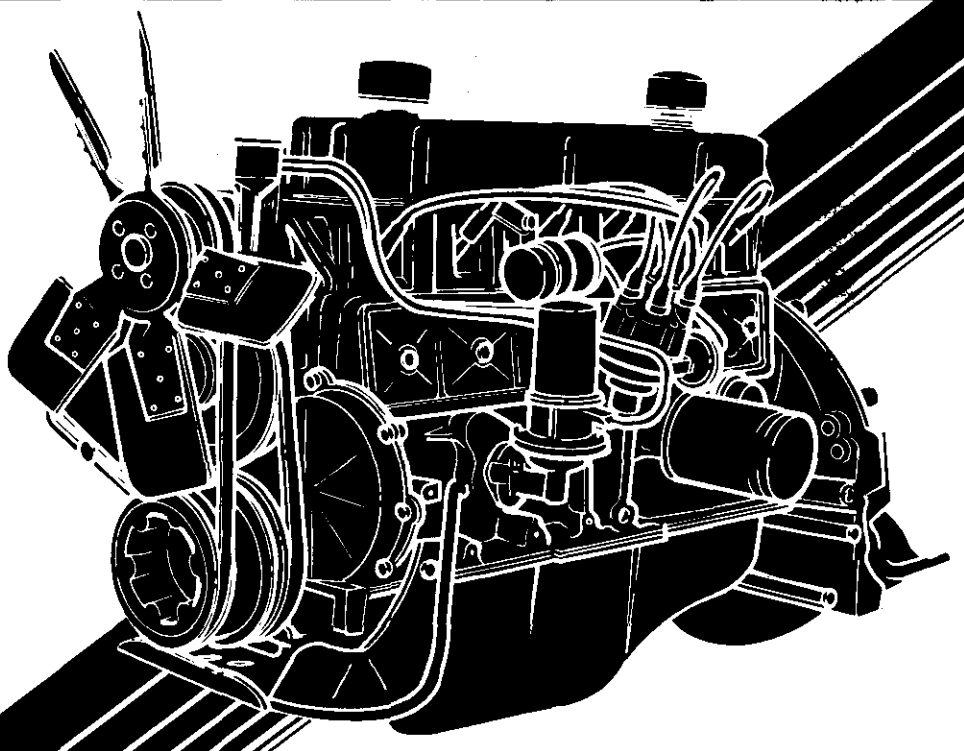
Ford

Power Products

CSG 649



INDUSTRIAL ENGINE SERVICE MANUAL

PPO-194 210-86

⚠ WARNING: ⚠

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

Introduction

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

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

FORD MOTOR COMPANY
Ford Parts and Service Division
Power Products Operations
3000 Schaefer Road
P.O. Box 6011
Dearborn, Michigan 48121

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

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

IMPORTANT SAFETY NOTICE

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

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

NOTES, CAUTIONS, AND WARNINGS

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

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts, when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

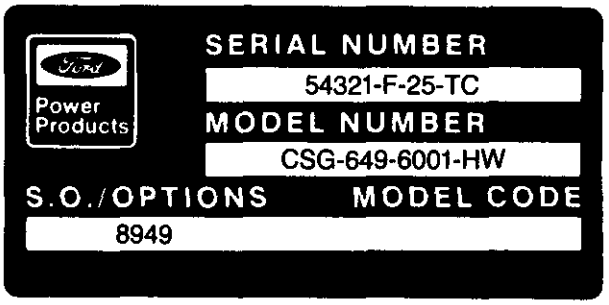
CSG-649 Gasoline Engine

Part 1 — Basic Engine

Part 1 — Basic Engine

IDENTIFICATION

An Identification Decal is affixed to the left side of the rocker cover of the engine. The decal contains the engine serial number which identifies this unit from all others. The model number and S.O. or special options determine the parts or components required on this unit. Use all the numbers when seeking information or ordering replacement parts for this engine.



DESCRIPTION

The Ford 4.9 Liter six-cylinder engine is available as an engine assembly or a complete ready-to-run power unit. In addition, a full range of optional equipment is available to custom tailor the engine or power unit to individual requirements.

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

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

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

DESCRIPTION (Continued)

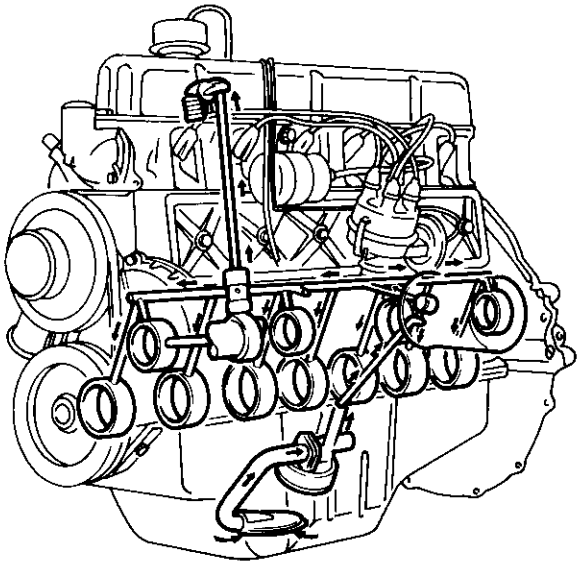
The camshaft is supported by four bearings pressed into the block. It is driven by gears from the crankshaft. Camshaft end play is controlled by a plate bolted to the front of the block. The distributor, located on the left side of the engine, is driven by a gear on the camshaft. The distributor drives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

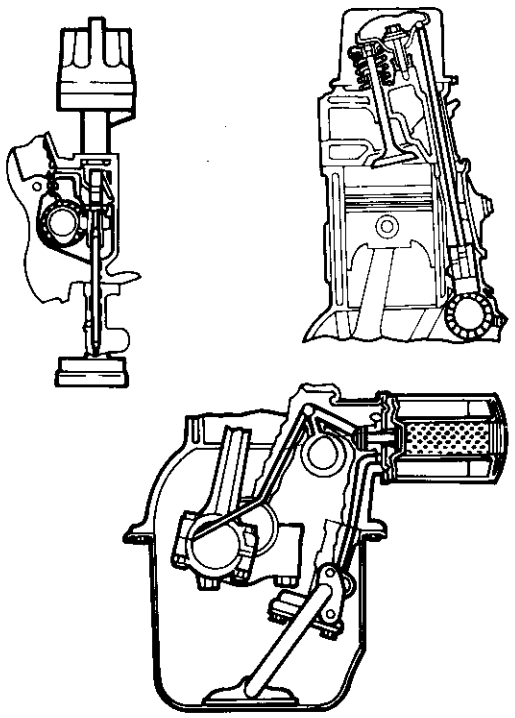
The cylinder head assembly contains the fuel intake passages, the valves, and the individual valve rocker arm assemblies. Valve guides are an integral part of the head. Optional hard-faced intake and exhaust valve seat inserts are pressed into the heads. The intake and exhaust valves are actuated through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

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

These engines are equipped with a positive, closed type ventilation system which directs the crankcase vapors to the intake manifold for combustion.

The 4.9L power unit is a complete ready-to-run engine mounted on a foot-type frame. Included are radiator, pusher or puller-type fan, power take-off instruments, throttle, choke, air cleaner, exhaust pipe, and a sheet metal shroud enclosing the front, rear and top of unit.





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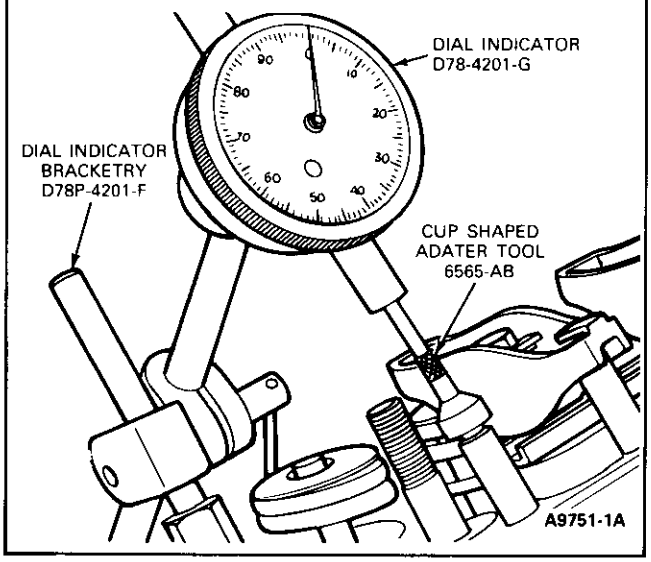
DIAGNOSIS AND TESTING

CAMSHAFT LOBE LIFT

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

1. Remove the air cleaner. Remove the heater hose and crankcase ventilation hose, if so equipped. Remove valve rocker arm cover.
2. Remove the rocker arm. Use the adapter for ball end push rods.
3. Make sure the push rod is in the valve lifter socket. Install a dial indicator so that the actuating point of the indicator is in the push rod socket and in the same plane as the push rod movement.
4. Connect an auxiliary starter switch in the starting circuit. Crank the engine with the ignition switch OFF.
5. Zero the dial indicator. Continue to rotate the crankshaft slowly until the push rod is in the fully raised position.
6. Compare the total lift recorded on the indicator with specification.
7. To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. **If the lift on any lobe is below specified wear limits, the camshaft and the valve lifters operating on the worn lobe(s) must be replaced.**
8. Remove the dial indicator and auxiliary starter switch.
9. Install the rocker arm.
10. Install the valve rocker arm cover and the air cleaner.



COMPRESSION TEST

COMPRESSION GAUGE CHECK

The following procedure is to be used when checking compression:

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

Test Conclusion

The indicated compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Refer to the quick reference chart for pressure limits between cylinders. Variations exceeding 75 percent implies an improperly seated valve or worn or broken piston rings. If one cylinder reads low, squirt approximately one tablespoon of engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

a. If compression improves considerably, the piston rings are at fault.

b. If compression does not improve, valves are sticking or seating poorly.

c. 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.

DIAGNOSIS AND TESTING (Continued)

Example

After checking the compression pressures in all cylinders, the highest reading obtained was 965 kPa (140 psi) and the lowest pressure reading was 689 kPa (100 psi). By locating 965 (140) in the Maximum column it is seen that the lowest allowable pressure listed in the Minimum column is 723 kPa (105 psi). Since the lowest cylinder reading was 689 kPa (100 psi), the engine is not within specifications and the compression is not considered satisfactory.

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

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DIAGNOSIS AND TESTING (Continued)

HYDRAULIC VALVE TAPPET

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.
6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, incorrect initial adjustment, or wear of tappet face, pushrod, rocker arm, rocker arm fulcrum or valve tip. With tappet collapsed, check gap between valve tip and rocker arm to determine if any other valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips or varnish that is causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low oil level in the oil pan, or by air being drawn into the system through a hole, crack, or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, it should be replaced.

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:

Functional Check

1. If the PCV valve rattles when shaken, reconnect it; if not, replace it.
2. With the engine at idle, disconnect hose from air cleaner, and feel for vacuum at the hose.
   - Some vacuum, system is OK.
   - No vacuum, either the system is plugged or the valve is leaking.

CRANKCASE VENTILATION REGULATOR VALVE TEST

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

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

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

DIAGNOSIS AND TESTING (Continued)

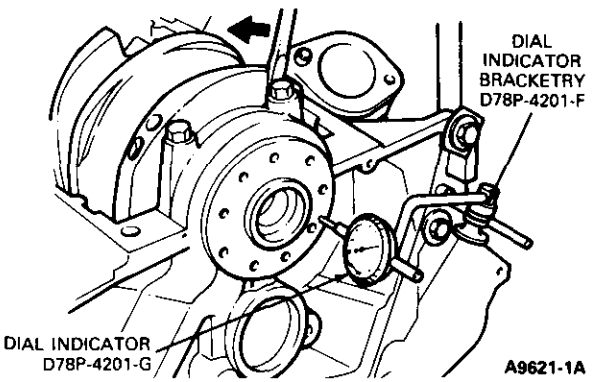
CRANKSHAFT END PLAY

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.
3. Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.
4. If the end play exceeds the wear limit, replace the thrust washers. If the end play is less than the minimum limit inspect the thrust bearing faces for scratches, burrs, nicks, or dirt.

FLYWHEEL FACE RUNOUT

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

If the clutch face runout exceeds specifications, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face if the mounting flange runout exceeds specifications.

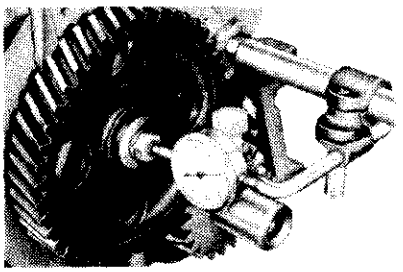


CAMSHAFT END PLAY

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

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

Remove the dial indicator.



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

A3010-A

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.

CLEANING AND INSPECTION (Continued)

INTAKE MANIFOLD

Cleaning

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

Inspection

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

EXHAUST MANIFOLDS

Cleaning

Remove all gasket material from the manifolds.

Inspection

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

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

VALVE ROCKER ARM

Cleaning

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

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

Inspection

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

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

PUSH RODS

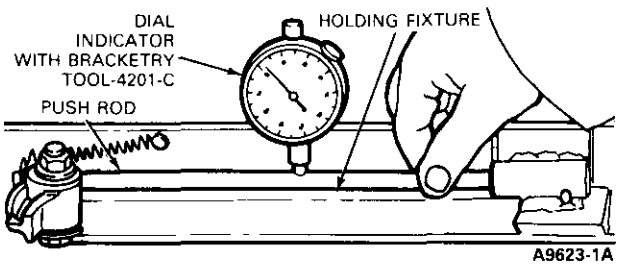
Cleaning

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

Inspection

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

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



CYLINDER HEADS

Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores with a valve guide cleaning tool. Using cleaning solvent to remove dirt, grease and other deposits, clean all bolt holes.

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

Inspection

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

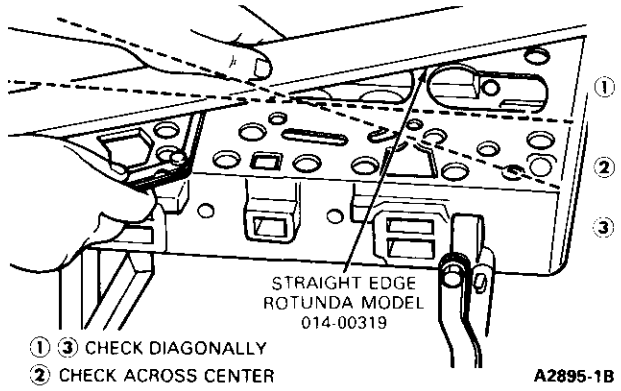
Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

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

CLEANING AND INSPECTION (Continued)

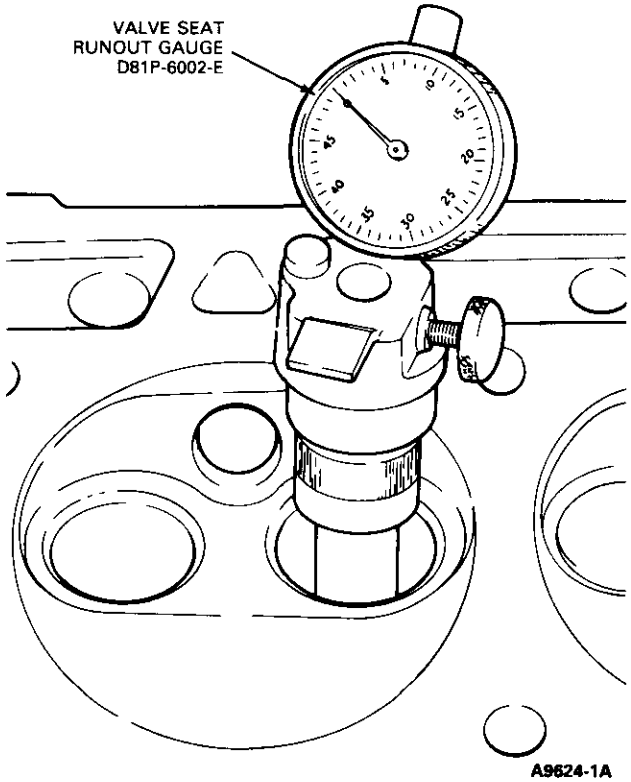
CYLINDER HEAD FLATNESS

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specifications. If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.254 mm (0.010 inch) from the original gasket surface.**



VALVE SEAT RUNOUT

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



VALVE SEAT WIDTH

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

VALVES

The critical inspection points and tolerances of the valve are illustrated. Refer to specifications for wear limits. Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

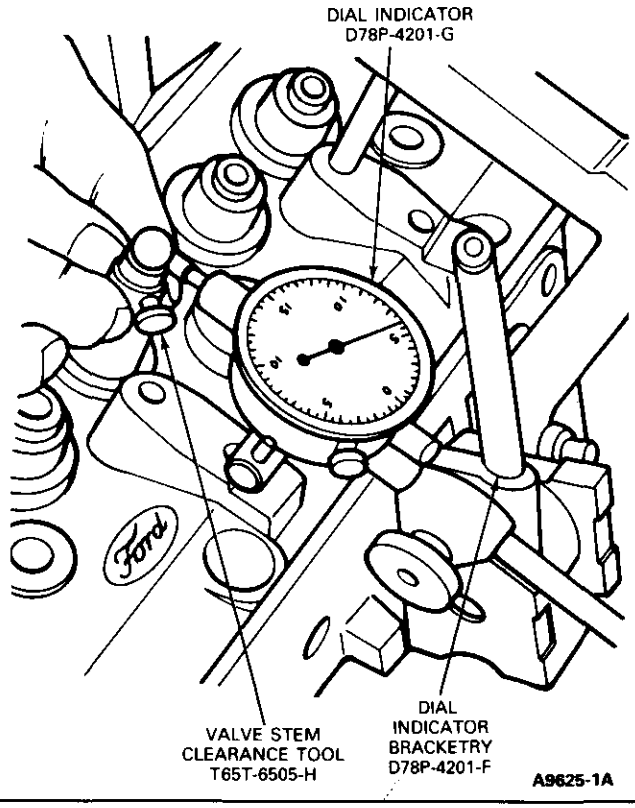
VALVE FACE RUNOUT

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

VALVE STEM CLEARANCE

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

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

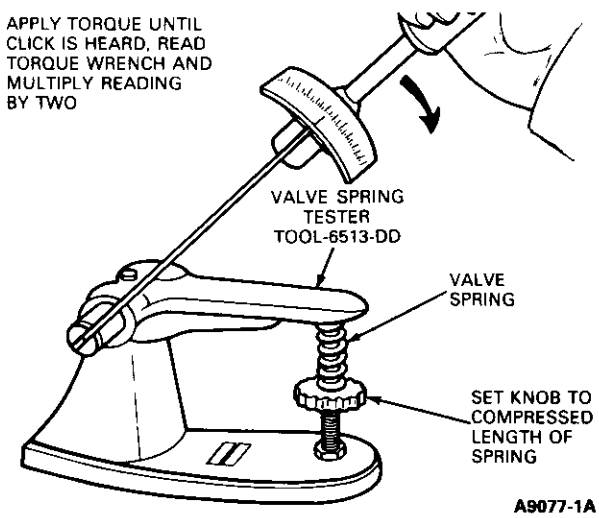


CLEANING AND INSPECTION (Continued)

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

VALVE SPRING PRESSURE

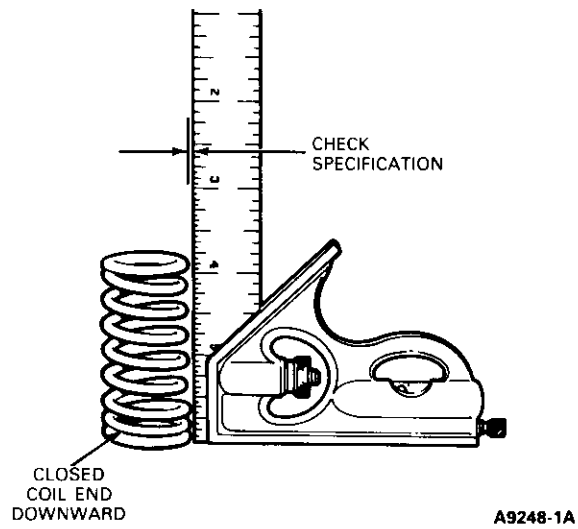
Check the valve spring for proper pressure at the specified spring lengths. Weak valve springs cause poor performance; therefore, if the pressure of any spring is lower than the wear limit, replace the spring.



VALVE SPRING SQUARENESS

Check each spring for squareness using a steel square and a surface plate. Stand the spring and square on end on the surface plate. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and square. If the spring is out-of-square more than specified, replace it.

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



CLEANING AND INSPECTION (Continued)

HYDRAULIC VALVE LIFTERS

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

Cleaning

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

Inspection

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

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

TIMING GEARS

Cleaning

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

Inspection

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

CRANKSHAFT VIBRATION DAMPER

Cleaning

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

Inspection

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

CAMSHAFT

Cleaning and Inspection

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

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

Check the distributor drive gear for broken or chipped teeth.

CLEANING AND INSPECTION (Continued)

CRANKSHAFT

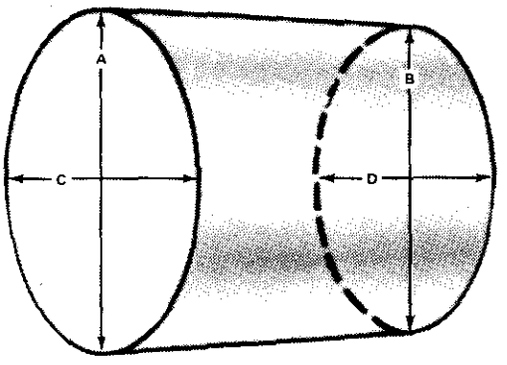
Cleaning

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

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

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



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Inspection

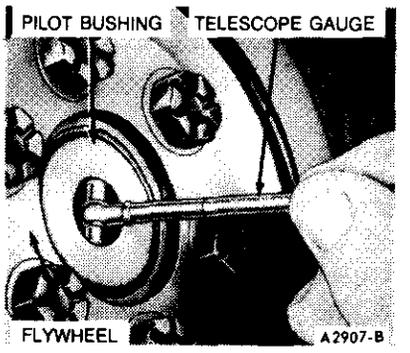
Inspect the main and connecting rod journals for cracks, scratches, grooves or scores.

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

On an engine used with a manual shift transmission, check the fit of the clutch pilot bushing in the bore of the crankshaft. The bushing is pressed into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the ID of the bushing. Replace the bushing if it is damaged or the ID is not within specifications.

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

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



FLYWHEEL

Inspection

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

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

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

CLEANING AND INSPECTION (Continued)

CONNECTING RODS

Cleaning

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

Inspection

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

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent or the piston pin hole is not in proper relation to the piston skirt and ring grooves.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, or a tapered connecting rod bore.

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

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the maximum limit and/or if the rod is fractured, it should be replaced.

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

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

After the connecting rods are assembled to the piston, check the rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specifications, the rod must be straightened or replaced.

PISTONS, PINS AND RINGS

Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean the ring groove with a ring groove cleaner. Make sure the oil ring slots (or holes) are clean.

Inspection

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

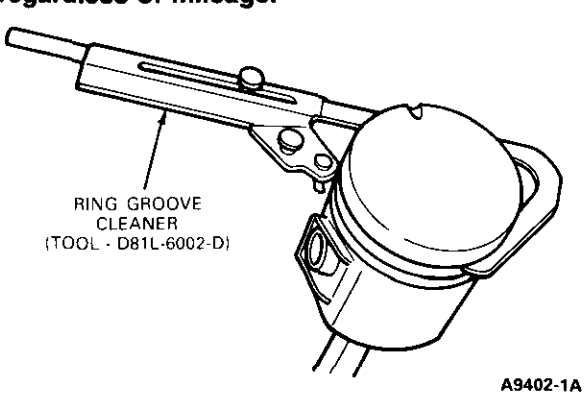
Spongy, eroded areas near the edge of the piston top are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear,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

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

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to Pistons and Connecting Rods Assembly in the pertinent engine section.

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

Replace all rings. Check the end gap and side clearance. It is good practice to always install new rings when overhauling an engine. **Rings should not be transferred from one piston to another regardless of mileage.**



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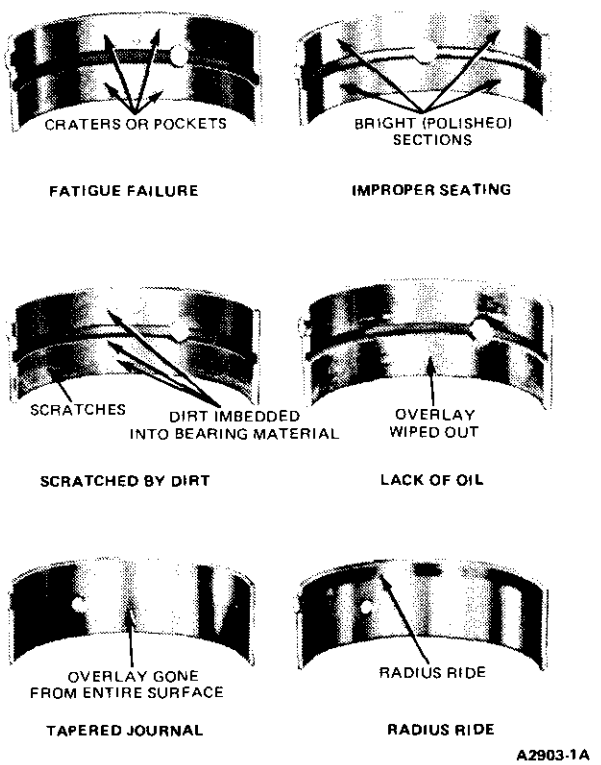
CLEANING AND INSPECTION (Continued)

MAIN AND CONNECTING ROD BEARINGS

Cleaning

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



Inspection

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

CYLINDER BLOCK

Cleaning

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

If the engine is disassembled, thoroughly clean the block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. 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.

Inspection

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

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone. Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications, **but not to exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.**

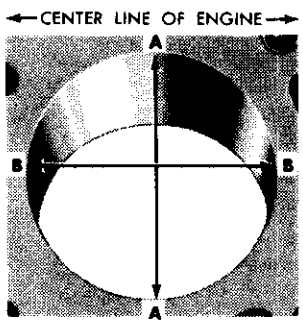
Replace all expansion-type plugs that show evidence of leakage.

CLEANING AND INSPECTION (Continued)

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. **Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.**

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed the wear limits.

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



A AT RIGHT ANGLE TO CENTER LINE OF ENGINE

B PARALLEL TO CENTER LINE OF ENGINE

1. OUT-OF-ROUND = DIFFERENCE BETWEEN **A** AND **B**
2. TAPER = DIFFERENCE BETWEEN THE **A** MEASUREMENT AT TOP OF CYLINDER BORE AND THE **A** MEASUREMENT AT BOTTOM OF CYLINDER BORE

A 2905-A

OIL PAN

Cleaning

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

Inspection

Check the pan for cracks, holes, damaged drain plug threads, and a loose baffle. Check the gasket surface for damage caused by over-torqued bolts. Straighten the surface as required to restore original flatness.

Replace the pan if repairs cannot be made.

CLEANING AND INSPECTION (Continued)

OIL PUMP

Cleaning

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

Inspection

Refer to the specifications for clearances and wear limits.

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

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

Measure the outer race to housing clearance.

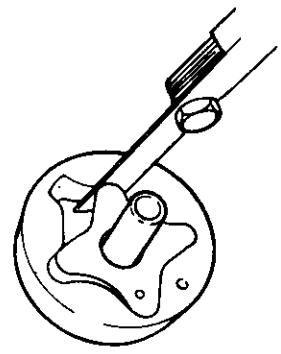
With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straight edge and the rotor and outer race.

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.



NOTE: INNER TO OUTER ROTOR TIP CLEARANCE MUST NOT EXCEED 0.305mm (0.012 INCH) WITH FEELER GAUGE INSERTED 12.7mm (1/2") MINIMUM AND ROTORS REMOVED FROM PUMP HOUSING.

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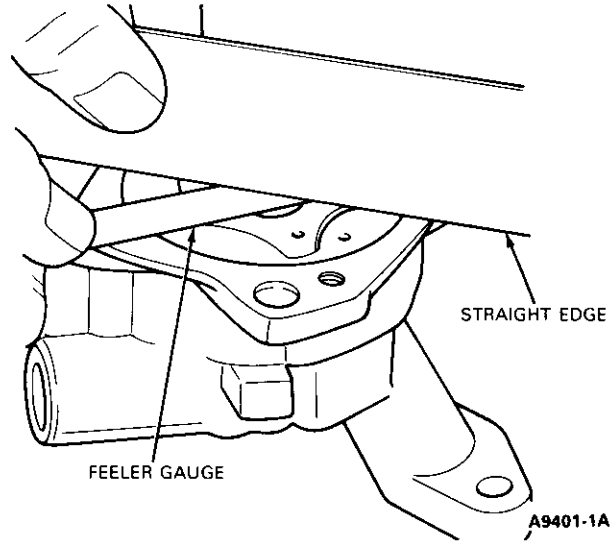


A9401-1A

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

Cleaning

Do not attempt to clean the crankcase ventilation regulator valve; perform the "Functional Check."

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

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

Clean the hoses with a low-volatility, petroleum-base solvent and dry with compressed air.

OVERHAUL

CYLINDER HEAD

Replace the head if it is cracked. **Do not plane or grind more than 0.245mm (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 to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: a 0.003-inch OS reamer with a standard diameter pilot, a 0.015-inch OS reamer with a 0.003-inch OS pilot, and a 0.030-inch reamer with a 0.015-inch OS pilot.

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

REFACING VALVE SEATS

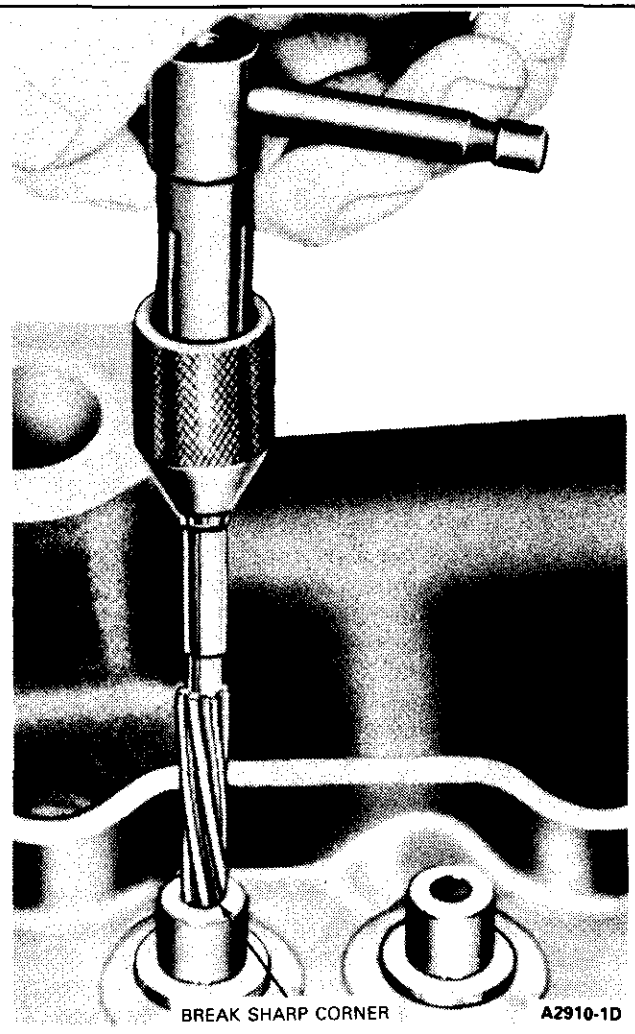
Refacing the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference fit will be maintained. This is important so that the valve and seat will have a compression-tight fit. Be sure that the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

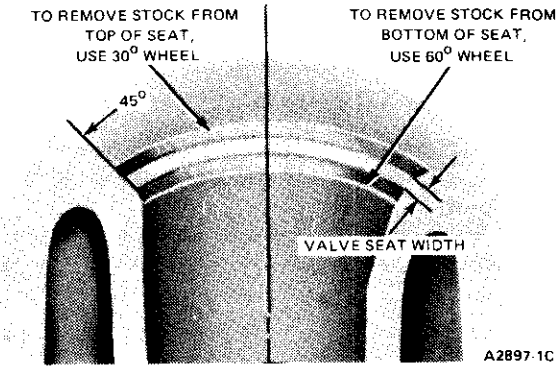
Grind the valve seats of all engines to a true 45 degree angle. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width.

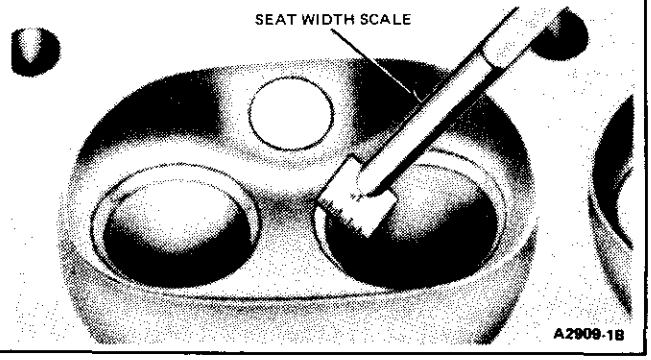
If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications.

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

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







OVERHAUL (Continued)

VALVES

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

Discard any worn or damaged valve train parts.

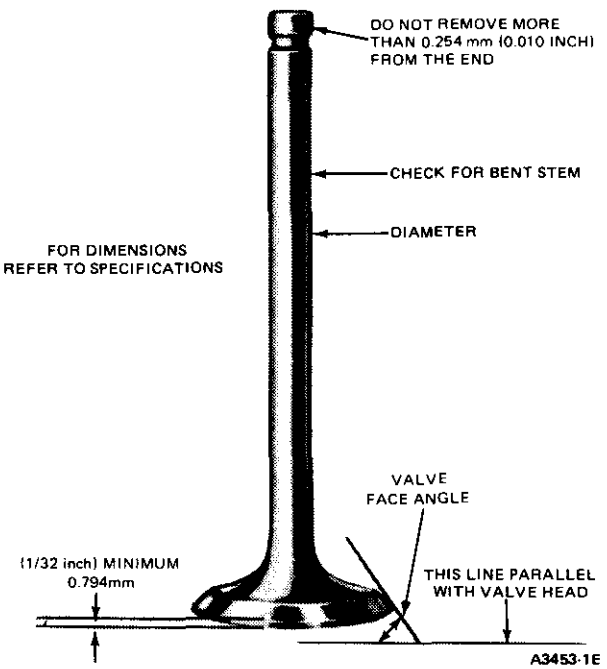
REFACING VALVES

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

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 0.794mm (1/32 inch) thick after grinding, 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 0.254mm (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.



SELECT FITTING VALVES

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

CAMSHAFT REPAIR

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

OVERHAUL (Continued)

CRANKSHAFT

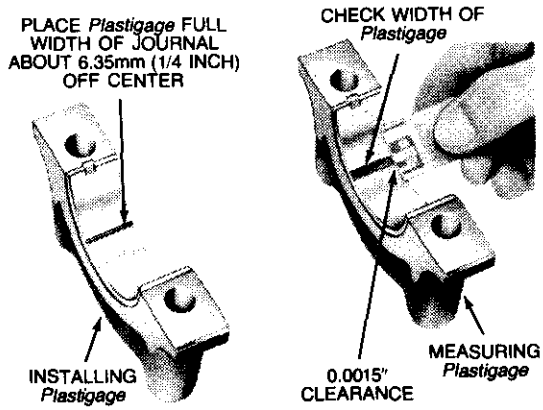
Dress minor scores with an oil stone. If the journals are severly marred or exceed the wear limit, they should be refinished to size for the next undersize bearing.

REFINISHING JOURNALS

Refinish the journals to give the 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 one half of a 0.001 or 0.002 inch undersize bearing in combination with a standard bearing to obtain the proper clearance.
2. If fitting a main bearing, **position a jack under counterweight adjoining bearing which is being checked. Do not place jack under front post of crankshaft.** Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.
3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center.
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 minmum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.
6. If clearance exceeds specified limits, try 0.001 or 0.002 inch undersize bearings in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.
7. After bearing has been fitted, remove the 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.

OVERHAUL (Continued)

PISTONS, PINS AND RINGS

FITTING PISTONS

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

The standard size pistons are color coded red or blue, or have .003 O.S. stamped on the dome. Refer to the Specifications for standard size piston dimensions.

Measure the cylinder bore and select the piston to assure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third a blue piston should be used. When the bore diameter is in the upper one-third, the 0.003 O.S. piston should be used.

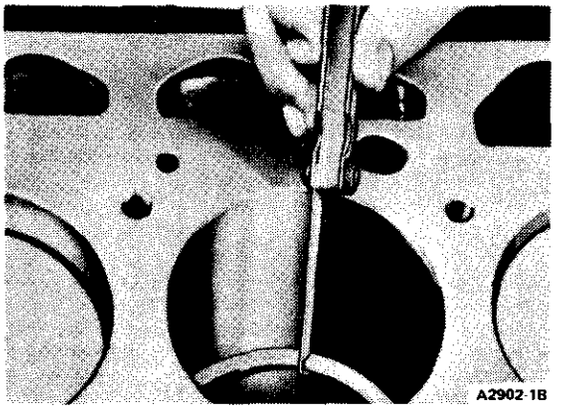
Measure the piston diameter to ensure that the specified clearance is obtained. It may be necessary periodically to use another piston (red or blue) that is either slightly larger or smaller to achieve the specified clearance.

If none can be fitted, refinish the cylinder to provide the proper clearance for the piston. When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted. If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze (refer to Cylinder Block, Refinishing Cylinder Walls). Be sure to clean the cylinder bore thoroughly.

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

FITTING PISTON RINGS

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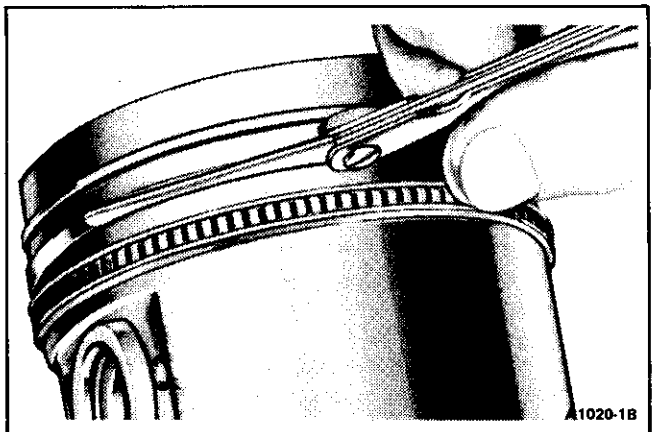
OVERHAUL (Continued)



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 kits complete with the piston pin, to ensure the correct fit. The piston pins should not be interchanged.

VALVE ROCKER ARM

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

PUSH RODS

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

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

OVERHAUL (Continued)

CYLINDER BLOCK

REFINISHING CYLINDER WALLS

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

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

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

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

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

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

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

REPAIRING SAND HOLES OR POROUS ENGINE CASTINGS

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

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

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

a. Clean the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 1/4 inch should not be repaired using metallic plastic. Openings in excess of 1/4 inch can be drilled, tapped and plugged using common tools. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

b. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.

c. Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing the epoxy into the hole or porosity.

d. Allow the repair mixture to harden. This can be accomplished by two methods: heat cure with a 250 degree 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

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (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 tappet completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will collapse and cease to function, and could prevent the valve seat face from properly seating on the valve seat. Valve will be held open.

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

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

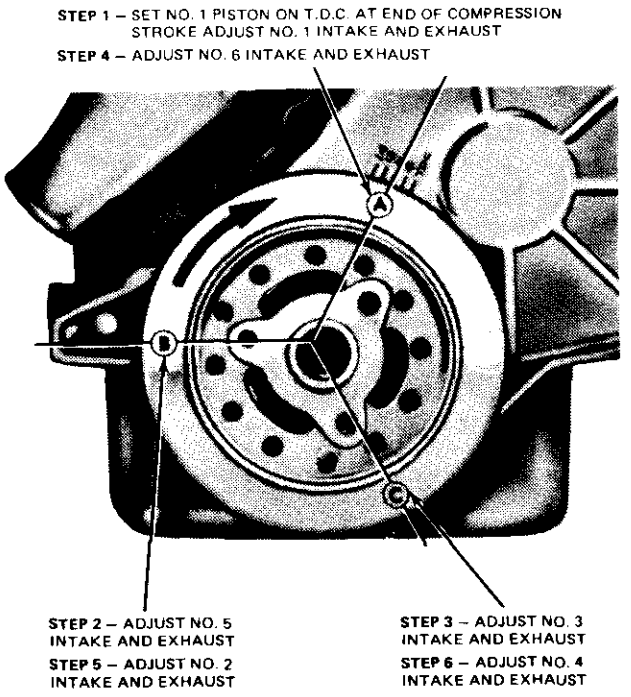
1. Install an auxiliary starter switch. **Crank the engine with the ignition switch Off.**
2. Make two chalk marks on the crankshaft damper. Space the marks approximately 120 degrees apart so that, with the timing mark, the damper is divided into three equal parts (120 degrees is one-third of the distance around the damper circumference).
3. With No. 1 piston on TDC at the end of the compression stroke, tighten the rocker arm bolts of the No. 1 intake and exhaust valves to specifications.

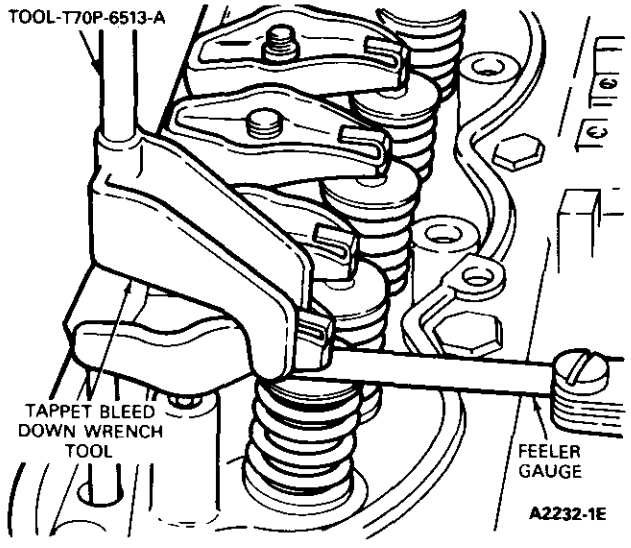
   Then slowly supply pressure to bleed down the hydraulic tappet until the plunger is completely bottomed using Tool T70P-6513-A or equivalent.

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

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

   If the clearance is greater than specifications, install a longer push rod.
4. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, one-third turn at a time, in the direction of rotation, while adjusting the valves in the firing order sequence, 1-5-3-6-2-4.





REMOVAL AND INSTALLATION

CRANKCASE VENTILATION SYSTEM

Removal

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

Installation

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

   Connect the air inlet hose to the crankcase filter cap and carburetor air cleaner.
4. Install the air cleaner. Operate the engine and check for leaks.

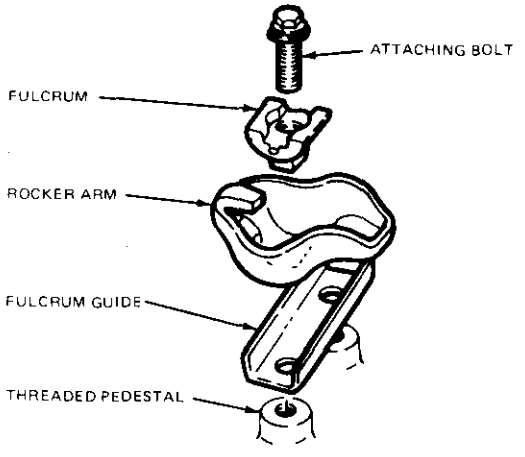
VALVE ROCKER ARM COVER AND ROCKER ARM

Removal

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

Inspect the rocker arm cover bolts for defective seals under the bolt heads and replace as necessary.

The valve rocker arm assembly is shown.



A4870-1A

Installation

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

REMOVAL AND INSTALLATION (Continued)

MANIFOLDS

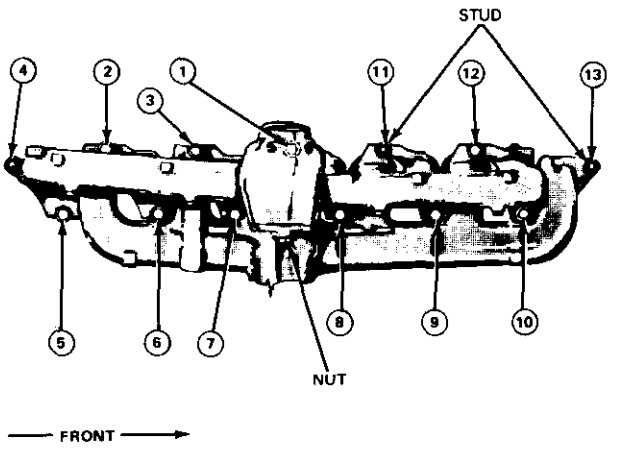
Removal

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

Installation

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

1. Clean the mating surfaces of the cylinder head and manifolds.
2. If one of the manifolds is to be replaced, remove the tube fittings from the discarded manifolds and install them in the new manifold as required. Also install new studs in the new manifold.
3. If the intake and exhaust manifolds have been separated, coat the mating surfaces lightly with graphite grease and place the exhaust manifold over the studs on the intake manifold. Install the lock washers and nuts. Tighten them finger tight.
4. Install a new intake manifold gasket.
5. Coat the mating surfaces lightly with graphite grease. Place the manifold assemblies in position against the cylinder head. **Make sure that the gaskets have not become dislodged. Install the attaching washers, bolts and nuts.** Torque the bolts and nuts to specifications in the sequence shown.



A3186-1D

If the intake and exhaust manifolds were separated, tighten the nuts joining them.

6. Connect the crankcase vent hose to the intake manifold inlet tube and position the hose clamp.
7. Connect the fuel inlet line and the distributor vacuum line to the carburetor.
8. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
9. Install the air cleaner. Adjust the engine idle speed and idle fuel mixture.

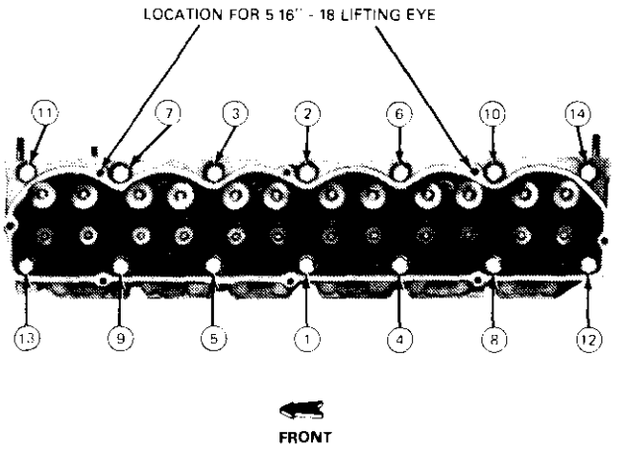
REMOVAL AND INSTALLATION (Continued)

CYLINDER HEAD

Removal

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

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



A3187-1B

Installation

1. Clean the cylinder head and cylinder block gasket surfaces. Clean the exhaust pipe.
2. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the head and block gasket surfaces.
3. Position the gasket over the dowel pins on the cylinder block.
4. Install lifting eyes on the cylinder head in the location shown and use a floor crane and lifting sling to lift the cylinder head over the cylinder block. Lower it carefully until it is properly positioned on the block and dowel pins. Remove the hoist and lifting eyes.
5. Coat the threads of the cylinder head bolts with engine oil. Install the bolts.
6. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown. Torque the bolts to specifications.
7. Apply Polyethylene Grease D0AZ-19584-A or equivalent to both ends of the push rods. Install the push rods in their original bores, positioning the lower end of the rods in the valve tappet sockets.

REMOVAL AND INSTALLATION (Continued)

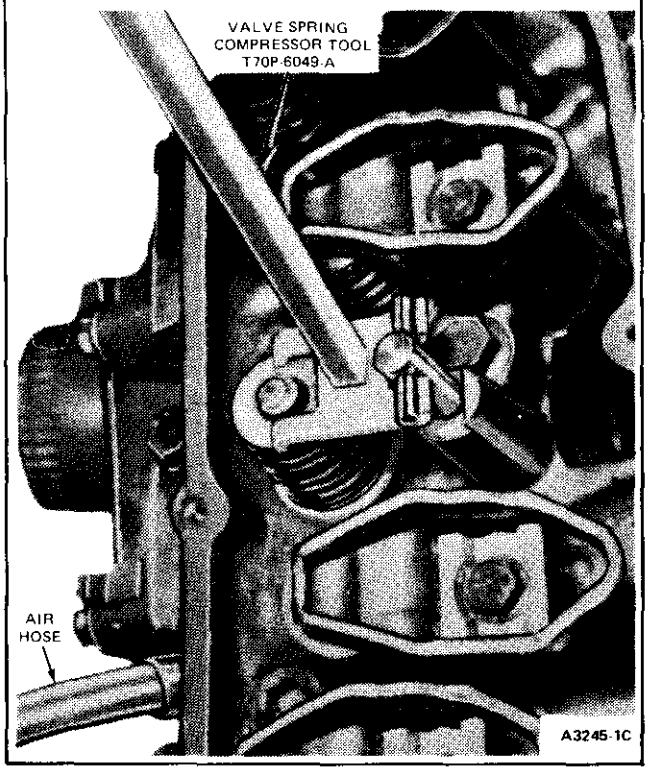
8. Apply Polyethylene Grease D0AZ-19584-A or equivalent to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Position the rocker arms and tighten the bolts.
9. Clean the valve rocker arm cover. Coat one side of a new valve rocker arm cover gasket with oil-resistant sealer. Lay the cemented side of the gasket in place in the cover. Position the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and torque in sequence (starting in the center) to specifications.
10. Connect the spark plug wires to the spark plugs.
11. Connect the crankcase vent hose to the inlet tube in the intake manifold. Install the crankcase ventilation regulator valve in the valve rocker arm cover.
12. Position the fuel inlet line and the distributor vacuum line on the engine. Connect the distributor vacuum line to the distributor and carburetor. Connect the carburetor fuel inlet line to the carburetor and fuel pump.
13. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
14. Connect the radiator upper hose to the coolant outlet housing.
15. Fill and bleed the cooling system.
16. Operate the engine until temperatures have stabilized. Adjust the engine idle speed and idle fuel mixture. Check for fuel, oil and coolant leaks.
17. Install the air cleaner.

VALVE SPRING, RETAINER AND STEM SEAL

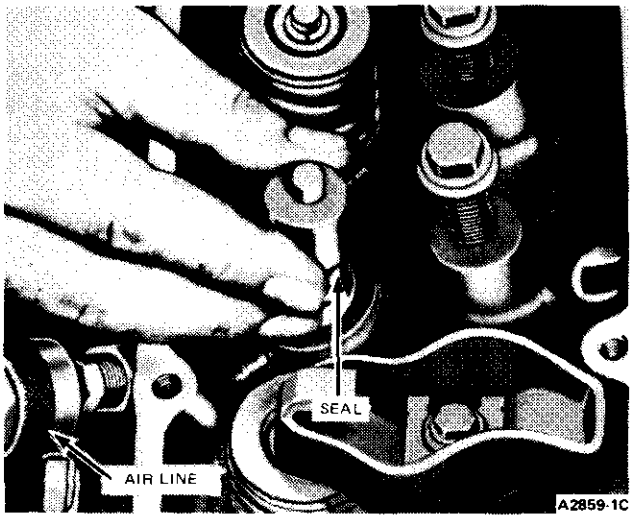
Broken valve springs or defective valve stem seals and retainers may be replaced without removing the cylinder head providing damage to the valve or valve seat has not occured.

Removal

1. Remove the air cleaner.
2. Disconnect the throttle rod from the carburetor throttle lever. Disconnect the choke cable at the carburetor.
3. Remove the crankcase ventilation regulator valve from the valve rocker arm cover and remove the valve rocker arm cover. Remove the applicable spark plug.
4. Crank the engine until the applicable piston is on TDC after the compression stroke.
5. Install an air line adapter in the spark plug hole and connect the air line.
6. Remove the applicable valve rocker arm bolt, fulcrum seat, valve rocker arm and push rod. Position the compressor tool as shown. Compress the valve spring and remove the retainer locks, spring retainer and valve spring. Remove and discard the valve stem seal.



REMOVAL AND INSTALLATION (Continued)



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

7. **If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.**
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 as outlined on page 1-26.**
9. If the condition of the valve proved satisfactory, hold the valve in the closed position and apply air pressure within the cylinder.

Installation

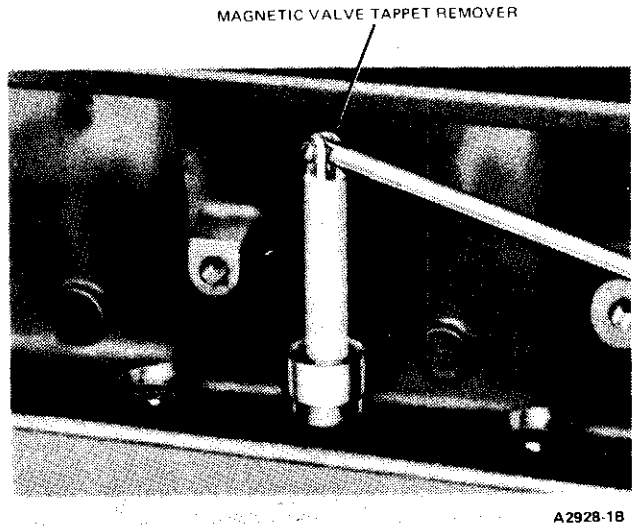
1. Oil the valve stem with heavy engine oil and install a new valve stem seal. Place the spring in position over the valve. **Be sure the closed coil end is next to the cylinder head.** Install the valve spring retainer. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool.
2. Apply Polyethylene Grease D0AZ-19584-A or equivalent to both ends of the push rod. Install the push rod. Apply Lubriplate to the tip of the valve stem.
3. Apply Polyethylene Grease D0AZ-19584-A or equivalent to the fulcrum seat and socket. Install the valve rocker arm, fulcrum seat and bolt.
4. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
5. Clean the valve rocker arm cover. Coat one side of a new gasket with oil-resistant sealer. Position the gasket on the rocker arm cover; **be sure the cemented side is towards the cover.** Install the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and torque them in sequence (starting in the center) to specifications.
6. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable to the carburetor.
7. Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the air cleaner.

REMOVAL AND INSTALLATION (Continued)

VALVE TAPPET

Removal

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



A2928-1B

Installation

1. Clean the rocker arm cover, push rod cover, cylinder head and block gasket surfaces.
2. Apply Polyethylene Grease D0AZ-19584-A or equivalent to the cam lobe contact surface of the valve tappet(s). Coat the rest of the valve lifter(s) with engine oil. Install the valve tappets with the tool shown.
3. Apply Polyethylene Grease D0AZ-19584-A or equivalent to both ends of the push rod(s). Install the push rod(s) in sequence. Engage the rocker arm(s) with push rod(s) and tighten the rocker arm bolt(s) sufficiently to hold the push rod(s) in place. **Be sure each push rod is properly seated in the valve lifter socket.**
4. Tighten the valve rocker arm bolts to specification.
5. Coat one side of new gaskets with oil-resistant sealer and position the gaskets, cemented side toward the cover. Install the push rod cover and the rocker arm cover. Torque the cover screws in sequence to specifications. Install the crankcase regulator valve in the rocker arm cover.
6. Position the coil on the cylinder head and install the attaching bolt.
7. Install the distributor cap and spark plug wire assembly. Connect the spark plug wires and coil secondary high tension wire.
8. Connect the throttle cable to the carburetor. Connect the choke cable to the carburetor.
9. Install the air cleaner. Start the engine and adjust the carburetor idle speed and fuel mixture.

WATER PUMP

Removal

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

REMOVAL AND INSTALLATION (Continued)

Installation

Before a water pump is re-installed, check it for damage. If it is damaged and requires repair, replace it.

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

CYLINDER FRONT COVER

Removal

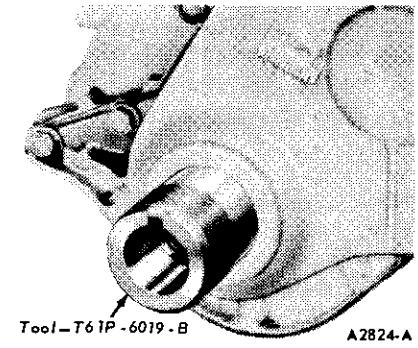
1. Drain the cooling system.
2. Remove the radiator.
3. Remove the alternator adjusting arm bolt, loosen the drive belt and swing the adjusting arm out of the way. Remove the fan and drive belts.
4. Remove the screw and washer from the end of the crankshaft and remove the damper.
5. Remove the front oil pan and front cover attaching screws.

CAUTION: Prevent foreign material from entering the crankcase during service work or the crankcase oil will have to be changed.

6. Remove the cylinder front cover and discard the gasket. It is a good practice to replace the crankshaft oil seal when the cylinder front cover is removed.

Installation

1. Coat a new seal with grease and install the seal. Drive the seal in until it is fully seated in the recess. After installation, check to be sure the seal is properly positioned in the cover and the spring is properly positioned in the seal.
2. Cut the old front oil pan seal flush at the cylinder block/pan junction. Remove the old seal material.
3. Clean all gasket surfaces — front cover, block, and oil pan.
4. Cut and fit the new pan seal flush to the cylinder block/pan junction. (Old seal may be helpful as a pattern.)
5. Coat the gasket surfaces of the block and cover with B5A-19554-A oil resistant sealer. Position a new front cover gasket on the block.
6. Align the pan seal locating tabs with the pan holes, pull the seal tabs through until the seal



is completely seated. Apply RTV silicone sealer D6AZ-19562-A or B or equivalent to the block/pan junction.

NOTE: When applying RTV sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.

7. Position the front cover assembly over the end of the crankshaft and against the cylinder block. Start the cover and pan attaching screws. Slide the cover alignment tool over the crank stub and into the seal bore of the cover. Install alternator adjusting arm, tighten all attaching oil pan and front cover screws.

NOTE: Tighten the oil pan screws first (compress pan seal) to obtain proper cover alignment.

8. Lubricate the crank stub, damper hub I.D. and the seal rubbing surface with Polyethylene Grease D0AZ-19584-A or equivalent. Align the damper keyway with the key on the crankshaft and install the damper.
9. Install the washer and capscrew. Tighten to specification.
10. Install the pulley(s), drive belt(s), spacer (if used) and fan. Adjust all drivebelt tensions to specification.
11. Install the shroud, radiator, and hoses.

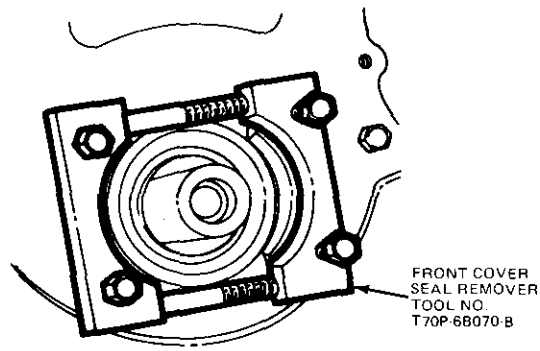
REMOVAL AND INSTALLATION (Continued)

12. Fill and bleed the cooling system. Use the specified antifreeze mix. If foreign material has not entered the crankcase during the service work, it is not necessary to change the engine oil.
13. Operate the engine at fast idle and check for coolant and oil leaks.

FRONT OIL SEAL

Removal

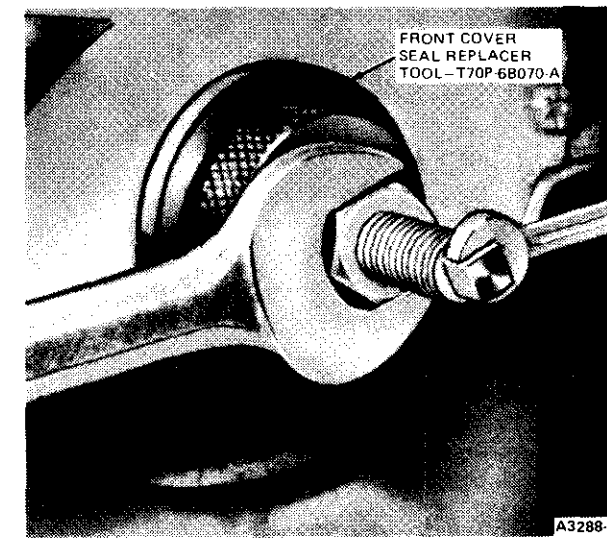
1. Remove the bolts attaching the fan shroud to the radiator.
2. Remove the fan and spacer bolts from the water pump shaft. Remove the fan, spacer and shroud.
3. Loosen the alternator, power steering, Thermactor and air conditioner drive belts, if so equipped. Remove the drive belts.
4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
5. Place the front seal removing tool (Tool T70P-6B070-B) onto the front cover plate over the front seal as shown. Tighten the two through bolts to force the seal puller under the seal flange.
6. Alternately tighten the four puller bolts a half turn at a time as shown to pull the oil seal from the front cover.



A5765-1B

Installation

1. Coat a new front cover plate oil seal with Polyethylene Grease D0AZ-19584-A or equivalent and place it onto the front oil seal alignment and installation sleeve as shown. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.



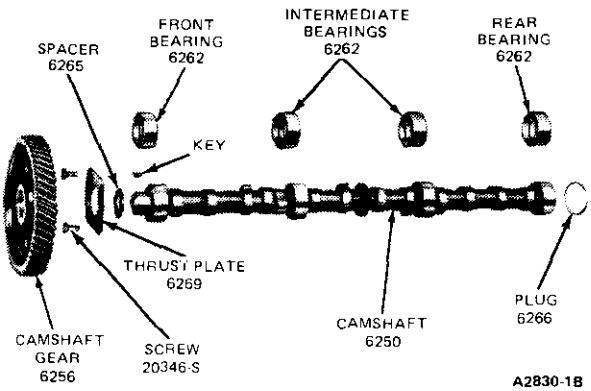
A3288-1C

2. Place the installation screw, washer and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.
3. Apply Polyethylene Grease D0AZ-19584-A 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.
4. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft. Install the cap screw and washer. Install the crankshaft pulley.
5. Install the alternator, power steering pump, Thermactor and air conditioner belts, if so equipped.
6. Position the fan shroud over the water pump pulley. Install the fan and spacer. Install the fan shroud attaching screws.
7. Adjust the drive belts to specification.

REMOVAL AND INSTALLATION (Continued)

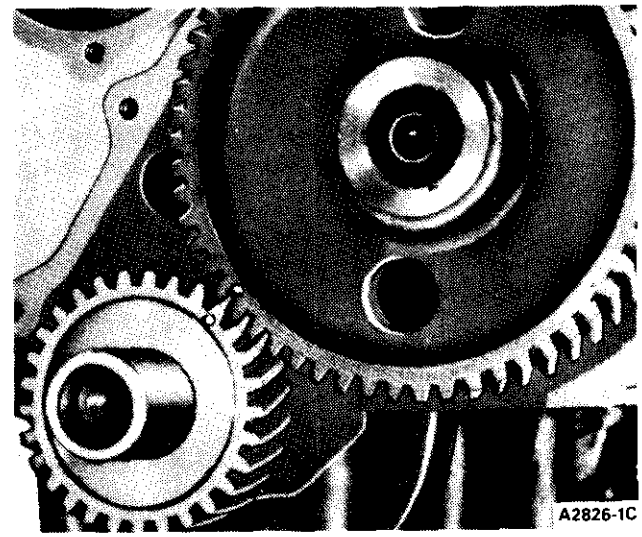
CAMSHAFT

The camshaft and related parts are shown.

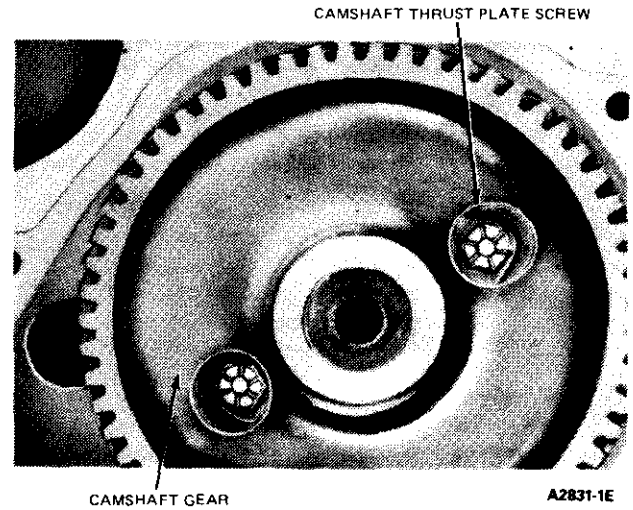


Removal

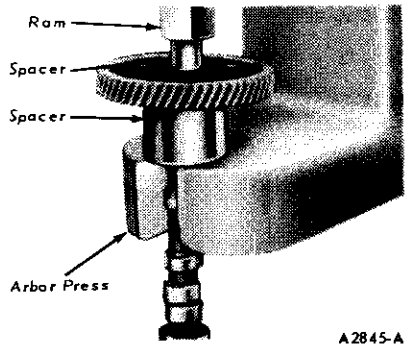
1. Drain the cooling system and the crankcase.
2. Remove the air cleaner. Remove the crankcase ventilation regulator valve from the rocker arm cover.
3. Disconnect the throttle rod from the carburetor throttle lever. Disconnect the choke cable at the carburetor. Disconnect the throttle at the carburetor and position out of the way.
4. Remove the radiator.
5. Loosen the alternator adjusting arm bolt and remove the drive belt.
6. Disconnect the spark plug wires at the spark plugs and disconnect the secondary high tension wire at the ignition coil. Remove the distributor cap and spark plug wires assembly.
7. Disconnect the fuel outlet lines at the fuel pump. Remove the fuel pump mounting bolts and position the fuel pump out of the way.
8. Disconnect the vacuum line at the distributor and the primary wire at the coil. Remove the distributor.
9. Remove the valve rocker arm cover. Loosen the rocker arm bolts, move the rocker arms to one side and remove the push rods in sequence. Place the push rods in a rack so they can be installed in their original locations.
10. Remove the valve push rod cover; then remove the valve lifters in sequence. Place the valve lifters in a tray or rack to facilitate installation in the same sequence in which they were removed.
11. Remove the cap screw and washer from the end of the crankshaft.
12. Remove the damper.
13. Remove the cylinder front cover following the procedure given in this section.
14. Check the camshaft end play, the timing gear backlash and the timing gear runout.



15. Turn the crankshaft to align the timing marks as shown.
16. Remove the camshaft thrust plate screws. Remove the camshaft. **Avoid damaging the camshaft lobes during removal.** Press the camshaft out of the gear in an arbor press. Remove the key, thrust plate and spacer.



REMOVAL AND INSTALLATION (Continued)



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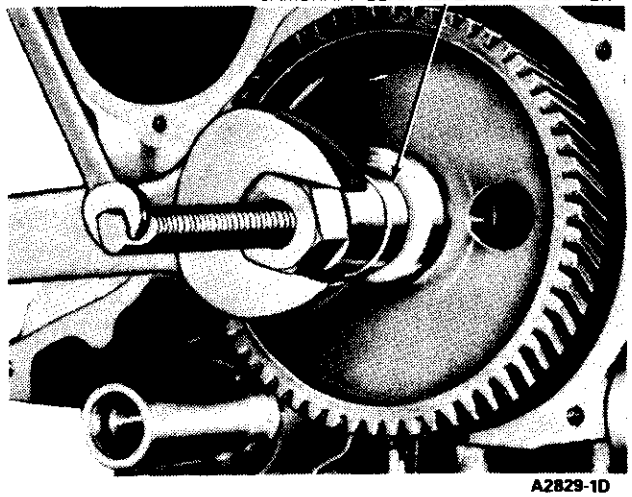
CAMSHAFT GEAR REPLACING ADAPTER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Installation

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

1. Oil the camshaft bearing journals and apply Polyethylene Grease D0AZ-19584-A or equivalent to all the lobes.
2. Install the camshaft and thrust plate.
3. Torque the thrust plate attaching screws to specifications.
4. Position the camshaft gear on the camshaft. Align the timing marks on the timing gears as shown. Install the camshaft gear with the tool shown. Be sure the gear and spacer are tight against the shoulder on the camshaft.
5. Crank the engine until the timing marks are aligned. **Do not turn the crankshaft again until the distributor is installed.**
6. Clean the cylinder front cover and cylinder block gasket surfaces. Install a new oil seal in the cylinder front cover. Clean the crankshaft damper and inspect it, following the procedures on page 1-11. Install the cylinder front cover and damper, following the applicable procedure under Cylinder Front Cover Installation.
7. Lubricate the valve lifters with heavy engine oil and install the lifters in the same bores from which they were removed. Apply Polyethylene Grease D0AZ-19584-A or equivalent to both ends of the push rods and install the push rods in the same sequence that they were removed. Be sure the push rods were seated in the valve lifter sockets.
8. Clean the valve push rod cover and cylinder block gasket surfaces. Apply oil-resistant sealer to one side of a new gasket and place the gasket on the push rod cover with the cemented side next to the cover. Install the cover and torque the bolts in sequence to specifications.
9. Apply Polyethylene Grease D0AZ-19584-A or equivalent to the valve pad on the rocker arms. Oil the valve stems with heavy engine oil. Align the valve rocker arms with the valves and push rods. Tighten the rocker arm bolts.
10. Clean the valve rocker arm cover and cylinder head gasket surface. Apply oil-resistant sealer to one side of a new gasket and install the gasket on the cover (sealer side against cover). Install the cover and torque the screws in sequence to specifications.
11. Install the distributor following the procedure in Part 2, Ignition System. Install distributor with rotor pointing at number one terminal position in cap, and armature and stator assembly poles aligned. Install hold-down clamp.
12. Clean the fuel pump and cylinder block gasket surfaces. Install the fuel pump with a new gasket. Torque the mounting bolts to specifications. Connect the fuel outlet line to the fuel pump.
13. Install the distributor cap and spark plug wires as an assembly. Connect the spark plug wires to the plugs and the secondary high tension wire to the coil.

REMOVAL AND INSTALLATION (Continued)

14. Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the throttle rod cable housing bracket on the cylinder head. Connect the throttle rod to the carburetor throttle lever. Connect the choke cable and the hand throttle cable.
15. Install the water pump pulley, cooling fan and drive belt. Adjust the belt tension to specifications.
16. Install the radiator. Connect the radiator upper hose to the thermostat housing cover. Connect the lower hose to the water pump.
17. Install the air cleaner.
18. Fill the cooling system.
19. Start the engine and check for oil, coolant and fuel leaks. Adjust the ignition timing. Connect the distributor vacuum line to the distributor. Adjust the carburetor idle speed and fuel mixture.

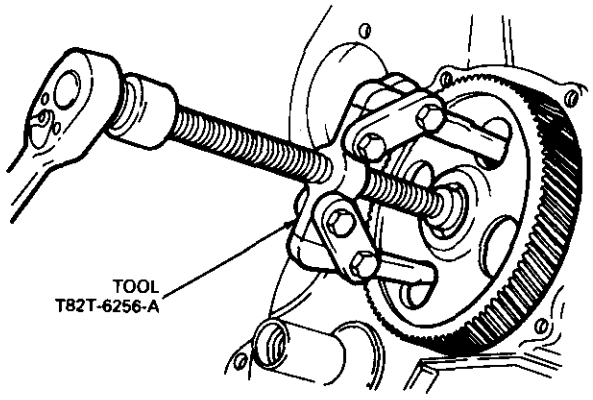
TIMING GEARS

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

CAMSHAFT GEAR — METAL GEAR

Removal

1. Drain the cooling system and crankcase.
2. Remove the cylinder front cover and oil pan, following the procedures under Cylinder Front Cover Removal.



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3. Check the camshaft end play, the timing gear backlash and the timing gear runout.
4. Crank the engine until the timing marks are aligned as shown.
5. Install the gear puller as shown and remove the camshaft gear.

Installation

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

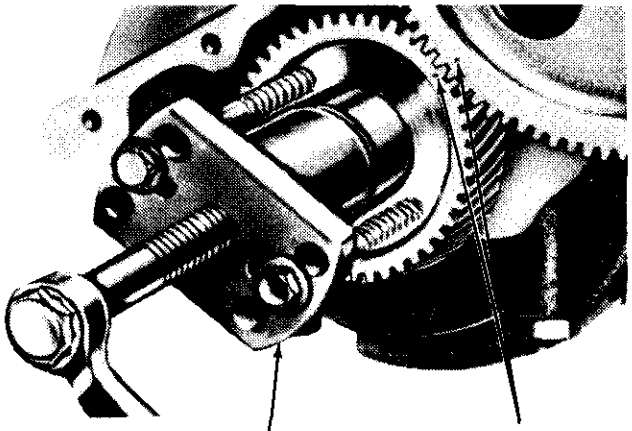
1. Be sure the key and spacer are properly installed. Align the gear keyway with the key and install the gear on the camshaft as shown. Be sure that the timing marks line up on the camshaft and crankshaft gears.
2. Install the cylinder front cover and related parts, following the procedures under Cylinder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

REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT GEAR

Removal

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



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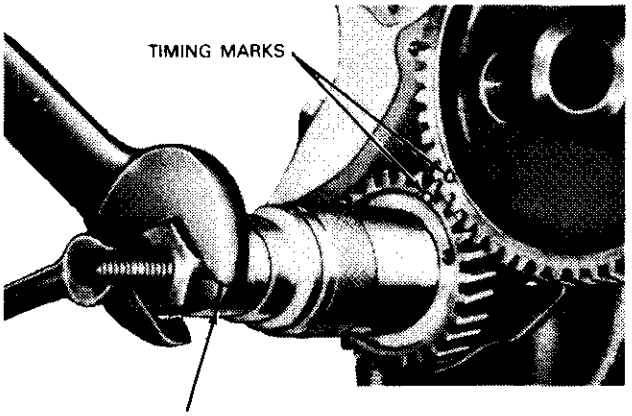
Installation

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



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CORE PLUGS

Removal

To remove a large core plug, drill a 12.70mm (1/2 inch) hole in the center of the plug and remove with a clutch pilot bearing puller (Tool T59L-100-B and T58L-101-) or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (1/4 inch) hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

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

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

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

Installation

Cup-Type

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

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

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

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

Expansion-Type

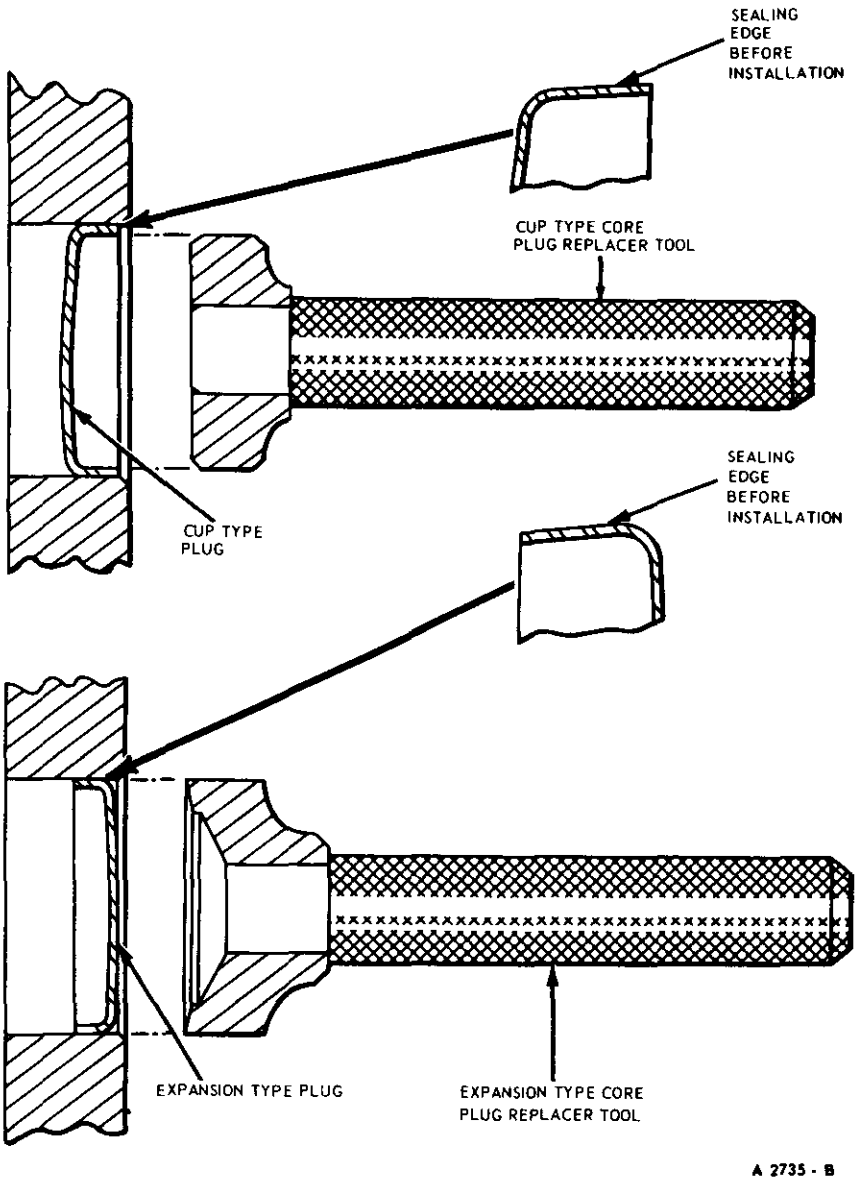
Expansion-type core plugs are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

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

REMOVAL AND INSTALLATION (Continued)

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.



REMOVAL AND INSTALLATION (Continued)

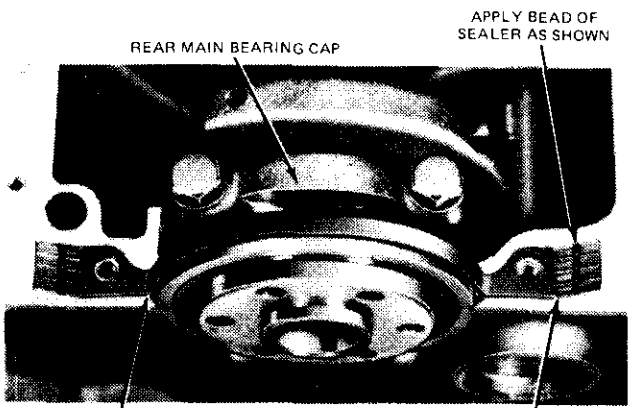
OIL PAN

Removal

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

Installation

1. Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Remove the rear main bearing cap to oil pan seal and cylinder front cover to oil pan seal. Clean the seal grooves.
2. Apply oil-resistant sealer B5A-19554-A or equivalent in the cavities between the bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.



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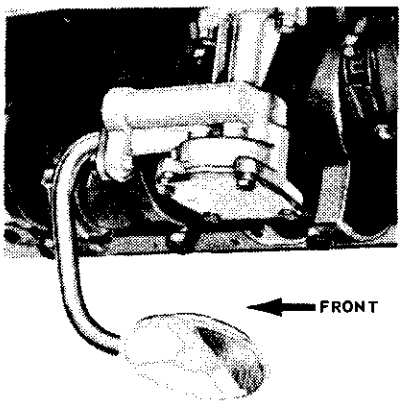
3. Install new side gaskets on the oil pan with oil-resistant sealer D7AZ-19B508-A or equivalent. Position a new oil pan to cylinder front cover seal on the oil pan.
4. Clean the inlet tube and screen assembly and place it in the oil pan.
5. Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Torque the screws to specifications. Position the oil pan against the cylinder block and install the attaching bolts. Torque the bolts in sequence to specifications.
6. Fill the crankcase and cooling system.
7. Start the engine and check for coolant and oil leaks.

OIL PUMP

Removal

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



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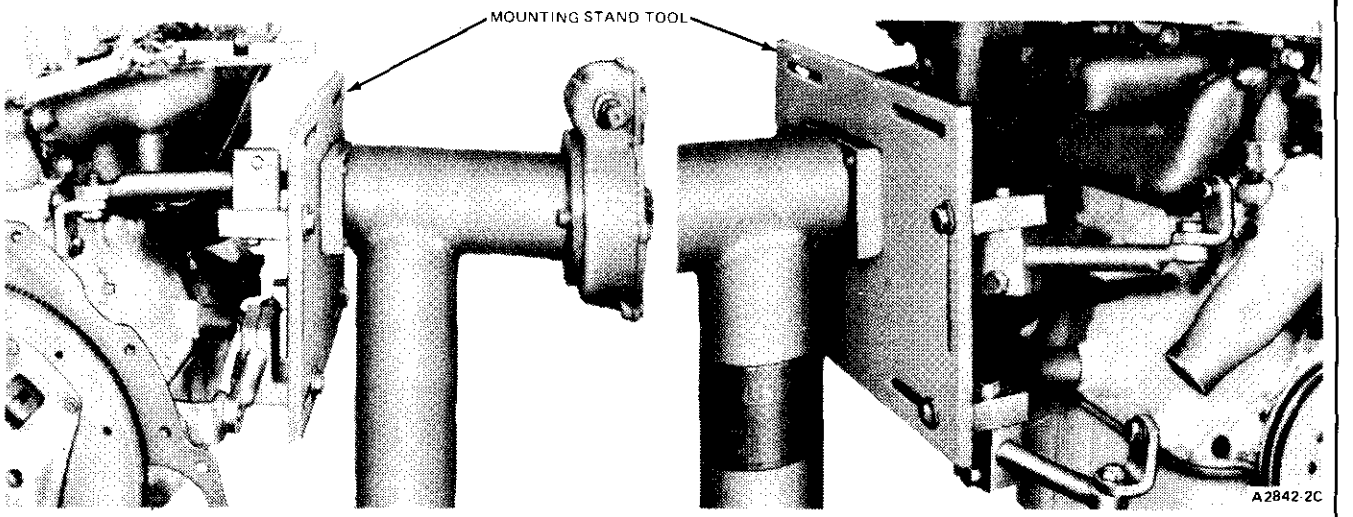
Installation

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

CRANKSHAFT REAR OIL SEAL

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

REMOVAL AND INSTALLATION (Continued)

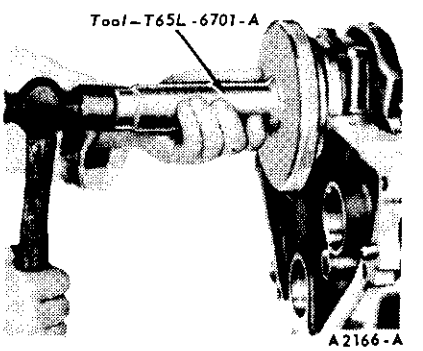


Removal

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

Installation

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



REMOVAL AND INSTALLATION (Continued)

MAIN BEARING

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

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

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

Removal

1. Drain the crankcase. Remove the oil pan and oil pump, following the procedure under Oil Pan Removal.
2. **Replace one bearing at a time, leaving the other bearings securely fastened.** Remove the main bearing cap to which new bearings are to be installed.
3. Insert the upper bearing remover (Tool 6331) in the oil hole in the crankshaft journal.
4. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
5. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings or a combination of a standard bearing and a 0.001 or 0.002 inch undersize bearing.

Installation

1. **The upper and lower bearing halves are not interchangeable. The upper half is drilled and grooved to provide entry of oil.** To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Tool 6331 can be inserted in the oil hole in the crankshaft journal. With Tool 6331 positioned in the oil hole, rotate the crankshaft slowly in the opposite direction of engine rotation until the bearing is seated. Remove the tool.

   Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings on page 1-19.
2. After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings, then install the bearing cap. Torque the cap bolts to specifications.
3. Repeat the procedure for the remaining bearings that require replacement.
4. If the thrust bearing cap (No. 5 main bearing) has been removed, install it as follows:

   Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.
5. **If the rear main bearing is replaced (on a work stand), apply a bead of oil-resistant sealer in each corner of the rear main bearing cap saddle the full length of the saddle. Be sure the main bearing is fitted and the cap bolts torqued to specifications before installing the new crankshaft rear oil seal.**
6. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until the oil emerges from the outlet opening.
7. Install the oil pump and oil pan, following the procedure under Oil Pan Installation.
8. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

REMOVAL AND INSTALLATION (Continued)

CONNECTING ROD BEARING

Removal

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

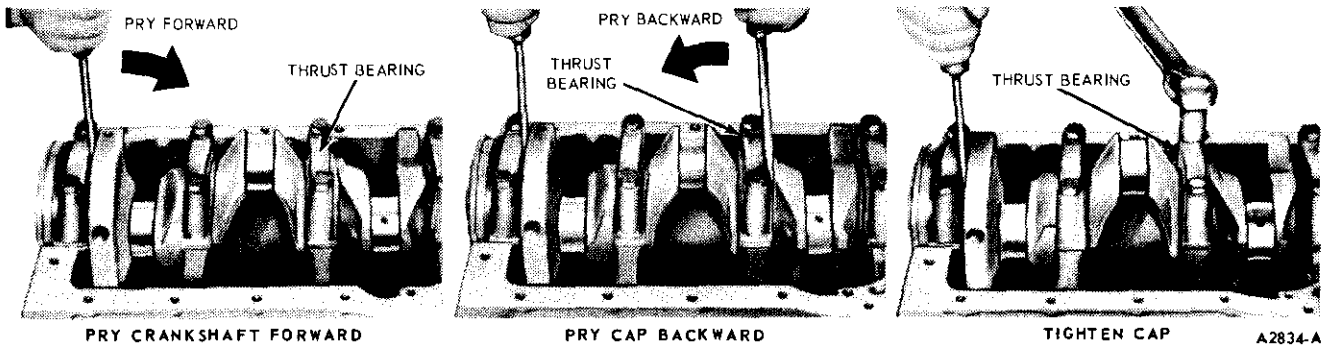
Refer to page 1-14 for the cleaning and inspection procedures.

Installation

1. Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots.
2. Pull the connecting rod assembly down firmly on the crankshaft journal.

Fit the bearing following procedures given under Fitting Main and Connecting Rod Bearings.

3. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap and torque the nuts to specifications.
4. Repeat the procedure for the remaining connecting rods that require new bearings.
5. Install the oil pan and oil pump, following the procedures under Oil Pan Installation in this section.
6. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.



PISTONS AND CONNECTING RODS

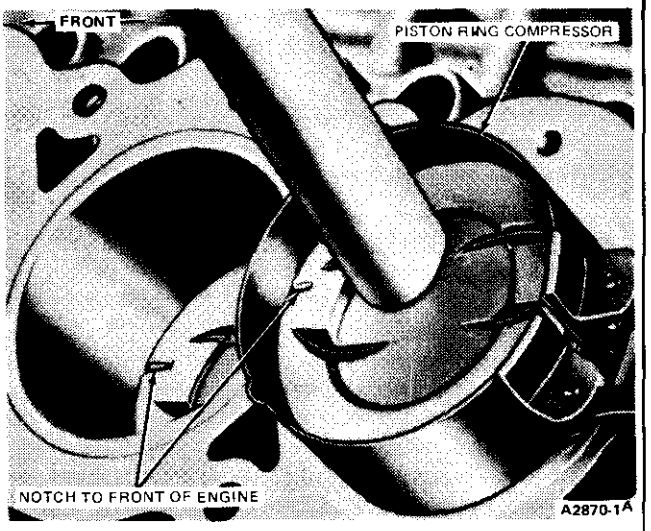
Removal

1. Drain the cooling system and the crankcase.
2. Refer to Cylinder Head Removal and remove the cylinder head and related parts.
3. Remove the oil pan following the procedure under Oil Pan Removal. Remove the oil pump inlet tube and the oil pump.
4. Turn the crankshaft until the piston to be removed is at the bottom of the stroke and place a cloth on the piston bead to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 0.74 mm (1/32 inch) when removing ridges.**
5. Make sure all connecting rod caps are marked so that they can be installed in their original positions. Remove the connecting rod cap.
6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

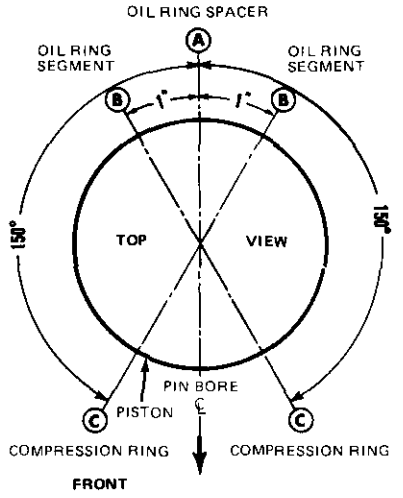
REMOVAL AND INSTALLATION (Continued)

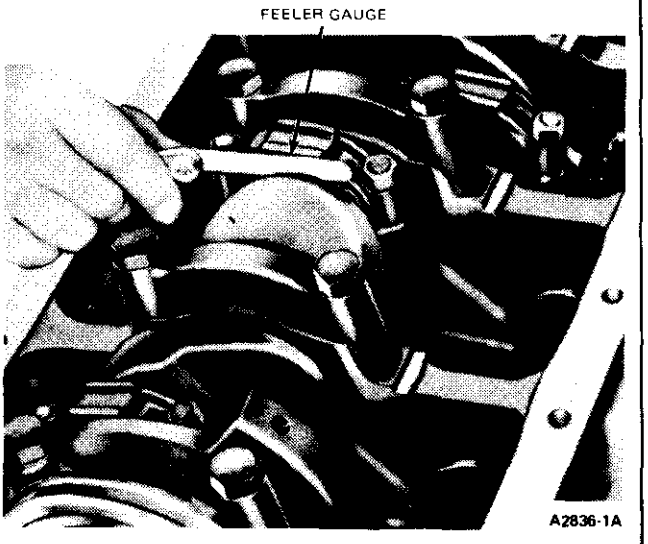
Installation

1. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.
2. Oil the piston rings, pistons and cylinder walls with light engine oil.
3. **Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod sand bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side when installing in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**
4. Make sure the ring gaps are properly spaced around the circumference of the piston. Oil the rings, then install a piston ring compressor on the piston. Make sure that the indentation in the head of the piston is toward the front, then push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals.
5. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.



6. After the bearings have been fitted, apply a light coat of engine oil to the journal and bearings.
7. Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.
8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.
9. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts.





REMOVAL AND INSTALLATION (Continued)

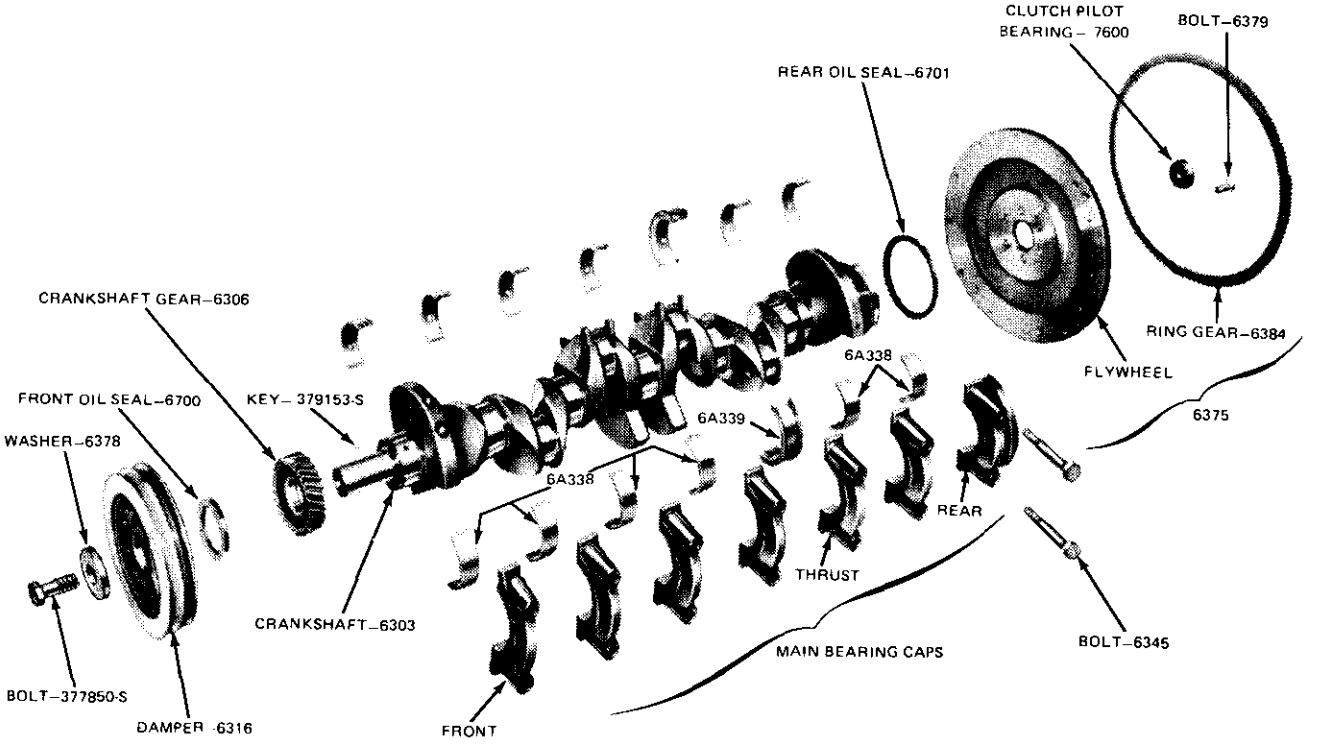
10. Refer to Cylinder Head Installation and install the cylinder head and related parts. Adjust the valve clearance.
11. Fill and bleed the cooling system. Fill the crankcase.
12. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.
13. Operate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

CRANKSHAFT

The crankshaft and related parts are shown.

Removal

1. Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the oil level dipstick.
3. Remove the crankshaft damper retaining capscrew and lock washer. Remove the crankshaft damper.
4. Remove the cylinder front cover and gasket.
5. Remove the flywheel and engine rear cover plate.
6. Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.
7. Use an awl to punch two holes in the crankshaft rear oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. **Use caution throughout this procedure to avoid scratching or otherwise damaging crankshaft oil seal surface.**



REMOVAL AND INSTALLATION (Continued)

8. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. **Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals.** Repeat this procedure and remove all connecting rod caps.
9. Remove the clutch pilot bushing if necessary.
10. Align the timing marks. Remove the crankshaft gear.
11. Remove the main bearing caps and bearings.
12. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged.

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

Refer to page 1-12 for the cleaning and inspection procedures. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

To refinish journals, dress minor imperfections, etc., refer to page 1-19.

Installation

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

REMOVAL AND INSTALLATION (Continued)

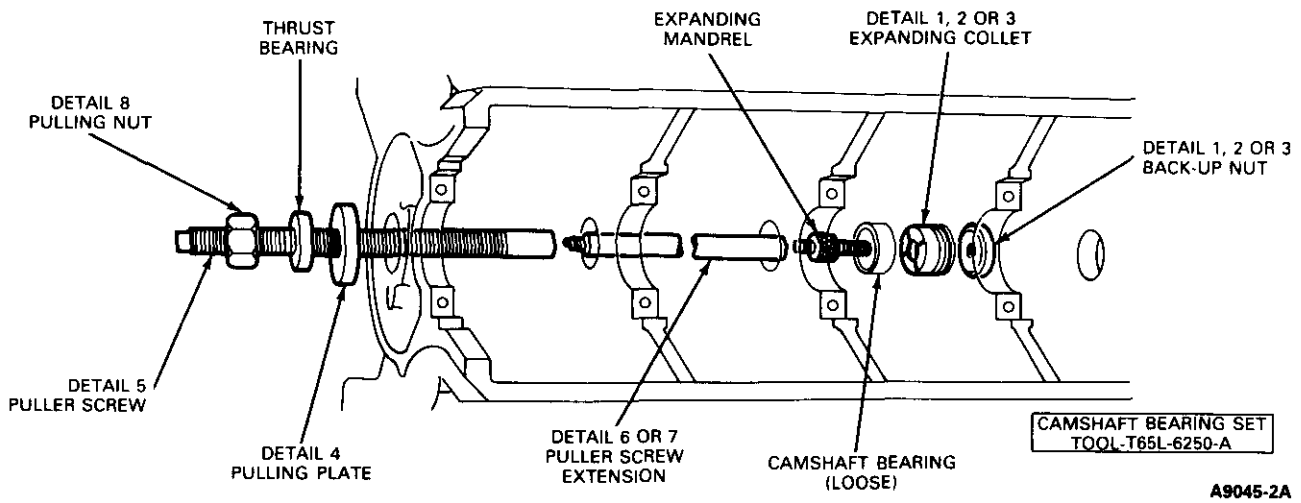
23. Install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install it with a new gasket. Torque the attaching bolts to specifications.
24. Install the clutch pilot bushing.
25. Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. **Coat the threads of the attaching bolts with oil-resistant sealer and install the bolts.** Torque the bolts to specifications.
26. Turn the engine on the work stand so that the front end is up.
27. Install the crankshaft gear following the procedure under Timing Gear Installation.
28. Install a new crankshaft front oil seal in the cylinder front cover. Install the cylinder front cover and crankshaft damper.
29. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with oil-resistant sealer. Position a new oil pan to the cylinder front cover seal on the oil pan and install the oil pan.
30. Install the oil level dipstick.
31. Remove the engine from the work stand. Fill crankcase, check the ignition timing and adjust if necessary.
32. Check the ignition timing and adjust if necessary.

CAMSHAFT BEARING

Camshaft bearings are available pre-finished to size for standard and 0.381mm (0.015 inch) undersize journal diameters.

Removal

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



REMOVAL AND INSTALLATION (Continued)

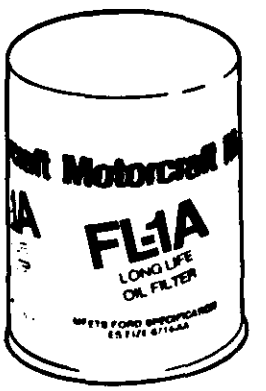
Installation

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

OIL FILTER

Disposable-Type

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



DISASSEMBLY AND ASSEMBLY

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

ENGINE ASSEMBLY

Disassembly

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

DISASSEMBLY AND ASSEMBLY (Continued)

17. Remove the crankshaft gear as shown.
18. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 0.74 mm (1/32 inch) when removing ridges.**
19. **Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.** Turn the crankshaft until the connecting rod being removed is down. Remove the connecting rod cap.
20. Push each connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**
21. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.
22. Remove the main bearing caps. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Remove the crankshaft rear oil seal. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**
23. Remove the main bearing inserts from the cylinder block and main bearing caps.
24. Remove oil dipstick tube, the cylinder head dowel pins and cylinder block drain plugs.
25. Disassemble the pistons, piston rings and connecting rods, following the procedures under Pistons and Connecting Rods Disassembly.
26. If the camshaft gear is to be removed from the camshaft, press the camshaft out of the gear in an arbor press.
27. Remove the thrust plate and spacer. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings. Refer to Camshaft Bearing Replacement.
28. Remove the carburetor from the intake manifold and discard the gasket. Remove the intake and exhaust manifolds from the cylinder head and separate the manifolds. Disassemble the cylinder head, removing the rocker arms, valves, valve springs, coolant outlet elbow, etc. Place all parts in a rack or identify them so they can be installed in the same location from which they were removed.

Assembly

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

1. Clean and inspect all parts per the appropriate procedures under Cleaning and Inspection, except do not disassemble the oil pump and hydraulic lifters for cleaning.
2. Remove the glaze from the cylinder bores by following the procedures on page 1-14, Refinishing Cylinder Walls.
3. Invert the engine on the work stand. Position new camshaft bearings in the cylinder block, making sure that the oil holes in the bearing are aligned with those in the block. Press them in place. **Be sure the camshaft front bearing is installed the specified distance below the front face of the cylinder block.**
4. Install a new camshaft rear bearing bore plug.
5. Oil the camshaft bearing journals and apply Polyethylene Grease D0A7-19584-A or equivalent to all the lobes. Then carefully slide the camshaft through the bearings.
6. If the camshaft gear was removed, install the spacer, thrust plate and gear, using the tool shown. Install the thrust plate screws and torque to specifications.
7. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean.
8. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.
9. Install the lower main bearing inserts in the bearing caps.
10. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
11. Check the clearance of each main bearing following the procedure given on page 1-19.
12. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). **Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.**
13. Install the thrust bearing cap and check the crankshaft end play following the procedure under Main Bearing Installation, page 1-39.

DISASSEMBLY AND ASSEMBLY (Continued)

14. Check the camshaft end play, camshaft gear backlash following the procedures on page 1-07. If the end play exceeds specifications, replace the thrust plate. If the gear backlash exceeds specifications, replace the camshaft gear and crankshaft gear.
15. Check the camshaft gear runout with a dial indicator. If the gear runout is excessive, replace the gears.
16. Check the piston to cylinder bore fit of each piston following the procedure on page 1-20.
17. Check the end gap of all piston rings on page 1-20. Assemble the pistons, piston rings and connecting rods, following the procedure under Pistons and Connecting Rods Assembly. Check the piston ring side clearance (page 1-20).
18. Install the piston and connecting rod assemblies and check the clearance of the connecting rod bearings. Refer to Piston and Connecting Rod Installation and Connecting Rod Bearing Replacement.
19. Coat a new crankshaft front oil seal with grease and install it in the cylinder front cover.
20. Coat the gasket surfaces of the cylinder front cover and cylinder block with oil-resistant sealer. Position the gasket on the block and install the cover. Torque the bolts to specifications.
21. Lubricate the damper end of the crankshaft with a white lead and oil mixture. Apply Polyethylene Grease D0A7-19584-A or equivalent to the seal surface of the front oil seal. Apply Polyethylene Grease D0A7-19584-A or equivalent to the seal surface of the crankshaft damper and install the crankshaft damper.
22. Apply a light film of engine oil on a new crankshaft rear oil seal. Apply Polyethylene Grease D0A7-19584-A or equivalent to the seal contact surface of the crankshaft and install the seal the specified distance below the face of the cylinder block. Be sure the seal was not damaged during installation.
23. Position the engine rear cover plate on the rear of the cylinder block and install the flywheel on the crankshaft. **Apply oil-resistant sealer to the threads of the flywheel attaching bolts. Install the bolts and torque them to specifications.**
24. Use a new gasket and install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Position a new gasket on the oil pump body and install the oil pump and inlet tube assembly. Torque the attaching bolts to specifications.
25. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.
26. Install new side gaskets on the oil pan with oil-resistant sealer. Position a new cylinder front cover seal on the oil pan and install the oil pan.
27. Coat both sides of a new water pump gasket with water-resistant sealer and position the gasket on the cylinder block. Coat the threads of the water pump bolts with sealer. Install the water pump. Torque the bolts to specifications.
28. Assemble the valves, springs, rocker arms, coolant outlet elbow, etc., following the procedures under Cylinder Head. Install the cylinder head dowel pins.
29. Place a new cylinder head gasket on the block. Carefully position the cylinder head on the block and install the bolts. Torque the bolts in sequence to specifications. When cylinder head bolts have been tightened it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.
30. Clean the exterior surface of the valve lifters with a clean, lint-free cloth and oil the surface with engine oil. Install the valve lifters in the same sequence that they were removed.
31. Apply polyethylene grease to both ends of the push rods and to the push rod bores in the cylinder head. Install the push rods in the same sequence that they were removed. Be sure the push rods are properly seated in the valve lifters. Engage the rocker arms with the push rods and tighten the bolts.
32. Adjust the valve clearance as described on page 1-23.
33. Coat the gasket surface of the push rod cover with oil-resistant sealer and position a new gasket on the cover. Install the cover and gasket on the cylinder block. Torque the cover bolts in sequence to specifications.
34. Install the carburetor, intake and exhaust manifold, following the procedure under Intake and Exhaust Manifold Installation.
35. Install a new gasket with oil-resistant sealer on the valve rocker arm cover. Install the cover on the cylinder head and torque the cover screws in sequence to specifications. Install the crankcase ventilation regulator valve in the rocker arm cover.
36. Install the cylinder block drain plugs and oil pressure sending unit. Install the oil level dipstick tube and dipstick fill crankcase.

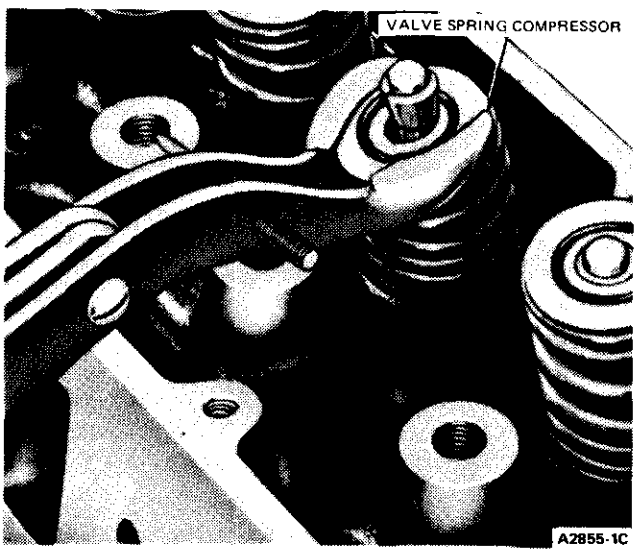
DISASSEMBLY AND ASSEMBLY (Continued)

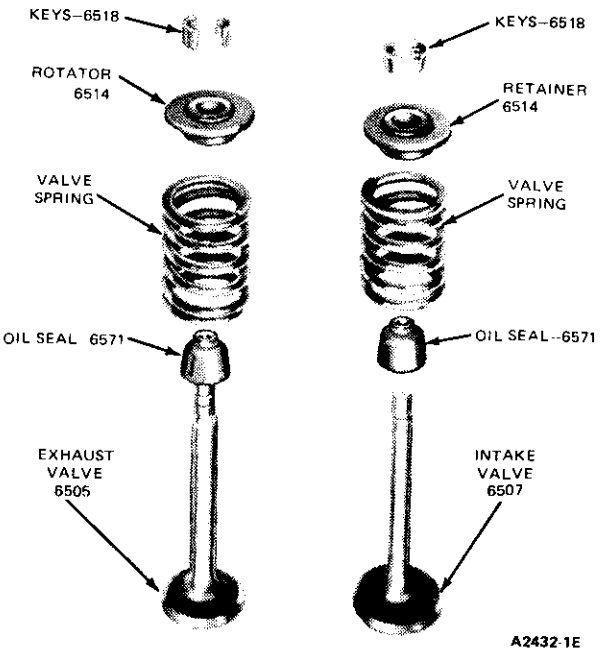
37. Install the oil filter mounting adapter. Coat the seal surface of a new oil filter with grease (or engine oil). Install the oil filter until the seal surface contacts the cylinder block, then tighten the filter an additional 1/2 turn.
38. Install the ignition coil and bracket.
39. Position No. 1 cylinder on TDC after the compression stroke. Install distributor with rotor pointing at number one terminal in cap, and armature and stator assembly poles aligned. Install hold-down clamp.
40. Use a new gasket and install the fuel pump. Torque the bolts to specifications. Install the carburetor fuel inlet line and distributor vacuum line.
41. Install the distributor cap and spark plug wires assembly. Connect the spark plug wires. Connect the distributor primary and secondary high tension wires to the ignition coil.
42. Remove the engine from the work stand.

CYLINDER HEAD

Disassembly

1. Remove the coolant outlet housing and thermostat. Discard the gasket.
2. Remove the intake manifold, exhaust manifold and carburetor as an assembly from the cylinder head. Discard the gasket.
3. Remove the spark plugs.
4. Remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. **Be careful not to scratch the cylinder head gasket surface.**
5. Compress the valve springs, then remove the valve spring retainer locks and release the spring.
6. Remove the spring retainer, spring, stem seal and valve. Discard the valve stem seals. Identify all valve parts.





Assembly

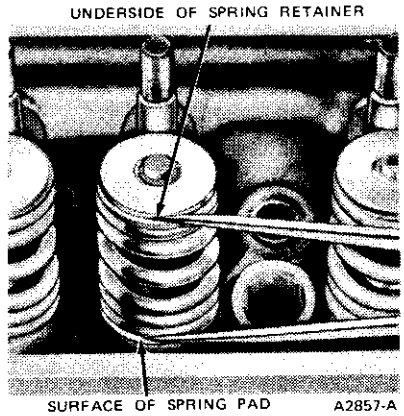
1. Lubricate the valve guides and valve stems with heavy engine oil. Apply polyethylene grease to the tip of the valve stems.
2. Install each valve in the valve guide from which it was removed or to which it was fitted.
3. Oil and install a new intake valve oil seal on the valves.
4. Install the valve spring over the valve. **Be sure the closed coil end is placed against the cylinder head.**
5. Position the spring retainer on all valve springs. Make sure that a positive rotating retainer is used on all of the exhaust valves.
6. Compress the spring. Install the retainer locks.

DISASSEMBLY AND ASSEMBLY (Continued)

7. 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.

Check the dividers against a scale. If the assembled height is greater than the specified limit, install the necessary 0.030 inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. **Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.**

8. Position a new intake manifold gasket on the cylinder head. Install the intake manifold, exhaust manifold and carburetor as an assembly. Torque the manifold bolts and nuts in sequence to specifications.
9. Using a new gasket coated with water-resistant sealer, install the thermostat and coolant outlet elbow. Torque the attaching bolts to specifications.



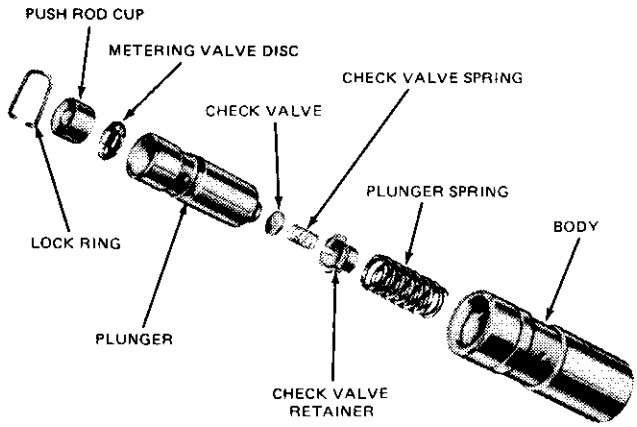
VALVE LIFTER

Disassembly

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

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

For the cleaning and inspection procedures, refer to page 1-11.



Assembly

Hydraulic valve lifter assembly is shown.

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring and 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 seat 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 the hydraulic valve lifter leakdown tester to fill the lifters with test fluid.

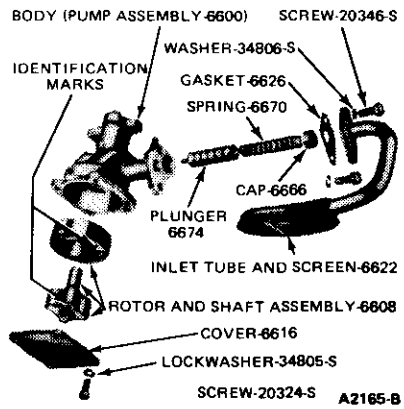
DISASSEMBLY AND ASSEMBLY (Continued)

OIL PUMP

Disassembly

1. Remove the cover attaching screws and remove the cover.
2. Remove the inner rotor and shaft assembly, then remove the outer race.
3. Scrape away the staking marks on the body around the oil pressure relief valve cap. Drill a 3.175mm (1/8-inch) hole in the relief valve cap and insert a self-threading sheet metal screw of proper diameter into the cap. Pull the cap out of the chamber. Remove the spring and plunger.

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



Assembly

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

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

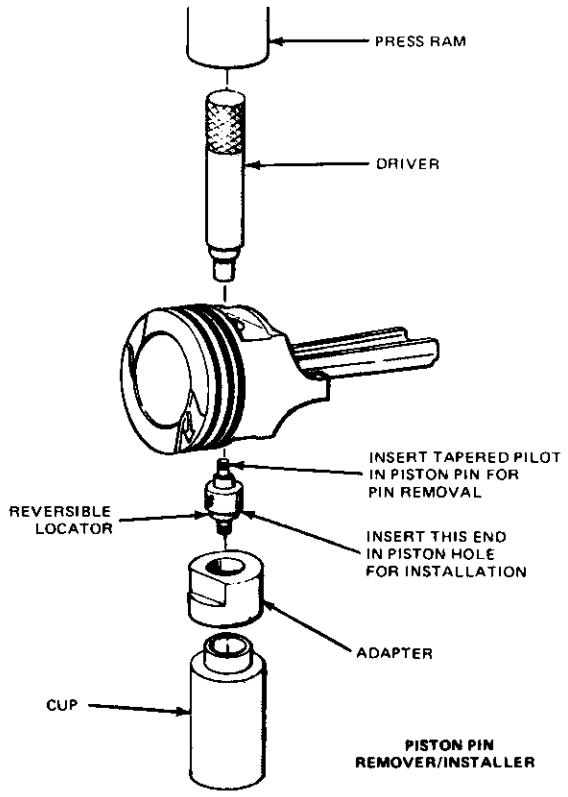
3. Install the cover and torque the attaching screws to specifications.

PISTON AND CONNECTING ROD

Disassembly

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

Refer to page 1-13 for the cleaning and inspection and repair procedures.



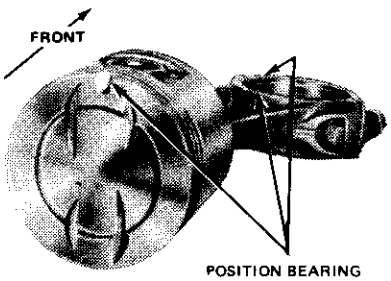
DISASSEMBLY AND ASSEMBLY (Continued)

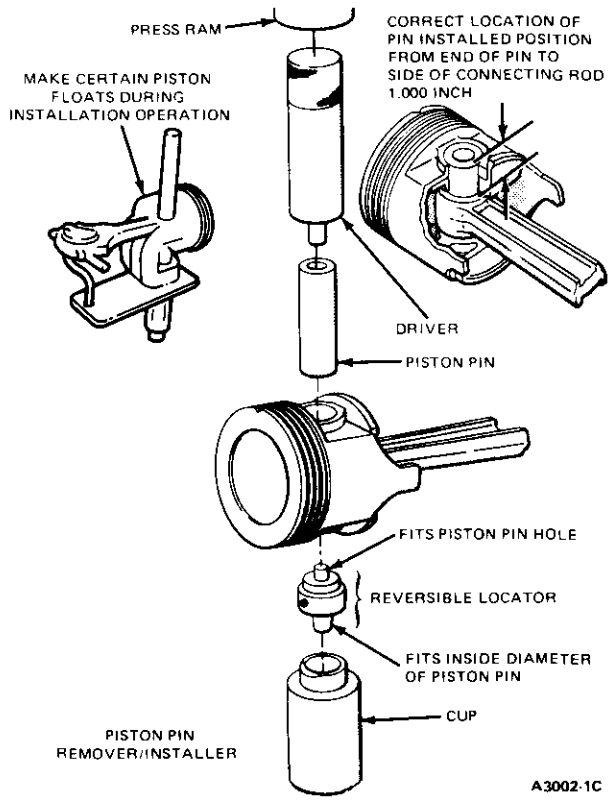
Assembly

Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

1. Apply a light coat of engine oil to all parts. **Assemble the piston to the connecting rod with the bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown.**
2. Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod.
3. Check the end gap of all piston rings (page 1-13). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have steps, the piston should be replaced.**
5. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts wil distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.





CYLINDER ASSEMBLY OR BLOCK

Disassembly

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

Assembly

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

Part 2 — Ignition System — Solid State

IDENTIFICATION

The distributor assemblies can be identified through the information stamped on a metal tag attached to the distributor by a diaphragm assembly attaching screw.

E2T2 ← PREFIX
12127 ← BASIC PART NUMBER
ABA ← SUFFIX

DESCRIPTION

The solid state ignition is the Duraspark II breakerless type. It is equipped with a vacuum and centrifugal advance to control ignition timing.

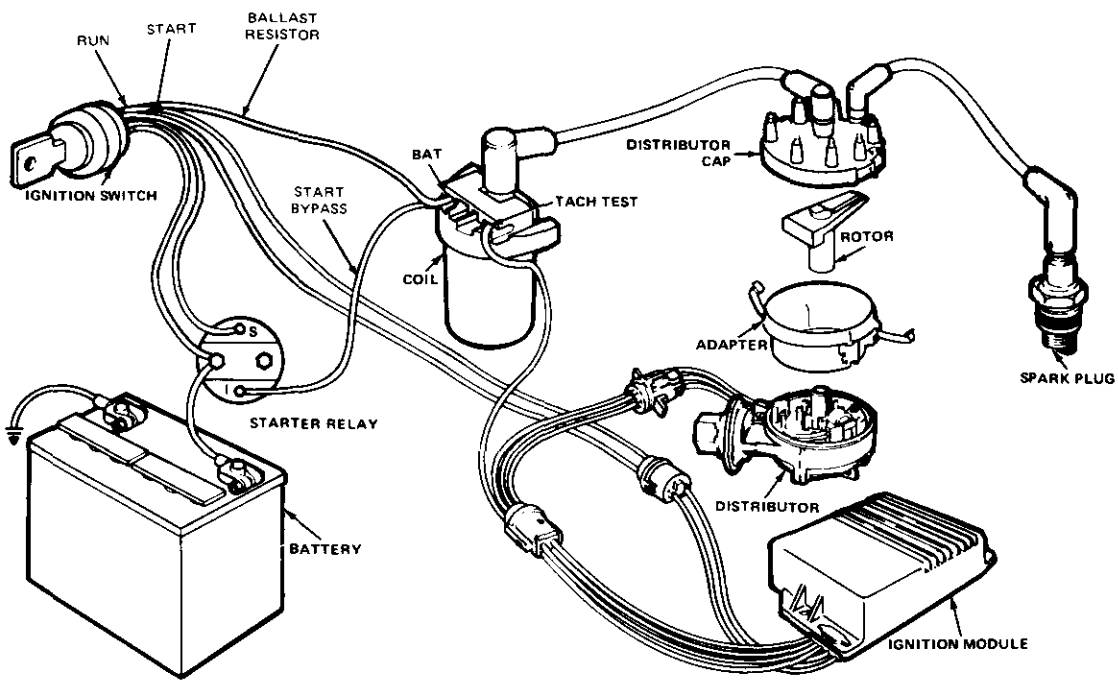
The distributor provides a signal to the ignition module which controls the timing of the spark at the spark plugs. The signal is generated as the armature, attached to the distributor shaft, rotates past the stator assembly. The rotating armature causes fluctuations in a magnetic field produced by the stator assembly magnet. These fluctuations induce a voltage in the stator assembly pick-up coil. This signal is connected to the ignition module by the wiring harness.

The occurrence of the signal to the ignition module, in relation to initial spark timing, is controlled by centrifugal and vacuum mechanisms. The centrifugal advance mechanism controls spark timing in response to the engine RPM. The vacuum mechanism controls spark timing in response to engine load.

The centrifugal advance mechanism varies the relationship of the armature to the stator assembly. The sleeve and plate assembly, on which the armature is mounted, rotates in relation to the distributor shaft. This rotation is caused by centrifugal weights moving in response to engine RPM. The movement of the centrifugal weights change the initial relationship of the armature to the stator assembly by rotating the sleeve and plate assembly ahead of its static position on the distributor shaft. This results in spark advance. The rate of movement of the centrifugal weights is controlled by calibrated springs.

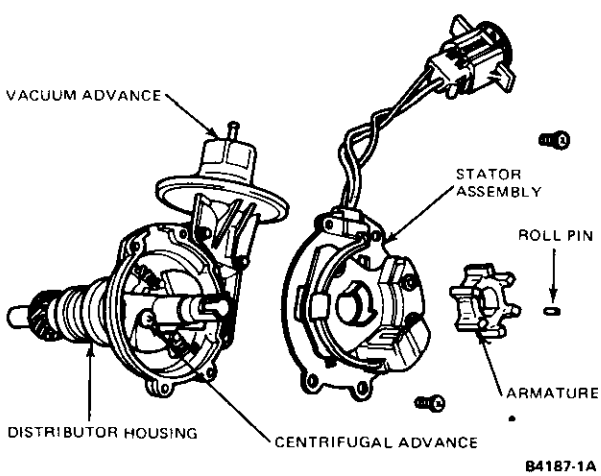
The vacuum spark control mechanism provides spark advance. The diaphragm assembly also varies the armature to stator relationship to provide spark advance. In this case the stator assembly position is changed by means of vacuum applied to the diaphragm assembly. Vacuum applied to the diaphragm assembly causes the diaphragm and attached diaphragm rod to move, compressing the advance spring, which controls the rate of spark advance. This movement of the diaphragm rod, which is attached to the stator assembly, causes the stator assembly to move with respect to the armature. This changes the initial armature to stator assembly relationship established during initial timing set, causing spark advance. The stator assembly is mounted on the lower plate assembly which, along with the diaphragm assembly, is attached to the distributor base.

DESCRIPTION (Continued)



The Duraspark II ignition module is shown. The standard base part number for this module is 12A199.

The ignition module performs the function of turning off current flow through the ignition coil in response to a control signal. In the Duraspark II ignition system this control signal comes from the distributor stator assembly.



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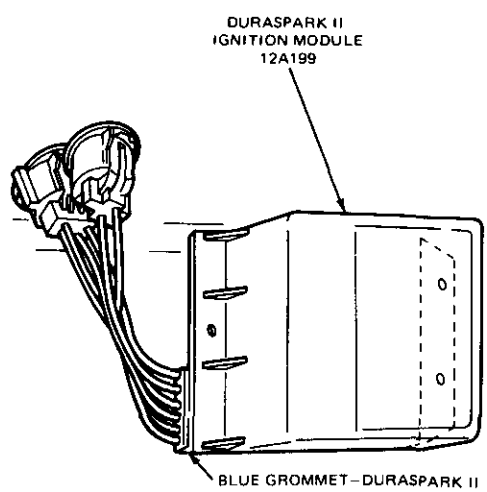


B4082-2C

DESCRIPTION (Continued)

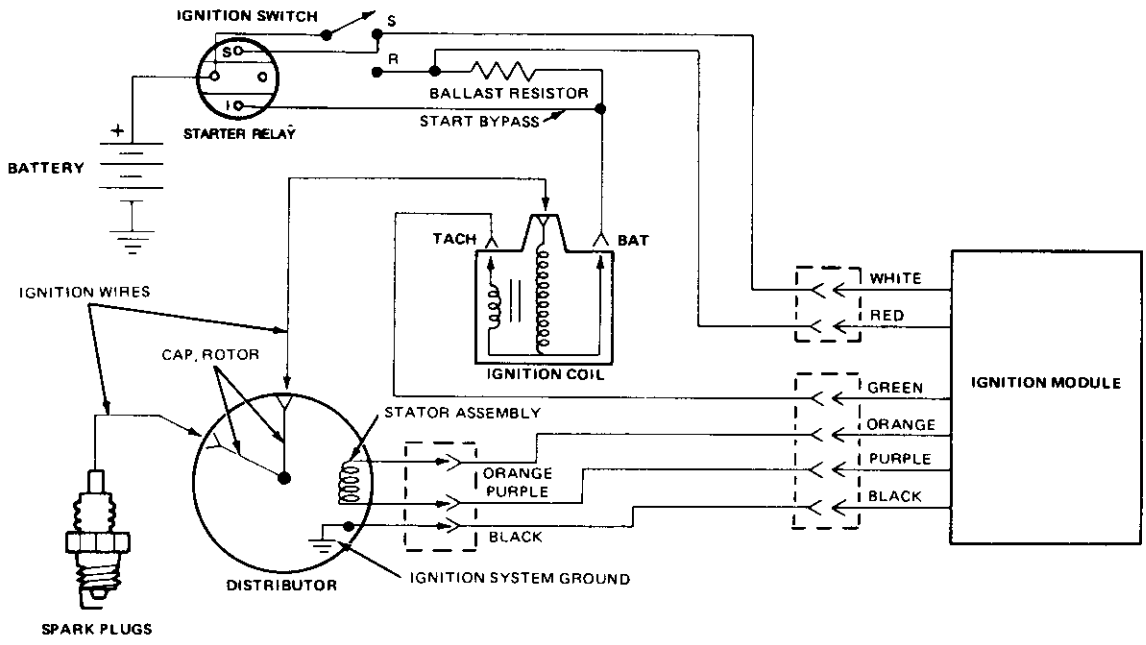
The Duraspark II ignition system consists of a primary and a secondary circuit.

The primary circuit consists of the:

1. Battery
2. Ignition Switch
3. Ballast Resistor — Start Bypass (Wires)
4. Ignition Coil Primary Winding
5. Ignition Module
6. Distributor Stator Assembly

The secondary circuit consists of the:

1. Battery
2. Ignition Coil Secondary Winding
3. Distributor Rotor
4. Distributor Cap
5. Ignition Wires
6. Ignition Switch
7. Ballast Resistor — Start Bypass (Wires)
8. Spark Plugs



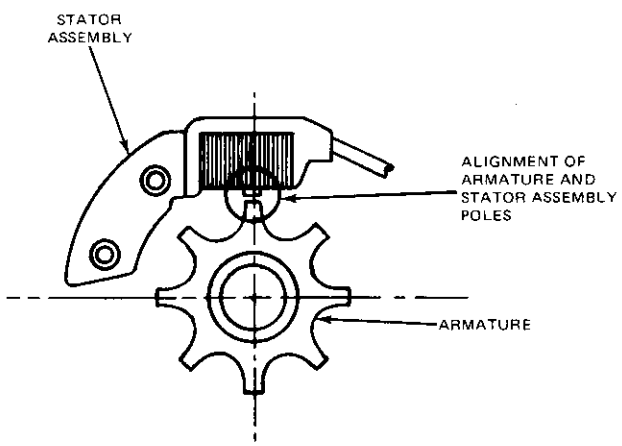
B4084-2A

DESCRIPTION (Continued)

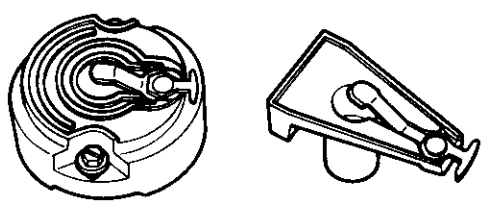
With the ignition switch in the Run position, primary circuit current flows from the battery, through the ignition switch, the ballast resistor, the ignition coil primary (BATTERY), the ignition module (GREEN wire), and back to the battery through the ignition system ground in the distributor (BLACK wire). This current flow causes a magnetic field to be built up in the ignition coil. When the poles on the armature and stator assembly align, the ignition module turns the primary current off, collapsing the magnetic field in the ignition coil. The collapsing field induces a high voltage in the ignition coil secondary winding. The ignition coil wire conducts the high voltage to the distributor where the cap and rotor distribute it to the appropriate spark plug.

A timing circuit in the ignition module turns the primary current back on after a short period of time. High voltage is produced each time the magnetic field is built up and collapsed.

The RED ignition module wire provides operating voltage for the ignition module's electronic components in Run mode. The WHITE wire provides voltage for the ignition module during Start mode. Bypass provides increased voltage for the ignition coil during Start mode.



B3509-1B



B4283-1B

ADJUSTMENTS

Ignition system adjustments are limited to initial timing and spark plug gap on Duraspark II systems.

INITIAL IGNITION TIMING

The timing marks and their locations are illustrated on page 2-18.

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:

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.
5. Direct the timing on the timing marks. The light should flash just as the notch on the pulley lines up between the 4 and 8. Check specifications for correct initial ignition timing.
6. If the timing is not to specification, loosen the distributor retaining bolt and rotate the distributor body until the marks are in line.

   Ignition timing is advanced by counterclockwise rotation of the distributor body, while clockwise rotation retards timing.
7. Tighten distributor retaining bolt and connect vacuum hose.
8. To determine if the advance mechanism is functioning, accelerate the engine while watching the timing mark with the timing light. The notch on the crankshaft pulley should advance as engine RPM increases.
9. Disconnect the timing light.

DIAGNOSIS AND TESTING

Procedures for ignition system diagnosis and testing are shown in the tests on the following pages.

DIAGNOSIS AND TESTING (Continued)

Checkout

- Visually inspect the engine compartment to ensure all vacuum hoses and spark plug wires are properly routed and securely connected.
- Examine all wiring harnesses and connectors for insulation damage, burned, overheated, loose, or broken conditions.
- Be certain the battery is fully charged.
- All accessories should be Off during diagnosis.

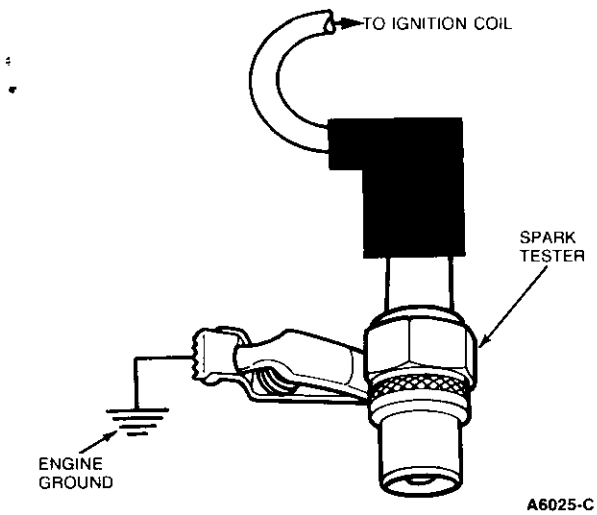
Equipment

Obtain the following test equipment or an equivalent:

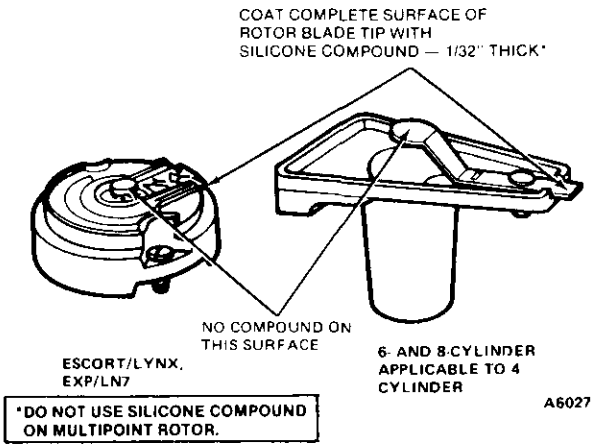
- Spark Tester, Special Service Tool D81P-6666-A.
- Digital Volt-Ohmmeter Rotunda 014-00407.
- Small straight pins (2).

Notes

- All wire colors referred to in this part relate to the colors of the ignition module wires. When working with a wiring harness, the wires must be traced back to the ignition module for proper color identification.
- When instructed to inspect a wiring harness, both a visual inspection and a continuity test should be performed.
- When making measurements on a wiring harness or connector, it is good practice to wiggle the wires while measuring.

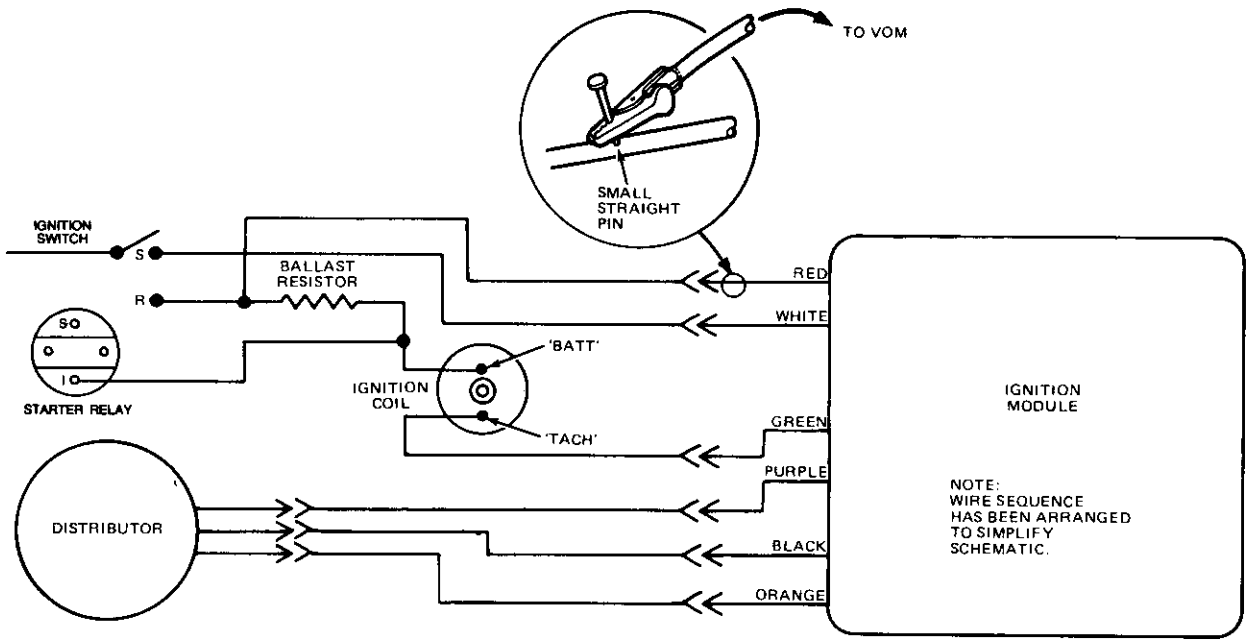
TEST STEP		RESULT	ACTION TO TAKE
1	START CIRCUIT		
• Connect spark tester between ignition coil wire and engine ground. • Crank engine using ignition switch.  		Sparks	GO to **2**.
		No Sparks	MEASURE resistance of ignition coil wire. Replace if greater than 5,000 ohms per inch. INSPECT ignition coil for damage, carbon tracking. CRANK engine to verify distributor rotation. GO to **5**.

DIAGNOSIS AND TESTING (Continued)

TEST STEP		RESULT	ACTION TO TAKE
2	RUN CIRCUIT		
• Turn ignition switch from Off to Run to Off position several times. • Spark should occur each time switch goes from Run to Off position. • Remove spark tester, reconnect coil wire to distributor cap.  		Sparks	INSPECT distributor cap, adapter, rotor for cracks, carbon tracking, lack of silicone compound. CHECK for roll pin securing armature to sleeve in distributor. CHECK that ORANGE and PURPLE wires are not crossed between distributor and ignition module.
		No Sparks	GO to **3**.

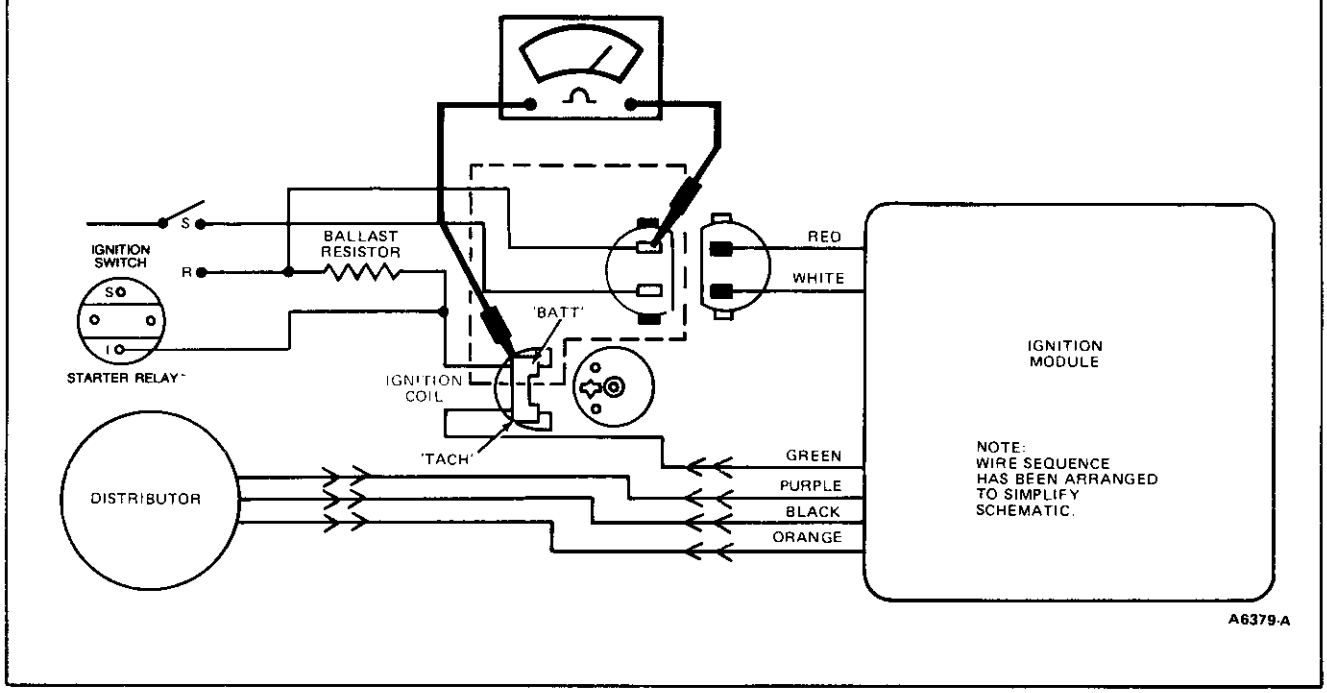
DIAGNOSIS AND TESTING (Continued)

TEST STEP		RESULT	ACTION TO TAKE
3	MODULE VOLTAGE		
• Turn ignition switch Off. 1. Carefully insert small straight pin in RED module wire. **CAUTION: Do not allow straight pin to contact electrical ground.** 2. Attach negative (–) VOM lead to distributor base. 3. Measure battery voltage. 4. Measure voltage at straight pin with ignition switch in Run position. 5. Turn ignition switch to Off position. 6. Remove straight pin.		90 percent of battery voltage or greater	GO to **4.**
		Less than 90 percent of battery voltage	Refer to wiring diagram. Inspect wiring harness between module and ignition switch. Worn or damaged ignition switch.



DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
4 BALLAST RESISTOR 1. Separate and inspect ignition module two wire connector with RED and WHITE wires. 2. Disconnect and inspect ignition coil connector. 3. Measure ballast resistor between BATT terminal of ignition coil connector and wiring harness connector mating with RED module wire. 4. Reconnect all connectors.	0.8 to 1.6 ohms	Problem is either intermittent or not in ignition system. GO to **5**.
	Less than 0.8 or greater than 1.6 ohms	Replace ballast resistor.

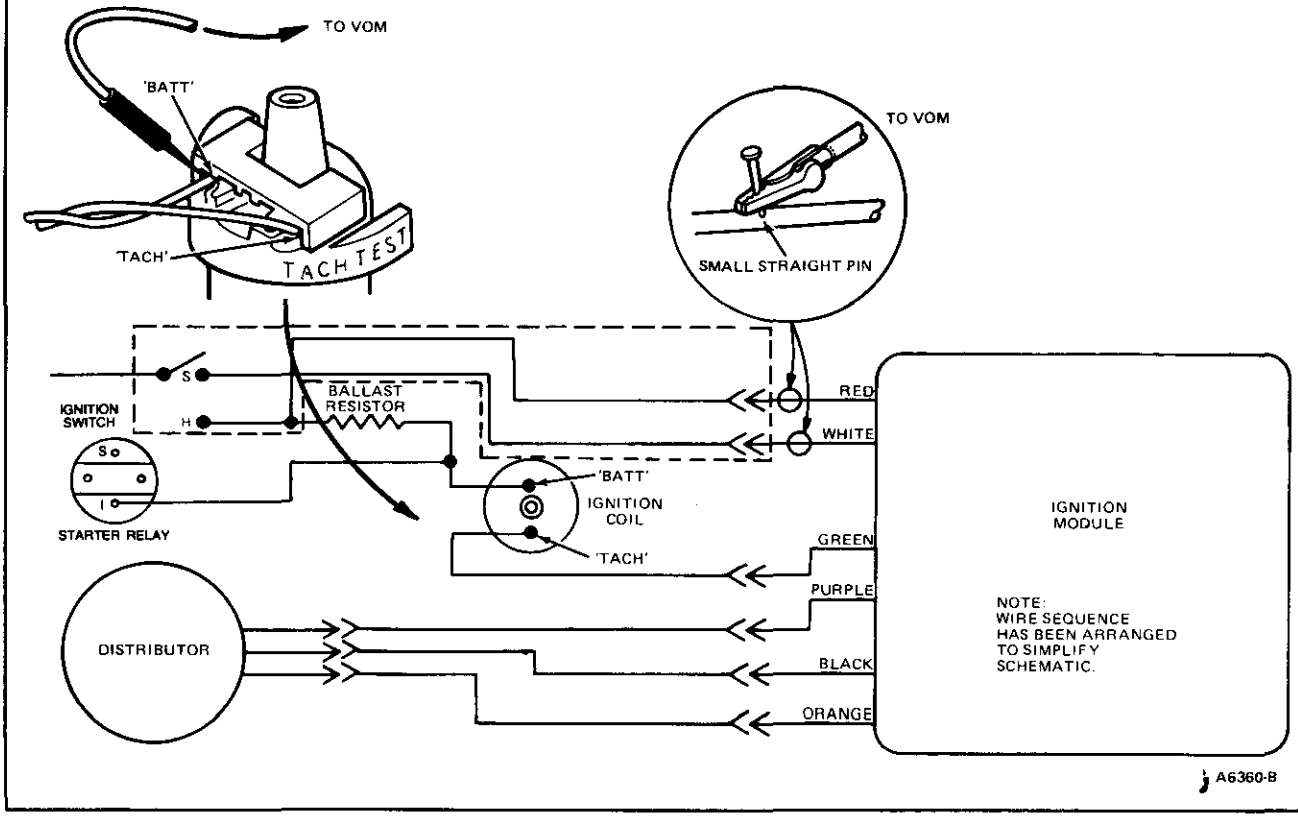


DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
5 SUPPLY VOLTAGE CIRCUITS 1. Remove SPARK TESTER, reconnect coil wire to distributor cap. 2. Disconnect cable from starter relay to starter motor. 3. Carefully insert small straight pins in RED and WHITE module wires. **CAUTION: Do not allow straight pins to contact electrical ground.** 4. Measure battery voltage. 5. Following table below, measure voltage at points listed with ignition switch in position shown. **NOTE** • **Attach negative (−) VOM lead to distributor base.** • **Wiggle wires in wiring harness when measuring.**	90 percent of battery voltage or greater	Test result OK. GO to **6.**
	Less than 90 percent of battery voltage	Refer to wiring diagram. Inspect wiring harness and connector(s) in faulty circuit(s). Worn or damaged ignition switch.

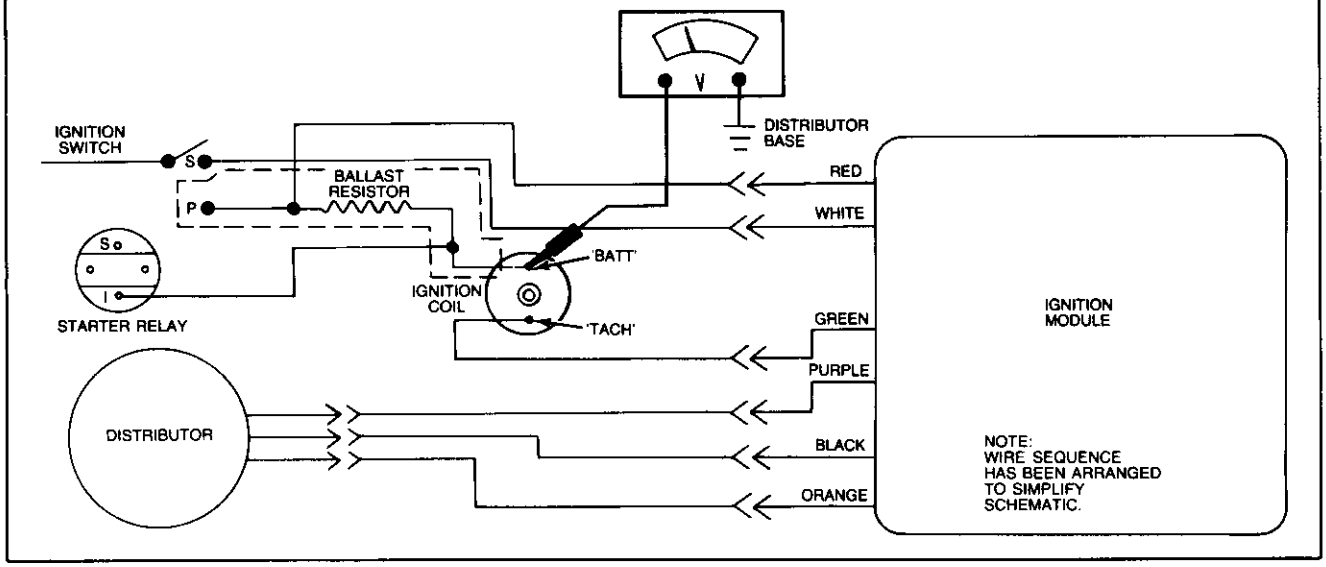
WIRE/ TERMINAL	CIRCUIT	IGN. SWITCH POSITION
RED	RUN	RUN
WHITE	START	START
"BATT" TERMINAL IGNITION COIL	BALLAST RESISTOR BYPASS	START

6. Turn ignition switch to Off position.
7. Remove straight pins.
8. Reconnect any cables/wires removed from starter relay.

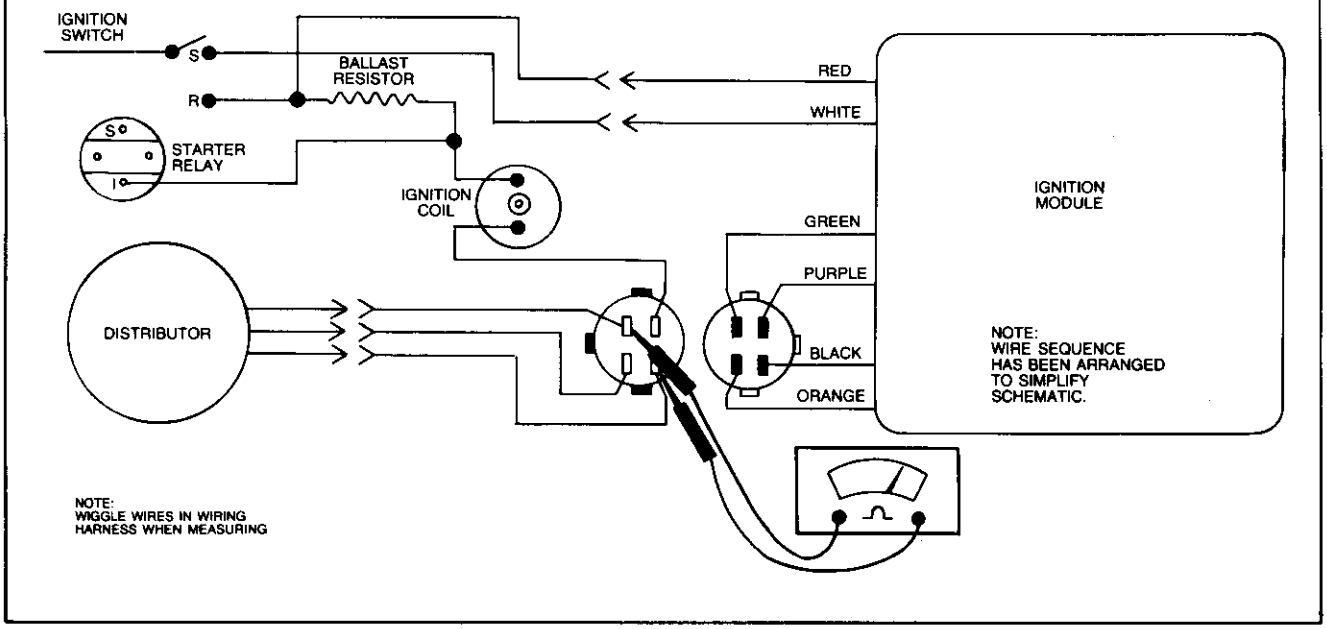


DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
6 IGNITION COIL SUPPLY VOLTAGE 1. Attach negative (−) lead of VOM to distributor base. 2. Turn ignition switch to Run position. 3. Measure voltage at BATT terminal of ignition coil. 4. Turn ignition switch to Off position.	6 to 8 volts	GO to **7**.
	Less than 6 volts or greater than 8 volts	GO to **12**.

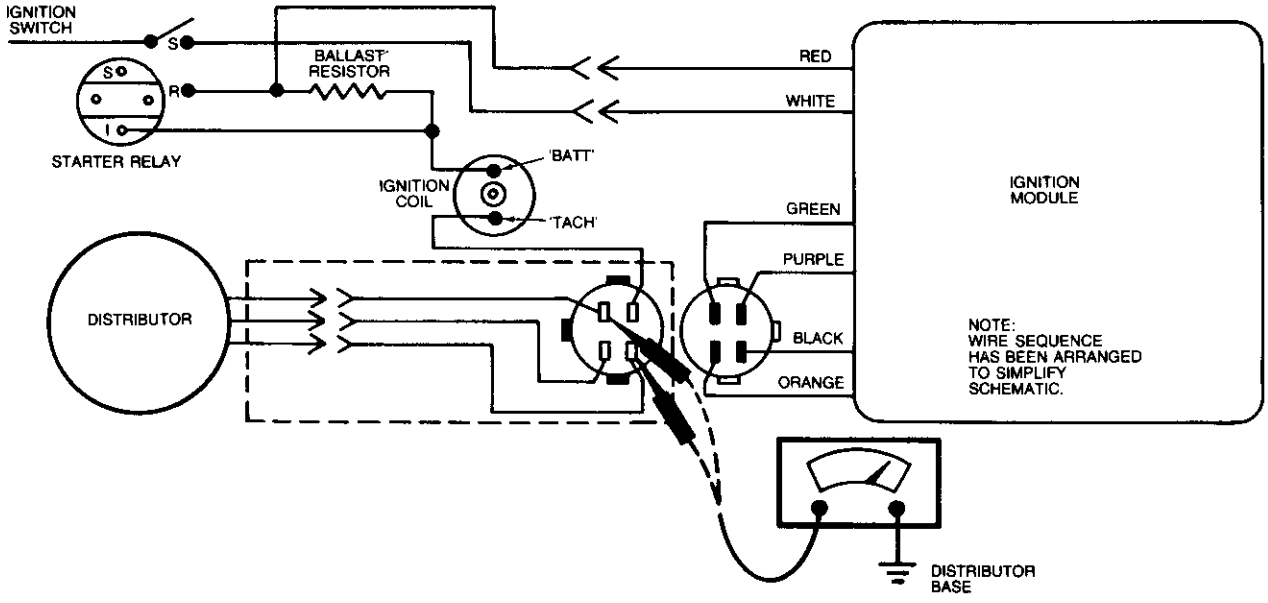


TEST STEP	RESULT	ACTION TO TAKE
7 DISTRIBUTOR STATOR ASSEMBLY AND WIRING HARNESS 1. Separate ignition module four wire connector. Inspect for dirt, corrosion, and damage. 2. Measure stator assembly and wiring harness resistance between wiring harness terminals mating with ORANGE and PURPLE module wires.	400 to 1,300 ohms	Test result OK. GO to **8**.
	Less than 400 or greater than 1,300 ohms	GO to **11**.

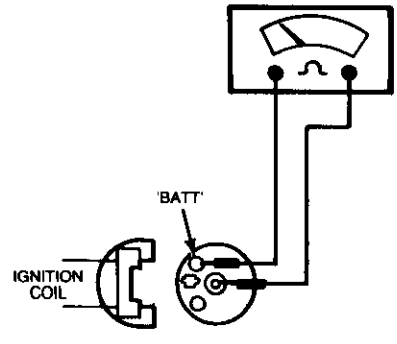


DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
8 DISTRIBUTOR STATOR ASSEMBLY WIRING HARNESS		
1. Attach one VOM lead to distributor base. 2. Alternately measure resistance between wiring harness terminals mating with ORANGE and PURPLE module wires and ground. 3. Reconnect four wire connector.	Greater than 70,000 ohms	Test result OK. GO to **9**.
	Less than 70,000 ohms	Inspect wiring harness between module connector and distributor, including distributor grommet.

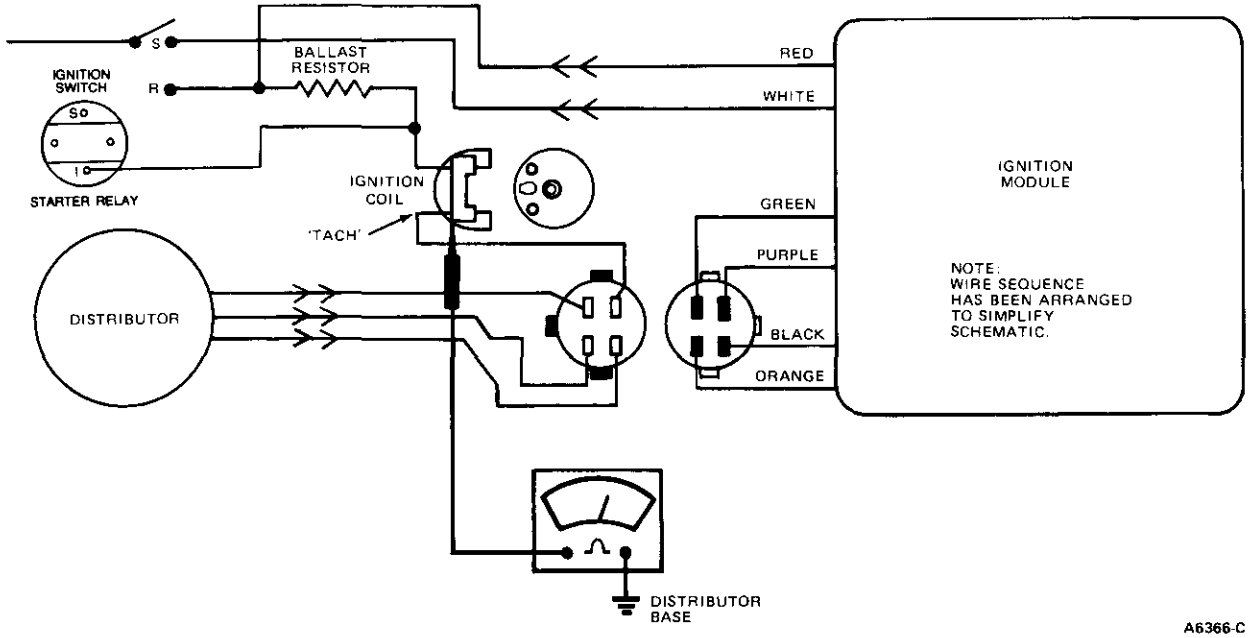


TEST STEP	RESULT	ACTION TO TAKE
9 IGNITION COIL SECONDARY RESISTANCE		
1. Disconnect and inspect ignition coil connector and coil wire. 2. Measure secondary resistance from BATT terminal to high voltage terminal. 3. Reconnect ignition coil wire.	7,700 to 10,500 ohms	Test result OK. GO to **10**.
	Less than 7,000 ohms or greater than 10,500 ohms	Replace ignition coil.

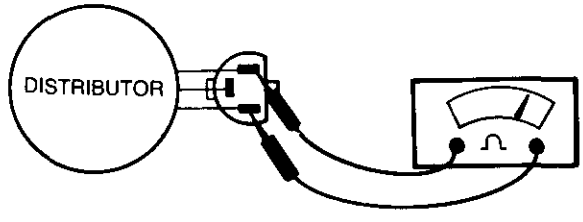


DIAGNOSIS AND TESTING (Continued)

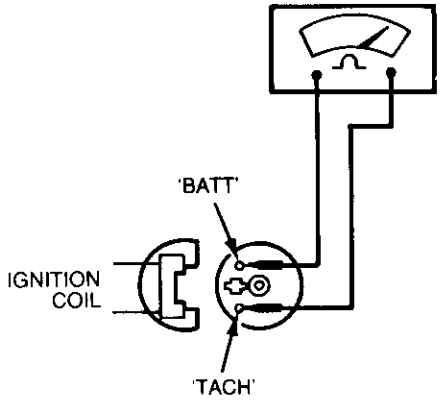
TEST STEP	RESULT	ACTION TO TAKE
10 MODULE TO COIL WIRE		
1. Separate and inspect ignition module four wire connector and ignition coil connector from coil. 2. Connect one lead of VOM to distributor base. 3. Measure resistance between TACH terminal of ignition coil connector and ground. 4. Reconnect ignition module and coil connectors.	Greater than 100 ohms	Replace ignition module.
	100 ohms or less	Inspect wiring harness between ignition module and coil.

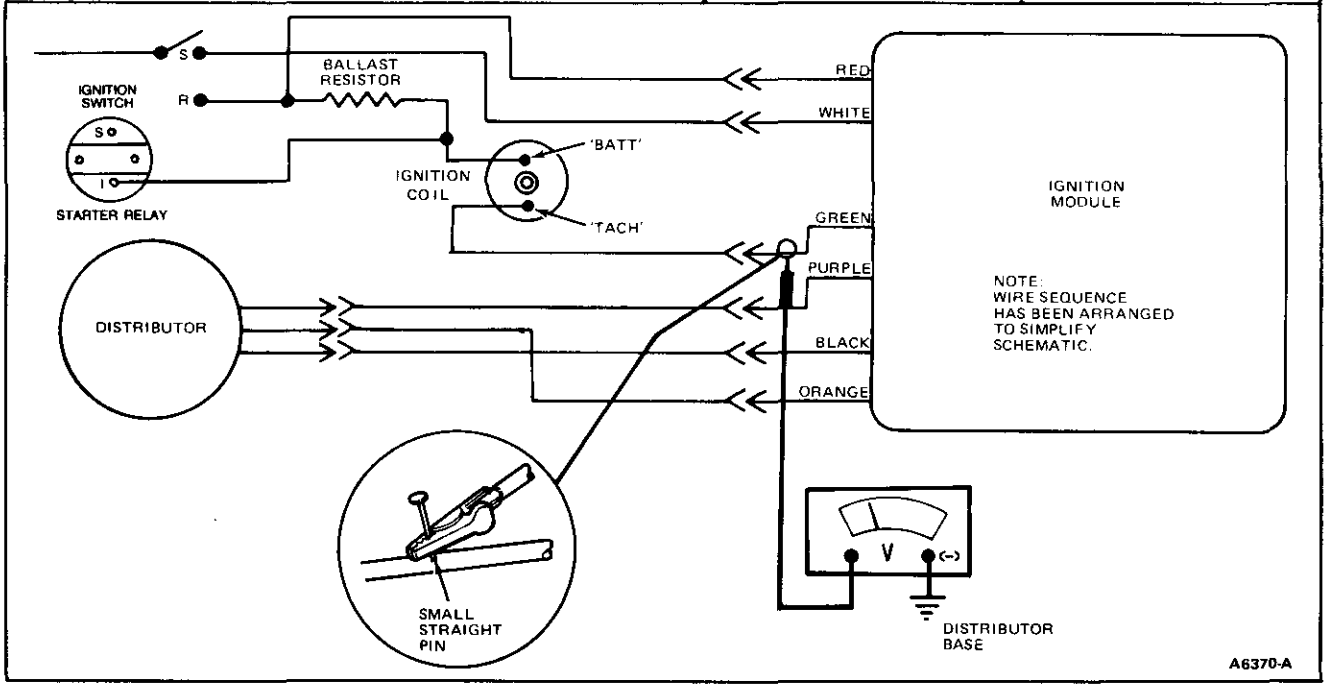


TEST STEP	RESULT	ACTION TO TAKE
11 DISTRIBUTOR STATOR ASSEMBLY		
1. Separate distributor connector from harness. Inspect for dirt, corrosion, and damage. 2. Measure stator assembly resistance across ORANGE and PURPLE wires at distributor connector. 3. Reconnect distributor and module connectors.	400 to 1,000 ohms	Test result OK. Inspect wiring harness between distributor and ignition module.
	Less than 400 or greater than 1,000 ohms	Replace stator assembly.



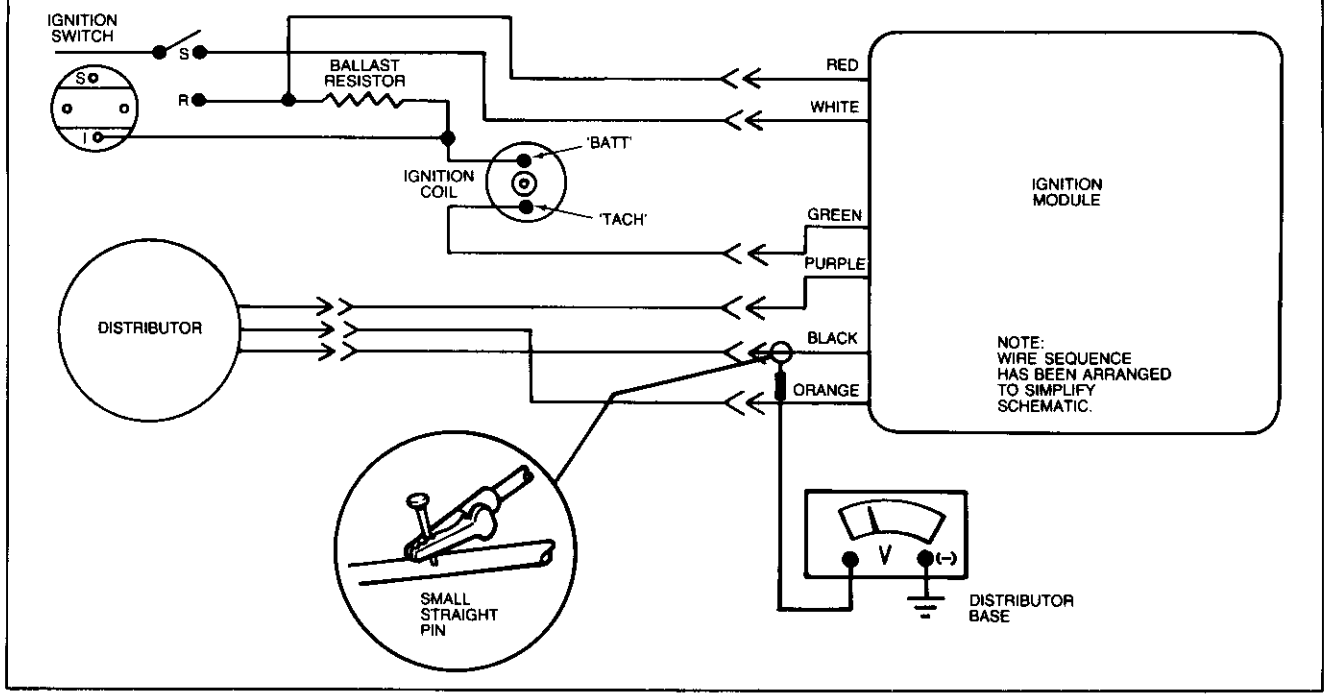
DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
12 IGNITION COIL PRIMARY RESISTANCE		
1. Disconnect ignition coil connector. 2. Measure primary resistance from BATT to TACH terminal. 3. Reconnect ignition coil connector. 	0.8 to 1.6 ohms	Test result OK. GO to **13**.
	Less than 0.8 or greater than 1.6 ohms	Replace ignition coil.
13 PRIMARY CIRCUIT CONTINUITY		
1. Carefully insert small straight pin in module GREEN wire. **CAUTION: Do not allow straight pin to contact electrical ground.** 2. Attach negative (−) VOM lead to distributor base. 3. Turn ignition switch to Run position. 4. Measure voltage at GREEN module wire. 5. Turn ignition switch to Off position. 6. Remove straight pin.	Greater than 1.5 volts	GO to **14**.
	1.5 volts or less	Inspect wiring harness and connectors between ignition module and coil.

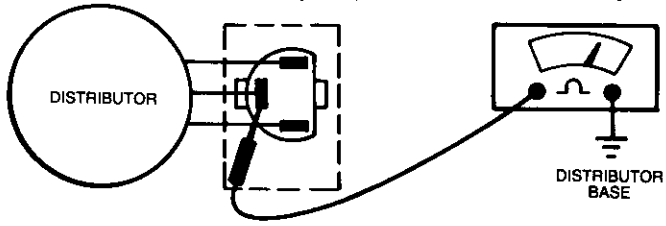


DIAGNOSIS AND TESTING (Continued)

TEST STEP	RESULT	ACTION TO TAKE
14 GROUND CIRCUIT CONTINUITY		
1. Carefully insert small straight pin in module BLACK wire. **CAUTION: Do not allow straight pin to contact electrical ground.** 2. Attach negative (–) VOM lead to distributor base. 3. Turn ignition switch to Run position. 4. Measure voltage at BLACK wire. 5. Turn ignition switch to Off position. 6. Remove straight pin.	Greater than 0.5 volt	GO to **15.**
	0.5 volt or less	Replace ignition module.



TEST STEP	RESULT	ACTION TO TAKE
15 DISTRIBUTOR GROUND CIRCUIT CONTINUITY		
1. Separate distributor connector from harness. Inspect for dirt, corrosion, and damage. 2. Attach one lead of VOM to distributor base. 3. Measure resistance by attaching other VOM lead to BLACK wire in distributor connector. **NOTE: Wiggle distributor grommet when measuring.** 4. Reconnect distributor connector.	Less than one ohm	Test result OK. Inspect wiring harness and connectors between distributor and ignition module.
	Greater than one ohm	Inspect ground screw in distributor.



REMOVAL AND INSTALLATION

DISTRIBUTOR

Removal

1. Remove distributor cap. Position it and ignition wires to one side.
2. Disconnect and plug diaphragm assembly hose(s).
3. Separate distributor connector from wiring harness.
4. Rotate engine to align stator assembly pole and any armature pole.
5. Scribe a mark on distributor body and engine block to indicate position of distributor in engine, and position of rotor.
6. Remove distributor holddown bolt and clamp.
7. Remove distributor from engine. Do not rotate engine while distributor is removed.

Installation

1. If engine was rotated while distributor was removed:
   a. Rotate engine until No. 1 piston is on compression stroke.
   b. Align timing marks for correct initial timing.
   c. Install distributor with rotor pointing at number one terminal position in cap, and armature and stator assembly poles aligned.
   d. Make sure oil pump intermediate shaft properly engages distributor shaft. It may be necessary to crank engine after distributor gear is partially engaged in order to engage oil pump intermediate shaft and fully seat distributor in block.
   e. If it was necessary to crank engine, again rotate engine until No. 1 piston is on compression stroke and align timing marks for correct initial timing.
   f. Rotate distributor in block to align armature and stator assembly poles and verify rotor is pointing at No. 1 cap terminal.
   g. Install distributor holddown bolt and clamp; do not tighten.
2. If engine was not rotated while distributor was removed and original distributor is being replaced:
   a. Position distributor in engine with rotor and distributor aligning with previously scribed mark. Armature and stator assembly poles should also align, if distributor is fully seated in block and properly installed. Crank engine if necessary to fully seat distributor in block.
   b. Install distributor holddown bolt and clamp; do not tighten.
3. If engine was not rotated while distributor was removed and new distributor is being installed:
   a. Position distributor in engine with rotor aligned with previously scribed mark. If necessary, crank engine to fully seat distributor.
   b. Rotate engine until timing marks for correct initial timing align and rotor is pointing at No. 1 one cap terminal.
   c. Rotate distributor in block to align armature and stator assembly poles.
   d. Install distributor holddown bolt and clamp; do not tighten.
4. If in steps 1-3 above the armature and stator assembly poles cannot be aligned by rotating distributor in block, pull distributor out of block enough to disengage distributor gear and rotate distributor shaft to engage a different distributor gear tooth and re-install distributor. Repeat steps 1-3 as necessary.
5. Connect distributor to wiring harness.
6. Install distributor cap and ignition wires. Check that ignition wires are securely connected to distributor cap and spark plugs.
7. Set initial timing to specification.
8. Tighten distributor holddown bolt to specification.
9. Recheck initial timing. Readjust if necessary.
10. Connect diaphragm assembly hose.

REMOVAL AND INSTALLATION (Continued)

STATOR ASSEMBLY

Removal

1. Remove distributor cap and rotor.
2. Separate distributor connector from wiring harness.
3. Using small gear puller or two screwdrivers, remove armature from sleeve and plate assembly. Use caution to avoid loss of roll pin.
4. Remove two screws retaining lower plate assembly and stator assembly to distributor base. Note there are two different screws.
5. Remove lower plate assembly and stator assembly from distributor.
6. Remove E-clip, flat washer and wave washer securing stator assembly to lower plate assembly and separate stator assembly from lower plate assembly. Note installation of wave washer.

Installation

1. Place stator assembly on lower plate assembly and install wave washer (outer edges up), flat washer and E-clip.
2. Install stator assembly/lower plate assembly on distributor base, being sure to engage pin on stator assembly in diaphragm rod.
3. Install two retaining screws in proper locations and tighten to specification.
4. Note there are two locating notches in armature. Install on sleeve and plate assembly with unused notch and new roll pin.
5. Connect distributor to wiring harness.
6. Replace distributor rotor and cap. Check that ignition wires are securely connected to cap and spark plugs.
7. Check initial timing.

DIAPHRAGM ASSEMBLY

Removal

1. Disconnect diaphragm assembly vacuum hose.
2. Remove diaphragm assembly attaching screws (2) and identification tag.
3. Disengage diaphragm rod from stator assembly pin and remove diaphragm assembly.

Installation

1. Adjust new diaphragm assembly per instructions included in carton.
2. Engage diaphragm rod with stator assembly pin.
3. Attach diaphragm assembly and identification tag to distributor base with two attaching screws and tighten to specification.
4. Ensure diaphragm rod is properly engaged with stator assembly pin.
5. Connect vacuum hose.

DISTRIBUTOR CAP, ADAPTER AND ROTOR

Removal

1. Remove the secondary wires.
2. Unclip the distributor cap and lift straight off the distributor.
3. Using a screwdriver, loosen the adapter attaching screws and remove the adapter.
4. Loosen the screws attaching the rotor to the distributor and remove the cap, if necessary.

Installation

1. If previously removed, position the distributor rotor with the square and round locator pins matched to the rotor mounting plate. Tighten screws to specification.
2. Install adapter in position and tighten attaching screws to specification.
3. Install the cap, noting the square alignment locator, and fasten the clips.
4. Install secondary wires, noting correct locations on the distributor cap.

REMOVAL AND INSTALLATION (Continued)

IGNITION WIRES

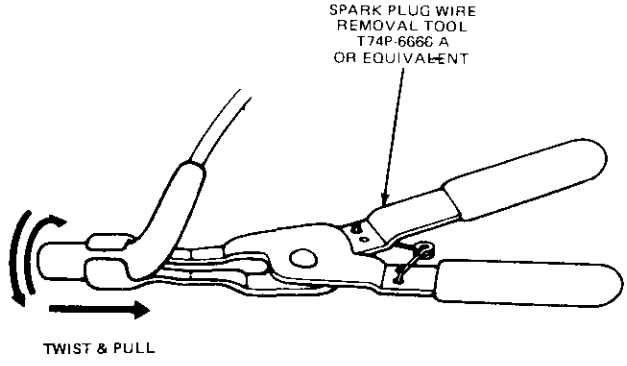
The ignition wires include the spark plug wires connecting the distributor cap to the spark plugs and the ignition coil wire connecting the distributor cap to the high voltage terminal of the ignition coil.

These wires are designed to reduce radio interference caused by high voltage discharges in the ignition system.

For testing, use an ohmmeter and check resistance from terminal in cap to spark plug terminal. Do not, under any circumstances, puncture an ignition wire with any type of probing device.

Removal

When removing wires from spark plugs, use Tool T74P-6666-A or equivalent. Grasp and twist the spark plug wire boot back and forth, then pull the wire off the plug. Do not pull directly on the spark plug wire, or it may separate from its terminal inside the spark plug wire boot.



Installation

Whenever an ignition wire is removed from a spark plug or ignition coil or distributor cap terminal, silicone compound must be applied to the spark plug wire boot before it is reconnected. Using a small clean tool, lightly coat the entire inner surface of the boot with Ford Silicone Dielectric Compound (D7AZ-19A331-A or equivalent).

1. Attach each wire to proper terminal of distributor cap. Be certain wires are fully seated on terminals.
2. Remove wire separators from old wire set and install them on new set in approximately same position.
3. Connect wires to proper spark plugs. Install ignition coil wire. Be certain all wires are fully seated on terminals.

SPARK PLUGS

Removal

1. Remove spark plug wire from spark plug, using Tool T74P-6666-A or equivalent with a twisting-pulling motion. Do not pull directly on spark plug wire.
2. Inspect spark plug wires for physical damage. Replace as necessary.
3. Clean area around each spark plug port with compressed air.
4. Remove spark plug.

Installation

1. Set spark plug gap to specification.
2. Install spark plug and tighten to specification.
3. Coat the inside of the spark plug wire boot with silicone compound and install on spark plug.

CLEANING AND INSPECTION

DISTRIBUTOR ASSEMBLY

Clean distributor using compressed air. Make sure no metal chips adhere to stator assembly. Inspect distributor to be certain all components are securely attached and stator assembly moves freely. Check that sleeve and plate assembly rotates freely on distributor shaft.

DISTRIBUTOR CAP AND ROTOR

Wipe the distributor cap and rotor with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air.

Examine for cracks, carbon tracking, dirt or missing carbon button in cap. Replace as necessary. Review Distributor Cap and Rotor Installation and Removal.

CLEANING AND INSPECTION (Continued)

SPARK PLUGS

Examine the spark plug for cracked ceramic insulator and condition of firing end. Refer to page 02-19 for various conditions and actions.

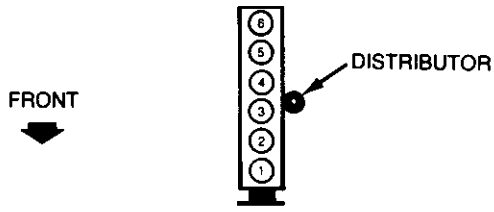
IGNITION WIRES

Without removing wires, inspect for visible damage such as cuts, pinches, cracked or torn boots. Replace as necessary.

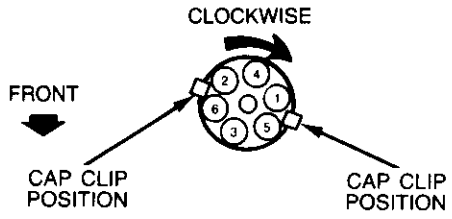
IGNITION COIL

Wipe coil tower with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

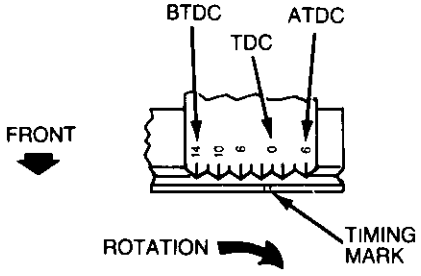
CYLINDER NUMBERING AND DISTRIBUTOR LOCATION



FIRING ORDER AND ROTATION



FIRING ORDER — 1-5-3-6-2-4



CRANKSHAFT TIMING MARKS

4.9L

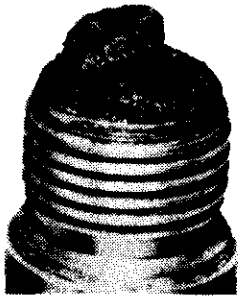
CLEANING AND INSPECTION (Continued)

GAP BRIDGED

IDENTIFIED BY DEPOSIT BUILDUP CLOSING GAP BETWEEN ELECTRODES.

CAUSED BY OIL OR CARBON FOULING. REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE, THE PLUG CAN BE CLEANED.

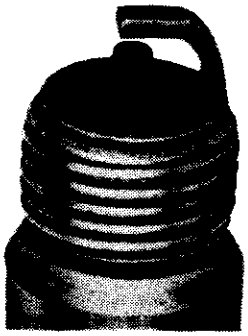
OIL FOULED



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.

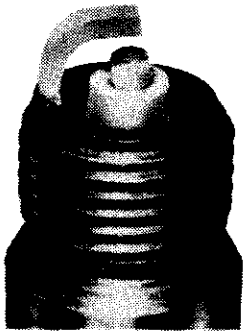
CARBON FOULED



IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES.

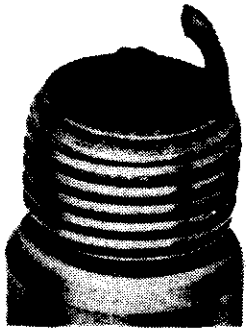
CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.

NORMAL



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

PRE-IGNITION



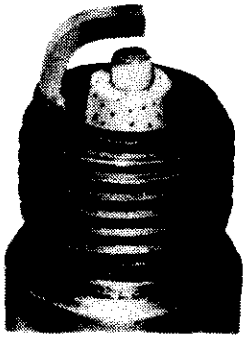
IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE.

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.

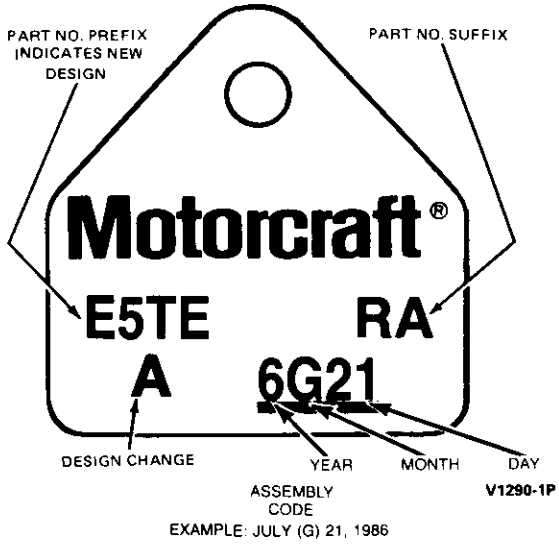
CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE, OTHERWISE REPLACE PLUG.

B4230-2A

Part 3 — Fuel System

IDENTIFICATION

The carburetor identification tag is attached to the upper body of the carburetor. The basic part number for all carburetors is 9510. To procure replacement parts, it is necessary to know the part number prefix and suffix.

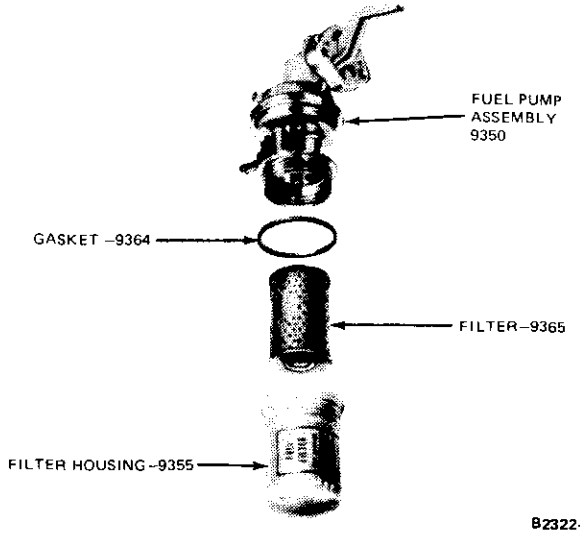


DESCRIPTION

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

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

The Holley 1940 carburetor is covered in detail later in this section.



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.

Low pressure is the most likely fuel pump trouble that will affect engine performance. Low pressure will cause a lean mixture and fuel starvation at high speeds.

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

CONDITION	PROBABLE CAUSE	
Low Fuel Pump Pressure	• Diaphragm stretched or leaking. • Fuel pump diaphragm spring is weak. • Cam eccentric worn or undersize. • 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.
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.	• 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. • Dirty air cleaner element.
Stalling	• Incorrect idle fuel mixture. • Engine idle speed too slow. • Dirt, water or ice in fuel filter. • Fuel lines restricted or leaking air. • Fuel tank vent restricted. • Leaking intake manifold or carburetor gaskets.	• Carburetor icing (cold, wet or humid weather). • Incorrect throttle linkage adjustment to carburetor. • Clogged air bleeds or idle passages. • Defective fuel pump. • Excessive looseness of throttle shaft in bore(s) of throttle body.

DIAGNOSIS AND TESTING (Continued)

CONDITION	PROBABLE CAUSE	
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 restricted. • Excessive dirt in air cleaner. • High or low float setting.
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. 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.	• Incorrect accelerating pump stroke adjustment. • Accelerating pump fuel inlet or outlet valve not seating. • Restriction in the accelerating pump discharge passage. A RICH MIXTURE CAN BE CAUSED BY: • 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.
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.
Reduced Power Output	• Float setting too high or too low. • Fuel pump pressure 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.

DIAGNOSIS AND TESTING (Continued)

PRESSURE AND CAPACITY (VOLUME) TESTING

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

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

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

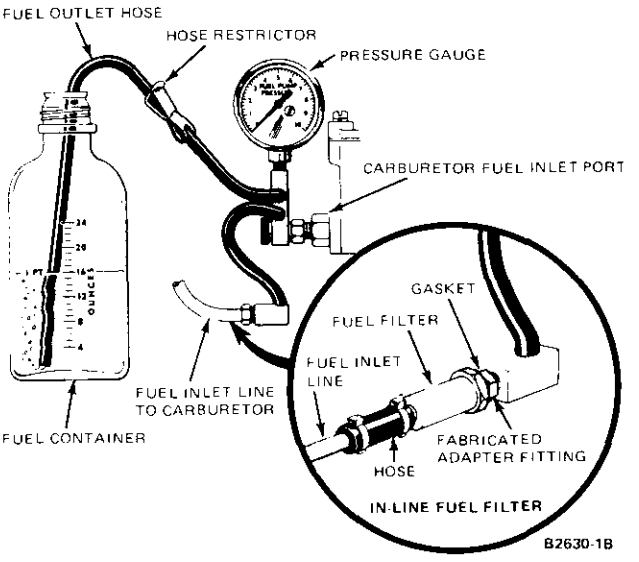
Pressure Tests

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

1. Remove the air cleaner assembly. Disconnect the fuel inlet line or the fuel filter at the carburetor. **Use care to prevent combustion due to fuel spillage.**
2. Connect a pressure gauge, a restrictor and a flexible hose between the fuel filter and the carburetor. **NOTE: Inside diameter of smallest passage in test flow circuit must not be smaller than .220.**
3. Position the flexible fuel outlet hose and the restrictor so the fuel can be discharged into a suitable graduated container.
4. Before taking a pressure reading, operate the engine at the specified idle RPM and vent the system into the container by opening the hose restrictor momentarily.
5. Close the hose restrictor, allow the pressure to stabilize, and note the reading. (Refer to the Specifications in Part 8).

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

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



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, while observing the time required to expel one pint. Close the restrictor. One pint or more of fuel should be expelled within the specified time limit.

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

REMOVAL AND INSTALLATION

FUEL PUMP ASSEMBLY

Removal

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

Installation

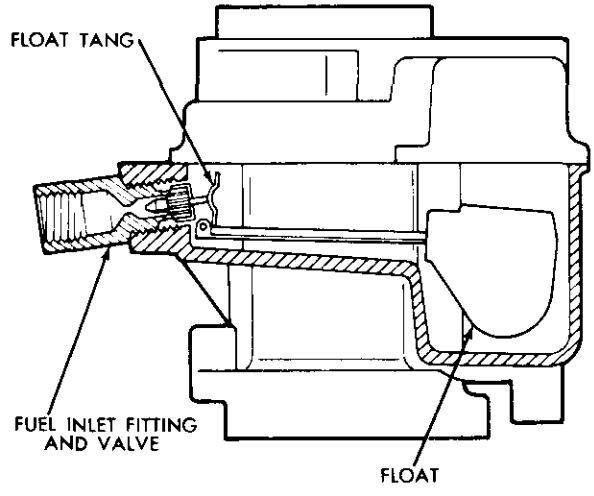
1. Remove all the gasket material from the mounting pad and pump flange. Apply oil-resistant sealer to both sides of a new gasket and to the threads on the attaching bolts.
2. Position the new gasket on the pump in position against the mounting pad. Make sure the rocker arm is riding on the camshaft eccentric. (Turn the engine over until the fuel pump eccentric is on the low side of the stroke.)
3. Press the pump tight against the pad, install the attaching screws and alternately tighten them to specifications.
4. Connect the fuel inlet and outlet lines.
5. Operate the engine and check for leaks.

HOLLEY 1940 ONE-BARREL CARBURETOR

DESCRIPTION AND OPERATION

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

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



FUEL INLET SYSTEM

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

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

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

HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

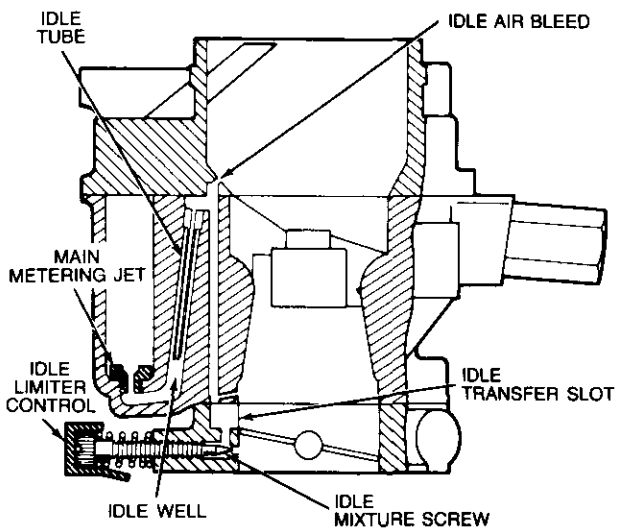
IDLE SYSTEM

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

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

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

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



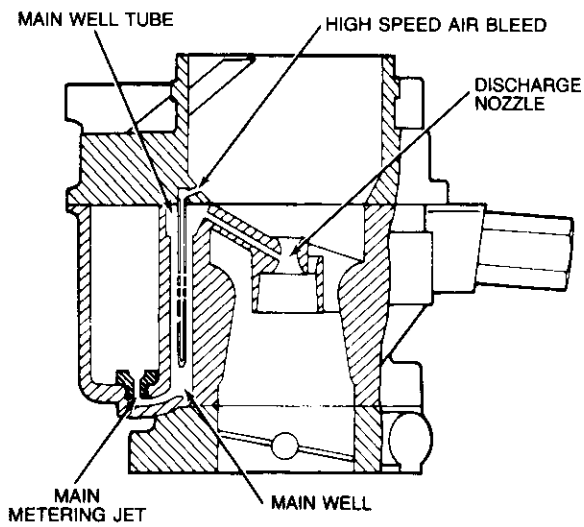
MAIN METERING SYSTEM

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

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

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

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



HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

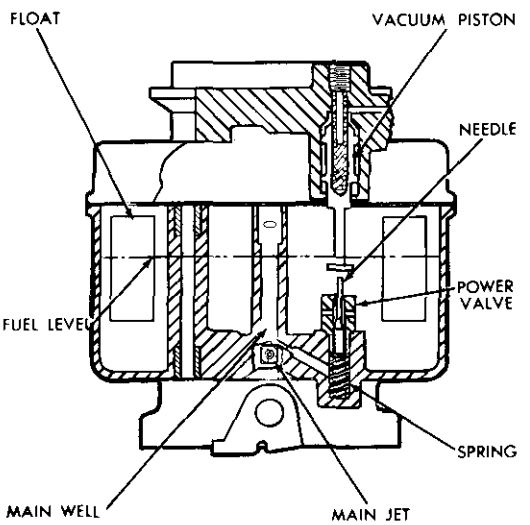
POWER ENRICHMENT SYSTEM MODEL 1940

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

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

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

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



ACCELERATOR PUMP SYSTEM

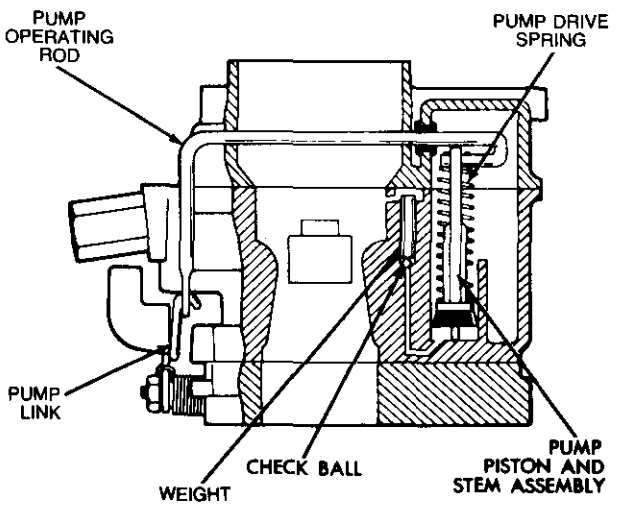
When the throttle plates are opened suddenly, the air flow through the carburetor increases almost immediately; however, there is a brief time interval or lag before the fuel can overcome its inertia and attain required flow to maintain the desired air-fuel ratio.

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

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

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

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



HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

ADJUSTMENTS

REPLACING IDLE MIXTURE SCREW

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

IDLE SPEED ADJUSTMENT

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

CARBURETOR IDLE MIXTURE ADJUSTMENT (ON ENGINE)

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

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

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

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

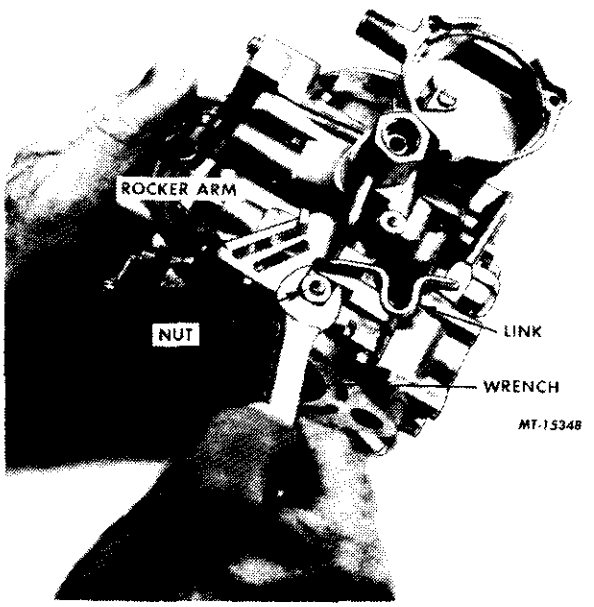
DISASSEMBLY

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

THE FOLLOWING PROCEDURES APPLY TO THE MODEL 1940

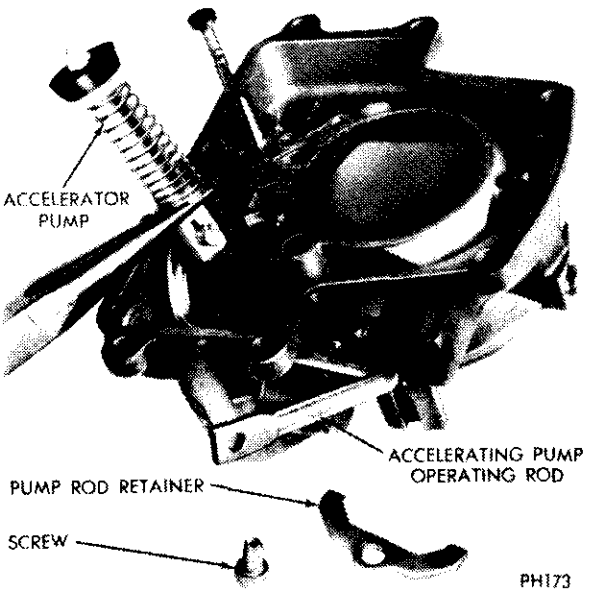
1. Remove nut and lockwasher retaining the pump rocker arm and pump link.
2. Remove the bowl cover screws.

Note the position of the link in the rocker arm slots and the position of the throttle return spring or the positive throttle return spring on some model applications for proper reassembly.

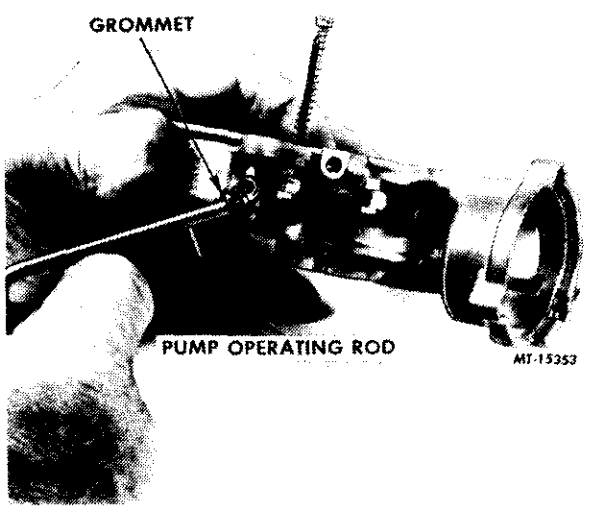


HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

3. Separate the bowl cover from the carburetor body. **Do not pry**. Tap gently from side to side with a plastic hammer or screwdriver handle.
4. Remove the accelerating pump operating rod retainer screw and retainer.
5. Rotate the pump operating rod and disconnect the pump drive spring and accelerating pump assembly. Set the pump assembly aside. Do not immerse in cleaner. A new pump cup is in the kit.

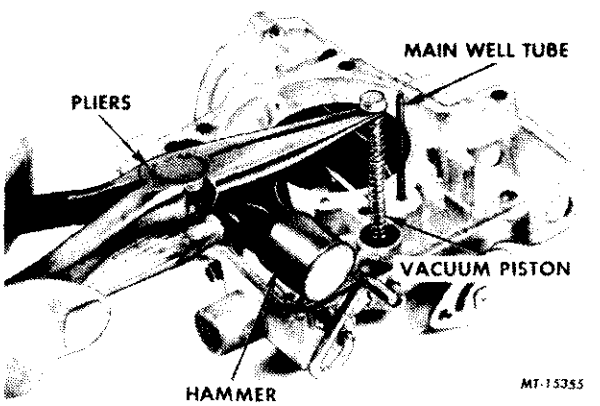


6. Rotate the pump operating rod and remove the rod and grommet from the bowl cover.



7. With a bearing scraper or a scraper ground from an old triangle file remove all the staking from the vacuum piston retainer.

8. With a suitable puller or long nosed pliers and support, remove the vacuum piston assembly.



9. Remove bowl vent valve from rod if so equipped. The rod cannot be removed.
10. Remove hot idle compensator valve cover, valve and gasket from cover, if so equipped.

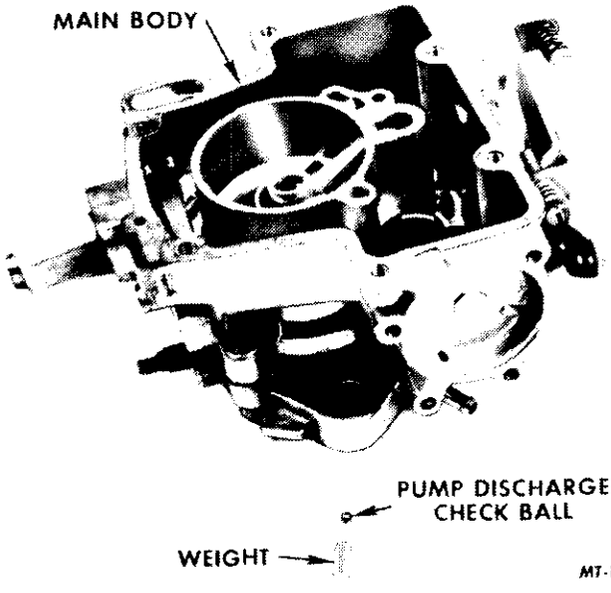
This normally completes disassembly of the bowl cover. If the carburetor is equipped with a mechanical power valve modulator rod it cannot be removed.

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

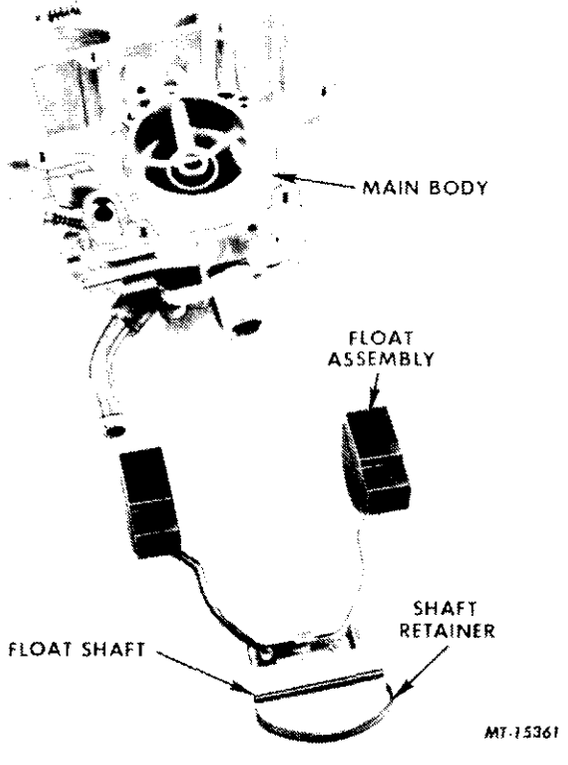
HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

CARBURETOR BODY DISASSEMBLY

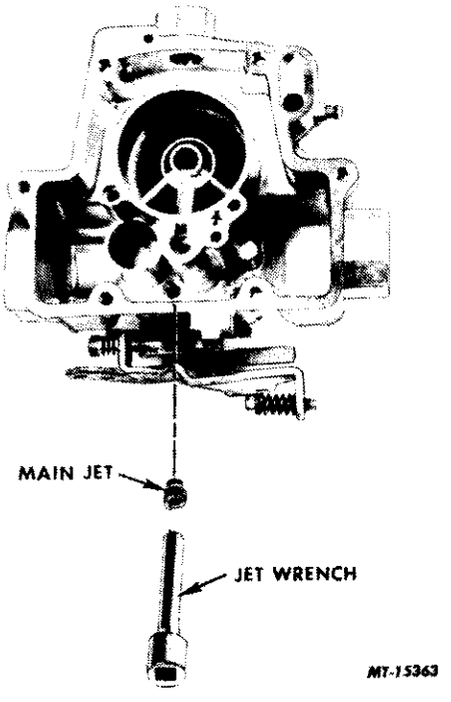
1. Turn the carburetor body upside down and remove the pump discharge ball and weight. Save the old ball in case the seat needs staking.



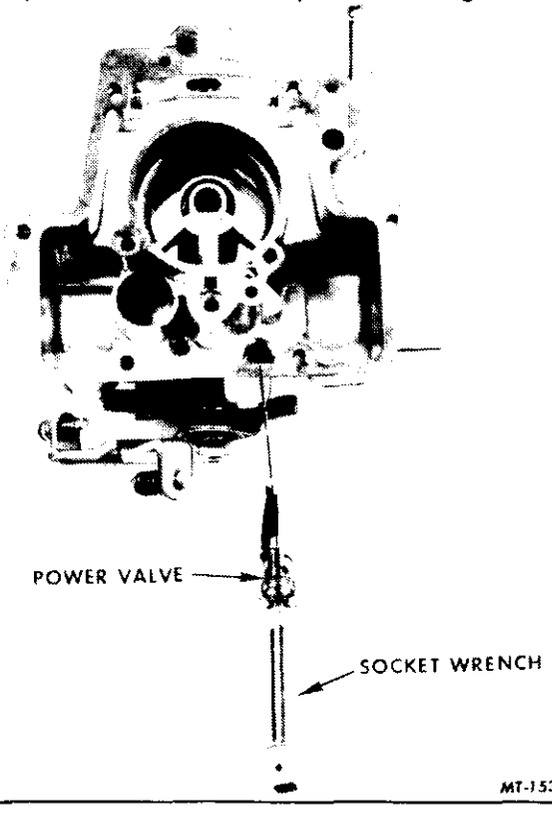
2. Remove the fuel inlet valve and fitting assembly; remove gasket. Remove spring float shaft retainer, float shaft and float.



3. Remove the main jet with a jet wrench. A 3/8" wide square point screwdriver may be used.

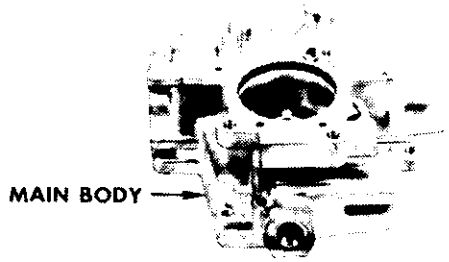


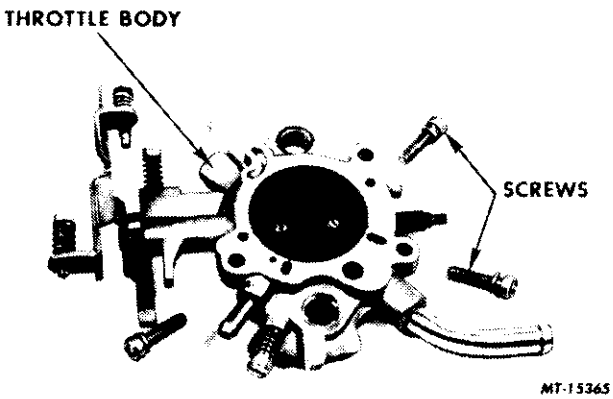
4. Remove the power valve assembly with a proper socket or a 3/8" wide screwdriver blade with a 1/16" x 3/8" deep slot sawed in the center of the blade. The slot will clear the power valve stem and prevent damage.



HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

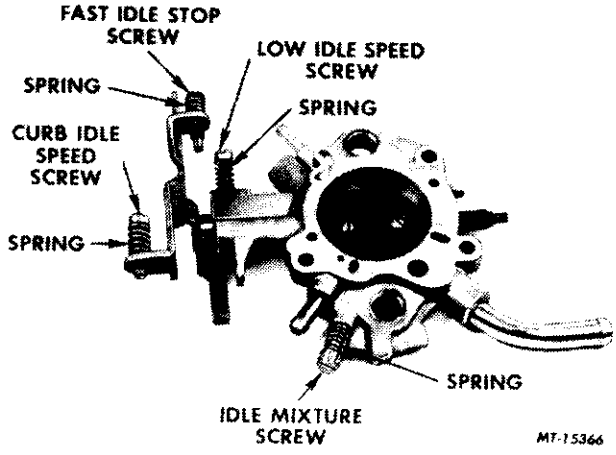
This completes the disassembly of the carburetor body. Remove the three carburetor body-to-throttle body screws. Tap gently and separate the throttle body from the main body.





THROTTLE BODY DISASSEMBLY

1. Gently turn the idle mixture screw clockwise until it seats. Record the starting position of the slot and the exact number of turns required to seat the screw. This procedure is necessary to reinstall it in the same position after cleaning.
2. Remove the curb idle screw and spring, low idle screw and spring and fast idle screw and spring. Certain applications may not have all of these screws.



3. Carefully inspect the throttle valve for nicks or burrs and the throttle shaft for wear. **Do not remove the throttle valve.** If damage or wear is evident, the throttle body or carburetor must be replaced. If the idle mixture screw is bent or grooved it must also be replaced. Correct idle adjustment cannot be achieved with a grooved or damaged idle mixture needle or screw.

HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

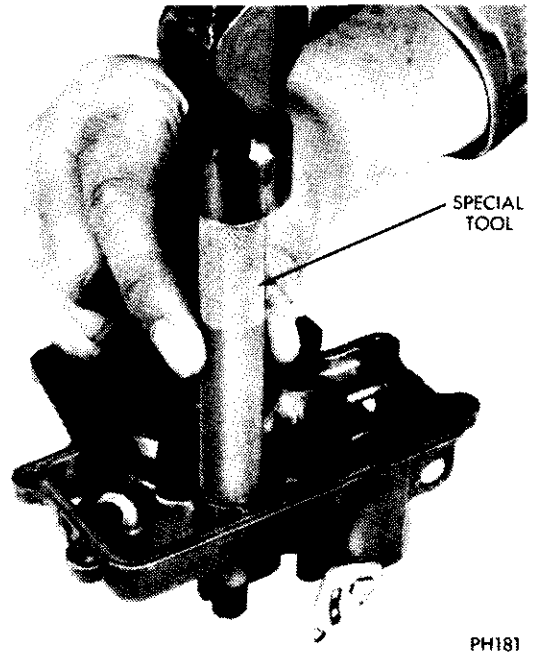
CLEANING

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

ASSEMBLY

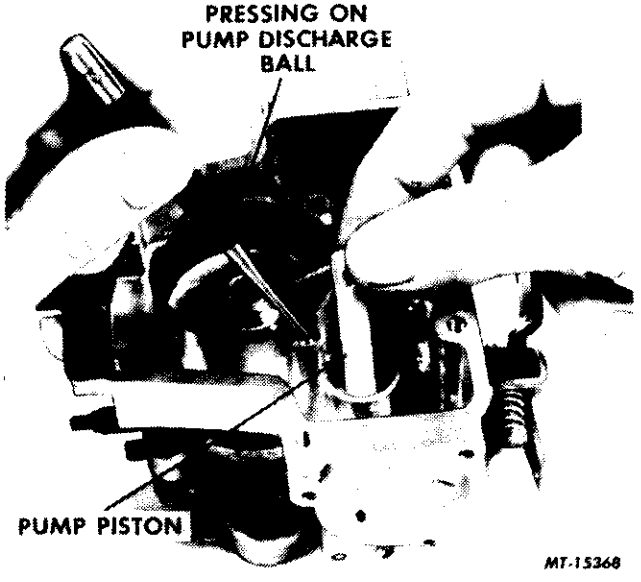
Except for the following vacuum piston staking operation, and testing the pump discharge valve, reassembly is the reverse of disassembly.

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



HOLLEY 1940 ONE-BARREL CARBURETOR (Continued)

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



ADJUSTMENTS DURING ASSEMBLY

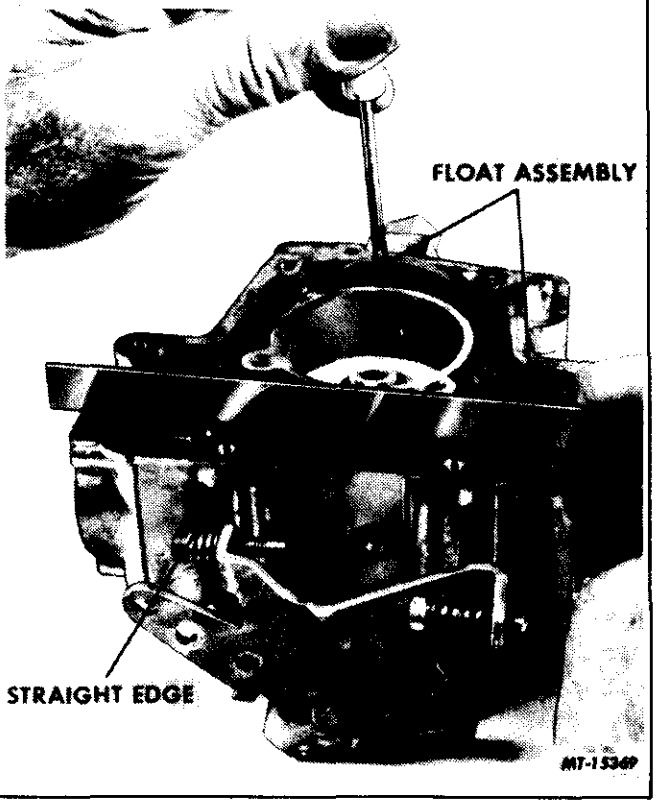
Assemble the throttle body, and assemble the throttle body to the main body. Use a new gasket and torque the screws to 30 in-lbs. in three even steps. Install the main jet and power valve with the proper tools.

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

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

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

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



Part 4 — Charging System

DESCRIPTION AND OPERATION

ALTERNATOR

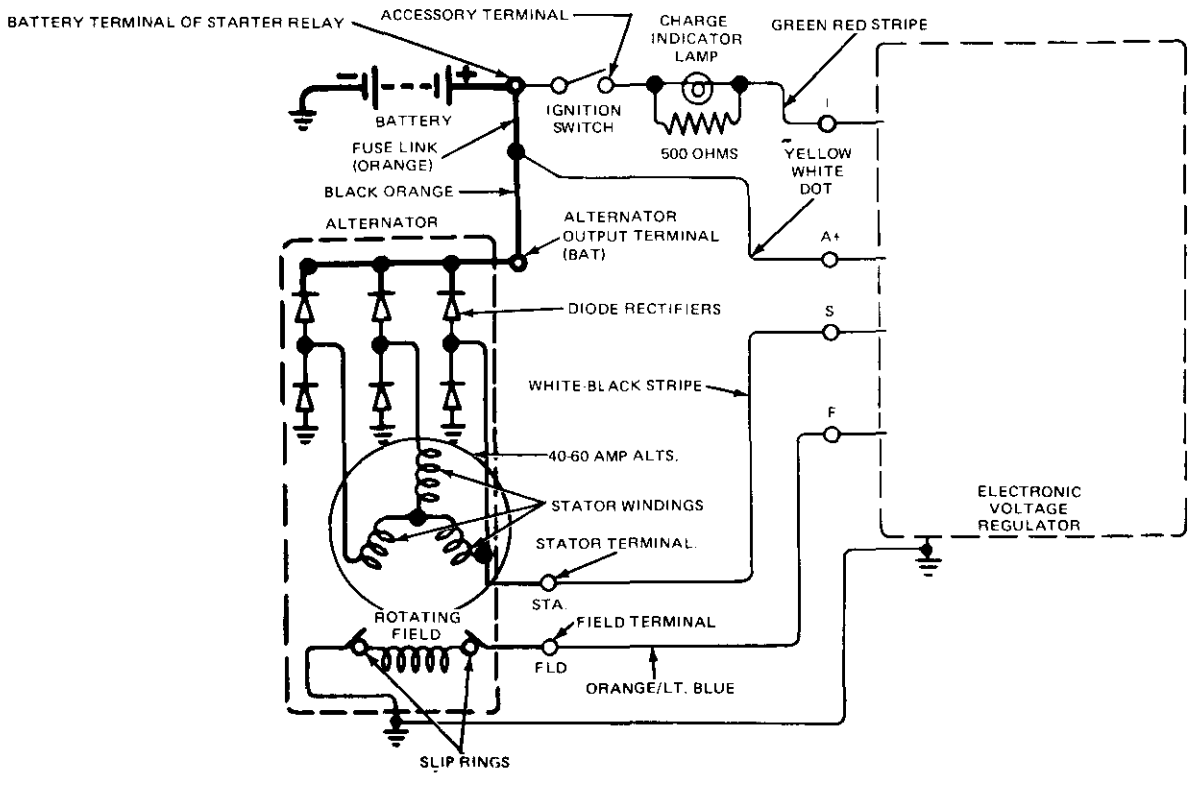
The 4.9 Liter Engines use either a Motorcraft or a Motorola alternator. Most of this section applies to the Motorcraft alternator, because the Motorola unit is serviced by Motorola.

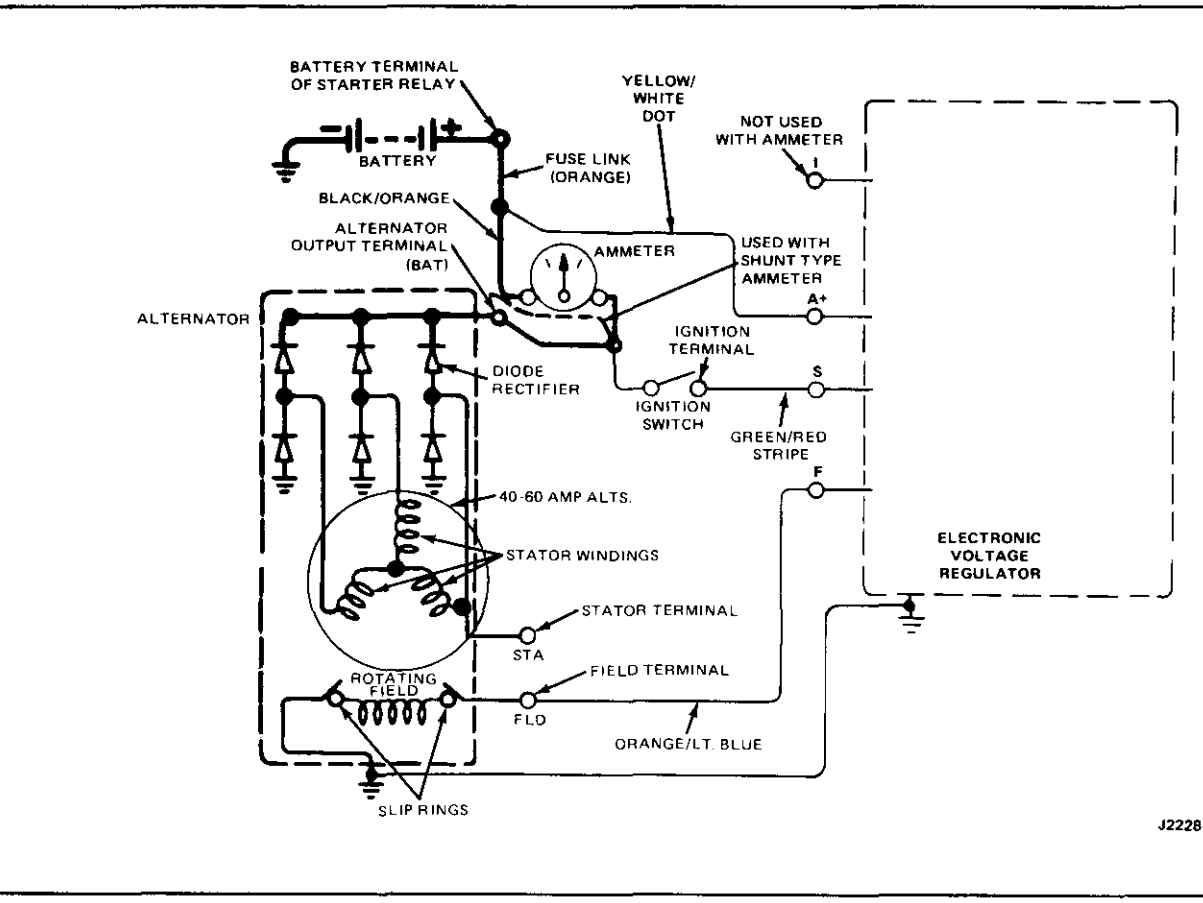
The alternator is belt driven from the engine. Current is supplied from the alternator-regulator system to the rotating field of the alternator through two brushes and two slip rings.

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. The alternator is self-current limiting.

The warning lamp control circuit passes current to the warning lamp when the ignition switch is in the Run position and there is no alternator voltage at terminal S. When the voltage at S rises to a preset value, current is cut off to the warning lamp. This circuit is not included in the regulator for vehicles equipped with an ammeter rather than the warning lamp.

DESCRIPTION AND OPERATION (Continued)





DESCRIPTION AND OPERATION (Continued)

A 500 ohm, 1/4 watt resistor is connected across the terminals of the lamp at the instrument cluster in vehicles equipped with an indicator warning lamp.

The switching circuit receives voltage from the ignition switch through the warning lamp control circuit on vehicles equipped with an indicator warning lamp or through terminal S on vehicles equipped with an ammeter. With an input voltage present, the switching circuit turns on the voltage control circuit, which in turn controls the output circuit. When the ignition switch is Off, the output circuit remains open and no current flows to the alternator field.

REGULATOR

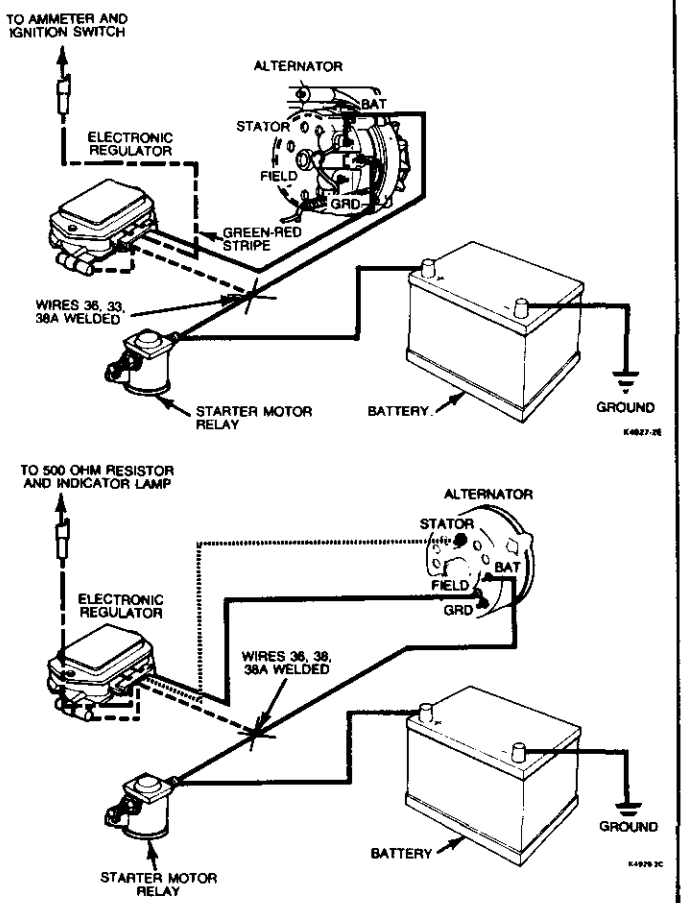
The electrical charging systems incorporate a new electronic voltage regulator. These regulators are 100 percent solid state, consisting of transistors, diodes, and resistors. The working functions are achieved using electronic components arranged in basically three circuit divisions as follows: the output stage, the voltage stage, and the solid state relay.

The new regulator will be released under two separate part numbers with color codes. The units will look alike, but are not interchangeable with the new regulator wiring harness connector plugs.

One of these units will be used on vehicles equipped with an ammeter, the other on vehicles equipped with an alternator warning indicator lamp. The regulators are calibrated and preset by the manufacturer. No readjustment is required or possible on these units.

The new solid state regulators being used in conjunction with other new components in the charging system that must be properly matched to prevent damage to the charging system are as follows:

1. A new alternator with higher field current requirement.
2. A new warning indicator lamp shunt resistor.
3. The alternator to regulator wiring harness is changed to incorporate a new regulator connector plug. The new plug is designed so that the connector will not index with the regulator terminals when the wrong regulator is inadvertently installed in the vehicle.



APPLICATION

Whenever the system components are being replaced, the following precautions should be followed so that the charging system will work properly and components will not be damaged.

1. Always use the proper alternator in the system being serviced. Older model alternators, if used in the present system, will have a slightly reduced output.
2. Never use an electro-mechanical regulator in the new charging system. The connector plug on the new system wiring harness will not index properly with the electro-mechanical regulator.
3. The electronic regulators are color coded for proper installation. Always use the black color coded regulator in systems which use the warning lamp indicator. The blue color coded regulators must be used in ammeter gauge systems.
4. The charging system uses a 500 ohm resistor on the back of the instrument cluster on units with a warning indicator lamp. Do not replace this item with the 15 ohm resistance wire.

DIAGNOSIS

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.

Before performing charging or starting 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 or no charge, alternator warning lamp does not come on or never goes out, voltmeter shows above or below open circuit nominal voltage. This information will aid in isolating the part of the system causing the symptom.

Next, visually inspect as follows:

1. Check 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. Inspect for evidence of arcing.
3. Check the alternator belt tension using belt tension gauge T63L-8620-A, Model 210019 or equivalent and tighten to specification (if necessary).

NORMAL CHARGE INDICATOR LIGHT

With ignition switch off . . . alternator light is off.

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

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

1. If the charge indicator light does not come on with the ignition key in the On position and the engine not running, 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.
2. If the charge indicator light does not go on, check the bulb for continuity and replace (if burned out).
3. If the bulb is not burned out, an open circuit exists between the ignition switch and the regulator.
4. Check the 500 ohm resistor across the charge indicator lamp. Engines equipped with an ammeter will not have a resistor.

NORMAL CHARGE AMMETER

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.

ISOLATING THE PROBLEM

Battery, starting system, and light systems problems can be caused by poor charging system performance. It is also possible to suspect the charging system because of an overload in another area of the electrical system.

To avoid guesswork, it is necessary to isolate the battery, the charging system, and the electrical circuits to correctly identify the area where the difficulty lies. The best method to do this is to check the battery first before any electrical system diagnosis. The battery must be in the proper state of charge. The battery must be operating properly before the other areas of the electrical system can perform normally.

TESTING

BATTERY

WARNING: KEEP BATTERIES OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF 15 MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

BATTERIES ARE HEAVY, WEIGHING 30 LBS. OR MORE. LIFT THEM WITH YOUR LEGS RATHER THAN YOUR BACK TO PREVENT MUSCLE STRAINS, AND BE CAREFUL NOT TO DROP THEM (POSSIBLE BREAKAGE) NOR TO SPILL THE CONTENTS (SULFURIC ACID).

CAUTION: 12-volt starting motors can be damaged beyond repair if connected to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor-generator set), even when cranking loads are relatively light. Extensive starting motor damage is more likely if the starter is connected to a 24-volt supply while being subjected to prolonged heavy cranking loads such as attempting to start an engine in subzero temperatures.

Tests are made on a battery to determine the state of charge and also its capacity or ability to crank an engine. The ultimate result of these tests is to show that the battery is good, needs recharging, or must be replaced.

Before attempting to test a battery, it is important to give it a thorough examination to determine if it has been damaged. Remove battery cable clamps, negative (−) terminal first. Check for dirty or corroded connections and loose battery posts. Remove holddowns and heat shields and inspect for broken or cracked case or cover. If worn or damaged, loose or broken post, or cracked case or cover, replace battery.

BATTERY DISCHARGE RATES

Ampere Hours	Discharge Rate Amperes
45	190
53	200
63	260
68	235
71	235
85	240
90	310

TEMPERATURE CORRECTION CHART-ALL BATTERIES

Temperature °F	Minimum Acceptable Load Voltage
70 (or above)	9.6
60	9.5
50	9.4
40	9.3
30	9.1
20	8.9
10	8.7
0	8.5

The battery capacity test should be run next to remove any surface charge prior to determining state of charge of a maintenance-free battery.

CAPACITY TEST

A high rate discharge tester in conjunction with a voltmeter is used for this test.

1. Turn the control knob on the Battery-Starter Tester to the Off position.
2. Turn the voltmeter selector switch to the 20-volt position and test selector switch to "AMP."
3. Connect both positive test leads to the positive (+) battery post and both negative leads to the negative (−) battery post. The voltmeter clips must contact the battery posts and not the high-rate discharge tester clips. Unless this is done, the actual battery terminal voltage will not be indicated.
4. Turn the load control knob in a clockwise direction until the ammeter reaches the applicable discharge rate specified in the discharge rate table.
5. With the ammeter reading the required load for 15 seconds, note the voltmeter reading. Avoid leaving the high discharge load on the battery for periods longer than 15 seconds.

   If the voltmeter reading is above the minimum specified in the table with the test equipment for that temperature, the battery has a good output capacity and will readily accept a charge, if required. Check the state of charge.

TESTING (Continued)

STATE OF CHARGE — MAINTENANCE-FREE BATTERIES

Read the battery open circuit terminal voltage with a digital voltmeter capable of reading 1/100 of a volt. If the open circuit voltage of the battery is below 12.40 volts and the battery has passed the capacity test, charge the battery.

CHARGING SYSTEM TESTS

MOTOROLA

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

CAUTION:
- **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.

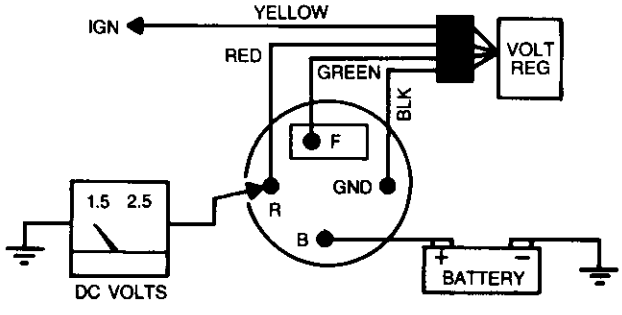
Test 1 — Ignition On — Engine Not Running

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

If voltage at regulator terminal is:

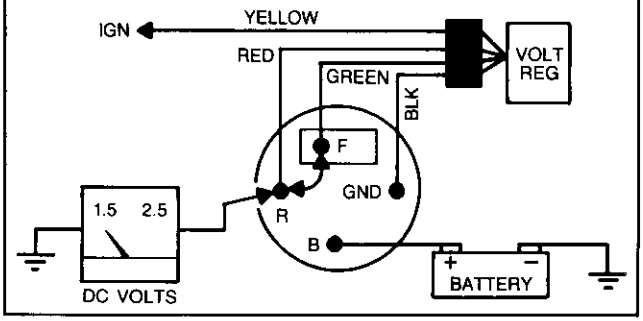
5.0 to 7.0 volts = open rotor (field circuit)
.75 to 1.1 volts = grounded rotor circuit
8.5 to 10.0 volts = open in regulator's load circuit
0 volts = open ignition switch or excitation resistor

If test results are uncertain, go to Test 2.



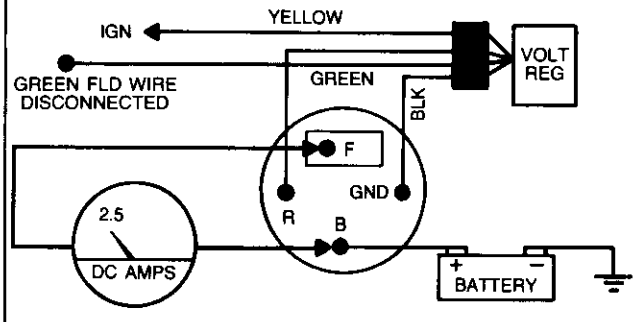
Test 2 — Ignition On — Engine Not Running

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.



Test 3 — Field Draw Test — Ignition Off

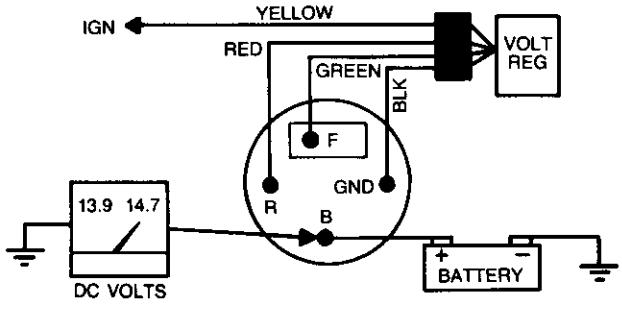
This test evaluates complete field circuit, independent of voltage regulator. Circuit is through brushes, slip rings, field coil to ground. Current should be 2 to 2.5 amps. If less than this, check brushes and slip rings. It is desirable to use a field rheostat in series with meter for protection of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



TESTING (Continued)

Test 4 — Ignition On — Engine Running at Fast Idle

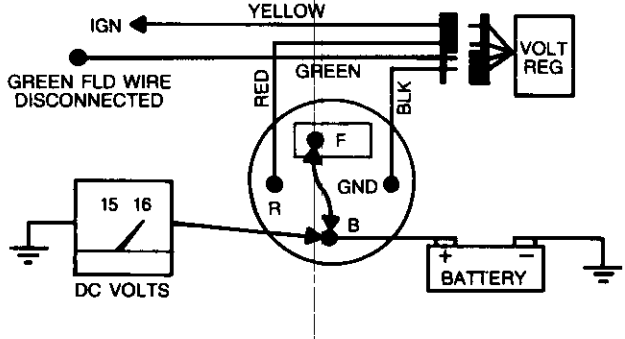
Voltage indicated is usually 13.9 to 14.7 volts depending on regulator ambient temperature. High voltage may be due to a poor ground connection. If ground connection is not faulty, regulator will require replacement.



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.



MOTORCRAFT

When performing charging system tests with a voltmeter, turn off all lights and electrical components.

CAUTION: Be sure field terminal connector is installed on the "Field" terminal stud at alternator and not the ground stud.

Always disconnect the connector plug from the regulator before checking alternator output with test probes or a jumper wire.

Always disconnect the connector plug from the regulator before removing the regulator mounting screws. Removing the connector from an un-grounded regulator with the ignition switch on will destroy the regulator.

Never attempt to polarize or test the alternator by grounding the field circuit, as this will destroy the regulator.

Base Voltage Test

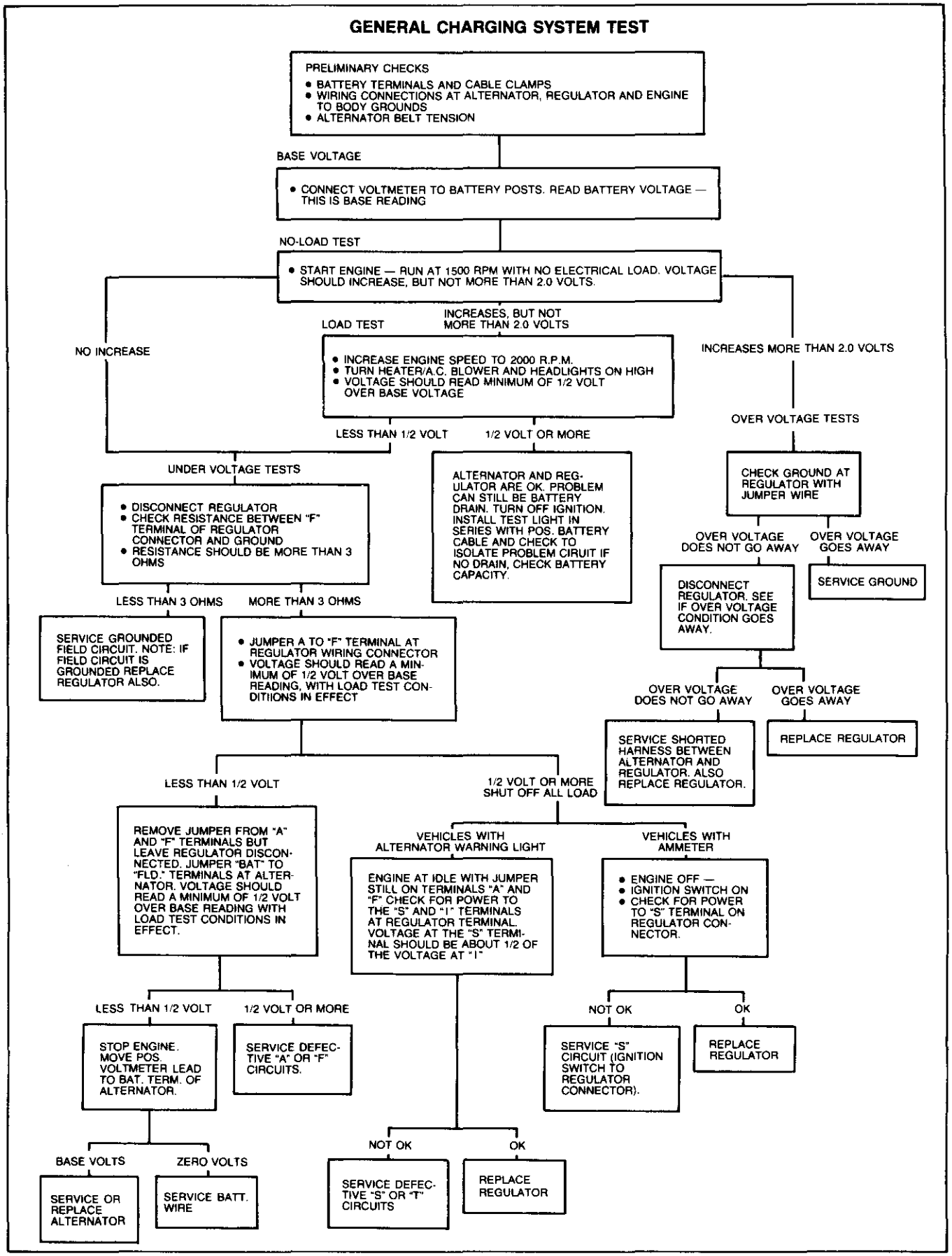
1. With ignition off and no electrical load on, connect the negative lead of the voltmeter to the negative battery cable clamp.
2. Connect the positive lead of the voltmeter to the positive battery cable clamp.
3. Record the battery voltage reading shown on the voltmeter scale (base voltage).

No Load Test

1. Connect a tachometer to the engine.
2. Start the engine and increase speed to approximately 1500 RPM. With no other electrical load, the voltmeter pointer should move upward (increase), but not more than 2 volts above the base voltage (first recorded battery voltage reading above). The reading should be taken when the voltmeter pointer stops rising. It may take a few minutes to reach this point. If the voltage increases to proper level, perform Load Test. If the pointer continues to rise, perform the Over Voltage Tests. If the voltage does not rise to proper level, perform the Under Voltage Tests.

TESTING (Continued)

GENERAL CHARGING SYSTEM TEST



TESTING (Continued)

Load Test

1. With the engine running, turn the heater or air conditioner blower motor on (high speed) and headlights on high beam.
2. Increase the engine speed to approximately 2000 RPM. The voltmeter should indicate a minimum of 0.5 volt above the base voltage. If not, perform the Under Voltage Tests described below.

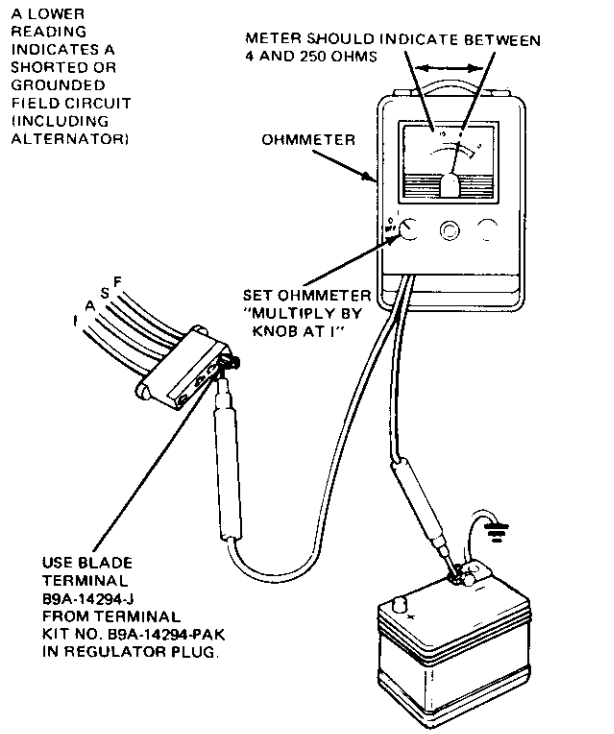
If the above tests indicate proper voltage readings (1/2 volt open circuit above base), the charging system is operating normally. Proceed to the tests below if one or more of the readings are different than shown above and use a test light to check for battery drain.

Over Voltage Tests

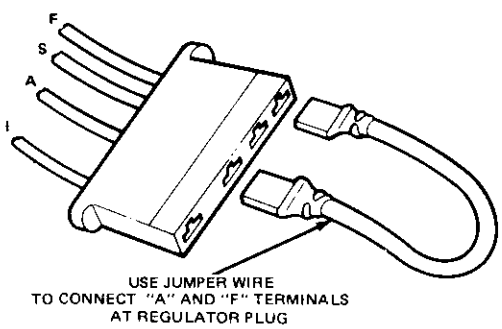
1. If the voltmeter reading indicates more than 2.0 volts above base voltage, connect a jumper wire between the regulator base and alternator frame. Repeat the No Load test. If over voltage condition disappears, check ground connections on alternator, regulator and from engine to firewall and to battery. Clean and tighten connections securely.
2. If over voltage condition still exists, disconnect the regulator wiring plug from the regulator and repeat the No Load test.
3. If over voltage condition disappears (voltmeter reads battery base voltage), replace voltage regulator.
4. If over voltage still exists with the regulator wiring plug disconnected, check for short between "A" and "F" in the wiring harness plug and service as required. Replace the regulator and connect the regulator wiring plug to the regulator.

Under Voltage Tests

1. If the voltage does not indicate more than 1/2 volt above base voltage, disconnect wiring plug from regulator and connect an ohmmeter from "F" terminal of plug to ground. Meter should indicate more than 2.4 ohms. If less than 2.4 ohms is indicated, service grounded field current in wire or alternator and repeat Load Test above.
2. If ohmmeter indicates more than 2.4 ohms connect jumper wire from "A" to "F" terminals of regulator plug. Repeat Load Test above. If voltmeter now indicates more than 1/2 volt above base voltage, service wiring to regulator or regulator.
3. If the voltmeter still indicates under voltage, remove the jumper wire from the regulator plug and leave the plug disconnected from the regulator. Connect a jumper wire to the FLD and BAT terminals on the alternator and repeat the Load Test. If the voltmeter now indicates more than 1/2 volt above the base voltage, perform S and I Circuit Test and service the wiring harness from the alternator to the regulator.
4. If the voltmeter still indicates under voltage, stop the engine and move the positive voltmeter lead to the alternator BAT terminal.
5. If the voltmeter now indicates the base voltage reading, service the alternator. If the voltmeter indicates zero volts, service alternator to starter relay wire.



J1633-1D



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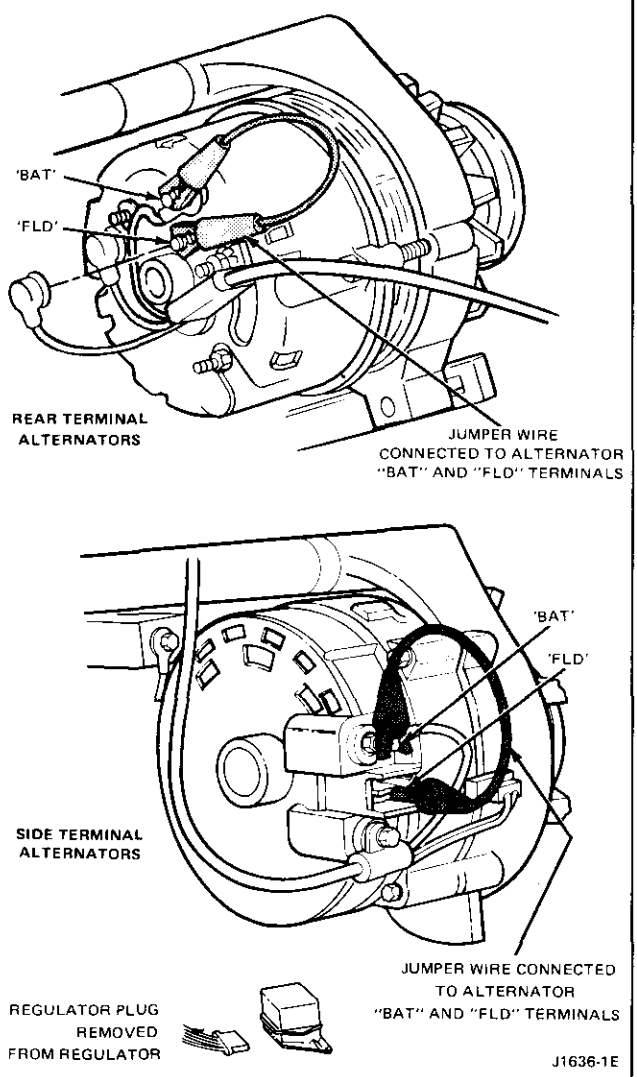
TESTING (Continued)



Regulator S and I Circuit Tests
S-Circuit with Ammeter

1. Connect the positive lead of the voltmeter to the S terminal of the disconnected regulator wiring plug and negative lead of voltmeter to battery ground terminal. Then, turn the ignition switch to the On position. DO NOT start the engine. No voltage should be indicated with ignition switch Off.
2. The voltmeter should indicate battery voltage.
3. If there is no voltage reading, service 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 Load Test.

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 negative voltmeter lead to the battery ground terminal and the positive lead of the voltmeter to the S terminal and then to the I terminal of the regulator wiring plug. The voltage of the S circuit should read approximately one-half of the I circuit.
3. If no voltage is present, service the wiring circuit. Reconnect the positive voltmeter lead to the positive battery cable terminal.
4. Then, remove the jumper wire from the regulator wiring plug and connect the wiring plug to the regulator. Repeat the Load Test.

TESTING (Continued)

BENCH TESTS

After the general charging system diagnosis has isolated the problem to the alternator, remove it from the vehicle for bench testing and service, or replacement. Refer to Alternator Removal and Disassembly in this section.

Rectifier Short or Grounded and Stator Grounded Test

These tests are performed with an ohmmeter (Rotunda 50-0010 or equivalent). Set the "Multiply By" knob at 1 and calibrate the ohmmeter as directed.

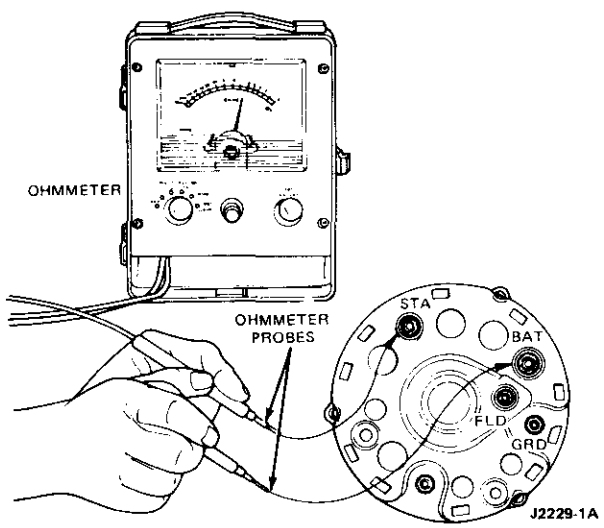
CAUTION: Digital meters cannot be used to perform these rectifier tests.

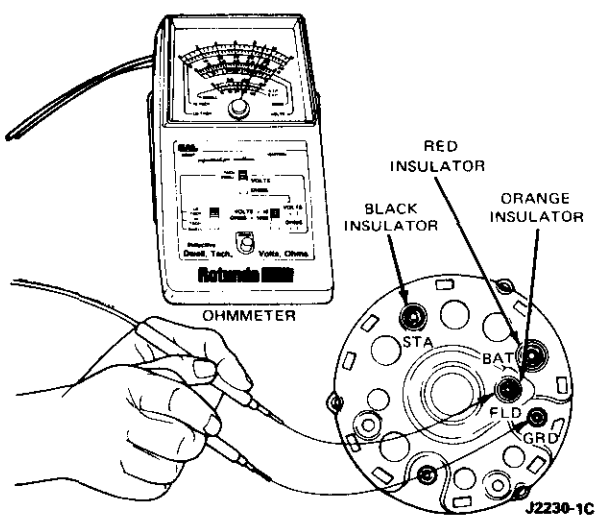
1. Contact one ohmmeter probe to the alternator BAT terminal (terminal with red insulator) and the other probe to the STA terminal (terminal with black insulator). Then, reverse the ohmmeter probes and repeat the test. Normally there will be no needle movement in one direction, indicating the rectifier diodes are being checked in the reverse current direction and are not shorted. A low reading with the probes reversed indicates that rectifier positive diodes are being checked in the forward current direction. Using the referenced tester, the low reading should be about 6 ohms but may vary if another type of tester is used. A reading in both directions indicates a bad positive diode, a grounded positive diode plate or a grounded BAT terminal.
2. Perform the same test using the STA and GND terminals. A reading in both directions indicates either a grounded stator winding, a bad negative diode, a grounded stator terminal, a grounded positive diode plate, or a grounded BAT terminal.
3. If there is no needle movement with the probes in one direction and a high resistance (significantly over 6 ohms) in the opposite direction, for either test, a bad connection exists between the stator lead terminal and the stator bolt head.

Field Open or Short Circuit Test

This test is performed with an ohmmeter. Set the ohmmeter "Multiply By" knob at 1 and calibrate the ohmmeter as directed inside the instrument cover.

1. 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 2.4 and 100 ohms and should fluctuate while the pulley is turning.
2. An infinite reading (no meter movement) indicates an open brush lead, worn or stuck brushes or a bad rotor assembly.
3. An ohmmeter reading less than 2.4 ohms indicates a grounded brush assembly, a grounded field terminal or a bad rotor.





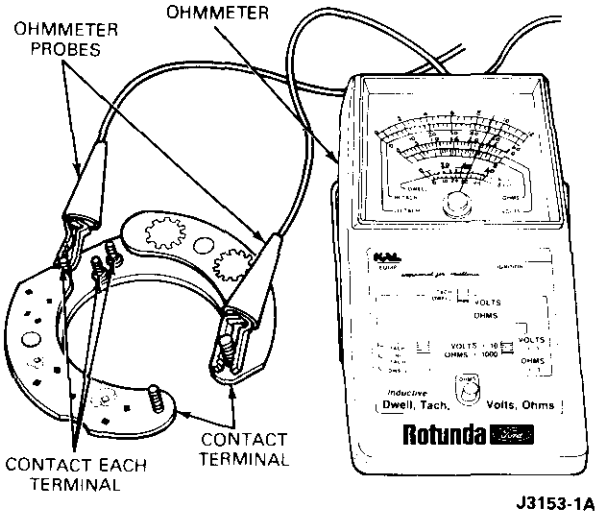
TESTING (Continued)

Diode Test

Remove the rectifier assembly from the alternator. Set the ohmmeter "Multiply By" knob at 1 and calibrate the meter as directed.

CAUTION: Digital meters cannot be used to perform these diode tests.

1. To test one set of diodes, contact one probe to the terminal bolt 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 6 ohms in one direction and an infinite reading (no needle movement) with the probes reversed. The low reading may vary with the type of tester used. This reading may be checked against a good rectifier if it is available.



2. Repeat the preceding tests for the other set of diodes except that the other terminal screw is used.
3. If the meter readings are not as specified, replace the rectifier assembly.

Stator Coil Grounded Test

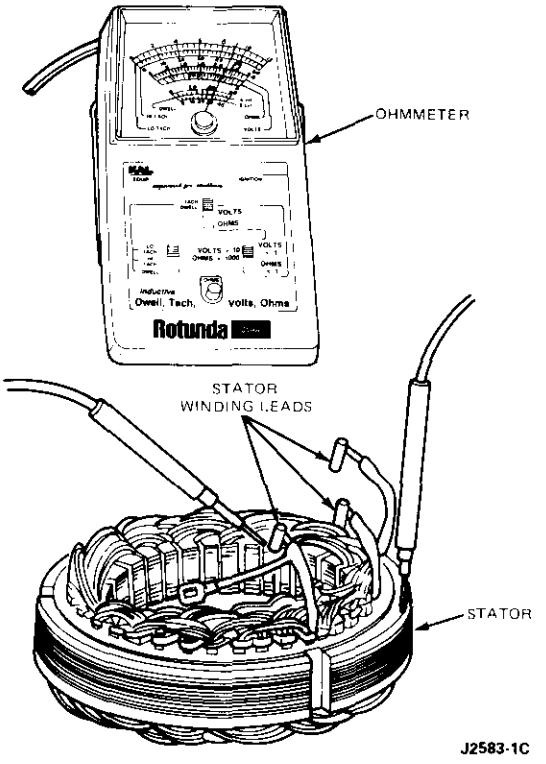
These tests are made to determine if the stator coil is operating properly. Remove the stator from the alternator and disconnect from the rectifier assembly (refer to Disassembly procedure in this section). Set the ohmmeter "Multiply By" knob at 1000.

1. 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).
2. If the meter does not indicate an infinite reading (needle moves), the stator winding is shorted to the core and must be replaced.
3. Repeat this test for each of the stator leads. Do not touch the metal probes or stator leads with the hands. Such contact will result in an incorrect reading.

Stator Coil Open Test

This test determines if there is an open stator circuit. Disconnect the stator from the rectifier assembly. Set the ohmmeter "Multiply By" knob at 1.

1. Connect one ohmmeter probe to a stator phase lead and touch the other probe to another stator lead. Check the meter reading.



2. Repeat this test with the other two stator lead combinations. If no meter movement occurs (infinite resistance) on a lead paired with either of the other two leads, that phase is open and the stator should be replaced.

TESTING (Continued)

Rotor Open or Short Circuit Test

Remove the rotor from the alternator. Set the ohmmeter "Multiply By" knob at 1 and calibrate the meter as directed.

1. Contact each ohmmeter probe to a rotor slip ring. The meter reading should be 2.0 to 3.5 ohms.
2. A higher reading indicates a damaged slip ring solder connection or a broken wire.
3. A lower reading indicates a shorted wire or slip ring. Replace the rotor if it is damaged and cannot be serviced.
4. Contact one ohmmeter probe to a slip ring and the other probe to the rotor shaft. The meter reading should be infinite (no deflection).
5. 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 not touching the rotor shaft or that excess solder is not grounding the rotor shaft or that excess solder is not grounding the rotor coil connections to the shaft. Replace the rotor if it is shorted and cannot be serviced.

REMOVAL AND INSTALLATION

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

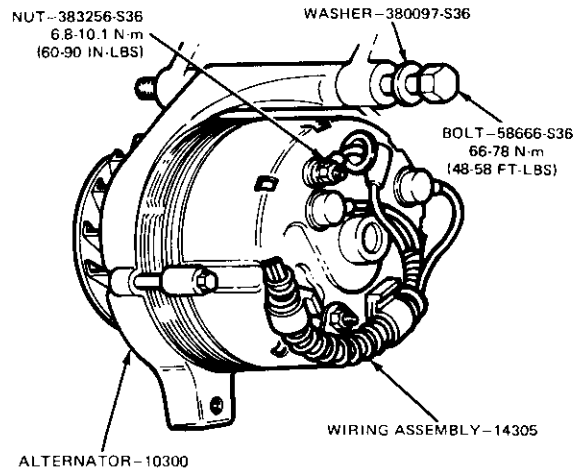
WARNING: KEEP OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG, OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

REMOVAL

1. Disconnect the ground cable from the battery.
2. Loosen the alternator pivot bolt and remove the adjustment arm-to-alternator bolt.
3. Disengage the alternator drive belt from the drive pulley.
4. Disconnect the wiring terminals from the back of the alternator. The stator and field wiring terminals are the push-on type. The push-on type terminal should be pulled straight off the terminal to prevent damage.
5. Remove the alternator pivot bolt.
6. Remove the alternator.

INSTALLATION

1. Position the alternator on the engine.
2. Install the alternator pivot bolt and adjuster bolt.
3. Connect the wiring terminals to the back of the alternator.
4. Install the drive belt over the alternator drive pulley.
5. Adjust the belt to specification.
6. Connect ground cable to battery.



J2550-1A

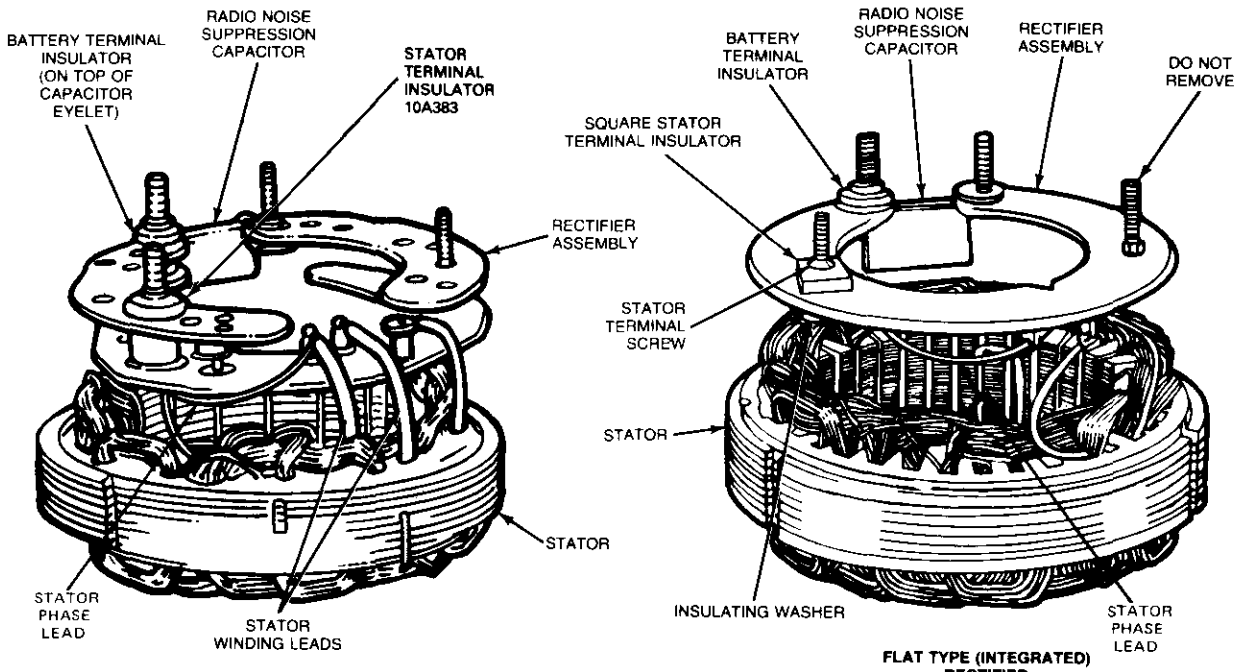
DISASSEMBLY AND ASSEMBLY

DISASSEMBLY

NOTE: All of the following disassembly steps may not be necessary to perform a particular test or repair. Perform only those steps that apply in your case.

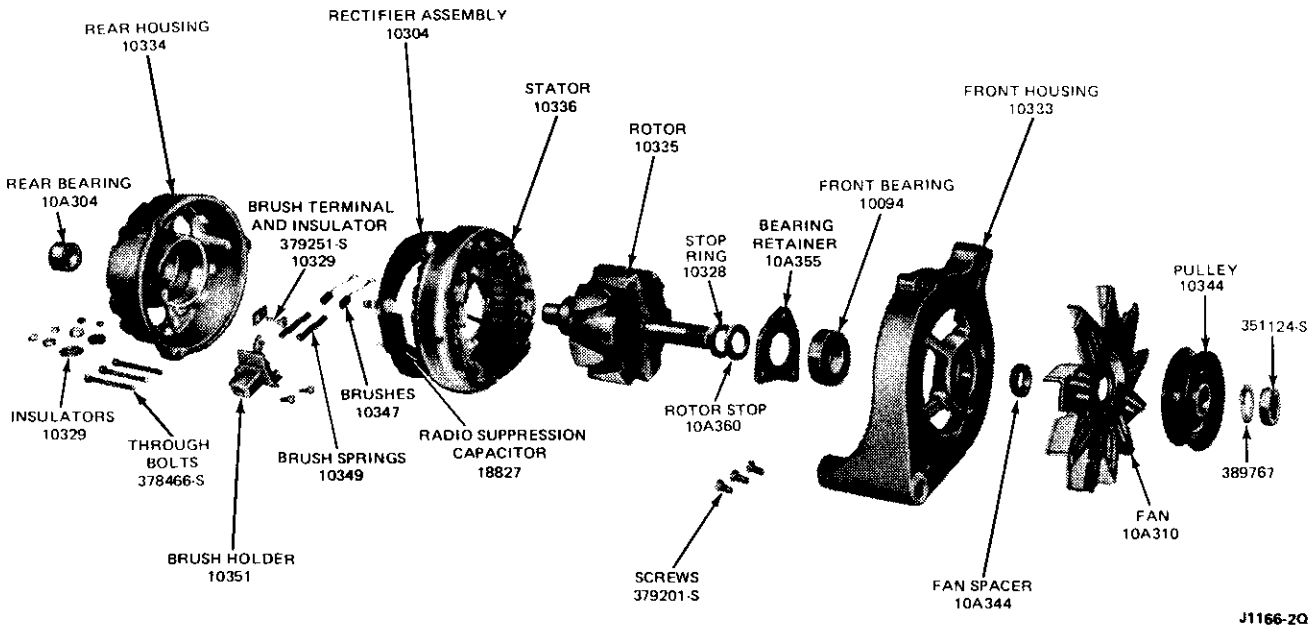
The rear terminal alternator will have one of two types of rectifier assembly. One is a flat design with built-in diodes. The other type is a stacked design with exposed diodes. Procedural steps affected by the differences in the rectifiers will be noted.

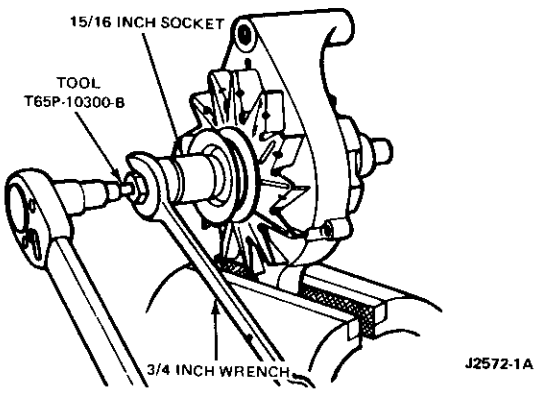
1. Scribe a line across the end housings and stator frame for alignment reference during assembly.
2. Remove the three housing through bolts.
3. Separate the front housing and rotor assembly from the stator and rear housing assembly. It may be necessary to tap the front housing with a plastic tipped hammer to loosen the front housing from the stator frame.
4. Remove the brush springs from the brush holder in the rear housing.
5. Remove the nuts, washers and insulators from the terminals on the back of the rear housing. Note the color and location of the insulators for assembly reference.
6. Remove the stator and rectifier assembly from the rear housing.
7. Remove the screws attaching the brush holder to the rear housing.
8. Remove the brush holder, the brushes and the brush terminal insulator from the rear housing.
9. Using a suitable arbor press, remove the bearing from the rear housing. Support the housing close to the bearing boss to prevent damage to the housing.
10. Clamp the front housing in a vise with protective jaws.
11. Remove the drive pulley retaining nut from the rotor shaft using Removal/Installation Tool, T65P-10300-B or equivalent.
12. Remove the lockwasher, drive pulley, fan and fan spacer from the rotor shaft.
13. Remove the rotor from the front housing and remove the housing from the vise.
14. Remove the front bearing spacer from the rotor shaft. Do not remove the stop ring from the rotor shaft unless it is damaged.
15. Remove the screws attaching the bearing retainer to the front housing and remove the retainer.
16. Remove the bearing from the front housing. If the bearing will not slide out, remove it using a suitable arbor press. Support the housing close to the bearing boss to prevent damage to the housing.



STATOR AND RECTIFIER ASSEMBLIES J2245-2D

DISASSEMBLY AND ASSEMBLY (Continued)





19. Disconnect the stator phase lead from the rectifier assembly as follows:

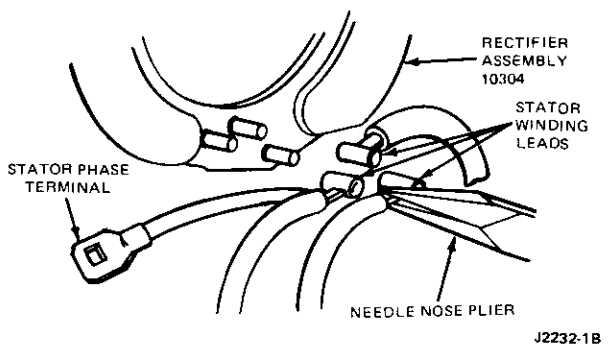
    Flat type (integrated) rectifier — Remove the stator terminal screw by pressing it straight out of the rectifier. Do not turn the terminal screw during removal. Turning the screw during removal will destroy the serrations cut into the rectifier to hold the terminal screw in position.

    Exposed diode (discrete) rectifier — Remove the stator terminal screw by turning it 1/4 turn to unlock it from the rectifier assembly.

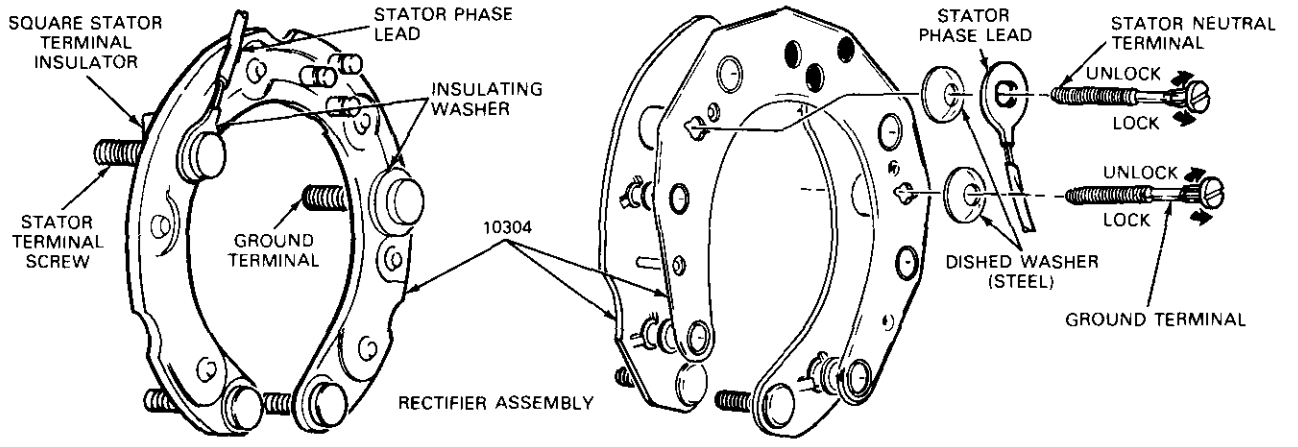
20. If necessary, the ground terminal can be removed from the rectifier assembly by following the appropriate procedure outlined in Step 19.

17. Remove the radio suppression capacitor and the battery terminal insulator from the rectifier assembly.

18. Using a 100 watt soldering iron, unsolder the stator leads from the rectifier assembly. Do not allow the soldering iron to overheat the rectifier. When removing the rectifier assembly from the alternator, do not cut the stator lead wires. Unsolder the stator terminals from the molded circuit board terminals and with needle nose pliers pull stator lead terminals upwards from the rectifier assembly. While the terminals are still hot, shake the molten solder from the terminals.



DISASSEMBLY AND ASSEMBLY (Continued)



FLAT TYPE (INTEGRATED) RECTIFIER

RECTIFIER (DISCRETE) WITH EXPOSED DIODES

J1401-2L

CLEANING AND INSPECTION

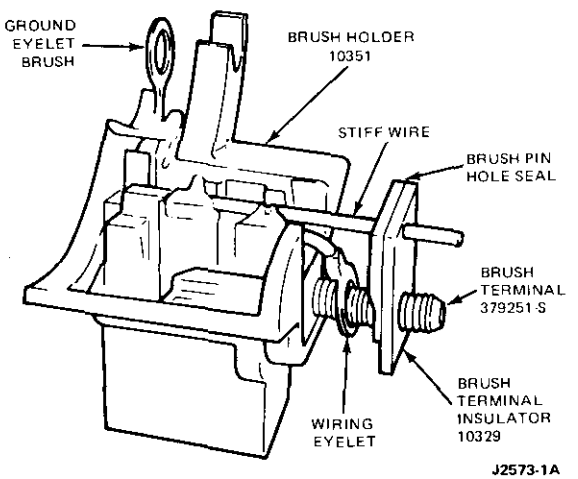
CAUTION: When rebuilding a high temperature 60 AMP alternator, use only high temperature rectifier assembly and bearings. Use of standard parts will result in alternator failure.

1. Wipe the rotor, stator and bearings with a clean cloth. Do not clean these parts with solvent.
2. Rotate the front bearing on the drive end of the rotor shaft. Check for any scraping noise, looseness or roughness. Look for excessive lubricant leakage. If any of these conditions exist, replace the bearing.
3. Inspect the rotor shaft rear bearing surface for roughness or severe chatter marks. Replace the rotor assembly if the shaft is not smooth.
4. Place the rear bearing on the slip ring end of the rotor shaft and rotate the bearing. Make the same check for noise, looseness, or roughness as was made for the front bearing. Inspect the rollers and cage for damage. Replace the bearing if these conditions exist, or if the lubricant is lost or contaminated.
5. Check the pulley and fan for excessive looseness on the rotor shaft. Replace any pulley or fan that is loose or bent out of shape.
6. Check both the front and rear housing for cracks, particularly in the webbed areas and at the mounting ear. Replace damaged or cracked housing.
7. Check all wire leads on both the stator and rotor assemblies for loose or broken soldered connections and for burned insulation. Resolder poor connections. Replace parts that show signs of burned insulation.
8. Check the slip rings for nicks and surface roughness. Nicks and scratches may be removed by turning down the slip rings. Do not go beyond the minimum diameter of 31 mm (1.22 inches). If the rings are badly damaged, replace the rotor assembly.
9. Replace the brushes if they are worn shorter than 6.35 mm (1/4 inch).

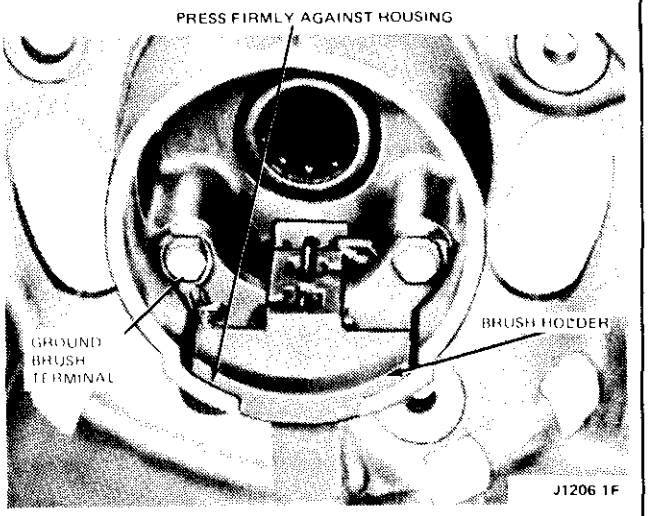
DISASSEMBLY AND ASSEMBLY (Continued)

ASSEMBLY

1. Install the bearing in the front housing. Press on the outer race only.
2. Position the bearing retainer on the front housing and install the attaching screws. Tighten the screws to 2.8-4.5 N•m (25-40 in-lb).
3. If the stop ring was removed from the rotor shaft, install a new ring by sliding it over the end of the shaft and into the groove. Do not open the ring with snap ring pliers as permanent deformation of the ring will result.
4. Install the bearing spacer on the rotor shaft with the recessed slide against the stop ring.
5. Install the rotor in the front housing and clamp the housing in a vise.
6. Install the fan spacer, fan, drive pulley lockwasher and nut on the rotor shaft. Tighten the nut to 82-135 N•m (60-100 ft-lb) using Removal/Installation Tool, T65P-10300-B or equivalent.
7. Remove the rotor and housing assembly from the vise.
8. Support the rear housing close to the bearing boss to prevent damage to the housing and install the bearing using a suitable arbor press. Press the bearing into the bore until it is flush with the housing.
9. Position the brush wiring eyelet over the brush terminal and install the brush terminal insulator.



10. Install the springs and brushes in the brush holder. Hold the brushes against spring tension by inserting a piece of stiff wire through the brush holder.



11. Position the brush holder in the rear housing and install the attaching screws. Tighten the screws to 1.9-2.8 N•m (17-25 ft-lb). Press the brush holder firmly against the housing while tightening the screws. Make sure the ground brush wiring eyelet is positioned under the screw before tightening.
12. Connect the stator phase lead to the rectifier assembly as follows:

    Flat type (integrated) diode rectifier — Position the stator terminal insulator and the stator phase lead on the rectifier assembly. Insert the terminal screw and press into position. The screw should be pressed in far enough to keep the phase lead terminal from moving.

    Rectifier with exposed diodes (discrete) — Position the stator phase lead and dished washer on the rectifier assembly. Insert the terminal screw and lock into place by rotating 1/4 turn.
13. If the ground terminal was removed from the rectifier assembly, it can be installed by pressing or turning as outlined in the appropriate procedure in Step 12.
14. Before soldering stator leads to rectifier, make sure that the insulator sleeves are in place. Wrap the stator winding leads around the terminals of the rectifier assembly and solder them, using a 100 watt soldering iron and resin core electrical solder. Do not allow the soldering iron to overheat the rectifier assembly. Press the sleeves on the terminals before rectifier soldering.
15. Install the radio suppression capacitor and battery terminal insulator on the rectifier assembly.
16. Install the insulator on the stator terminal screw.

DISASSEMBLY AND ASSEMBLY (Continued)

17. Align the terminal screws on the rectifier assembly with the holes in the back of the rear housing and install the stator rectifier assembly in the rear housing. Make certain the terminal insulators are seated in their recesses.
18. Install the external insulators, washers and nuts on the terminals. The insulators are color coded as follows:

    Black on the stator (STA) terminal. Tighten nut to 2.8-3.9 N•m (25-35 in-lb).

    Red on the battery (BAT) terminal. Tighten nut to 3.4-6.2 N•m (30-55 in-lb).

    Orange on the field (FLD) terminal. Tighten nut to 2.8-3.9 N•m (25-35 in-lb).
19. Wipe the rear end bearing surface of the rotor shaft with a clean, lint-free rag.
20. Position the rear housing and stator assembly over the rotor and align the scribe marks made during disassembly.
21. Seat the machined portion of the stator core into the stop in both end housings and install the housing through bolts. Tighten the bolts to 4.1-6.7 N•m (35-60 in-lb).
22. Remove the wire holding the brushes.

CAUTION: This step is important so that regulator will not be damaged.

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 belt tension shown in the specifications.**

BELT TENSION

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

Part 5 — Starting System

DESCRIPTION AND OPERATION

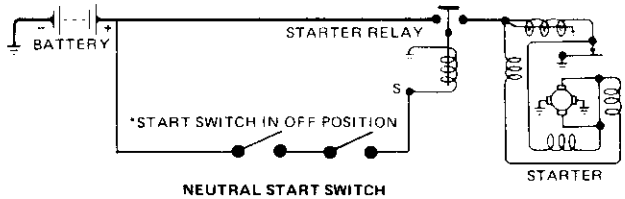
The starting system includes the starter motor with an integral positive-engagement drive, the battery, a remote control starter switch (part of the ignition switch), the neutral-start switch (used with automatic transmissions), the starter relay, starter interlock switch (used with manual transmission), and heavy circuit wiring.

Turning the ignition key to the Start position actuates the starter relay through the starter control circuit. The starter relay then connects the battery to the starter.

Vehicles equipped with an automatic transmission have a neutral-start switch in the starter control circuit. This prevents operation of the starter on vehicles with an automatic transmission if the selector lever is not in the N (NEUTRAL) or P (PARK) position.

When the starter is not in use, one of the field coils is connected directly to ground through a set of contacts. When the starter is first connected to the battery, 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 ring gear.

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



NEUTRAL START SWITCH
(AUTOMATIC TRANSMISSION ONLY)
OR
CLUTCH INTERLOCK SWITCH
(MANUAL TRANSMISSION ONLY)

J1083-1N

TESTING

ROAD SERVICE

On road service calls or cases of a starter that will not crank the engine or a starter that cranks very slowly, a booster battery may be connected to the 12-volt system. If the engine still will not turn with the booster connected, refer to the following tests:

TO JUMP START (NEGATIVE GROUNDED BATTERY)

WARNING: BATTERIES ARE HEAVY, WEIGHING 30 LBS. OR MORE. LIFT THEM WITH YOUR LEGS RATHER THAN YOUR BACK TO PREVENT MUSCLE STRAINS, AND BE CAREFUL NOT TO DROP THEM (POSSIBLE BREAKAGE) NOR TO SPILL THE CONTENTS (SULFURIC ACID).

CAUTION: 12-volt starting motors can be damaged beyond repair if connected to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor-generator set), even when cranking loads are relatively light. Extensive starting motor damage is more likely if the starter is connected to a 24-volt supply while being subjected to prolonged heavy cranking loads such as attempting to start an engine in subzero temperatures.

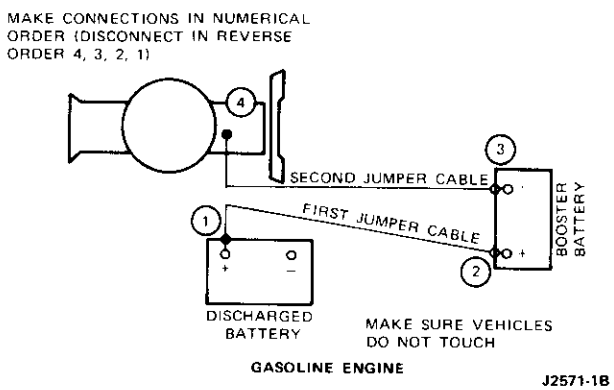
CAUTION: To prevent damage to electrical or lighting components during jump starting, the following procedure must be followed:

1. Turn all lamps off before and during jump starting.
2. Turn on heater blower motor to remove transient voltage.
3. Shield eyes. Use safety goggles or similar eye protection.
4. Connect ends of one cable to positive (+) terminal of discharged battery and the other end to the positive (+) terminal of the booster battery.
5. Connect one end of the other cable to negative (−) terminal of "good" battery.
6. Connect other end of cable to engine bolthead or similar good contact spot on the vehicle being started (NOT to negative (−) terminal of battery).
7. Make sure jumper cables are not in the way of moving engine parts.
8. Start engine of vehicle with the booster battery and run at moderate speed.
9. Start engine of vehicle with discharged battery. Follow starting procedure described in owner's manual.
10. To prevent damage to other electrical components on vehicle being started, make certain that engine is at idle speed before disconnecting jumper cables.
11. Remove cable from engine block before disconnecting cable from battery positive terminal. Lamps may now be turned on.

ON VEHICLE TESTING

IF STARTER CRANKS SLOWLY

1. BATTERY — Use jumper cables per instructions. If this corrects problem, check condition of battery, recharge or replace if necessary. Clean battery posts, cable lugs and tighten.
2. CABLES — If the above does not correct the problem, clean and tighten connections at starter, relay and battery ground on engine. Eyelet terminals should not be easily rotated by hand. Also check for short to ground.
3. STARTER — If the above does not correct the problem, replace starter.



TESTING (Continued)

IF STARTER DOES NOT CRANK BUT STARTER RELAY OPERATES (CLICKS)

1. BATTERY — Use jumper cables, check battery, etc. as above.
2. CABLE — Clean and tighten connections at starter and relay. Make sure wire strands are secure in eyelets.
3. STARTER — If the above does not correct the problem, replace starter.

IF STARTER DOES NOT CRANK AND RELAY CHATTERS OR DOES NOT CLICK

1. BATTERY — Use jumper cables, check battery, etc. as above.
2. RELAY — Remove push-on connector from relay (red w/blue stripe wire) and make sure connection is clean and secure. Make sure relay bracket is grounded.

   If connections are good, check operation by jumping with push-on connection off and transmission in PARK or NEUTRAL. Jumper above described terminal to relay main terminal (BAT side) or battery positive post. If this corrects problem, check ignition switch, neutral switch and wiring in start circuit for open of loose connections.

   If jumper across relay does not correct problem, replace relay.

IF STARTER SPINS (HUMMING NOISE) BUT DOES NOT CRANK ENGINE

STARTER — Remove and check armature shaft for corrosion, clean or replace. If no corrosion, repair starter or replace the starter drive.

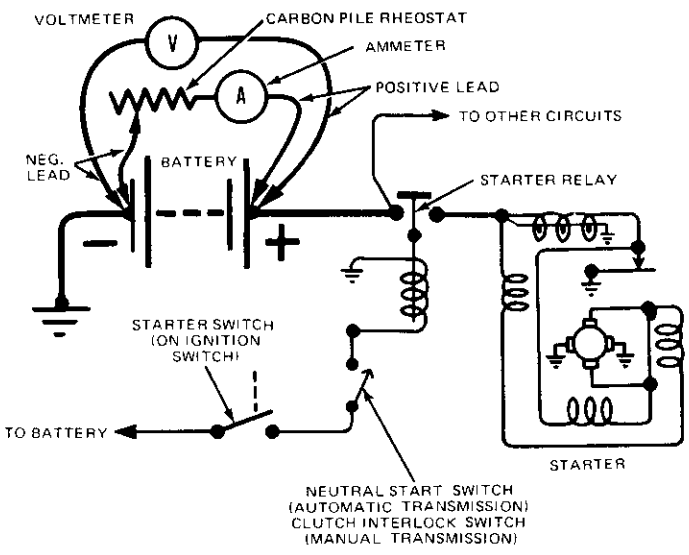
STARTER LOAD TEST

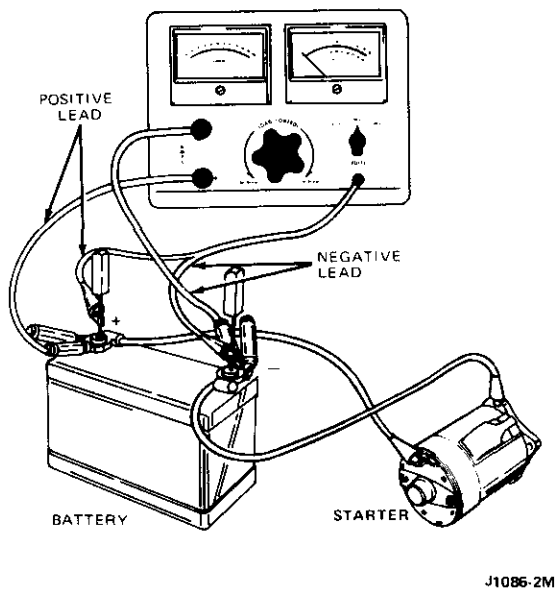
Conduct this test if the starter cranks slowly and a comparison of the current output with specifications is desired.

Connect the test equipment as shown. 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 the push-on connector "S" at the starter relay and by connecting the remote control starter switch from the positive battery terminal to the "S" terminal of the starter 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. (Refer to Specifications at the end of this section.)





J1086-2M

TESTING (Continued)

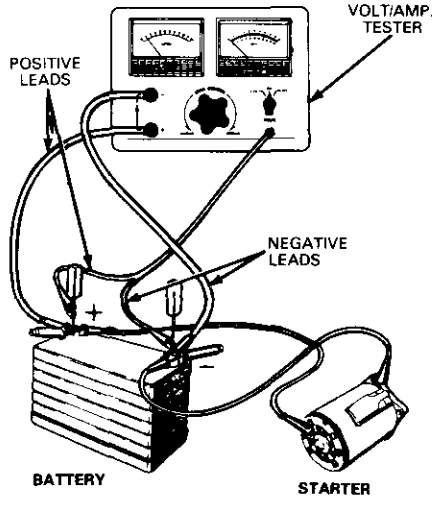
BENCH TESTS

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. 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.



J1087-1G

ARMATURE OPEN CIRCUIT TEST

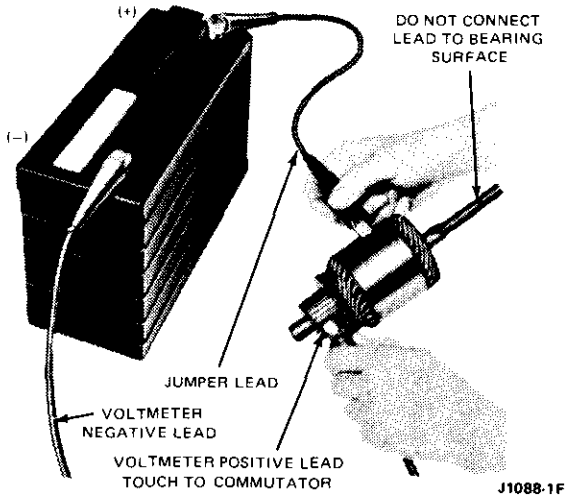
An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

ARMATURE AND FIELD GROUNDED CIRCUIT TEST

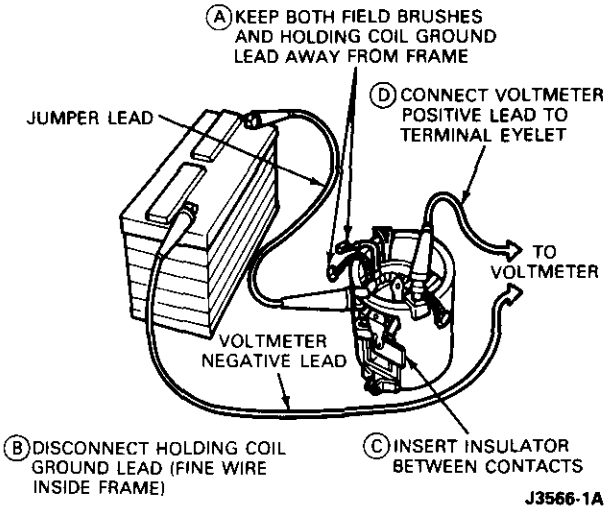
This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core.

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

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



J1088-1F

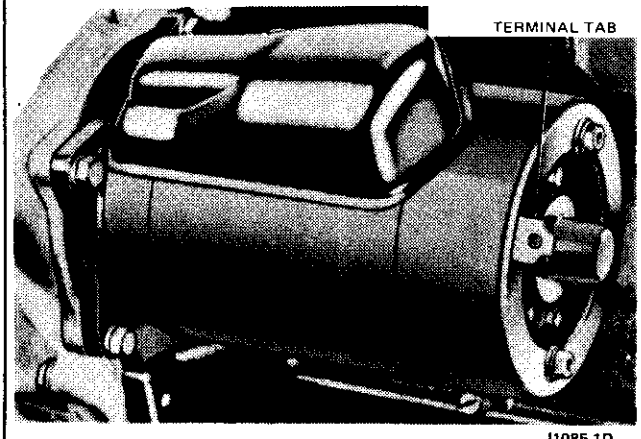


J3566-1A

REMOVAL AND INSTALLATION

REMOVAL

1. Disconnect the negative battery cable.
2. Raise the vehicle on a hoist.
3. Disconnect the starter cable at the starter terminal.
4. Remove the starter mounting bolts. Remove the starter assembly.



INSTALLATION

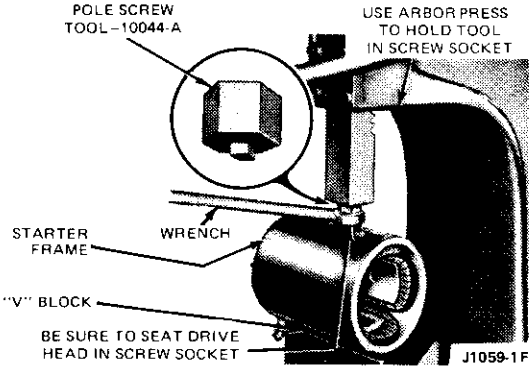
1. Position the starter assembly to the flywheel housing, and start the mounting bolts.
2. Snug all bolts while holding the starter squarely against its mounting surface and fully inserted into the pilot hole. Tighten the bolts to 21-27 N•m(15-20 ft-lb).
3. Connect the starter cable.
4. Lower the vehicle. Connect negative battery cable to battery. Check the operation of the starter.

DISASSEMBLY AND ASSEMBLY

Use the following procedure when it becomes necessary to completely overhaul the starter. The figure on page 5-06 illustrates a disassembled starter.

DISASSEMBLY

1. Remove the cover screw, cover, and through bolts.
2. Remove the pivot pin retaining the starter gear plunger lever and remove the lever, the starter drive end housing, and lever return spring.
3. 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.
4. Remove the brush end plate and insulator assembly.
5. Remove brushes from plastic brush holder and lift out brush holder. Note location of brush holder with respect to end terminal.
6. Remove the two screws retaining the ground brushes to frame. (The 4-inch starter has copper rivets.)
7. On the field coil that operates the starter drive gear actuating lever, bend the edges on the field coil retaining sleeve and remove the sleeve and retainer.
8. Remove the three coil retaining screws using an arbor press. The arbor press prevents the wrench from slipping out of the screw. Cut the field coil connection at the switch post lead and remove the small diameter ground wire from the upper tab riveted to frame. Remove pole shoes and coils from frame.

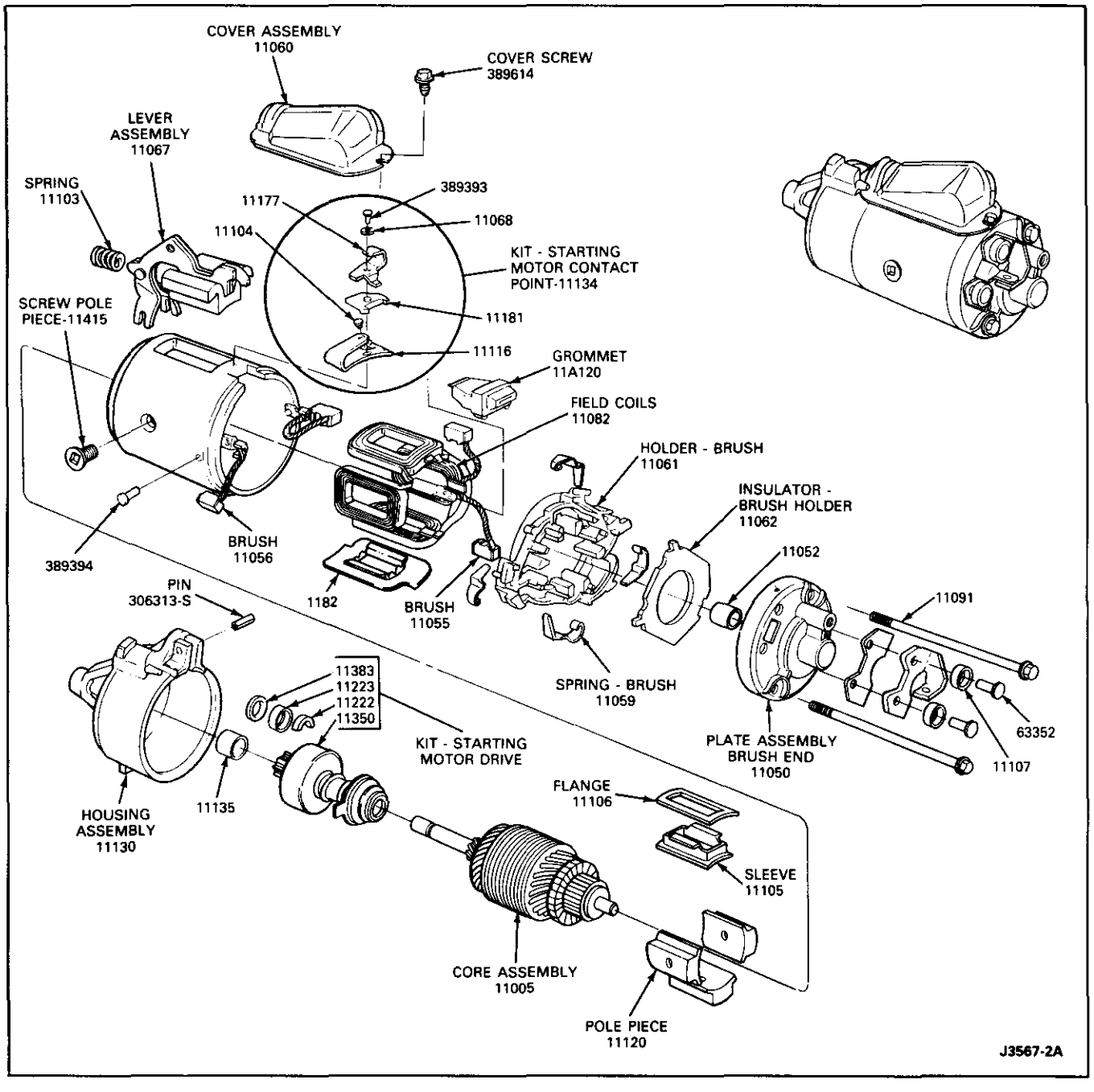


9. Cut the positive brush leads from the field coils, as close to the field connection point as possible.

CLEANING AND INSPECTION

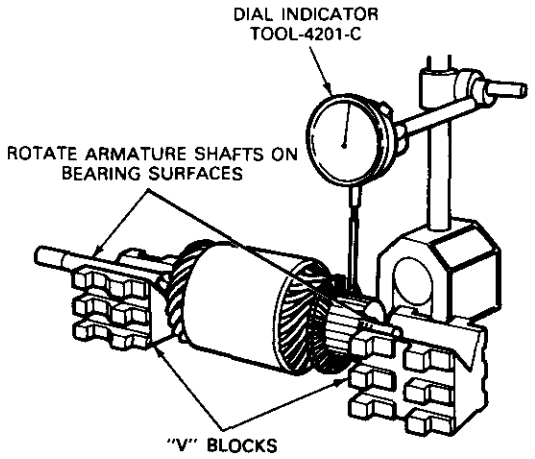
1. Use a brush or air to clean the field coils, armature, commutator, armature shaft, brush end plate, and drive end housing. Wash all other parts in solvent and dry the parts.
2. Inspect the armature windings for broken or burned insulation and unsoldered or open connections.
3. Check the armature for open circuits and grounds.

DISASSEMBLY AND ASSEMBLY (Continued)



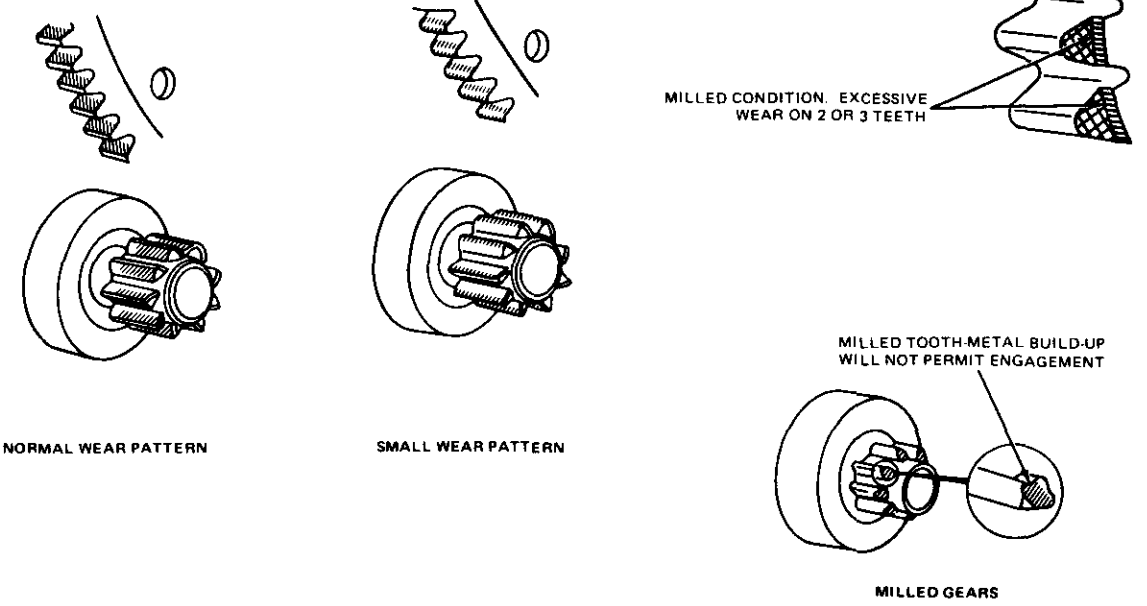
DISASSEMBLY AND ASSEMBLY (Continued)

4. Check the commutator for runout using Dial Indicator TOOL-4201-C. Inspect the armature shaft and the two bearings for scoring and excessive wear. If the commutator is rough, or more than 0.127mm (0.005 inch) out-of-round, turn it down.



J2716-1A

5. Check the plastic brush holder for cracks or broken mounting pads. Replace the brushes if worn to 6.35mm (1/4 inch) in length. Check the field brush connections. A brush kit and contact kit are available. All other assemblies are to be replaced rather than repaired.
6. Examine the wear pattern on the starter drive teeth. The pinion teeth must penetrate to a depth greater than one-half the ring gear tooth depth, to eliminate premature ring gear and starter drive failure.
7. Replace starter drives and ring gears having milled, pitted or broken teeth or that show evidence of inadequate engagement.



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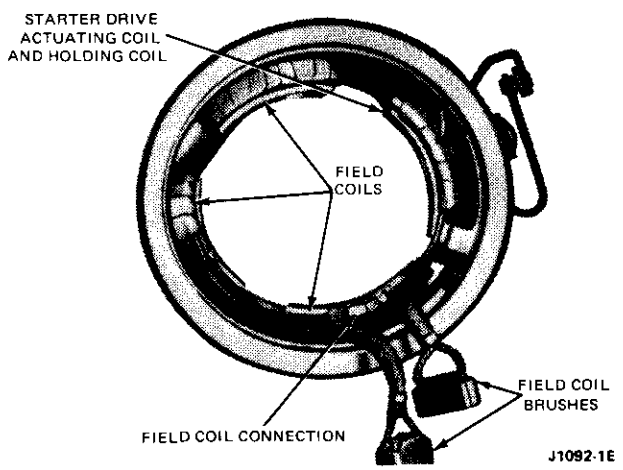
DISASSEMBLY AND ASSEMBLY (Continued)

ASSEMBLY

1. Position the three coils and pole pieces, then install the attaching screws. 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.
2. Install the remaining coil and retainer and bend the tabs to secure the coils to the frame.
3. 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. Use a 300 watt iron.
4. Check for continuity and grounds in the assembled coils.
5. The coil which is around the retaining sleeve is to be grounded by positioning the small diameter wire leading from it, under the copper tab held by the rivet which attaches the contact to the frame.
6. Attach the ground brushes to the starter frame with the screws. (4.0-inch starter has copper rivets.)
7. Apply a thin coating of Lubriplate 777 or equivalent 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.
8. Install the armature in the starter frame.
9. Partially fill the drive end housing bearing bore with Grease ESB-M1C.63-A or equivalent (approximately 1/4 full). Position the starter drive gear plunger lever to the frame and starter drive assembly.



10. Position the starter drive plunger lever return spring and the drive end housing to the frame. Install brush holder, insert brushes and springs. Install brush holder insulator.
11. Position end plate to frame, align plate locater with frame slot. Install and tighten the through bolts to 6.21-8.47 N•m (55-75 in-lb). Do not pinch brush leads when installing end plate. Install pivot pin.
12. Position the drive gear plunger lever cover on the starter and fasten with the cover screw in the frame.
13. Check the starter no-load current draw.

STARTER DRIVE REPLACEMENT

1. Remove the starter drive plunger cover.
2. Remove the pivot pin retaining the starter drive plunger lever.
3. Loosen the through bolts enough to allow removal of the drive end housing and the starter drive plunger lever return spring and 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, or equivalent 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. **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 ESB-M1C.63-A or equivalent (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 6.21-8.47 N•m (55-75 in-lb). Install pivot pin.
8. Position the starter drive plunger lever cover on the starter. Tighten the attaching screw.

DISASSEMBLY AND ASSEMBLY (Continued)

BRUSH REPLACEMENT

Replace the starter brushes when they are worn to 6.35mm (1/4 inch). Always install a complete set of new brushes.

1. Remove the two through bolts from the starter frame.
2. Remove the brush end plate, brush springs and brushes from the holder.
3. Remove the ground brush attaching screws or rivets from the frame and remove the brushes.
4. Cut the insulated brush leads from the field coils, as close to the field connection point as possible.
5. Check the plastic brush holder for cracks or broken mounting pads. Replace if necessary.
6. 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 a 300 watt iron and rosin core solder.
7. Install the ground brush leads to the frame with the attaching screws or rivets.
8. Install brush holder and insert brushes in holder and install brush springs. Positive brush leads should be positioned in their respective slots in the brush holder to prevent potential grounding.
9. Install the brush end plate. Be sure end plate insulator is positioned properly on the end plate.
10. Install the two through bolts to the starter frame and tighten to 6.21-8.47 N•m (55-75 in-lb).
11. Secure the starter in a vise and connect the starter to a battery to check its operation.

ARMATURE REPLACEMENT

1. Remove starter drive plunger lever cover retainer screw and remove cover.
2. Remove the through bolts, the drive end housing, plunger lever and the drive plunger lever return spring, brush end plate. Remove brushes and lift out brush holder.
3. Remove the pivot pin retaining the starter gear plunger lever.
4. Remove the armature. If the starter drive gear assembly is being reused, remove 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.
8. Partially fill the drive end housing bearing bore with Grease ESB-M1C.63A or equivalent (approximately 1/4 full). Position the drive plunger lever return spring, the drive end housing to the starter frame. Be sure that the stop ring retainer is seated properly in the drive housing.
9. Install brush holder and insert brushes in holder and install brush springs. Positive brush leads should be positioned in their respective slots to prevent grounding.
10. Install the brush end plate (be certain end plate insulator is positioned properly on end plate).
11. Install the two through bolts to the starter frame and tighten to 6.21-8.47 N•m (55-75 in-lb). Install pivot pin.
12. Install starter drive plunger lever cover and tighten retaining screw.
13. Check the starter no-load current draw.

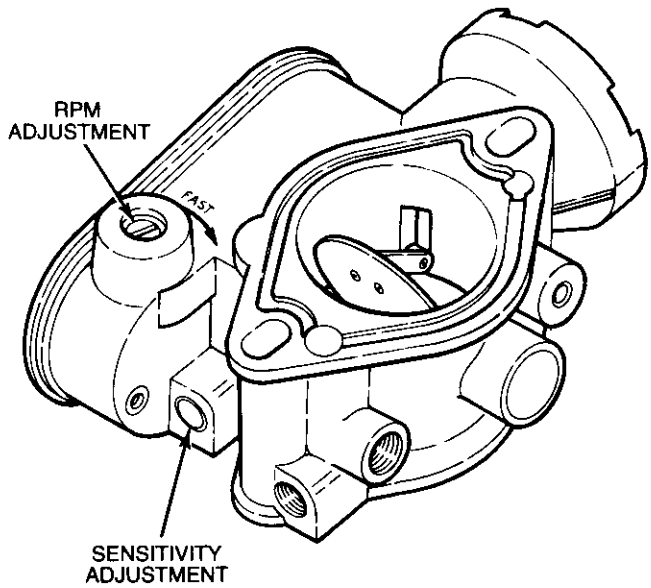
Part 6 — Governors

DESCRIPTION AND OPERATION

The 4.9 liter engine uses either a velocity governor or a belt driven mechanical governor.

VELOCITY GOVERNOR

The velocity governor 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 valve. The governor throttle valve is offset in the throttle bore so that the combined force of manifold vacuum and the fuel air flow through the bore has greater effect on the larger, upstream area of the valve. This forces the throttle valve to move toward the closed position restricting fuel-air flow. The closing action of the throttle valve 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 valve and the action of the control spring at all engine speeds.

Under operating conditions, the governor throttle valve does not close, but remains 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 carburetor throttle valve controls engine speed, the orifice in the carburetor throat opening controls the spark advance the same as if it were not governor equipped.

However, when the governor controls engine speed vacuum produced below the governor throttle plate pulls the spark transfer valve, permitting an opening from below the governor throttle plate to the diaphragm. At the same time the transfer valve closes off the opening from the carburetor orifice.

DESCRIPTION AND OPERATION (Continued)

MECHANICAL GOVERNOR — BELT DRIVEN

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

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

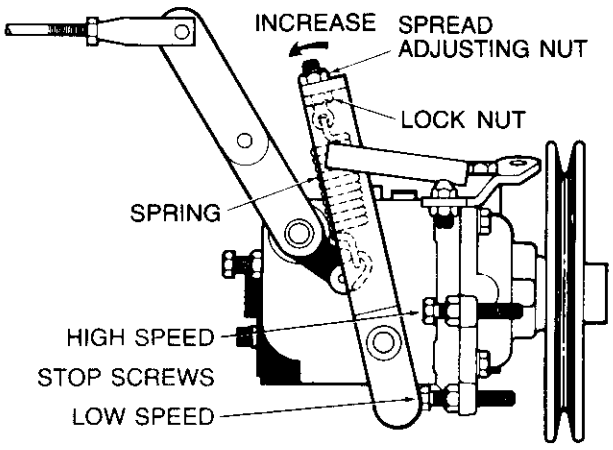
The variable speed type allows engine governor operation from idle to a maximum setting. The variable speed lever is actuated by the throttle cable, which in turn adjusts the spring tension and engine speed.

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

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

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

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



TROUBLESHOOTING

MECHANICAL GOVERNOR

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

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

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

Engine overspeed on accelerating can be caused by excessive friction in the carburetor linkage, throttle shaft and/or accelerator pump, if so equipped. The throttle rod may also be bending or rubbing, or the drive belt(s) may be slipping. These should be checked before making the adjustments.

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

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

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

ADJUSTMENTS

PRELIMINARY CHECKS

MECHANICAL GOVERNORS

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

ADJUSTMENTS (Continued)

Oil Level

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

Belt Tension

Belt tension should be checked on a cold belt only.

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

Throttle Control Rod

1. Manually move the governor throttle lever to maximum open throttle with spring tension on the governor.
2. Check the gap between the carburetor throttle shaft lever and its maximum open position stop. It should be 1/32 to 1/16 inch wide.
3. If adjustment is necessary, loosen the control rod ball joint lock nuts, remove the rod from the carburetor throttle lever and adjust the length of the rod with the ball joints.
4. Install the throttle control rod on the carburetor throttle lever and recheck the gap. Tighten the lock nuts.

SPREAD ADJUSTMENT

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

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

The spread adjustment is the eyebolt type. Adjustment is made with the eyebolt that attaches the spring to the variable speed lever.

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

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

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

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

RPM ADJUSTMENT

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

Disengage engine load and loosen the locknut on the governor high speed stop screw. The location of this screw will vary from governor to governor. Slowly pull the throttle to the desired maximum engine speed and adjust the high speed stop screw to maintain this speed.

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

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

NO-LOAD SURGE ADJUSTMENT

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

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

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

ADJUSTMENTS (Continued)

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.

To increase the engine RPM, turn the RPM adjusting screw clockwise.

To decrease the engine RPM, turn the RPM adjusting screw counterclockwise.

SENSITIVITY ADJUSTMENT

The sensitivity of the governor has been set at the factory to cover a wide range of engine RPM. If the governor control is too sharp or not sharp enough, perform the following:

Drill welch plug covering sensitivity screw with a 1/16" drill. Insert a 1/16" rod in drilled hole and pry off welch plug.

- If governor control is too sharp which causes surging or hunting: turn sensitivity screw clockwise 1/4 turn at a time. It will be necessary to turn RPM adjusting screw counterclockwise approximately one turn for every 1/4 turn of the sensitivity screw to bring the RPM back to normal.
- If the governor is not sharp enough, which causes too great a variation in speed between load and no load: turn sensitivity screw counter clockwise 1/4 turn at a time. It will be necessary to turn the RPM adjusting screw clockwise approximately one turn for each 1/4 turn of the sensitivity screw to bring the RPM back to normal.

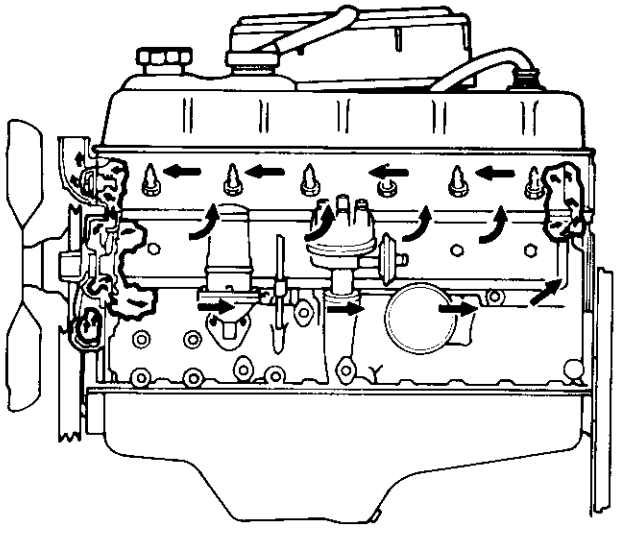
Seal sensitivity adjustment by inserting a brass lock washer into the hole engaging tang of washer into slot in adjusting screw. Insert new welch plug and tap lightly, using a flat punch.

CAUTION: Too sharp a blow against welch plug may upset sensitivity adjustment.

Part 7 Cooling

DESCRIPTION AND OPERATION

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



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COOLANT

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

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

When the cooling system is drained, fill the radiator with specified coolant. The cooling system is filled with a 50-50 solution of Ford Permanent Anti-Freeze and water which prevents corrosion, keeps the cooling system clean, provides anti-freeze protection to −35 degrees F in winter and provides for higher summer operation temperatures.

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

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

Ordinary tap water may be used in an emergency except in areas that 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 of more than 50 percent anti-freeze except in areas where anti-freeze protection below −35 degrees F is required. In this case, refer to the coolant mixture chart on the Ford Permanent Anti-Freeze container.

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

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

DRAINING AND FILLING THE SYSTEM

To prevent loss of anti-freeze when draining the radiator, attach a hose to 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.

DESCRIPTION AND OPERATION (Continued)

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

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

TESTING

PRESSURE TEST

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

- Blown or leaking cooling system gaskets.
- Internal or external cooling leakage.
- 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 to 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 block.

   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) 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 rechecked.
11. If the system holds pressure, remove the radiator cap to release the pressure; then, reinstall the cap.
12. Remove the adapter and reinstall the temperature sending unit. Check coolant level and replenish, if necessary, with the correct coolant solution.

TESTING (Continued)

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

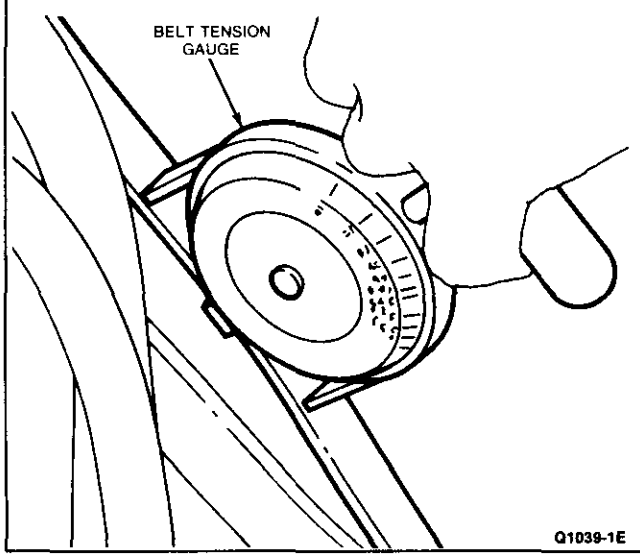
DRIVE BELT

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 tension shown in the specifications.**

BELT TENSION

1. Install the belt tension tool on the drive belt and check the tension.
2. If adjustment is necessary, loosen the alternator mounting bolts and move the alternator adjusting arm bolts. Move the alternator towards or away from the engine until the correct tension is obtained. Remove the gauge.



THERMOSTAT REPLACEMENT

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

Removal

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

Installation

1. Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with water-resistant sealer. Position the water outlet housing gasket to the head opening.
2. Install the thermostat in the water outlet opening with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.
3. Position the water outlet housing against the head. Install and torque the retaining bolts to specifications.
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 SPECIFICATIONS	
Bore and Stroke	4.00 x 3.98
Firing Order	1-5-3-6-2-4
Idle Speed (rpm)	500-550

CYLINDER HEAD	
Gasket Surface Flatness	0.006 inch in any 6 inches or 0.007 inch overall
Valve Guide Bore Diameter	0.3433-0.3443
Valve Seat Width —	
Intake	0.060-0.080
Exhaust	0.070-0.090
Valve Seat Angle	45°
Valve Seat Runout	0.0015-0.002

VALVE MECHANISM	
Valve Stem Diameter — Standard	
Intake and Exhaust	0.3416-0.3423
Valve Stem Diameter — .003 Oversize	
Intake and Exhaust	0.3446-0.3453
Valve Stem Diameter — .015 Oversize	
Intake and Exhaust	0.3566-0.3573
Valve Stem Diameter — .030 Oversize	
Intake and Exhaust	0.3716-0.3723
Valve Face Angle	44°
Valve Stem to Valve Guide Clearance	
Intake and Exhaust	0.0010-0.0027
Wear Limit	0.0055
Valve Head Diameter	
Intake	1.772-1.790
Exhaust	1.551-1.569
Valve Face Runout	0.0020
Valve Spring Assembled Height	
Intake	1.61-1.67
Exhaust	1.44-1.50
Valve Spring Free Length — Approximate	
Intake	1.96
Exhaust	1.78
Valve Out of Square — Maximum	5/64 (0.078)
Valve Spring Pressure — Lbs.	
@ Specified Length	
Intake	66-74 @ 1.640
Wear Limit	10% Loss of Pressure
Intake	166-184 @ 1.240
Wear Limit	10% Loss of Pressure
Exhaust	66-74 @ 1.470
Wear Limit	10% Loss of Pressure
Exhaust	166-184 @ 1.070
Wear Limit	10% Loss of Pressure
Hydraulic Valve Lifter Leak	
Down Rate — Seconds	10-50
Valve Push Rod Runout — Maximum	0.015
Valve Tappet Diameter —	
Standard	0.8740-0.8745
Valve Tappet to Tappet Bore	
Clearance	.0007-.0027
Wear Limit	0.0050

VALVE MECHANISM (Cont'd.)	
Collapsed Tappet Gap	
Allowable	0.100-0.200
Desired	125-.175

CAMSHAFT AND TIMING GEARS	
Camshaft Journal Diameter —	
Standard	2.017-2.018
Camshaft Journal Runout	0.008
Camshaft Journal to Bearing	
Clearance	0.001-0.003
Wear Limit	0.006
Camshaft Journal Out-of-Round	0.0005
Camshaft End Play	0.001-0.007
Wear Limit	0.009
Camshaft Gear to Crankshaft	
Gear Backlash	0.004-0.010
Camshaft Lobe Lift	
Intake	0.247-0.249
Exhaust	0.247-0.249
Maximum Allowable Lobe Lift Loss	0.005
Assembled Gear Face Runout —	
Maximum	0.005
Inside Diameter	2.0190-2.0200
Location in Relation to Front Face of Block	
Cam Bearing Bore Face — No. 1 Bearing Only — Below	0.020-0.035

CRANKSHAFT	
Main Bearing Journal Diameter	2.3982-2.3990
Main Bearing Journal Runout	0.002
Wear Limit	0.005
Connecting Rod and Main Bearing Journals	
Out-of-Round — Maximum	0.0006
Connecting Rod and Main Bearing Journals	
Taper — Maximum Per Inch	0.0005
Thrust Bearing Journal Length	1.199-1.201
Main Bearing Journal Thrust Face	
Runout	0.001
Connecting Rod Journal	
Diameter	2.1228-2.1236
Crankshaft Free End Play	0.004-0.008
Wear Limit	0.012
Assembled Gear Face Runout	0.003
Main Bearings to Journal Clearance	
Desired	0.0008-0.0015
Allowable	0.0010-0.0028
Crankshaft to Rear Face of Block Runout	
TIR Max.	0.005
Flywheel Ring Gear Lateral Runout	
Standard Transmission	0.040
Automatic Transmission	0.060
Flywheel Clutch Face Runout —	
Maximum	0.010

CONNECTING ROD	
Piston Pin Bushing ID —	
Standard	0.9734-0.9742

SPECIFICATIONS (Continued)

CONNECTING ROD (Cont'd.)

Bearing Bore Diameter	2.2750-2.2758
Bearing Bore Out-of-Round	0.0006
Bearing Taper	0.0004
Connecting Rod Length — Center to Center	6.2082-6.2112
Twist Total Difference — Maximum*	0.024
Bend Total Difference — Maximum*	0.012
Connecting Rod Assembly — Assembled to Crankshaft Side Clearance	0.006-0.013
Wear Limit	0.018

*Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.

Connecting Rod Bearings to Crankshaft Clearance	
Desired	0.0008-0.0015
Allowable	0.0007-0.0024

PISTON

Piston Diameter	
Coded Red	3.9982-3.9988
Coded Blue	3.9994-4.0000
0.003 Oversize	4.0008-4.0014
Piston Pin Bore Diameter	0.9754-0.9757
Piston to Bore Clearance*	0.0010-0.0018

*Measured 90° to pin centerline and at pin centerline height.

Piston Pin Diameter — Standard	0.9749-0.9754
Piston Pin Length	3.150-3.170
Piston Pin to Piston Clearance	0.0002-0.0004
Wear Limit	0.0008
Piston Pin to Connecting Rod Bushing Clearance	Interference Fit
Piston Ring Groove Width	
Top	0.0800-0.0810
Bottom	0.0800-0.0810
Oil	0.1880-0.1890

PISTON RINGS

Compression Ring Width	
Top	0.0774-0.0781
Bottom	0.0770-0.0780
Compression Ring Side Clearance	
Top	0.0019-0.0036
Bottom	0.0020-0.0040
Compression Ring Side Clearance — Wear Limit	0.0060
Oil Ring Side Clearance	Snug
Compression Ring — Standard Bore — Ring Gap Width	
Top	0.010-0.020
Bottom	0.010-0.020
Oil Ring — Standard Bore — Ring Gap Width	0.015-0.055

CYLINDER BLOCK

Cylinder Bore Diameter	4.0000-4.0048
Cylinder Bore Out-of-Round Maximum	0.0015
Wear Limit	0.0050
Cylinder Bore Taper	0.001
Wear Limit	0.010
Main Bearing Bore Diameter	2.5902-2.5910
Head Gasket Surface Flatness	0.003 inch in any 6 inches or 0.007 inch overall
Cylinder Tappet Bore Diameter	0.8752-0.8767
Distributor Shaft Bearing Bore Diameter	0.5155-0.5165
Cylinder Bore Surface Finish RMS	15-35
Camshaft Bearing Bore	2.019-2.020

OIL PUMP

Oil Pressure — Hot @ 2000 rpm	35-60
Relief Valve Spring Tension — Lbs. @ Specified Length	20.6-22.6 @ 2.490
Relief Valve Clearance	0.0015-0.0030
Drive Shaft to Housing Bearing Clearance	0.0015-0.0030
Rotor Assembly End Clearance — Pump Assembled	0.0011-0.0040
Inner to Outer Rotor TIC Clearance — Max. (with feeler gauge inserted 1/2 inch min. and rotor removed from pump housing).	0.012
Outer Race to Housing — Radial Clearance	0.001-0.013
Oil Capacity (Qts.) (Add 1 qt. for filter change)	6

IGNITION SYSTEM

Ignition Timing — B.T.D.C. — Recommended	6°
Coil	
Primary Resistance (Ohms)	1.15-1.25 (75°F.)
Secondary Resistance (Ohms)	7700-10500 (75°F.)
Amperage Draw	
Engine Stopped	4
Engine Idling	5
Ballast Resistor (Ohms)	0.8-1.6 (75°F.)
Stator Assembly Resistance (Ohms)	400-1000
Spark Plug Gap (Inches)	0.045

SPECIFICATIONS (Continued)

DISTRIBUTOR ADVANCE CHARACTERISTICS

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

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
600	0-2	0
800	3-5	0
1200	6-8	0
1600	6-8 1/2	0
2000	6-8 3/4	0

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

rpm (Distributor)	Advance (Degrees)	Vacuum (Inches of Mercury)
1000	4 1/2-7 1/2	8
1000	6-8 3/4	10
1000	8 3/4-11 1/4	14

FUEL PUMP — MECHANICAL

Static Pressure (psi)* 5-7
Eccentric Total Lift (Inch) ..... .290-.310
Volume Flow — Minimum* .. 1 Pt. in 20 seconds
Inside diameter of smallest passage in test flow circuit must not be less than 0.220 inch.)
*(On engine, with temperatures normalized, and at normal idle speed, in neutral.)

THERMOSTAT

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

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				Starter Brushes			Through Bolt Torque N·m (in-lbs)	Mounting Bolt Torque N·m (ft-lbs)
Dia. mm (inches)	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed (rpm)	Current Draw No. Load (Amps)	Mfg. Length mm (inches)	Wear Limit mm (inches)	Spring Tension kg (Ounces)		
101.60 (4)	150-200	180-250	70	12.2 (0.50)	6.35 (0.25)	1.134 (40)	6.21-8.47 (55-75)	21-27 (15-20)
114.30 (4.5)	150-180	150-290	80	12.2 (0.50)	6.35 (0.25)	1.134 (40)	6.21-8.47 (55-75)	21-27 (15-20)

Maximum Commutator runout is 0.1270mm (0.005 inch). Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

ALTERNATOR

Rating		Field Current* Amps @ 12V	Slip-Ring Turning mm (inches)		Brush Length mm (inches)		Pulley Nut Torque N·m (Ft-Lb)	Belt Tension ①	
Amperes @ 15V	Watts @ 12V		Min. Dia.	Max. Runout	New	Wear Limit		N	(Lb)
40	600	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)
60	900	4.25	31 (1.22)	.0127 (0.0005)	12.19 (.480)	6.35 (1/4)	82-135 (60-100)	311-489	(70-110)

①For belt tension specifications, refer to Section 27-06 Accessory Drive Belts in the Engine Shop Manual.
*A field current of 4 amps is used with solid-state regulator.

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Item	Torque	
	N·m	ft-lbs
Connecting Rod Nut	55-61	40-45
Cylinder Front Cover	17-24	12-18
Cylinder Head Bolts	①	①
Damper to Crankshaft	177-203	130-150
Flywheel to Crankshaft	102-115	75-85
Main Bearing Cap Bolts	82-94	60-70
Manifolds to Cylinder Head ②	30-43	22-32
Oil Filter Insert to Cylinder Block/Adaptor	20-48	15-35
Oil Filter Adaptor to Cylinder Block	55-67	40-50
Oil Filter to Adaptor or Cylinder Block	1/2 turn after gasket contacts sealing surface — oiled gasket	
Oil Inlet Tube to Pump	14-20	10-15
Oil Pan Drain Plug	21-33	15-25
Oil Pan to Cylinder Block	14-17	10-12
Oil Pump to Cylinder Block	14-20	10-12
Oil Inlet Tube to Main Bearing Cap	30-43	22-32
Pulley to Damper Bolt	48-67	35-50
Rocker Arm Bolt	24-31	17-23
Spark Plug to Cylinder Head	14-20	10-15
Valve Rocker Arm Cover	7.9-11.9	(70-105 in-lbs)

Item	Torque	
	N·m	ft-lbs
Valve Push Rod — Cover to Cylinder Block	2.8-3.9	(25-35 in-lbs)
Water Outlet Housing	17-24	12-18
Water Pump to Block/Front Cover	17-24	12-18
Alternator Bracket to Cylinder Block — Bolt	41-61	30-45
Alternator Adjusting Arm to Cylinder Block Bolt	26-36	19-27
Alternator Adjusting Arm to Alternator Bolt	33-54	24-40
Carburetor Attaching Nuts	17-20	12-15
Camshaft Thrust Plate to Cylinder Block	16-24	12-18
Fuel Pump to Cylinder Block/Front Cover	17-24	12-18
Carburetor Mounting Stud	7-13	5-10
Distributor Clampdown	24-33	17-25
Intake Manifold Vacuum Fittings	8-13	6-10
Pressure Plate and Cover Assy. to Flywheel	16-25	12-18
Fuel Line Nuts	20-25	15-18
Item	**N·m**	**As Noted**
Distributor Holddown Bolt	23-34	17-25 ft-lbs
Distributor Adaptor to Distributor Base	2-2.5	18-23 in-lbs
Stator Assy. Lower Plate Assy. to Distributor Base	1.7 min.	15 in-lbs (min.)
Diaphragm Assembly to Distributor Base	1.7 min.	15 in-lbs (min.)
Spark Plug to Cylinder Head	20-27	15-20 ft-lbs

①Progressively increase the tightness in three steps using this sequence:
1st step — tighten all bolts to 67-75 N·m (50-55 ft-lb)
2nd step — tighten all bolts to 82-88 N·m (60-65 ft-lb)
3rd step — tighten all bolts to 94-115 N·m (70-85 ft-lb)
②Follow bolt tightening sequence in Part 1.

SPECIAL SERVICE TOOLS

Tool Number	Description	Tool Number	Description
T50T-100-A	Impact Slide Hammer	T58P-6316-D	Crankshaft Damper Remover
T59L-100-B	Impact Slide Hammer	T82T-6256-A	Camshaft Gear Remover
T58L-101-A	Puller Attachment	TOOL-6331-E	Upper Main Bearing Insert Remover & Replacer
D78P-4201-B	Dial Indicator Mag. Base	T74P-6375-A	Flywheel Holding Tool
TOOL-4201-C	Dial Indicator With Bracketry	T70P-6513-A	Tappet Bleed Down Wrench
T70P-6000	Engine Lifting Bracket	TOOL-6513-ABA	Valve Holdup Air Adaptor
T64L-6011-EA	Cylinder Ridge Reamer	TOOL-6513-DD	Valve Spring Tester
T73L-6011-A	Cylinder Hone Set	T62F-6565-A	Valve Spring Compressor
T61P-6019-B	Front Cover Aligner	TOOL-6565-AB	Cup Shaped Adaptor
T68P-6135-A	Piston Pin Remover/Replacer	T73L-6600-A	Pressure Gauge
T81P-6135-A	Piston Pin Remover/Replacer Adaptors	T82L-12270-A	Distributor Wrench
D79L-6250-A	Heavy Duty Reversible Ratchet	T74P-6666-A	Spark Plug Wire Remover
D79L-6250-B	Ratchet Handle	T75L-6666-A	Plug Boot Installation Tool
D79L-6250-C	Ratchet Adaptor	T65P-6701-A	Rear Oil Seal Replacer
D79L-6250-D	Ratchet Adaptor	D79L-6731-A	Oil Filter Wrench
T65L-6250-A	Camshaft Bearing Set	T74P-7137-A	Pilot Bearing Replacer
T65L-6306-A	Camshaft Gear Replacing Adaptor	T63L-8620-A	Belt Tension Gauge
T52L-6306-AEE	Crankshaft Damper Replacer	T65P-10300-B	Alternator Pulley Remover