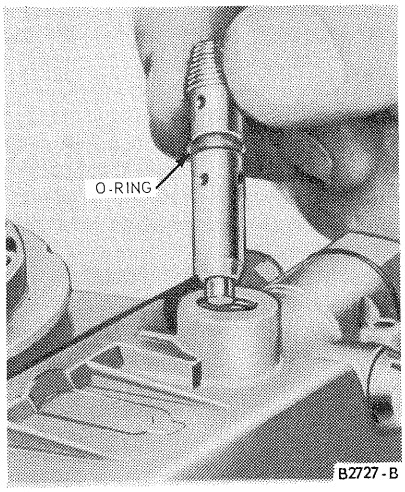


FIG. 54 Removing Fuel Inlet Seat and Needle

Installation

1. Position the fuel inlet needle and seat assembly in the fuel bowl.
2. Position the adjusting nut gasket and nut on the fuel inlet needle and seat assembly. Align the flat on the ID of the nut with the flat on the OD of the fuel inlet needle and seat assembly.
3. Install the fuel level adjustment lock screw and gasket.
4. Adjust the fuel level.

DISASSEMBLY AND ASSEMBLY

DISASSEMBLY

To facilitate working on the carburetor and to prevent damage to the throttle plates, install bolts about 2¼ inches long of the correct diameter through the carburetor attaching bolt holes with a nut above and below the flange (or install carburetor legs).

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 disassembling the entire unit. For a complete carburetor overhaul, follow all the steps. To partially overhaul the carburetor or to install a new gasket kit, follow only the applicable steps.

Fuel Bowl and Metering Block

Refer to Figure 55 for the correct location of the fuel bowl parts.

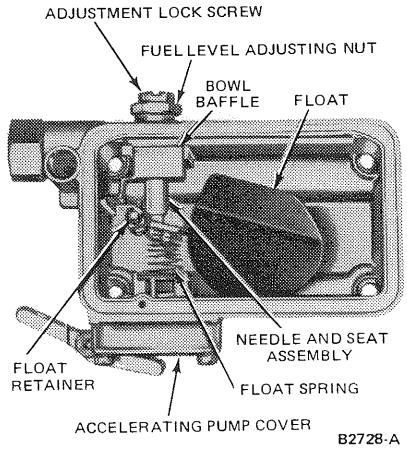


FIG. 55 Fuel Bowl

1. Remove the fuel bowl and gasket, and the metering block and gasket. Discard the gaskets.
2. Using a socket wrench, remove the power valve and gasket (Figure 56). Discard the gasket. Using a jet wrench, remove the main jets (Figure 57).

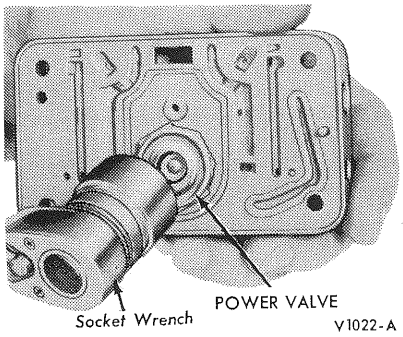


FIG. 56 Removing or Installing Power Valve

3. Remove the fuel level adjustment lock screw and gasket. Turn the adjusting nut counterclockwise and remove the lock nut and gasket, and the fuel inlet needle and seat assembly. **Do not disassemble the fuel inlet needle and seat. They are matched, and are replaced as an assembly.**

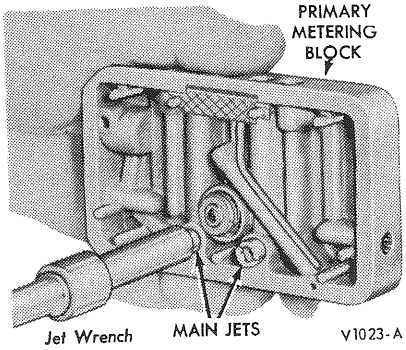


FIG. 57 Removing or Installing Main Jet

4. Using needle nose pliers, remove the float retainer (Figure 58).
5. Slide the float off the shaft. Remove the spring from the float.
6. Remove the fuel level sight plug and gasket. Remove the fuel inlet fitting, gasket, and filter screen.
7. Invert the fuel bowl and remove the accelerating pump cover, diaphragm, and spring. The accelerating pump inlet ball check is not removable.

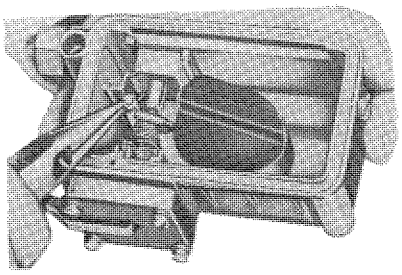


FIG. 58 Removing Float Shaft Retainer

Main Body

1. Invert the carburetor and remove the throttle body from the main body. Disconnect the choke rod from the choke control shaft lever assembly by pushing the rod toward the main body and releasing it from the lever. Discard the throttle body gasket.
2. Remove the elastic stop nuts from the choke plate and remove the screws, flat spring, spacers, choke plate and the choke plate poppet valve. Remove the choke rod from the choke plate shaft. Slide the choke rod out of the choke shaft as the shaft is removed from the housing. Remove the choke rod seal from the main body.
3. Remove the retainers, spring seats, and springs from the poppet valve on the front of the choke plate housing. **Use caution to avoid losing the springs as they are under compression.** Remove the pins and poppet valve.
4. Remove the accelerating pump discharge nozzle from the main body.
5. Invert the main body and let the accelerating pump discharge needle fall into the hand (Figure 59). Remove the throttle operating shaft housing back-upplate and gasket.

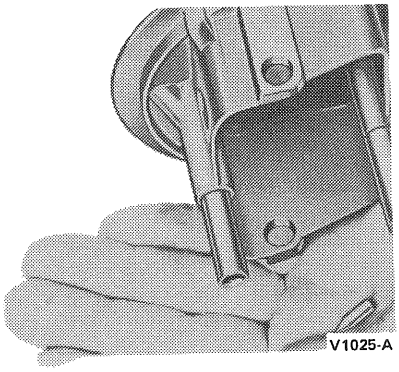
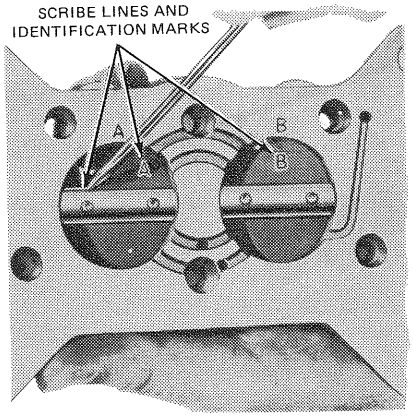


FIG. 59 Removing Accelerating Pump Discharge Needle

6. If it is necessary to remove the throttle plates, lightly scribe both throttle plates along the throttle shaft and mark each throttle plate and its corresponding barrel to insure proper installation (Figure 60). Remove the throttle plates. Remove the retainer from each end of the shaft. Slide the throttle shaft out of the throttle body.

Throttle Operating Shaft Housing

1. Remove the engine idle speed adjusting screw and spring. Remove the fast idle adjusting pin and screw.
2. Loosen the throttle lever screw. Remove the throttle lever retaining pin. Remove the throttle lever and the accelerating pump cam. Remove the throttle pick-up lever and swivel assembly.
3. Remove the throttle shaft retainer and slide the throttle shaft out of the housing.



V1026-A

FIG. 60 Removing Throttle Plate

ASSEMBLY

Make sure all holes in the new gaskets have been properly punched and that no foreign material has adhered to the gaskets. Make sure the accelerating pump diaphragm is not torn or cut. An exploded view of the carburetor is shown in Figure 67.

Throttle Operating Shaft Housing

Refer to Figure 67 for the correct location of the parts.

1. Slide the throttle operating lever and shaft assembly into the housing. Install the accelerating pump cam in the throttle lever. Position the pick-up lever and swivel assembly on the shaft.
2. Aligning the retaining pin hole in the throttle lever and shaft, position the throttle lever on the shaft. **Be sure the throttle lever can be rotated from the full open position to the full closed position. Install the throttle lever retaining pin. Install the throttle lever screw.**
3. Install the engine idle speed adjusting screw and spring. Install the fast idle adjusting pin and screw.

Throttle Body

Refer to Figure 61 for the correct locations of the parts.

1. If the throttle plates were removed, position the bushings on the throttle shaft and slide them into the throttle body. Install the retainer on each end of the shaft. Referring to the lines scribed on the throttle plates, install the plates in their proper location with the screws snug, but not tight. Close the throttle plates and hold the throttle body up to the light. Little or no light should show between the throttle plates and the throttle bores. If the throttle plates are properly installed and there is no binding when the throttle shafts are rotated, tighten and stake the throttle plate screws.
2. Position the throttle operating shaft housing back-up plate assembly gasket and plate assembly on the throttle body by sliding them over the clutch lever on the throttle shaft.
3. Insert the throttle operating housing attaching screws in the housing. Slide the housing gasket over the screws.
4. Open the throttle plates and install the throttle operating housing on the throttle body. **If the housing is correctly installed, the throttle lever will close the throttle plates, but will not open them.**
5. Install the accelerating pump lever on the throttle body.
6. Install the idle adjusting needles and springs. Turn the needles in gently until they touch the seat, then back them out 1-1½ turns.

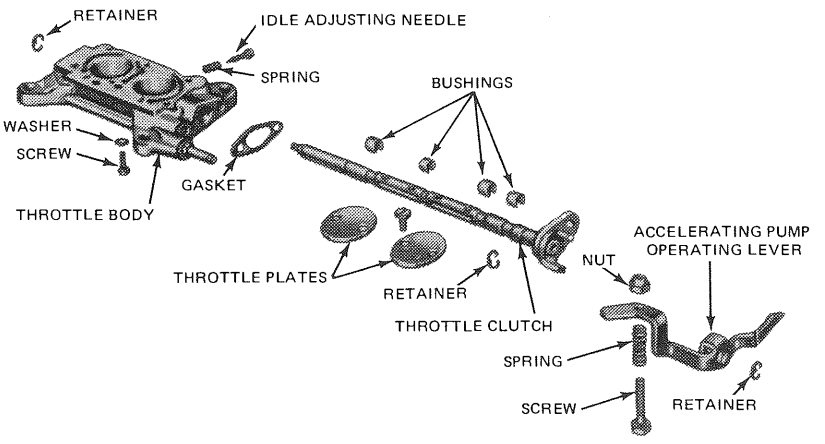


FIG. 61 Throttle Body Assembly

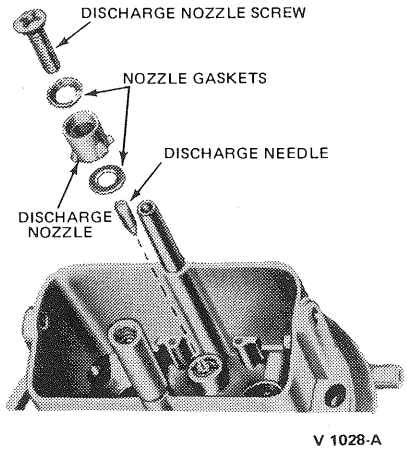


FIG. 62 Accelerating Pump Discharge Needle Installation

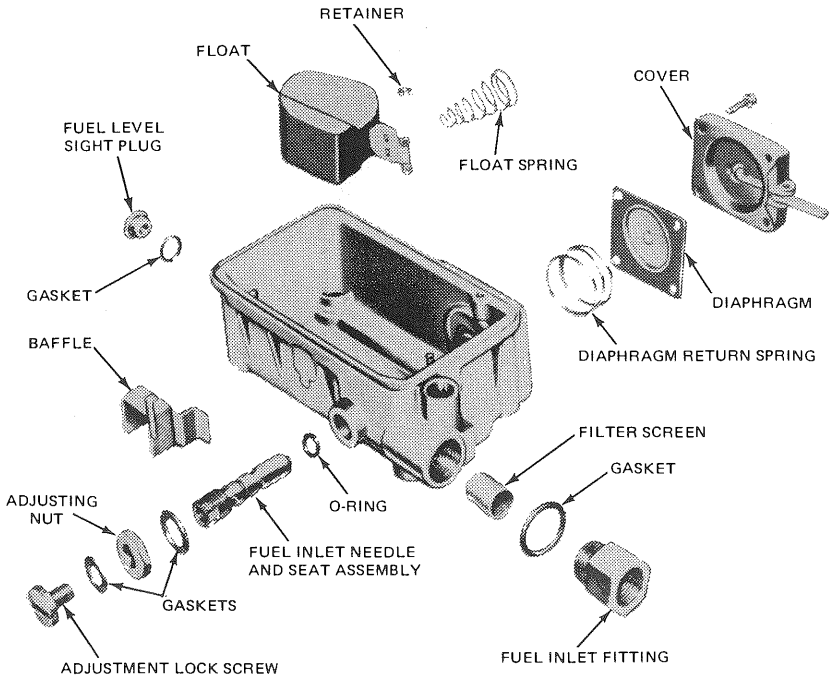


FIG. 63 Fuel Bowl Assembly

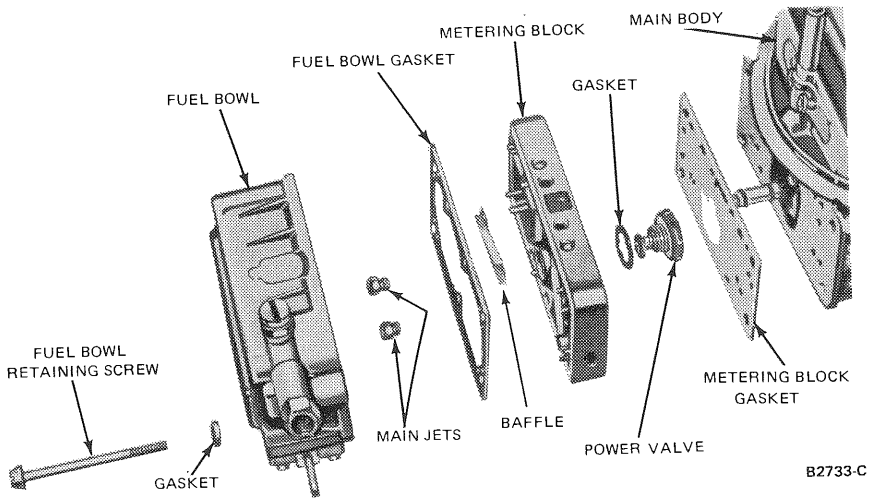


FIG. 64 Fuel Bowl and Metering Block Assembly

Main Body

1. Drop the accelerating pump discharge needle into the well (Figure 62). Seat the needle with a brass drift and a light hammer. Make sure it is free. Position the accelerating pump discharge nozzle gasket and nozzle in the main body; then install the attaching screw and gasket.
2. Place the choke rod seal in the groove located on the underside of the carburetor air cleaner flange.
3. Working from the underside of the carburetor air cleaner flange, slide the choke rod (with the small upset end of the top) through the opening in the main body and rod seal.
4. Place the air horn poppet valve in position on the main body. From inside the air horn, insert the pins through the main body and poppet valve, install the spring, spring seats, and retainers.
5. Position the choke plate shaft in the air horn. Position the choke rod in the choke plate shaft lever and over the spring.
6. Position the choke plate poppet valve over the retaining screws, then position the choke plate on top of the poppet valve.
7. Place the spacers over the screws, then position the flat spring over the screws so that the curved portion is down. Install the attaching nuts.
8. Invert the main body and position the gasket on the main body. Place the throttle body in position on the main body sliding the choke rod into the choke rod lever as the throttle body is placed into position. Install the throttle body to main body screws and lockwashers.

Fuel Bowl and Metering Block

Refer to Figures 63 and 64 for the correct location of the fuel bowl parts.

1. Place the accelerating pump diaphragm spring and diaphragm in the accelerating pump chamber. The diaphragm must be positioned so that the large end of the lever disc will be against the operating lever. Install the cover with the screws finger tight. Make sure the diaphragm is centered, then compress the diaphragm with the pump operating lever and tighten the cover screws.
2. Install the fuel level sight plug and gasket.
3. Install the fuel inlet filter screen, gasket, and fitting.
4. Slide the baffle plate on the ridges in the fuel bowl (Figure 66).
5. Install the float spring on the float, slide the float on the shaft and install the float retainer.
6. Apply petroleum jelly to a new O-ring seal and slide it on the fuel inlet needle and seat assembly.
7. Position the fuel inlet needle and seat assembly in the fuel bowl through the top of the bowl. Position the adjusting nut gasket and nut on the fuel inlet needle and seat. Align the flat on the ID of the nut with the flat on the OD of the fuel inlet needle and seat assembly.
8. Adjust the float so that the top of the float is parallel with the top of the fuel bowl with the fuel bowl inverted (see Adjustment).
9. Install the fuel level adjusting lock screw and gasket.
10. Using a socket wrench, install the power valve and a new gasket. **Be sure to install the correct power valve. Refer to the specifications for the correct identification number. The number is stamped on a flat on the base of the valve.** Using a jet wrench, install the main jets.
11. Position the metering block gasket on the dowels on the back of the metering block. Lay the metering block in place on the main body. Position the baffle on the metering block, then position the fuel bowl gasket on the metering block. Place the attaching screws and new compression gaskets in the fuel bowl. Lay the bowl in place on the metering block. Tighten the screws.

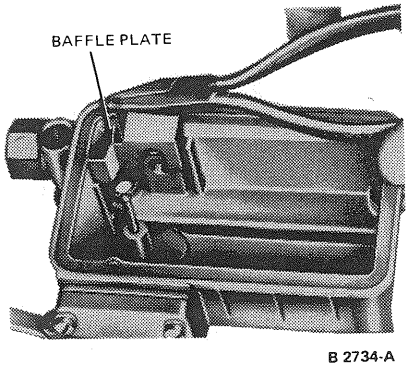


FIG. 65 Baffle Plate Installation

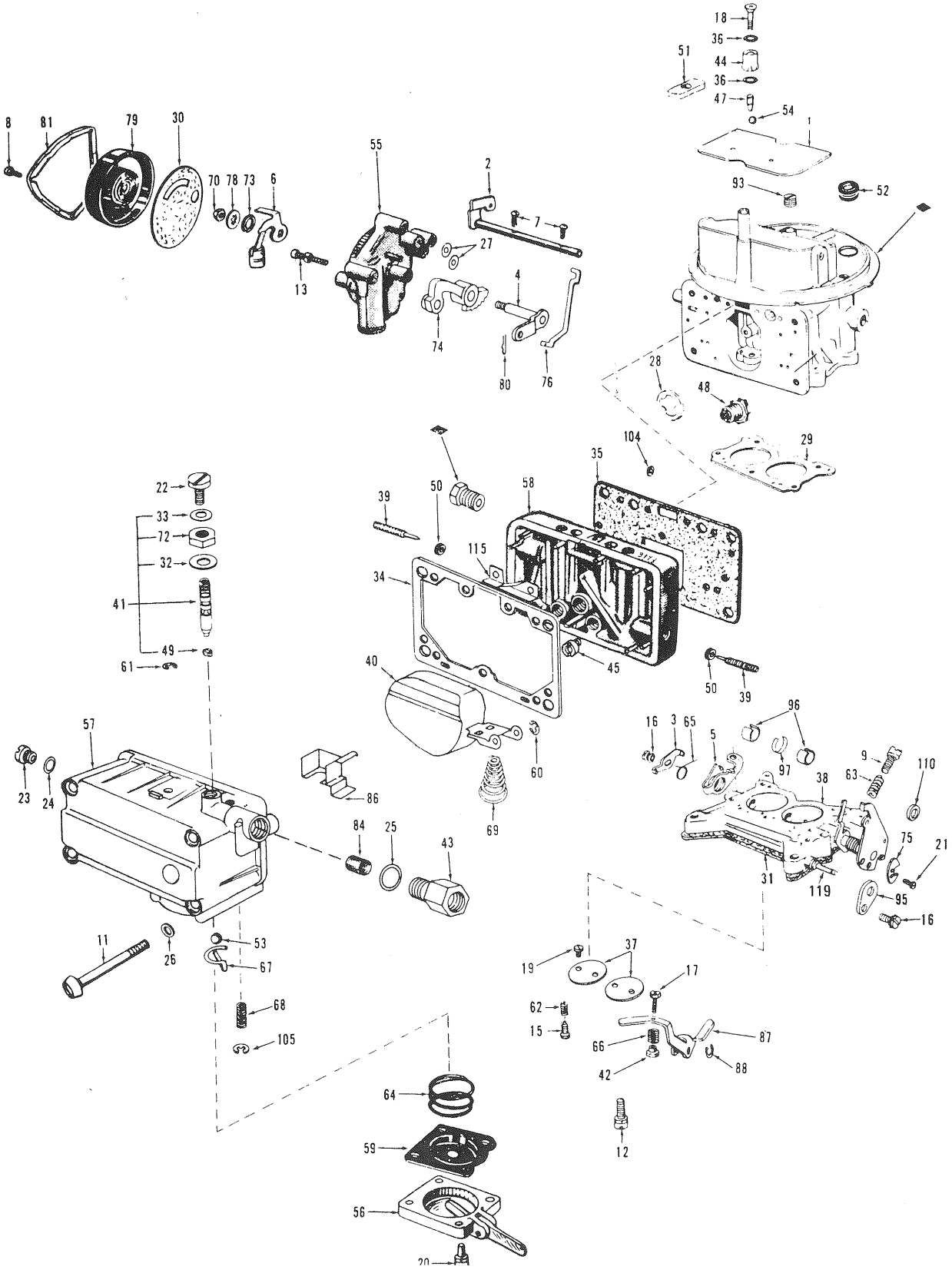


FIG. 67 Model 2300C Carburetor — Exploded View

TYPICAL NOMENCLATURE

Index Number	Part Name	Index Number	Part Name	Index Number	Part Name
1	Choke Plate	35	Metering Body Gasket	70	Choke Thermostat Shaft Nut
2	Choke Shaft Assembly	36	Pump Discharge Nozzle Gasket	72	Fuel Valve Seat Adj. Nut
3	Fast Idle Pick-up Lever	37	Throttle Plate	73	Choke Therm. Lever Spacer
4	Choke Hsg. Shaft & Lev. Assy.	38	Throt. Body & Shaft Assy.	74	Fast Idle Cam Assembly
5	Fast Idle Cam Lever	40	Float & Hinge Assy.	76	Choke Rod
6	Choke Therm. Lev., Link & Piston Assembly	41	Fuel Inlet Valve & Seat Assy.	78	Choke Therm. Shaft Nut L.W.
		42	Pump Oper. Lev. Adj. Scr. Fitting	79	Thermostat Housing Assembly
7	Choke Plate Screw	43	Fuel Inlet Fitting	80	Choke Rod Retainer
8	Therm. Hsg. Clamp Screw	44	Pump Discharge Nozzle	81	Thermostat Housing Clamp
9	Throttle Stop Screw	45	Main Jet	84	Filter Screen Assembly
11	Fuel Bowl to Main Body Screw	47	Pump Discharge Needle Valve or Check Ball Weight	86	Baffle Plate
12	Throt. Body Scr. & L.W.			87	Pump Operating Lever
13	Choke Hsg. Scr. & L.W.	48	Power Valve Assembly	88	Pump Operating Lev. Retainer
15	Fast Idle Cam Lever Screw	49	Fuel Valve Seat "O" Ring Seal or Gasket	93	Air Adapter Hole Plug
16	Fast Idle Cam Lev. & Throt. Lev. Screw & L.W.			95	Throttle Lever
		50	Idle Needle Seal	96	Throttle Shaft Bearing
17	Pump Oper. Lev. Adj. Screw	51	Choke Rod Seal	97	Throttle Shaft Brg. (center)
18	Pump Discharge Nozzle Screw	52	Choke Cold Air Tube Grommet	104	Diaphragm Link Retainer
19	Throttle Plate Screw	53	Pump Inlet Check Ball	105	Air Vent Rod Spg. Retainer
20	Fuel Pump Cov. Assy. Scr. & L.W.	54	Pump Discharge Check Ball	110	Throt. Link Connecor Pin Washer
21	Pump Cam Lock Scr. & L.W.	55	Choke Hsg. & Plugs Assy.	115	Metering Body Vent Baffle
22	Fuel Valve Seat Lock Screw	56	Fuel Pump Cover Assy.	119	Pump Oper. Lever Stud
23	Fuel Level Check Plug	57	Fuel Bowl & Plugs Assy.	*	Vent Tube
24	Fuel Level Check Plug Gasket	58	Main Metering Body & Plugs Assy.	*	Heat Tube Nut
25	Fuel Inlet Fitting Gasket	59	Pump Diaphragm Assembly	*	Heat Tube Ferrule
26	Fuel Bowl Screw Gasket	60	Float Spring Retainer	*	Fuel Tube Hose Clamp
27	Choke Housing Gasket	61	Air Vent Retainer	*	Retainer
28	Power Valve Body Gasket	62	Fast Idle Cam Lev. Scr. Spring	*	Air Cleaner Stud (Long)
29	Throttle Body Gasket	63	Throttle Stop Screw Spring	*	Air Cleaner Stud (Short)
30	Choke Therm. Housing Gasket	64	Pump Diaphragm Return Spring	*	Choke Heat Tube
31	Flange Gasket	65	Fast Idle Cam Lev. Spring	*	Fuel Line Hose
32	Fuel Valve Seat Adj. Nut Gskt.	66	Pump Oper. Lev. Adj. Spring	*	Fresh Air Hose
33	Fuel Valve Seat Lock Scr. Gskt.	67	Pump Inlet Check Ball Retainer	*	Spring
34	Fuel Bowl Gasket	69	Float Spring		

Part 4 Charging System

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 302/351 engine uses either a Ford alternator or a Motorola alternator. most of this section applies to the Ford alternator, because the Motorola unit is serviced by them.

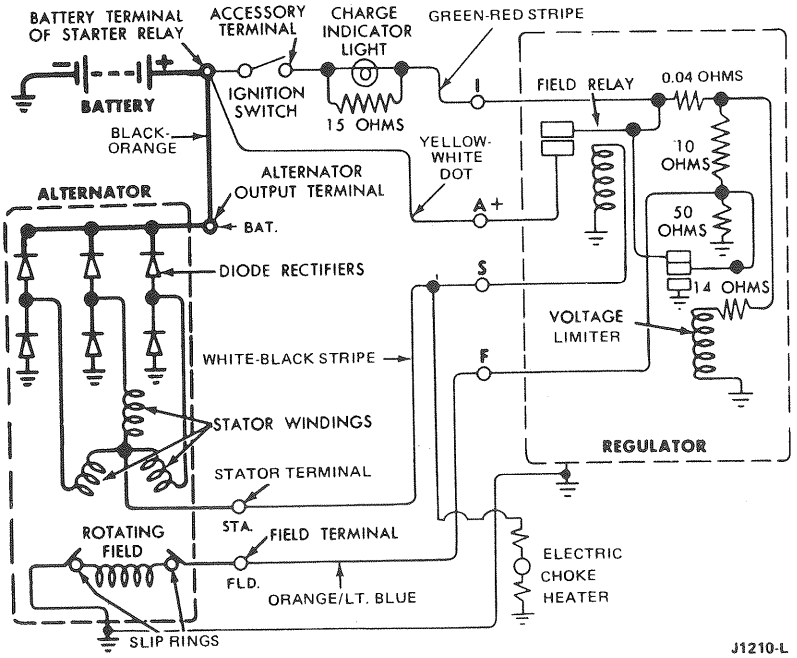


FIG. 1 Alternator Charging System — Indicator Light

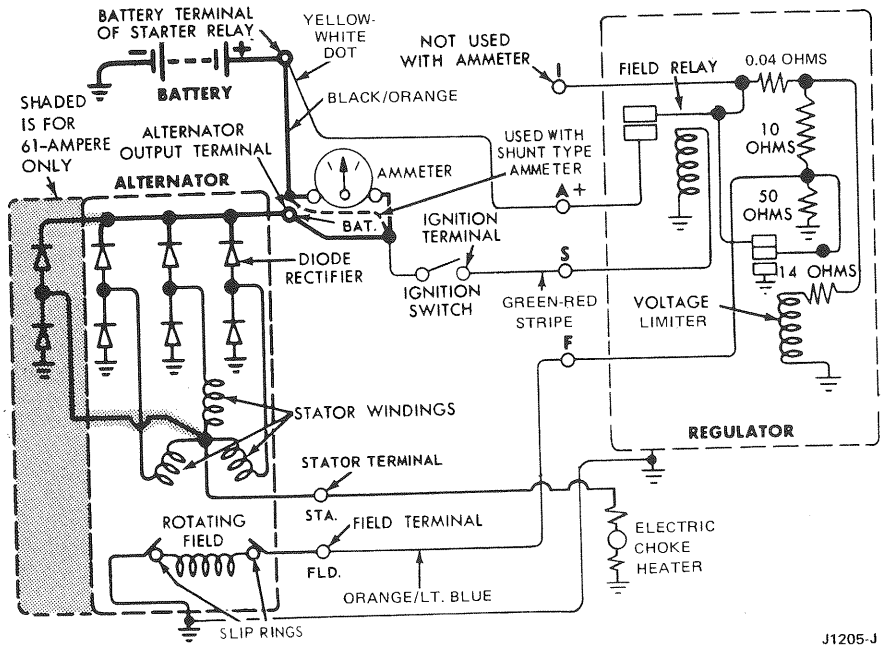


FIG. 2 Alternator Charging System — Ammeter

DIAGNOSIS AND TESTING — MOTOROLA

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

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

Test precautions:

— DO NOT disconnect alternator output lead while alternator is operating.
— DO NOT disconnect voltage regulator while alternator is operating.
— DO NOT ground field terminal.
— Check battery condition. Use a fully charged battery when testing alternator.
— Disconnect ground cable of battery when removing and installing the alternator.

All readings indicated are for correct operation.

TEST 1 — IGNITION ON — ENGINE NOT RUNNING

(Refer to Figure 3)

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

If voltage at regulator terminal is:

5.0 to 7.0 volts = open rotor (field circuit)
.75 to 1.1 volts = grounded rotor circuit
8.5 to 10.0 volts = open in regulator's load circuit
0 volts = open ignition switch or excitation resistor

If test results are uncertain, make Test 2.

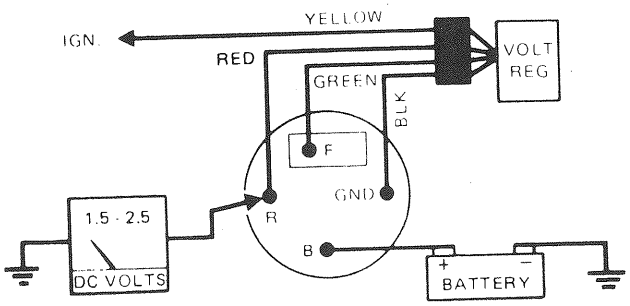


FIG. 3 Ignition On — Engine Not Running

TEST 2 — IGNITION ON — ENGINE NOT RUNNING

(Refer to Figure 4)

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

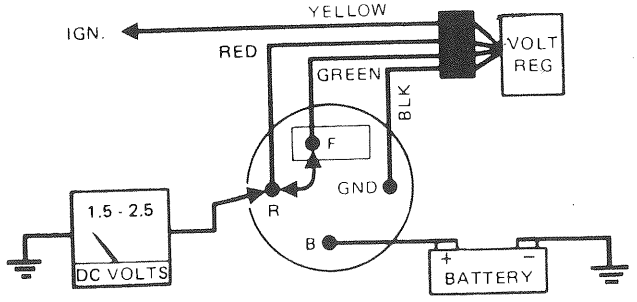


FIG. 4 Ignition On — Engine Not Running

TEST 3 — FIELD DRAW TEST — IGNITION OFF

(Refer to Figure 5)

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

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

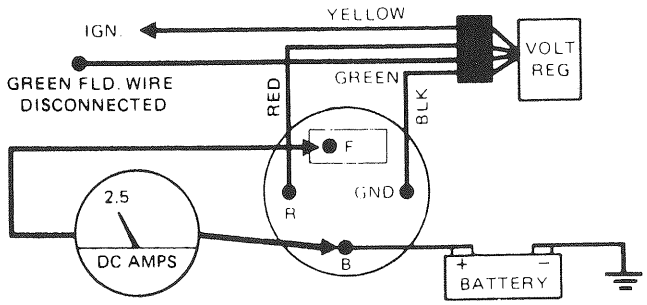


FIG. 5 Field Draw Test — Ignition Off

TEST 4 — IGNITION ON — ENGINE RUNNING AT FAST IDLE

(Refer to Figure 6)

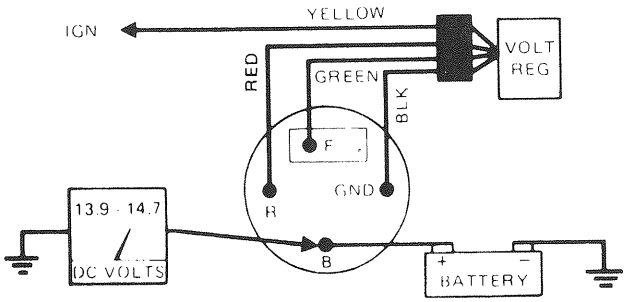


FIG. 6 Ignition On-Engine Running at Fast Idle

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

TEST 5 — FIELD TERM DISCONNECTED VOLTAGE REGULATOR PLUG DISCONNECTED BATTERY TERMINAL SHORTED TO FIELD TERMINAL IGNITION ON — ENGINE RUNNING AT IDLE

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

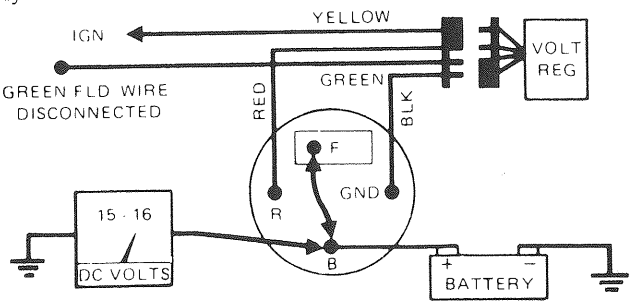


FIG. 7 Field Term Disconnected Volt Reg. Plug Disconnected Bat. Term. Shorted to Fld. Term. Ignition On — Engine Running at Idle

DIAGNOSIS AND TESTING FORD ALTERNATOR

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

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

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

ON VEHICLE TESTS

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

Visual Inspection

1. Check the battery posts and battery cable terminals for clean and tight connections. Remove the battery cables (if corroded), clean and install them securely.
2. Check for clean and tight wiring connections at the alternator, regulator and engine.
3. Check the alternator belt tension and tighten to specification (if necessary).

INDICATOR LIGHT — ALTERNATOR CHARGING SYSTEM

Normal Charge Indicator

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

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

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

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

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

AMMETER-ALTERNATOR CHARGING SYSTEM

Normal Charge Indicator

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

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

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

Tests Using a Voltmeter

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

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.

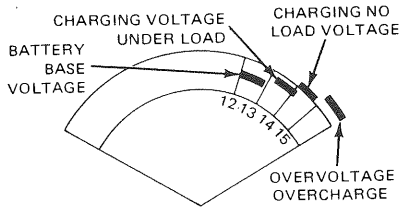


FIG. 8 Voltmeter Test Scale

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.**

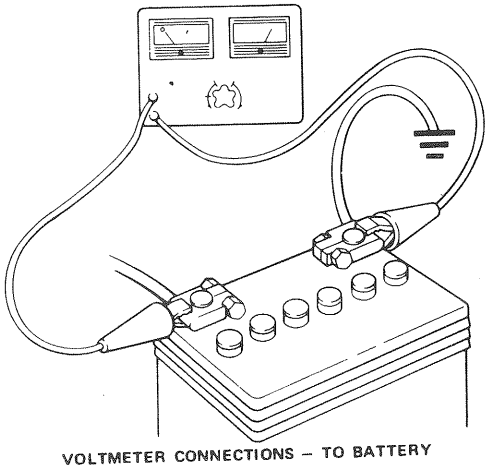


FIG. 9 Voltmeter-to-Battery Connections

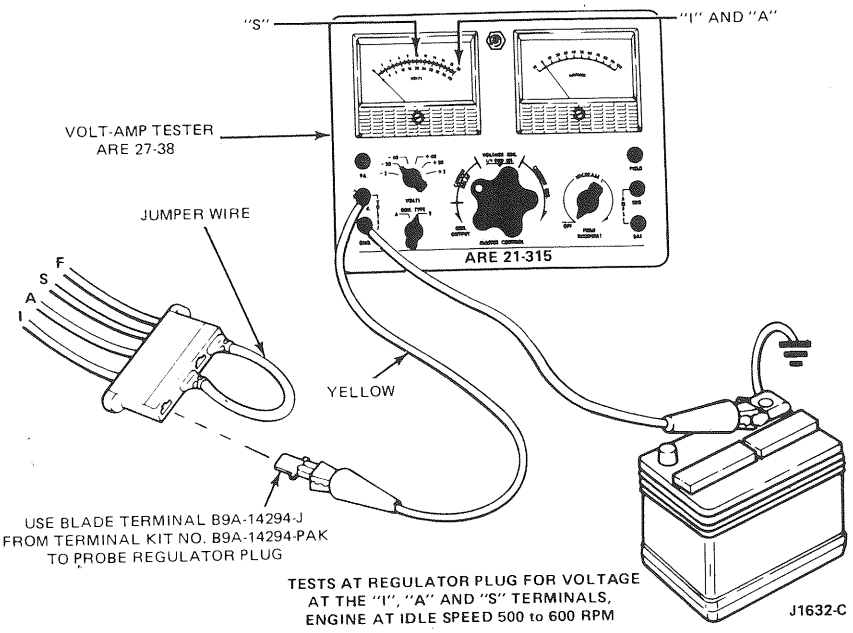


FIG. 10 Regulator Plug Voltage Tests

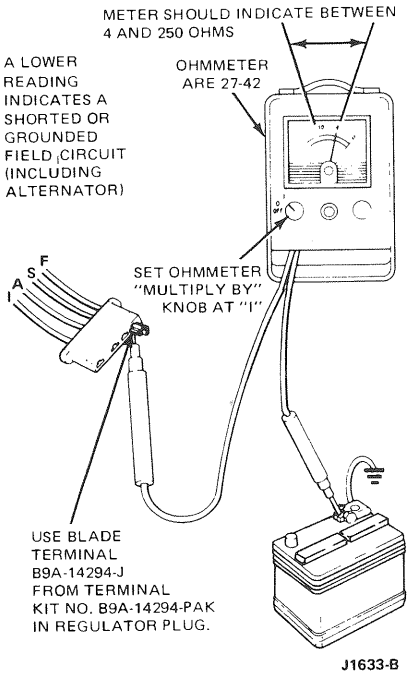


FIG. 11 Field Circuit Test

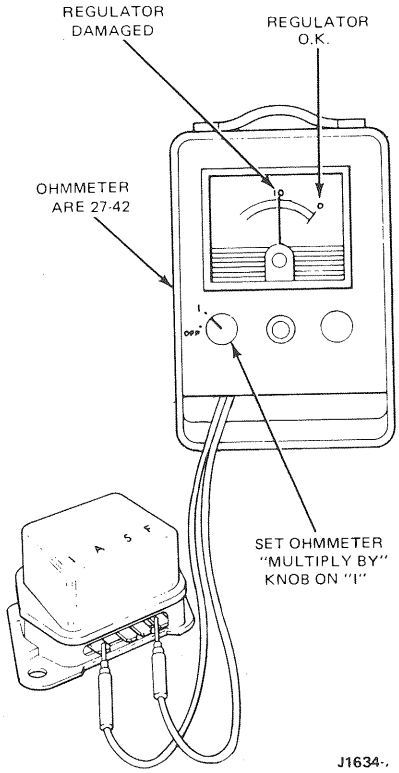


FIG. 12 Regulator Burned — Open Connector Wire Test

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.

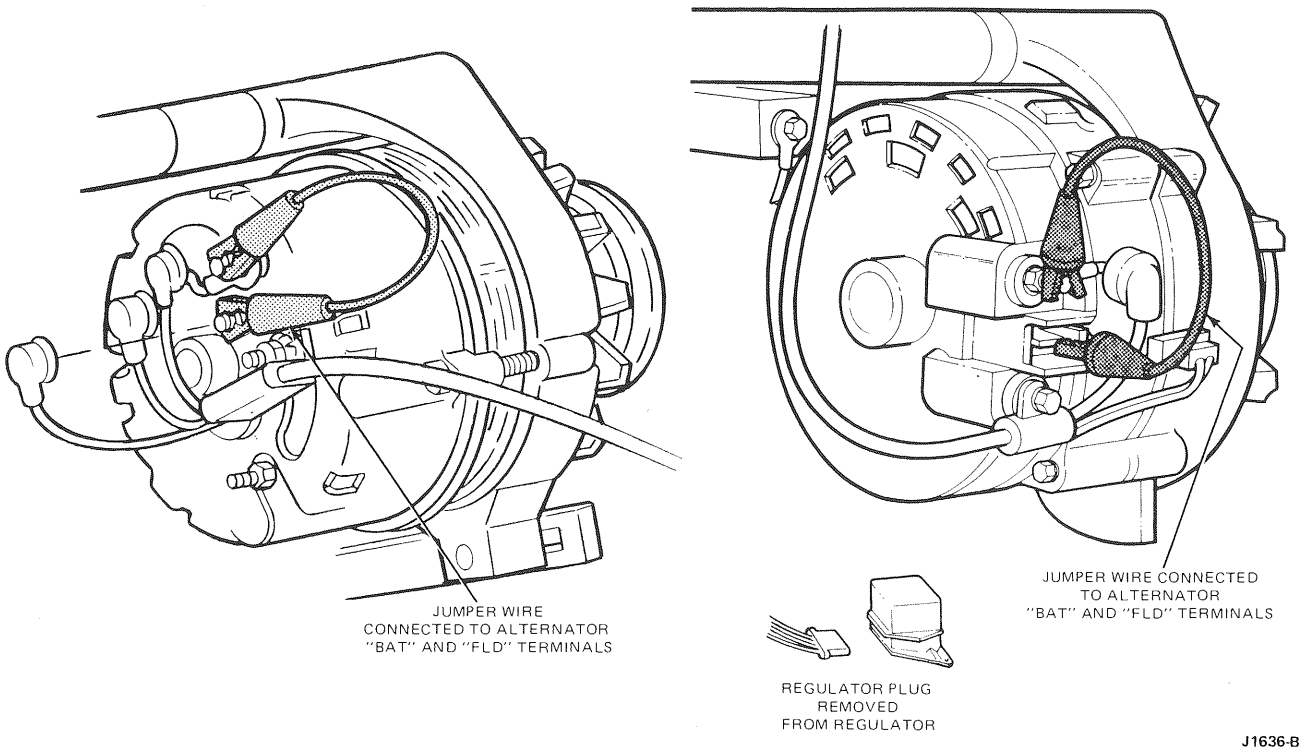


FIG. 13 Jumper Wire Connections

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.

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 meter 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.

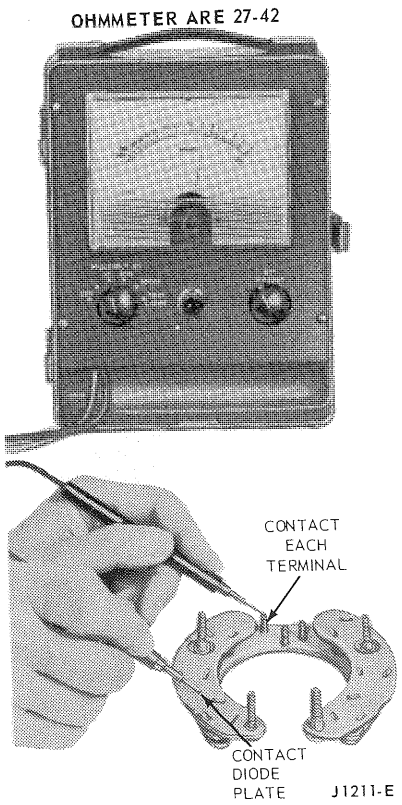


FIG. 14 Diode Test — Rear Terminal Alternator

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.

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.

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.

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).

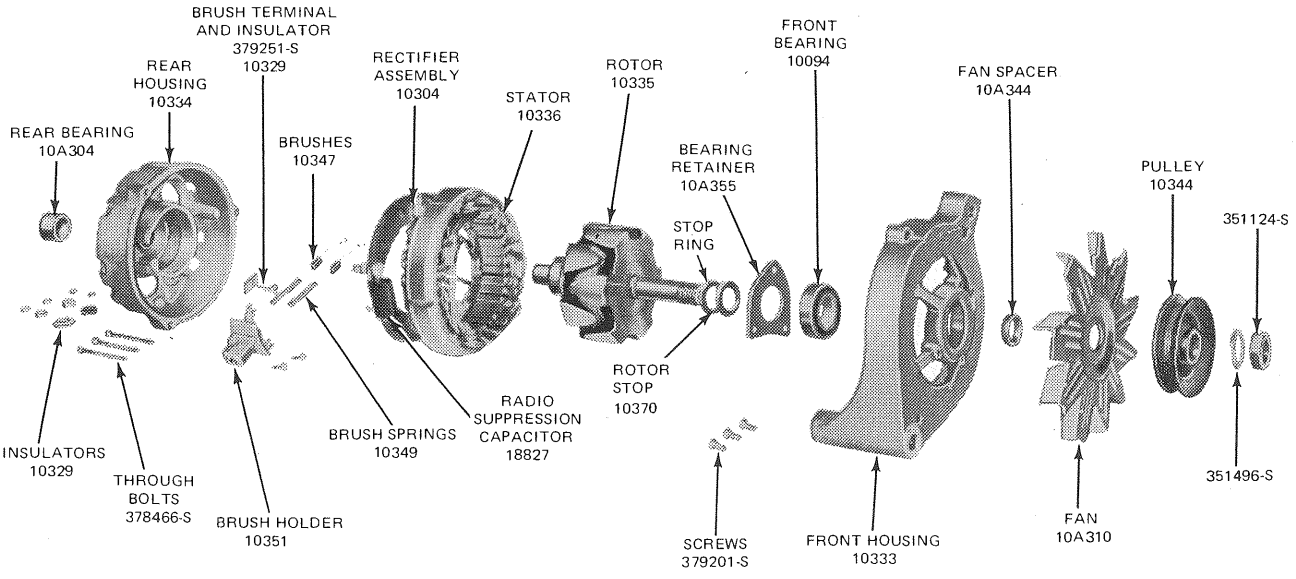


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FIG. 15 Disassembled Alternator

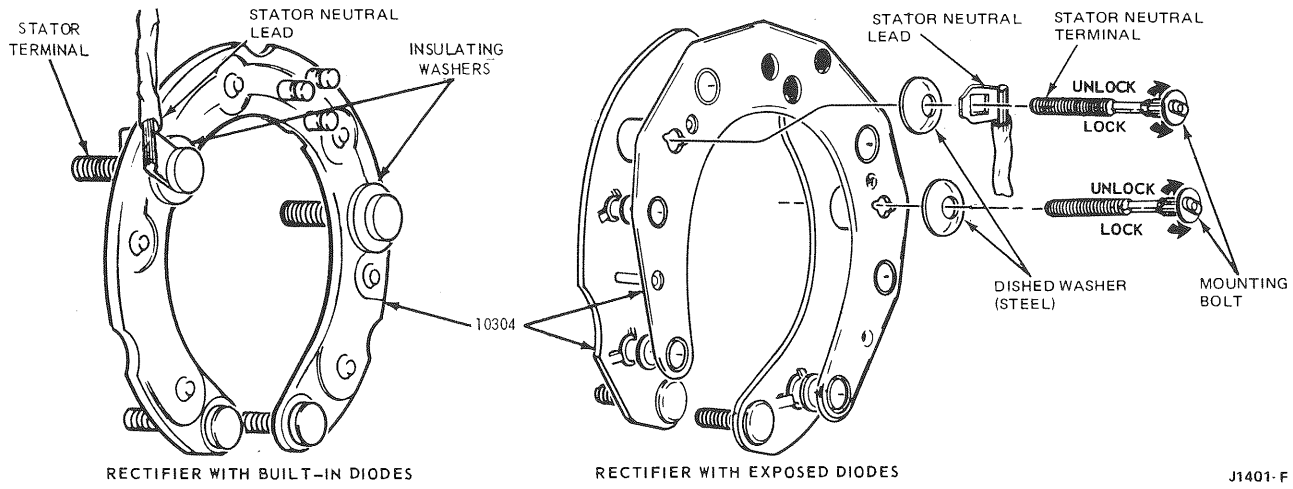


FIG. 16 Rectifier Assembly

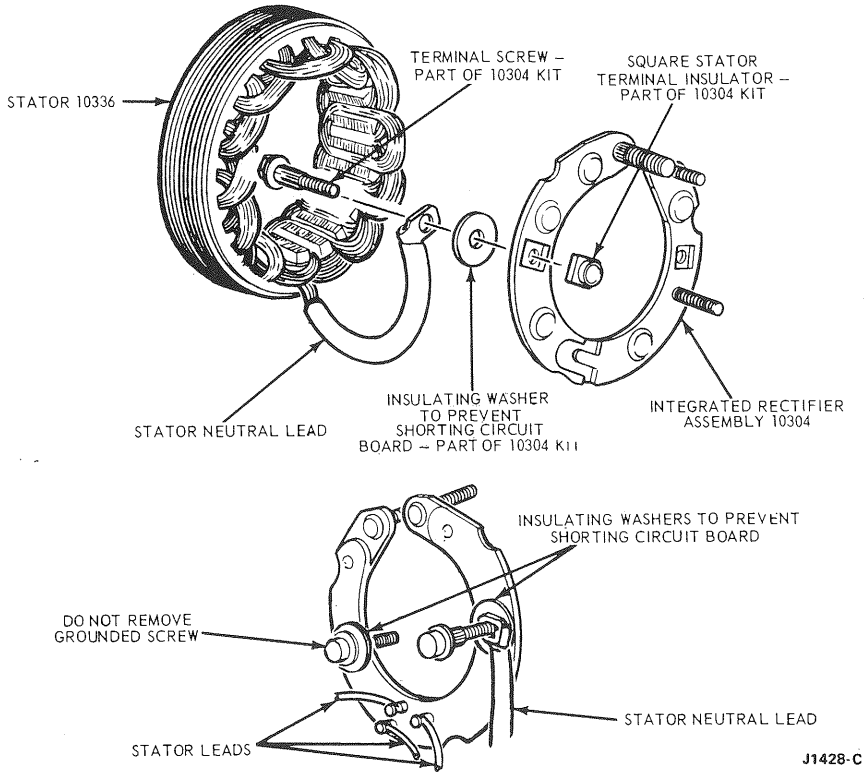


FIG. 17 Stator Terminal Installation — Integral Rectifier Circuit Board

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).

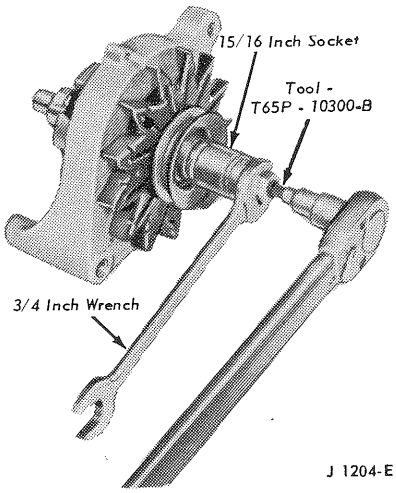


FIG. 18 Pulley Removal

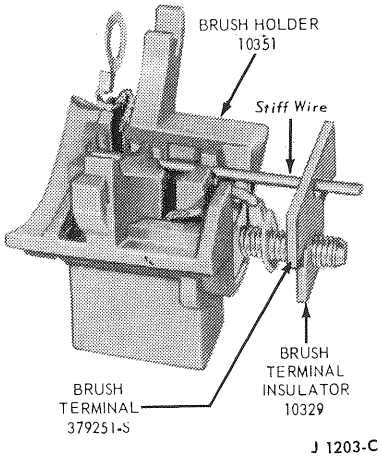


FIG. 19 Brush Holder Assembly

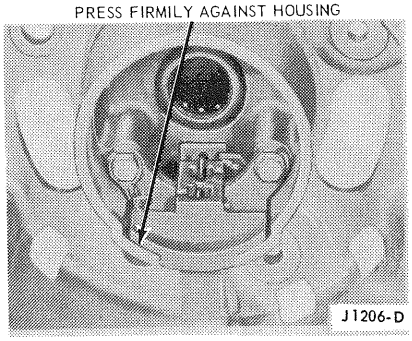


FIG. 20 Brush Lead Positions

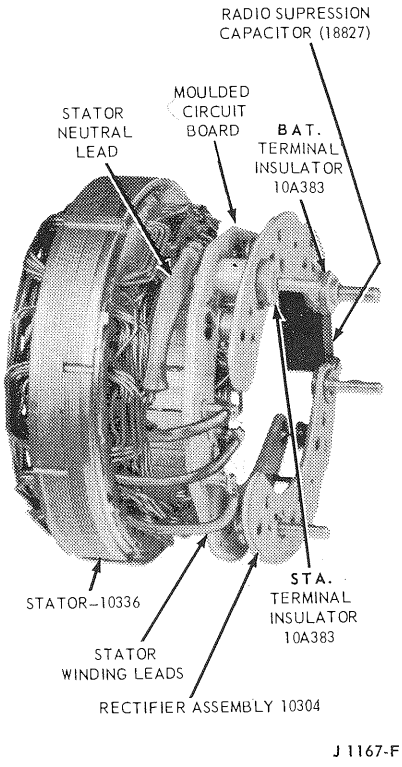


FIG. 21 Stator Lead Connections

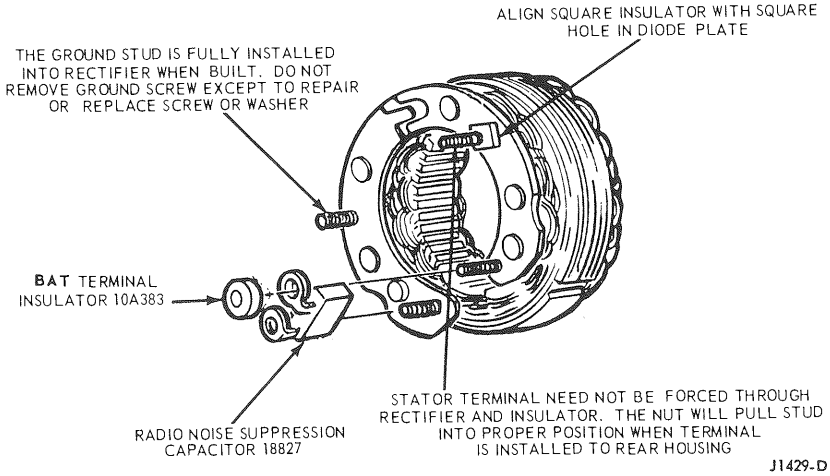


FIG. 22 Terminal Insulators — Fiber Glass Circuit Board

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

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

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

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

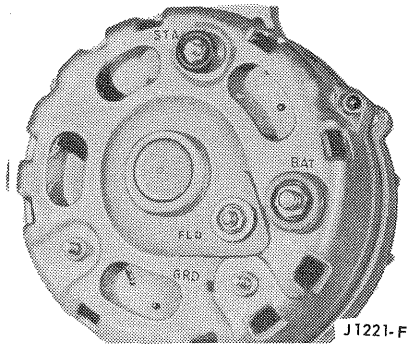


FIG. 23 Alternator Terminal Locations

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

Part 5 Starting System

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.

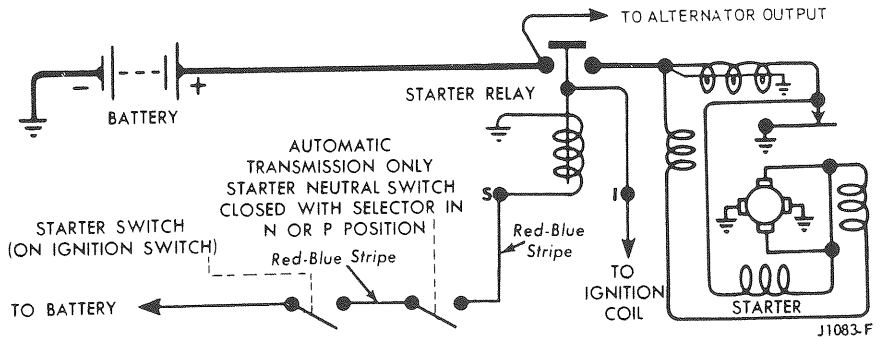


FIG. 1 Starting Circuit Positive Engagement

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 grounding the 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.

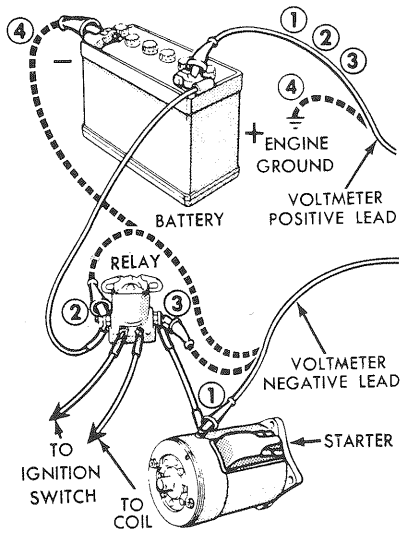
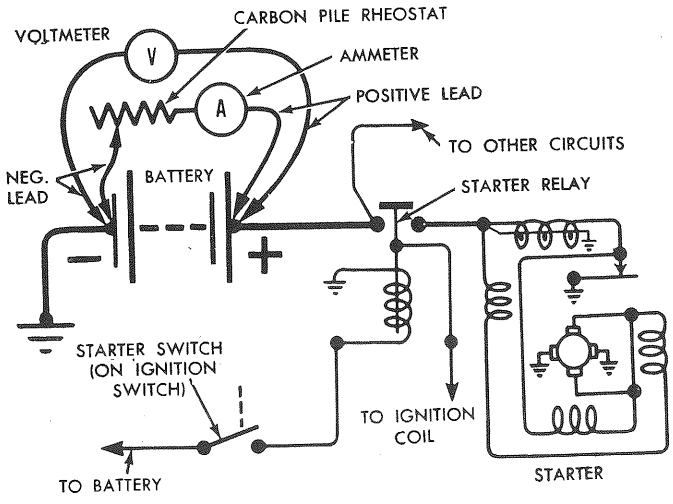


FIG. 2 Starting Cranking Circuit Test



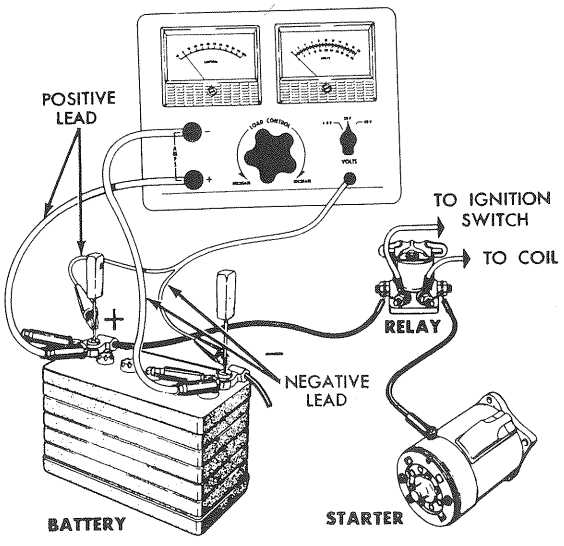


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FIG. 3 Starter Load Test

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.

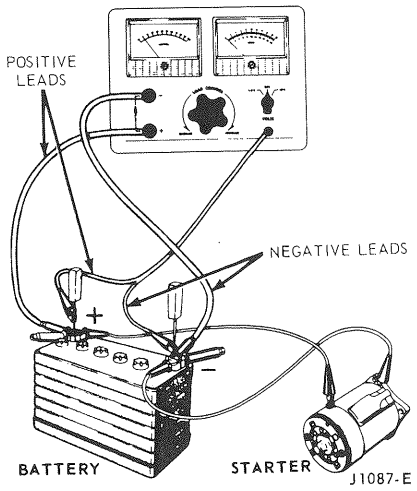

FIG. 4 Starter No-Load Test on Test Bench

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 — On Test Bench

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.

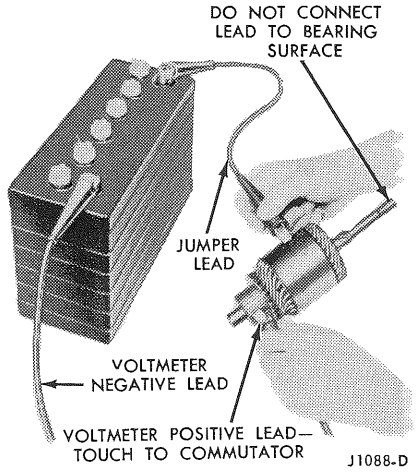

FIG. 5 Armature Grounded Circuit Test

Armature and Field Grounded Circuit Test — On Test Bench

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.

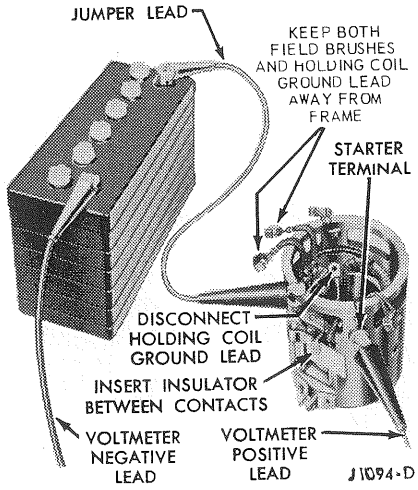

FIG. 6 Field Grounded Circuit Test

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.
3. Connect the starter cable.
4. Lower the engine. Check the operation of the starter.

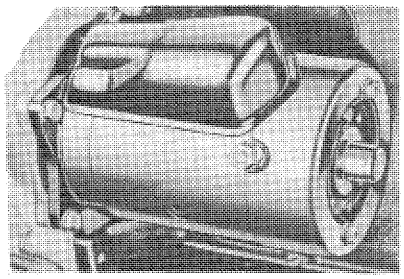

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FIG. 7 Starter Mounting

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.

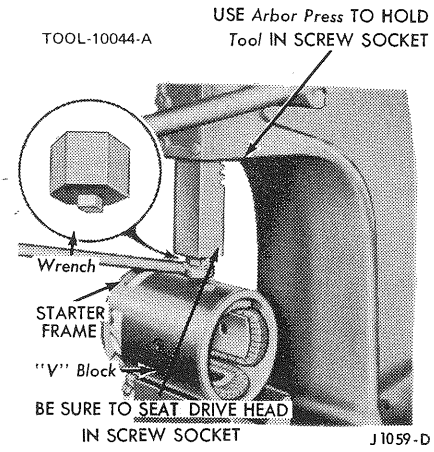


FIG. 9 Pole Shoe Screw Removal

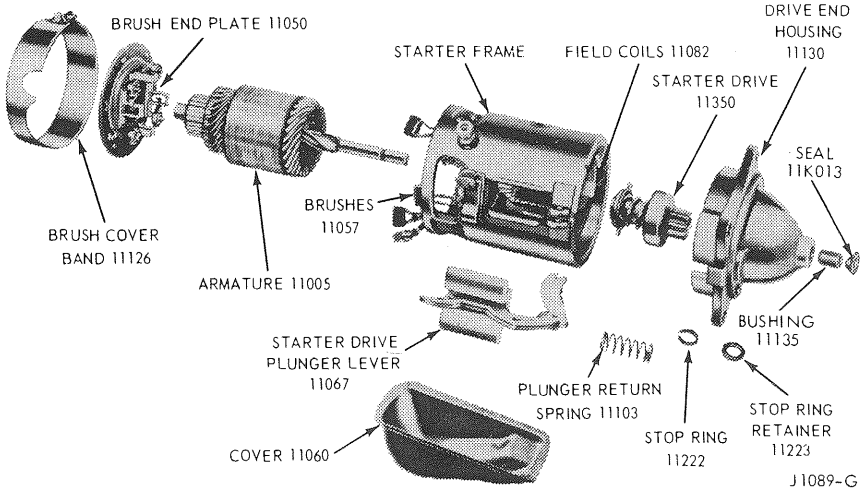


FIG. 8 Starter Disassembled

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.

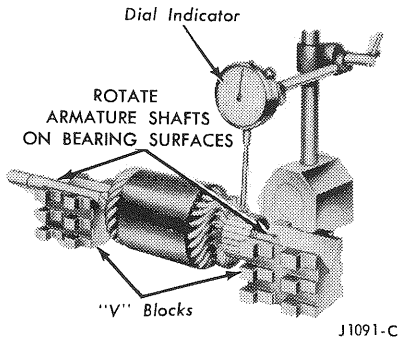


FIG. 10 Checking Commutator Runout

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).

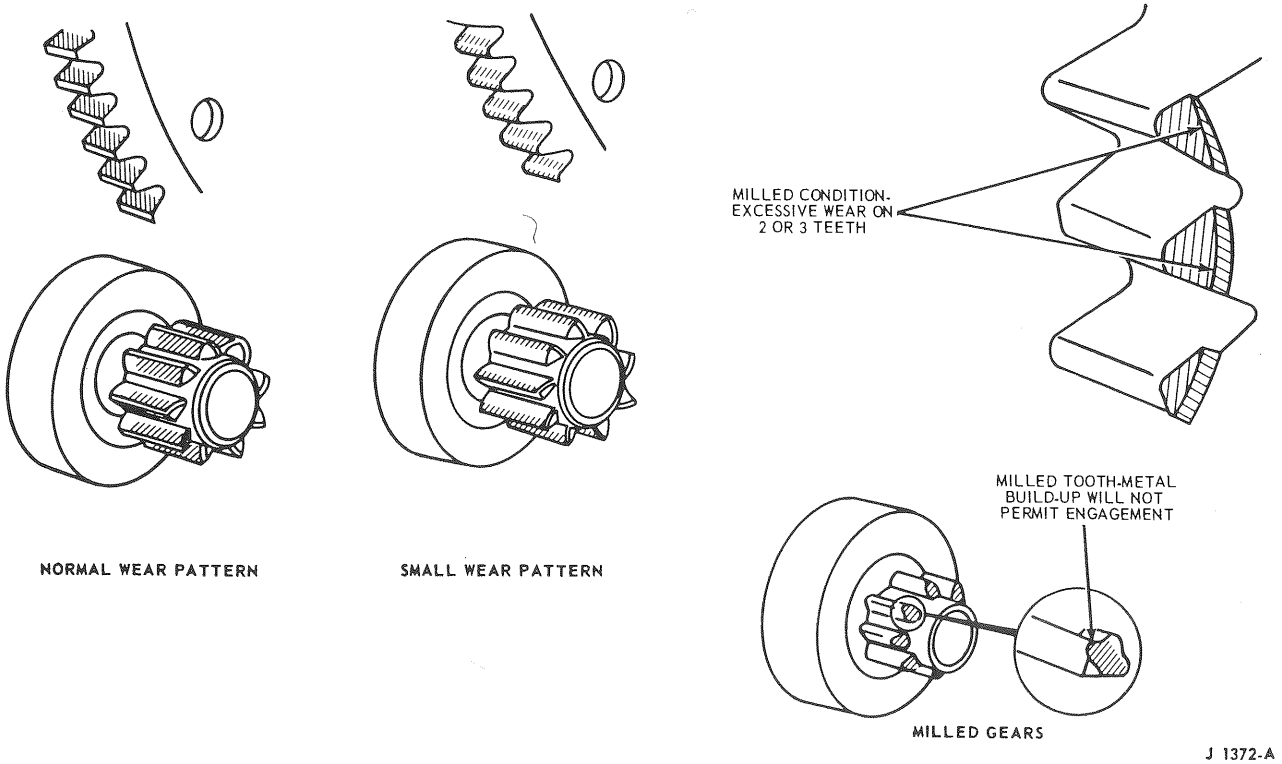


FIG. 11 Pinion and Ring Gear Wear Patterns

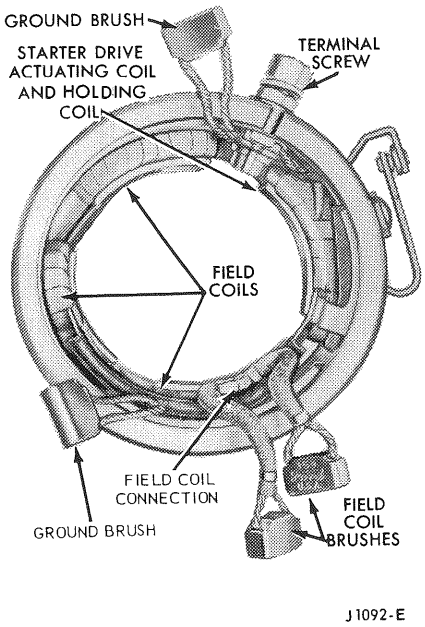


FIG. 12 Coil Assembly

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.
5. 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

DESCRIPTION AND OPERATION

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.

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.

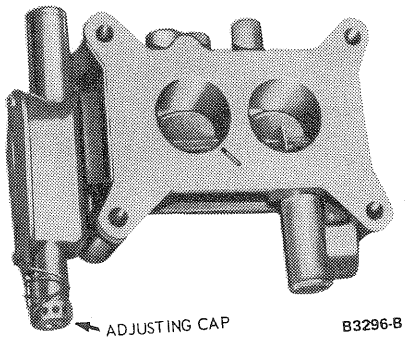


FIG. 1 Typical Velocity Governor

ADJUSTMENTS

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 sea 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 2), 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 adjustment 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.

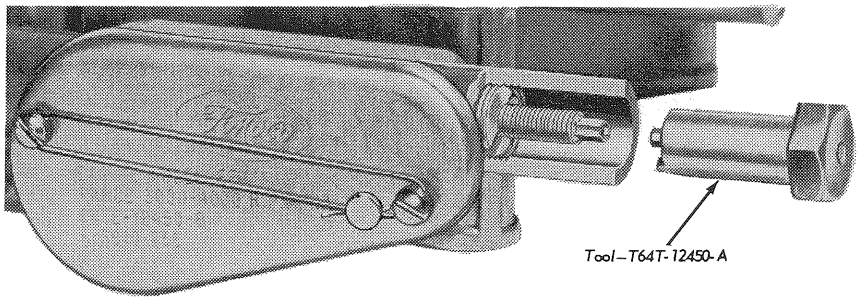


FIG. 2 Altitude Compensation Adjustment

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.

CB1023-A

FIG. 3 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

DESCRIPTION AND OPERATION

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

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

COOLANT (INDUSTRIAL)

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

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

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

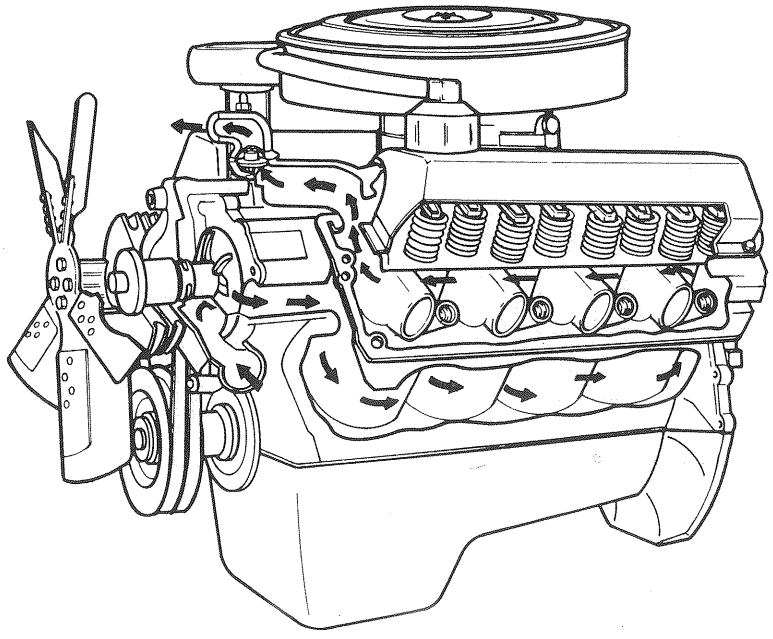
All coolant added should be the specified mixture of Ford permanent anti-freeze and water. If Ford Permanent Anti-freeze is not available, another reputable permanent anti-freeze may be used and diluted with an equal quantity of water.

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

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

A standard ethylene glycol hydrometer can be used to check the protection level of the long-life coolant.

To prevent damage to the cooling system during periods of below freezing ambient temperature, when water or anti-freeze is added to the supply tank, always operate the engine at fast idle for 30 minutes before letting the engine set in the OFF position for prolonged periods. This will allow a uniform mixture throughout the cooling system and prevent damage by freezing, when sufficient anti-freeze is used.



G. 1 Cooling System

DRAINING AND FILLING THE SYSTEM

To prevent loss of anti-freeze when draining the radiator, attach a hose on the radiator drain cock and drain the coolant from the radiator into a clean container.

To drain the radiator, open the drain cock located at the bottom of the radiator and remove the radiator or supply tank cap. The cylinder block is drained by removing the drain plugs located on both sides of the block.

To fill the cooling system, install the cylinder block drain plug(s) and close the radiator drain cock.

After the initial fill, the coolant level will drop approximately 1 quart after the engine has been operated about 20 minutes at 2000 rpm. This is due to the displacement of entrapped air. Refill radiator as required.

TESTING

PRESSURE TEST

It is recommended that a cooling system pressure test gauge be used to properly test the system for:

a. Blown or leaking cooling system sealing gaskets.
b. Internal or external cooling leakage.
c. Pressure cap malfunction.

Some modification of existing pressure testers may be required in order to use this procedure.

1. 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.**
2. 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.
3. 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.
4. 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.
5. 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.
6. 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. 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.

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 2) and check the tension.

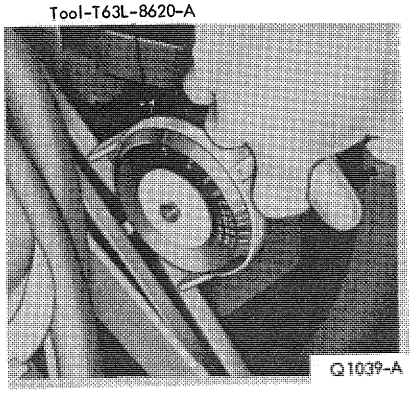


FIG. 2 Belt Tensioning

2. If adjustment is necessary, loosen the alternator mounting bolts and move the alternator adjusting arm bolts. Move the alternator toward or away from the engine until the correct tension is obtained. Remove the gauge.
3. Tighten the alternator adjusting arm bolt and the mounting bolts. Install the tension gauge and check the belt tension.

THERMOSTAT REPLACEMENT

Do not attempt to repair the thermostat. It should be replaced if it is not operating properly. Check the thermostat before installing it, following the procedure under Thermostat Testing.

Removal

1. Drain the cooling system so that the coolant level is below the thermostat.
2. Remove the water outlet housing retaining bolts. Bend the upper hose upward and remove the thermostat and gasket.

Installation

1. Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with water-resistant sealer. Position the water outlet housing gasket on the intake manifold opening.
2. Install the thermostat in the intake manifold opening with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.
3. Position the water outlet housing against the intake manifold. Install and torque the retaining bolts to specifications.
4. Fill and bleed the cooling system. Operate the engine until normal operating temperature is reached; then check the coolant level and check for leaks.

CLEANING AND INSPECTION

COOLING SYSTEM

To remove rust, sludge and other foreign material from the cooling system, use either FoMoCo Regular Cooling System Cleanser or in severe cases use Heavy Duty Cleanser. Removal of such material restores cooling efficiency and avoids overheating.

In severe cases where cleaning solvents will not properly clean the cooling system for efficient operation, it will be necessary to use the pressure flushing method.

Various types of flushing equipment are available. If pressure flushing is used, make sure the cylinder head bolts are properly tightened to prevent possible water leakage into the cylinders.

Always remove the thermostat prior to pressure flushing.

A pulsating or reversed direction of flushing water flow will loosen sediment more quickly than a steady flow in the normal direction of coolant flow.

Part 8 Specifications

GENERAL

Displacement
- 850 ..... 8 cylinder 5.0 liter (302 cubic in.)
- 858 ..... 8 cylinder 5.8 liter (351 cubic in.)

Bore and Stroke
- 850 ..... 4.00 x 3.00
- 858 ..... 4.00 x 3.50

Oil Pressure — Hot @ 2000 rpm
- 850 ..... 40-60 psi
- 858 ..... 40-65 psi

Firing Order
- 850 1-5-4-2-6-3-7-8
- 858 1-3-7-2-6-5-4-8

Oil Capacity (Qts.) —
(add 1 qt. with filter change) ..... Industrial 4, Marine 5

CYLINDER HEAD

Combustion Chamber Volume (cc)
- 850 ..... 56.7-59.7
- 858 ..... 58.9-61.9

Valve Guide Bore Diameter 0.3433-0.3443
Valve Seat Width — Intake and Exhaust 0.060-0.080
Valve Seat Angle — Intake and Exhaust ..... 45°
Valve Seat Runout — Maximum 0.0020
Surface Flatness ..... 0.003 inch in any 6 inches
or 0.007 inch overall
Valve Arrangement (Front to Rear) ..... Right I-E-I-E-I-E-I-E
Left E-I-E-I-E-I-E-I
Rocker Arm Stud Bore Diameter — Standard 0.3680-0.3695
Gasket Surface Flatness ..... 0.003 inch in any 6 inches
or 0.007 inch overall
Gasket Surface Finish RMS 60-150

VALVE ROCKER ARMS, PUSH RODS AND LIFTERS

Rocker Arm Lift Ratio 1.61:1
Valve Push Rod Runout — Maximum 0.015
Rocker Arm Stud Diameter
- Standard 0.3714-0.3721
- 0.006 Oversize 0.3774-0.3781
- 0.010 Oversize 0.3814-0.3821
- 0.015 Oversize 0.3864-0.3871

Hydraulic Lifter Leakdown Rate ..... 5-50 seconds maximum
measured at 1/16 inch plunger travel.
Hydraulic Lifter Standard Diameter 0.8740-0.8745
Hydraulic Lifter Clearance to Bore 0.0007-0.0027
Wear Limit — 0.005
Hydraulic Lifter Collapsed Gap
- 850
  - Allowable 0.071-0.193
  - Desirable 0.096-0.165
- 858
  - Allowable 0.098-0.198
  - Desired 0.123-0.173

VALVES

Valve Stem Diameter
- Intake
  - Standard 0.3416-0.3423
  - 0.003 Oversize 0.3446-0.3453
  - 0.015 Oversize 0.3566-0.3573
  - 0.030 Oversize 0.3716-0.3723
- Exhaust
  - Standard 0.3411-0.3418
  - 0.003 Oversize 0.3441-0.3448
  - 0.015 Oversize 0.3561-0.3568
  - 0.030 Oversize 0.3711-0.3718

Valve Face Angle ..... 44°

Valve Stem to Valve Guide Clearance —
- Intake 0.0010-0.0027
- Exhaust 0.0015-0.0032
  - Wear Limit 0.0055

Valve Head Diameter
- Intake 1.773-1.791
- Exhaust 1.453-1.468

Valve Face Runout (Maximum) 0.0020

Valve Spring Free Length — Approximate
- 850
  - Exhaust 1.87
  - Intake 1.94
- 858
  - Exhaust 1.87
  - Intake 2.06

Valve Spring Out-of-Square — Maximum 5/64 (0.078)

Valve Spring Pressure — Lbs. at Specified Length
- 850 ..... 76-84 @ 1.69
  190-210 @ 1.31
- 858 ..... 71-79 @ 1.79
  190-210 @ 1.31

Service Limit ..... 10% Pressure Loss @ Spec. Length

Valve Spring Assembled Height — Pad to Retainer
- 850 — Intake ..... 1-21/32 — 1-23/32
  - Exhaust ..... 1-19/32 — 1-5/8
- 858 — Intake ..... 1-49/64 — 1-13/16
  - Exhaust ..... 1-19/32 — 1-5/8

CAMSHAFT AND BEARINGS

Camshaft Journal Diameter Standard
- No. 1 Bearing 2.0805-2.0815
- No. 2 Bearing 2.0655-2.0665
- No. 3 Bearing 2.0505-2.0515
- No. 4 Bearing 2.0355-2.0365
- No. 5 Bearing 2.0205-2.0215

Camshaft Journal to Bearing Clearance 0.001-0.003
Wear Limit — 0.006

Camshaft End Play 0.001-0.007
Wear Limit — 0.009

Camshaft Lobe Lift —
- 850 Low Output
  - Intake 0.2303
  - Exhaust 0.238
- 850
  - Intake 0.2600
  - Exhaust 0.278
- 858
  - Intake 0.278
  - Exhaust 0.283

CAMSHAFT AND BEARINGS (Cont'd)

Maximum Allowable Lobe Lift Loss 0.005
Bearing Inside Diameter
Bearing No. 1 .....2.0825-2.0835
Bearing No. 2 .....2.0675-2.0685
Bearing No. 3 .....2.0525-2.0535
Bearing No. 4 .....2.0375-2.0385
Bearing No. 5 .....2-0225-2.0235
Camshaft Journal Diameter — Standard
Bearing No. 1 .....2.0805-2.0815
Bearing No. 2 .....2.0655-2.0665
Bearing No. 3 .....2.0505-2.0515
Bearing No. 4 .....2.0355-2.0365
Bearing No. 5 .....2.0205-2.0215
Camshaft Journal Maximum Runout 0.005
Camshaft Journal Maximum Out-of-Round 0.005
Camshaft Bearing Location — No. 1 Bearing 0.0050-0.0200*
Timing Chain Deflection — Maximum 0.500
*Distance in inches that the front edge of the bearing is installed toward the rear from the front face of the cylinder block.

CRANKSHAFT AND FLYWHEEL

Main Bearing Journal Diameter
850 .....2.2482-2.2490
858 .....2.9994-3.0002
Main Bearing Journal Out-of-Round — Maximum 0.0006
Connecting Rod Journal Diameter
850 .....2.1228-2.1236
858 .....2.3103-2.3111
Connecting Rod Journal Out-of-Round — Maximum 0.0006
Main Bearing Journal Taper — Maximum .....0.0006 per inch
Connecting Rod Journal Taper — Maximum ....0.0006 per inch
Connecting Rod Journal Diameter
850 .....2.1228-2.1236
858 .....2.3103-2.3111
Thrust Bearing Journal Length 1.137-1.139
Main Bearing Journal Thrust Face Runout 0.001
Crankshaft to Rear Face of Block Runout TIR — Maximum 0.005
Crankshaft Free End Play 0.004-0.008
Wear Limit — 0.012
Flywheel Clutch Face Runout — Maximum 0.010
Assembled Flywheel Ring Gear Lateral Runout TIR
Standard 0.030
Automatic 0.060

MAIN BEARINGS

Journal Clearance
850 No. 1 Bearing
Desired 0.0001-0.0015
Allowable 0.0001-0.0020
All others
Desired 0.0005-0.0015
Allowable 0.0005-0.0024
858
Desired 0.0008-0.0015
Allowable 0.0008-0.0026
Wall Thickness
850 No. 1 Bearing.....0.0961-0.0966
All Others.....0.0957-0.0962
858 .....0.0957-0.0960
All Others.....0.0957-0.0962

CARBURETORS

CARBURETORS	D2JL C 302	D2JL E 351	D3JL S 302-351	D4JL F 302	D4JL G 351
Carburetor Size					
Throttle Bore Diameter					
Primary —	1.5	1.5625	1.50	1.5	1.5610
Secondary —	1.5	1.5625	—	1.5	1.5610
Venturi Diameter					
Primary —	1.094	1.250	1.187	1.094	1.250
Secondary —	1.094	1.3125	—	1.094	1.312
Fuel System					
Fuel Level (Wet)	①	①	③	③ ⑤	④ ⑤
Float Level (Dry)	②	②	②	②	②
Main Metering System					
Main Jet					
Primary —	#58	#64	#60	#582	#622
Secondary —	N/A	N/A	—	N/A	N/A
Power Valve Timing	8.5	5.0	5	8.5	2.5
Idle Mixture (Prelim. Setting)	1½	1½	1½	1½	1½
Accelerator Pump System					
Capacity — cc/10 Strokes	21-31	25-35	25-35	21-31	22-32
Pump Rod Location	#2	#1	#1	#2	#2
Override Spring Adjustment	.015''	.015''	.015''	.015''	.015''
Pump Cam Color	Red	Pink	Pink	Red	Pink
Idle Speed	550-575	550-575	550-575	550-575	550-575
Curb Idle RPM	1500	1500	1500	1500	1500
Fast Idle RPM	3 Lean	3 Lean	3 Lean	Index	Index
Choke Cover Setting	.300''	.300''	.300''	.300''	.270''
Dechoke	.140''	.140''	.140''	.140''	.120''
Choke Qualifying	¼-½	¼-½	—	¼-½	¼-½
Secondary Throttle Opening					
Supplier	Holley	Holley	Holley	Holley	Holley
Supplier I.D. Number	6407	6576-A	7036	7159	7163
Carburetor Model	4160C	4160C	2300C	4160C	4160C

① Lower Edge of Sight Plug Hole.
② Parallel with Float Bowl Floor (bowl inverted).
③ ½'' Primary ⅝'' Secondary
④ ½'' Primary ¾'' Secondary
⑤ Use Kent Model Gauge #10193

TORQUE LIMITS — FT.-LBS.

Cylinder Head Bolts
- 850 50
  - Step 1 60
  - Step 2 65-70
  - Step 3 .....
- 858 90
  - Step 1 100
  - Step 2 112
  - Step 3 .....

Oil Pan to Cylinder Block 8-11
- 5/16-18 7-9
- 1/4-20 23-25

Intake Manifold Bolts 18-24
Exhaust Manifold Bolts 10-15
Water Outlet Housing 75-85
Flywheel to Crankshaft .....
Main Bearing Cap 60-70
- 850 95-105
- 858 15-25

Oil Pan Drain Plug 22-32
Oil Pump to Cylinder Block 10-15
Oil Inlet Tube to Oil Pump 6-9
Oil Pump Cover Plate .....

TORQUE LIMITS — FT.-LBS. (Cont'd)

Oil Filter Insert to Block 20-30
Oil Filter to Block Cartridge Type
With grease on gasket surface, hand-tighten until gasket contacts adapter face then tighten ½ turn more.
Cylinder Front Cover 12-18
Water Pump Bolts 12-18
Camshaft Sprocket to Camshaft 40-45
Camshaft Thrust Plate to Block 9-12
Vibration Damper to Crankshaft 70-90
Crankshaft Pulley to Vibration Damper 35-50
Connecting Rod Nuts
302 19-24
351 40-45
Valve Rocker Arm Cover 3-5
Fuel Pump to Cylinder Front Cover 19-27
Rocker Arm Stud Nut 17-23
After nuts contact shoulder
Alternator Pivot Bolt 45-57

TORQUE LIMITS FOR VARIOUS SIZE BOLTS — FT.-LBS.

CAUTION: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits in the preceding tables prevail.

Size (Inches)	Torque (Ft.-Lbs.)
1/4-20	6-9
5/16-18	12-18
3/8-16	22-32
7/16-14	45-57
1/2-13	55-80
9/16-18	85-120

IGNITION SYSTEM

Initial Spark Advance — BTDC ..... Marine & Industrial 6°
Breaker Arm Spring Tension (ounces) 17-21
Contact Spacing
Industrial 0.014-0.020
Marine:
GPD 0.014-0.019
Mallory 0.019-0.021
Prestolite 0.014-0.019
Dwell Angle at Idle Speed
Industrial ..... 26°-30°;
Marine
GPD ..... 26°
Mallory ..... 26°
Prestolite ..... 31°
Gear Location Dimension — Distributor (Distance from bottom of mounting flange to bottom of gear) 4.031-4.038
Shaft End Play Clearance — Distributor 0.024-0.025
Condenser
Capacity — Microfarads 0.21-0.25
Minimum Leakage — Megohms 10
Maximum Series Resistance Ohms 1
Coil
Primary Resistance Wire — Ohms ..... 1.40-1.54 (75°F)
Secondary Resistance — Ohms ..... 7600-8800 (75°F)
Amperage Draw
Engine Stopped 4.5
Engine Idling 2.5
Primary Circuit Resistance — Ohms ..... 1.30-1.40 (75°F)
Spark Plugs
Plugs (Motorcraft)
Industrial BRF-42

IGNITION SYSTEM (Cont'd)

Marine ..... BRF-3 or ARF-32
Size
Industrial 18mm
Marine ..... 14mm or 18mm
Torque (Ft.-Lbs) 15-20

Industrial Distributor

Centrifugal Advance. Set the test stand to 0° at 250 rpm and 0 inches of vacuum.

Distributor (rpm)	Advance (Degrees)	Vacuum (Inches of Mercury)
500	1½-3	0
750	4½-6	0
1000	6½-8	0
1500	9½-11	0
2000	11½-13	0

Vacuum Advance. Set the test stand to 0° at 1000 rpm and 0 inches of Hg.

1000	0-1½	5
1000	6-9	10
1000	6-9	15
1000	6-9	20

Maximum Advance Limit ..... 9°

Marine Distributor

0-550	0	0
750	4-6½	0
1000	9½	0
1500	11½	0
2000	13½	0

FUEL SYSTEM

Fuel Pump Static Pressure @ 500 rpm 5.0-7.0
Minimum Feed Pump Volume Flow
@ 500 rpm ..... 1 pint/20 sec.
Eccentric Total Lift 0.630-0.710

COOLING SYSTEM

Thermostat
Low Temperature ..... Opens 157°-164°F
Fully Open — 184°F
High Temperature ..... Opens 188°-195°F
Fully Open — 212°
Drive Belt Tension ..... New — 160 Ft.-Lbs.
Used — 120 lbs. (any belt operated over 10 minutes)

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.

POSITIVE ENGAGEMENT STARTER

Positive Engagement Starter Motor					
Dia. (Inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm)	Min. Stall Torque @ 5 Volts (Ft-Lbs)	Max. Load (Amps)	No. Load (Amps)
4	150-200	180-250	9.0	460	70
4½	150-180	150-290	15.5	670	80

Starter Brushes				
Mfg. Length (Inches)	Wear Limit (Inches)	Spring Tension (Ounces)	Through Bolt Torque (In-Lbs)	Mounting Bolt Torque (Ft-Lbs)
0.50	0.25	40	55-75	15-20
0.50	0.25	40	55-75	15-20

Maximum Commutator runout is 0.005 inch. Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.