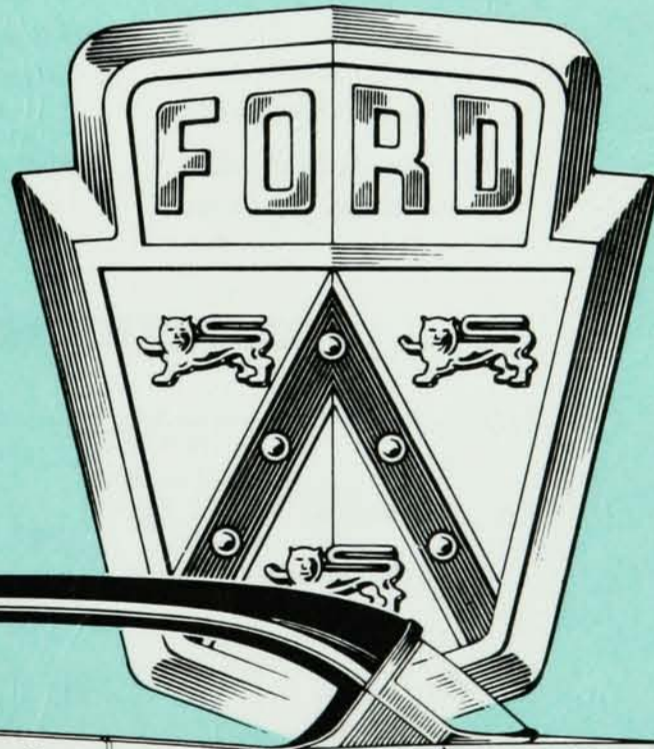


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## **1957 Ford Car and Thunderbird Shop Manual**

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# 1957

# FORD CAR

## AND *Thunderbird*

# Shop Manual

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# FOREWORD

This manual has been prepared to provide information for the proper servicing of 1957 Ford Cars and the 1957 Ford Thunderbird. The manual should be kept where it will be readily available for reference at all times.

The manual is divided into 13 parts as designated on the title page. A title page is also included at the beginning of each part that lists the chapters and the sections contained in the part. The heading on each left-hand or even-numbered page indicates the name of the chapter and the heading on each right-hand or odd-numbered page indicates the section covered.

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

SERVICE DEPARTMENT  
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**Chapter 1** GENERAL ENGINE SERVICE

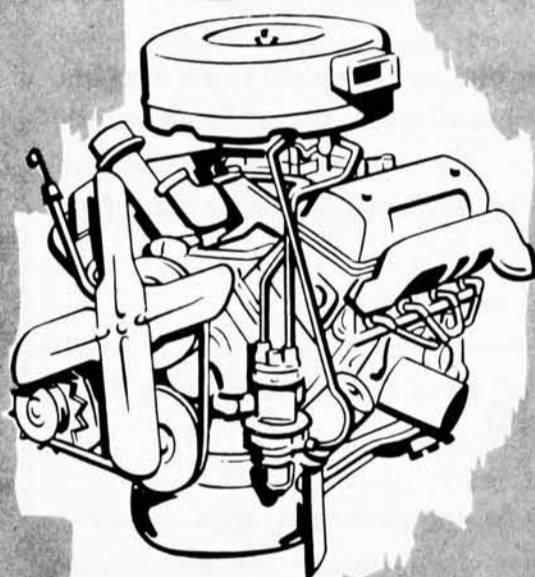
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# Part 1 — ENGINES

## Chapter 1

### GENERAL ENGINE SERVICE

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The service procedures contained in this chapter apply to all engines. The cleaning, inspection, repair, and overhaul procedures of the component engine parts apply after the parts have been removed from the engine, or in the case of a complete engine overhaul, after the engine has been disassembled.

To completely disassemble or assemble an engine, follow all the removal or installation procedures in the applicable engine chapter. To remove or install an individual part, refer to the section covering the part in the applicable engine chapter.

## 1. GENERAL ENGINE TROUBLE SHOOTING

Poor engine performance can be caused by the need of a general engine tune-up, by gradual wear of engine parts, or by a sudden parts failure. A good trouble diagnosis will indicate the need of a complete engine tune-up, individual adjustments, part(s) replacement or overhaul, or the need of a complete engine overhaul.

The five major steps in restoring good engine performance are:

1. **ESTABLISH THE TROUBLE.** Make sure that the trouble as stated by the owner actually exists. Determine, if possible, if any work has been performed recently which could be the cause of the present trouble.
2. **ISOLATE THE CAUSE IN THE PROPER SYSTEM.** Trace the cause of the trouble to the point where it has been isolated in one of the following systems: *ignition, fuel, engine, cooling, or exhaust.*
3. **LOCATE THE CAUSE IN THE SYSTEM.**
4. **CORRECT THE TROUBLE.**
5. **ROAD TEST.** Before deciding that the trouble has been corrected, road test the car as a final check on

*engine starts, but fails to keep running; engine runs, but misses; rough engine idle; poor acceleration; engine does not develop full power, or has poor high speed performance; excessive fuel consumption; engine overheats; or the engine fails to reach normal operation temperature.*

Table 1 is a general trouble shooting chart which lists basic engine troubles with procedures and checks to be performed to help isolate the cause of the trouble in a particular system. The reference after each check refers to that part of the manual which covers, in detail, checking procedures as well as corrections to be made in the various systems. When a particular trouble can not be traced to a definite system by a simple check, the possible systems that could be at fault are listed in the order of their probable occurrence; therefore, in most cases, the checks should be made in the order listed. Some consideration, however, should be given to logical order. For example, if the spark plugs are removed for testing and they are not the cause of the trouble, and several checks later calls for a compression test, to save time, check the compression while the spark plugs are out.

A separate trouble shooting chart is included in the

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complaints usually fall under the following headings: *engine will not start; engine runs, but will not start;*

ignition, fuel, and cooling system chapters. These charts list the basic troubles listed in Table 1, but cover only the items relating to the particular system under consideration. For example, in Table 1 under Poor Acceleration, the ignition system is listed as a probable

cause of the trouble. In the Ignition System Trouble Shooting Chart under Poor Acceleration, all the ignition system items that affect acceleration are listed. These items should be all checked before proceeding to the next probable system listed in Table 1.

**Table 1—General Engine Trouble Shooting**

### **Engine Will Not Crank**

The cause of this trouble is usually in the starting system (Part 7—Chapter 2).

If the starting system is not at fault, check for a hydrostatic lock or a seized engine. Remove the spark plugs, then attempt to crank the engine with the starter. If the engine cranks, it indicates that water is leaking into the cylinders. Remove the cylinder head and inspect the gasket and/or head for cracks. Also examine the cylinder block for cracks.

### **Engine Cranks Normally, But Will Not Start**

Check the fuel supply.

If there is sufficient fuel in the tank, the cause of the trouble probably lies in either the ignition or the fuel system.

To isolate the cause:

Remove the ignition wire from one spark plug, and insert a piece of proper sized metal rod in the insulator so that it protrudes from the insulator. With the ignition on and the starter cranking the engine, hold the end of the rod approximately 3/16 inch from the cylinder block.

If there is no spark or a weak spark, the cause of the trouble is in the ignition system (Part 2—Chapter 1).

If the spark is good, check the spark plugs (Part 2—Chapter 1).

If the spark plugs are not at fault, check the fuel system (Part 2—Chapter 2).

If the fuel system is not at fault, check the valve timing (page 1-17).

### **Engine Starts, But Fails To Keep Running**

If the engine starts and runs for a few seconds, then stops, check the:

Fuel system (Part 2—Chapter 2).

Ignition system (Part 2—Chapter 1).

### **Engine Runs, But Misses**

First, determine if the miss is steady or erratic and at what speed the miss occurs by running the engine at various speeds under load.

**MISSES STEADY AT ALL SPEEDS.** Isolate the miss by running the engine with one cylinder not firing. This is done by running the engine with the ignition wire removed from one spark plug at a time, until all cylinders have been checked. Ground the spark plug wire removed.

If the engine speed changes when a particular cylinder is shorted out, that cylinder was delivering power before being shorted out. If no change in the engine operation is evident, the miss was caused by that cylinder not delivering power before being shorted out, check the:

Ignition system (Part 2—Chapter 1).

Engine compression to determine which mechanical component of the engine is at fault (page 1-9).

**MISSES ERRATICALLY AT ALL SPEEDS.** If the miss cannot be isolated in a particular cylinder, check the:

Exhaust gas control valve (page 1-10).

Ignition system (Part 2—Chapter 1).

Fuel system (Part 2—Chapter 2).

Engine compression to determine which mechanical component of the engine is at fault (page 1-9).

Exhaust system for restrictions (page 1-30).

for internal leaks and/or for a condition that prevents the engine from reaching temperature (Part 2—Chapter 3).



Table 1—General Engine Trouble Shooting (cont'd)

**Engine Runs, But Misses (cont'd)**

**MISSES AT IDLE ONLY.** Check the:

- Fuel system (Part 2—Chapter 2).
- Ignition system (Part 2—Chapter 1).
- Vacuum booster pump, lines and fittings for leaks.
- Valve lash adjustment (page 1-15).
- Engine compression for low compression (page 1-9).

**MISSES AT HIGH SPEED ONLY.** Check the:

- Ignition system (Part 2—Chapter 1).
- Fuel system (Part 2—Chapter 2).
- Cooling system for overheating or internal leakage (Part 2—Chapter 3).

**Rough Engine Idle**

- Valve lash (page 1-15).
- Exhaust gas control valve (page 1-10).
- Vacuum booster pump (Part 2—Chapter 2).
- Ignition System (Part 2—Chapter 1).
- Leaking power brake vacuum booster (Part 6—Chapter 2).
- Fuel system (Part 2—Chapter 2).
- Loose engine mounts (Part 1—Chapter 2 or 3).
- Improper cylinder head bolt torque.

**Poor Acceleration**

- Ignition system (Part 2—Chapter 1).
- Fuel system (Part 2—Chapter 2).
- Exhaust gas control valve (page 1-10).
- Valve lash adjustment (page 1-15).
- Dragging brakes (Part 6—Chapter 1).
- Slipping clutch (Conventional and Overdrive Transmission) (Part 3—Chapter 1).
- Improper adjustment of the Fordomatic transmission.

**Engine Does Not Develop Full Power, Or Has Poor High Speed Performance**

Determine if the trouble exists when the engine is cold, at normal operating temperature, or at all engine temperatures.

**ENGINE COLD**

- Exhaust gas control valve (page 1-10).
- Fuel system (Part 2—Chapter 2).
- Cooling system if the engine reaches operating temperature slowly (Part 2—Chapter 3).

**ENGINE AT NORMAL OPERATING TEMPERATURE**

- Exhaust gas control valve (page 1-10).
- Fuel system (Part 2—Chapter 2).

**ALL ENGINE TEMPERATURES**

- Engine compression (page 1-9).
- Ignition system (Part 2—Chapter 1).
- Fuel system (Part 2—Chapter 2).
- Valve lash adjustment (page 1-15).
- Camshaft lift (page 1-19).
- Timing (page 1-17).
- Cooling system if the engine overheats (Part 2—Chapter 3).



Table 1—General Engine Trouble Shooting (cont'd)

**Engine Does Not Develop Full Power, Or Has Poor High Speed Performance (cont'd)**

Excessive back pressure in the exhaust system.  
 Torque converter stall speed.  
 Torque converter fails to lock up at high speeds.  
 Brake adjustment (Part 6—Chapter 1).  
 Tire pressure (Part 4—Chapter 3).  
 Excessive carbon in engine.

**Excessive Fuel Consumption**

Determine the actual fuel consumption with test equipment installed in the car.

If the test indicates that the fuel consumption is not excessive, demonstrate to the owner how improper driving habits will affect fuel consumption.

If the test indicates that the fuel consumption is excessive, make the preliminary checks listed below before proceeding to the fuel and ignition systems.

**PRELIMINARY CHECKS**

Tires (Part 4—Chapter 3).  
 Wheel alignment (Part 4—Chapter 1).  
 Brakes (Part 6—Chapter 1).  
 Exhaust gas control valve (page 1-10).  
 Odometer calibration (Part 8—Chapter 1).  
 Ignition timing (Part 2—Chapter 1).  
 Valve lash (page 1-15).

**FUEL SYSTEM** (Part 2—Chapter 2)

**IGNITION SYSTEM** (Part 2—Chapter 1)

**ENGINE COMPRESSION** (page 1-9)

**COOLING SYSTEM** (Part 2—Chapter 3)

**TORQUE CONVERTER STALL SPEED**

**TORQUE CONVERTER CONTINUES TO CONVERT AT LOCKUP SPEED**

**Engine Overheats**

Temperature sending unit (Part 8—Chapter 1).  
 Temperature gauge (Part 8—Chapter 1).  
 Exhaust gas control valve (page 1-10).  
 Cylinder head bolt torque (Part 1—Chapter 2 or 3).  
 Cooling system (Part 2—Chapter 3).  
 Ignition timing (Part 2—Chapter 1).  
 Valve timing (page 1-17).  
 Valves (page 1-14).  
 Exhaust system (page 1-30).  
 Brake adjustment (Part 6—Chapter 1).

**Engine Fails To Reach Normal Operating Temperature**

Temperature sending unit (Part 8—Chapter 1).  
 (Part 8—Chapter 1).  
 (Part 2—Chapter 3).



## 2. TUNE-UP

A tune-up is a systematic procedure for testing various engine components, and, if necessary, bringing them within recommended specifications to restore engine efficiency and performance.

The Tune-Up Schedule (Table 2) is applicable for

either a minor or major tune-up as governed by the condition of the engine. The reference after each operation refers to that part of the manual which describes, in detail, the procedure to be followed. Perform the operations in the sequence listed.

Table 2—Tune-Up Schedule

Operation	Perform on		Recommended Procedure
	Minor	Major	
<b>BATTERY AND CABLES</b> Clean cables, connectors, and terminals.		x	Part 7 Chapter 1
Inspect cables for worn insulation.		x	
Inspect battery for cracks and leaks.		x	
Check battery state of charge.	x	x	
Grease battery cables.		x	
<b>GENERATOR</b> Check generator output.		x	Part 7 Chapter 1
<b>REGULATOR</b> Visually inspect wiring.	x	x	Part 7 Chapter 1
Check current and voltage.		x	
<b>ENGINE COMPRESSION</b> Take compression reading of each cylinder.		x	Page 1-9
<b>SPARK PLUGS</b> Clean, adjust, and test.	x	x	Part 2 Chapter 1
<b>INTAKE MANIFOLD</b> Check and adjust manifold bolt torque.		x	Part 1 Chapter 2 or 3
<b>VALVE LASH</b> Check and adjust intake and exhaust valve lash.	x	x	Page 1-15
<b>DISTRIBUTOR</b> Check and adjust breaker arm spring tension.		x	Part 2 Chapter 1
Check condition of contact points.	x	x	
Check and adjust point dwell.	x	x	
Check and adjust vacuum advance.		x	
Check and adjust mechanical advance (8-cyl. engines).		x	
distributor circuit and		x	
	x	x	

Operation	Perform on		Recommended Procedure
	Minor	Major	
<b>CONDENSER</b> Check for leakage, series resistance, and capacity.		x	Part 2 Chapter 1
<b>COIL AND RESISTOR</b> Check coil output.		x	Part 2 Chapter 1
Check the voltage drop at the resistor.		x	
<b>TIMING</b> Check and adjust ignition timing.	x	x	Part 2 Chapter 1
<b>VACUUM</b> Check manifold vacuum.	x	x	Page 1-9
<b>FUEL PUMP</b> Clean fuel pump bowl.	x	x	Part 2 Chapter 2
Test fuel pump pressure.		x	
Test fuel pump capacity.		x	
<b>CARBURETOR</b> Clean carburetor air cleaner filter.	x	x	Part 2 Chapter 2
Clean carburetor fuel bowl.		x	
Adjust float setting.		x	
Check fuel level (Holley and Ford Carburetors).		x	
Adjust engine idle speed.	x	x	
Adjust idle fuel mixture.	x	x	
<b>FUEL FILTER</b> Clean fuel line filter.		x	Part 2 Chapter 2
<b>EXHAUST ANALYSIS</b> Perform an exhaust gas analysis.		x	Page 1-10
<b>IGNITION SYSTEM RESISTANCE TEST</b> Perform a primary circuit and secondary circuit resistance test.		x	Part 2 Chapter 1
<b>COOLING SYSTEM</b> Check and adjust the tension of the drive belts.	x	x	Part 2 Chapter 3
Check condition of hoses and radiator cap.	x	x	



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## Manifold Vacuum Test

A test of manifold vacuum is a valuable aid in determining the condition of an engine and also in helping to locate the cause of poor engine performance. To test manifold vacuum:

1. Operate the engine for a minimum of ½-hour at 1200 rpm.
2. Install an accurate, sensitive vacuum gauge on the fuel pump end of the fuel pump vacuum line.
3. Run the engine at recommended idle rpm.
4. Check the vacuum reading on the gauge.

**TEST CONCLUSIONS.** Manifold vacuum is affected by carburetor adjustment, valve timing, the condition of the valves, cylinder compression, and leakage of the manifold, carburetor, or cylinder head gaskets.

Because abnormal gauge readings may indicate that more than one of the above factors is at fault, exercise caution in analyzing an abnormal reading. For example, if the vacuum is low, the correction of one item may increase the vacuum enough so as to indicate that the trouble has been corrected. It is important, therefore, that each cause of an abnormal reading be investigated and further tests conducted where necessary in order to arrive at the correct diagnosis of the trouble.

Table 3 lists various types of readings and their possible causes. This table is merely a guide, however, and not a firm standard.

Allowance should be made for the affect of altitude on the gauge reading. The engine vacuum will decrease with an increase in altitude.

## Engine Compression Test

1. Be sure the battery is good. Operate the engine for a minimum of ½ hour at 1200 rpm. Turn the ignition switch off, then remove all the spark plugs.

2. Set the throttle (primary throttle plates only on 4-barrel carburetor) and choke in the wide open position.

3. Install a compression gauge in No. 1 cylinder.

4. Crank the engine until the gauge registers a maximum reading and record the reading. Note the number of compression strokes required to obtain the maximum reading.

5. Repeat the test on each cylinder, cranking the engine the same number of strokes for each cylinder as was required to obtain a maximum reading on No. 1 cylinder.

**TEST CONCLUSIONS.** A variation of  $\pm 10$  pounds from specified pressure is satisfactory. However, the compression of all cylinders should be uniform within 10 pounds.

A reading of more than 10 pounds above normal indicates excessive deposits in the cylinder.

A reading of more than 10 pounds below normal indicates leakage at the head gasket, rings, or valves.

A low even compression in two adjacent cylinders indicates a head gasket leak. This should be checked before condemning the rings or valves.

To determine whether the rings or the valves are at fault, squirt the equivalent of a tablespoon of heavy oil in the combustion chamber, then crank the engine to

Table 3—Manifold Vacuum Gauge Readings

Gauge Reading	Engine Condition
18-20 inches (6-cylinder engine) 19-20 inches (8-cylinder engine)	Normal
Low and steady	Loss of power in all cylinders caused possibly by late ignition or valve timing, or loss of compression due to leakage around the piston rings.
Very low	Manifold, carburetor, or cylinder head gasket leak.
Needle fluctuates steadily as speed increases.	A partial or complete loss of power in one or more cylinders caused by a leaking valve, leaking head or manifold gasket, a defect in the ignition system, a weak valve spring.
Gradual drop in reading at engine idle.	Restriction in the exhaust system.
Intermittent fluctuation	An occasional loss of power possibly caused by a defect in the ignition system or a sticking valve.
Fluctuating of the needle.	Improper idle mixture adjustment, carburetor or manifold gasket leak, or possibly late valve timing.

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distribute the oil and repeat the compression test. The oil will temporarily seal leakage past the rings. If approximately the same reading is obtained, the rings are satisfactory, but the valves are leaking. If the compression has increased 10 pounds or more over the original reading, there is leakage past the rings.

During a compression test, if the pressure fails to climb steadily and remains the same during the first two successive strokes, but climbs higher on the succeeding strokes, or fails to climb during the entire test, it indicates a sticking or stuck valve.

### 3. MANIFOLDS AND EXHAUST GAS CONTROL VALVE

Hot exhaust gases are diverted into the intake manifold to provide the heat necessary to vaporize the incoming fuel-air mixture and to minimize engine stalling and carburetor icing during cold engine operation. The hot exhaust gases are directed into the intake manifold by a thermostatically controlled valve located in the exhaust manifold.

On the 6-cylinder engine, the hot exhaust gases are directed into a chamber (heat riser) which is cast into the intake manifold section where the carburetor and exhaust manifold are attached.

All 8-cylinder intake manifolds contain a passage through the center section and under the carburetor, through which the hot exhaust gases are directed.

#### Manifolds

Clean the manifolds in a suitable solvent, then dry them with compressed air. Scrape all carbon deposits from the center exhaust passage below the carburetor

#### Exhaust Gas Analysis

An exhaust gas analysis is a method of testing the ratio of fuel and air entering the cylinders, and the adjustment and performance of the carburetor. *However it cannot be used to calibrate a carburetor.*

As there are various types of analyzers, follow the instructions of the manufacturer. On a dual exhaust system, install the analyzer in the outlet pipe opposite the side of the system that contains the exhaust gas control valve. For example, if the valve is on the right side, install the analyzer in the left muffler outlet pipe.

heat riser of the intake manifolds. This carbon acts as an insulator restricting the heating action of the hot exhaust gases.

Blow out the automatic choke passages of the 8-cylinder intake manifolds with compressed air. Make sure the passages are completely open, otherwise choke operation will be impaired.

On intake manifolds used with a four-barrel carburetor, check the fresh air heat tube that passes through the manifold for leaks, as follows:

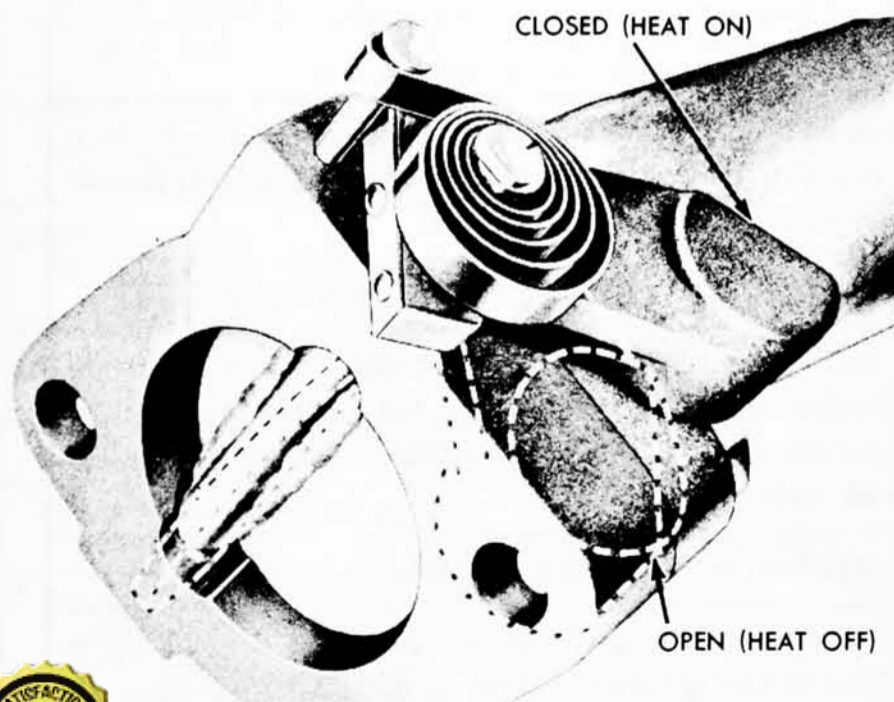
Adjust a vacuum pump to obtain a steady reading of three inches of vacuum. Block off one opening of the tube with a moistened finger, then connect the vacuum pump hose to the other opening. If the pump does not maintain a steady reading there is a leak in the tube and the tube should be replaced.

Inspect the manifolds for cracks, leaks, or other defects that would make them unfit for further service. Replace all studs that are stripped or otherwise damaged.

*Remove all filings and foreign matter that may have entered the manifolds as a result of repairs.*

#### Exhaust Gas Control Valve

Check the thermostatic spring to make sure it is



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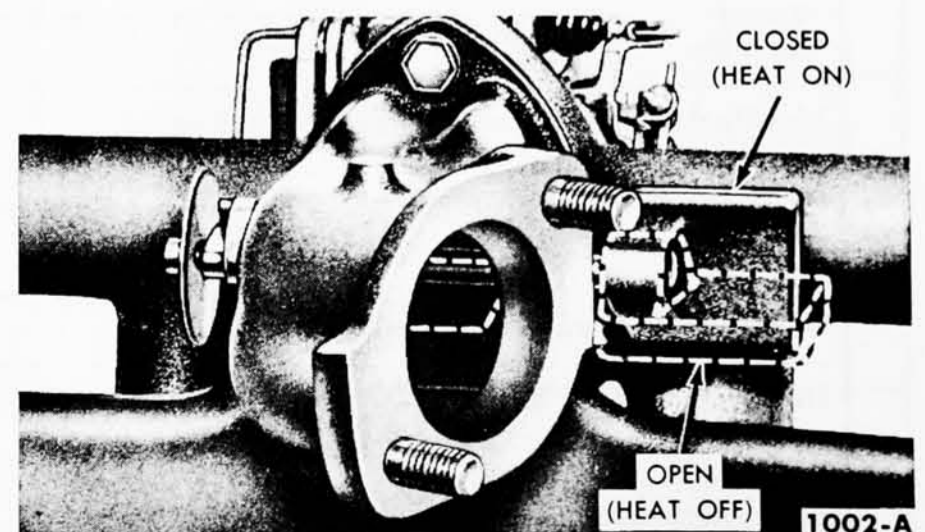


Fig. 2—Exhaust Gas Control Valve—6-Cylinder Engine

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Valve—8-Cylinder Engines

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hooked on the stop pin. The spring stop is at the top of the valve housing when the valve is properly installed. The action of the valves is illustrated in Figs. 1 and 2.

Check to make sure the spring holds the valve closed when the engine is cold. Actuate the counterweight by hand to make sure it moves freely through approximately 90° of rotation without binding.

The valve is closed when the engine is at normal

operating temperature and running at idle speed. However, a properly operating valve will open when very light finger pressure is applied to the counterweight. Rapidly accelerate the engine to make sure the valve momentarily opens. The valve is designed to open when the engine is at normal operating temperature and is operated at high rpm. Free stuck valves with a penetrating oil or graphite mixture.

## 4. ROCKER ARM ASSEMBLY, PUSH RODS, AND CYLINDER HEADS

### Rocker Arm Assembly

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

Check the clearance between each rocker arm and the shaft by checking the I. D. of the rocker arm bore and the O. D. of the shaft. If the clearance between any rocker arm and the shaft approaches 0.006 inch (wear limit), replace the shaft and/or the rocker arm. Inspect the shaft and the rocker arm bore for nicks, scratches, scores, or scuffs. Dress up minor surface defects with a hone.

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

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

Check for broken locating springs and inspect the oil drain tube for cracks or sharp bends.

### Push Rods

Check the ball end and the socket end 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 between ball and cup centers with a dial indicator (Fig. 3). If the runout exceeds 0.020 inch at any point, discard the rod. **Do not attempt to straighten push rods.**

### Cylinder Heads

To protect the machined surfaces of the cylinder head, do not remove the holding fixtures while the head is off the engine.

**CLEANING AND INSPECTION.** With the valves installed to protect the valve seats, remove carbon deposits from the combustion chambers and valve heads with a wire brush. **Be careful not to damage gasket surface.** After the

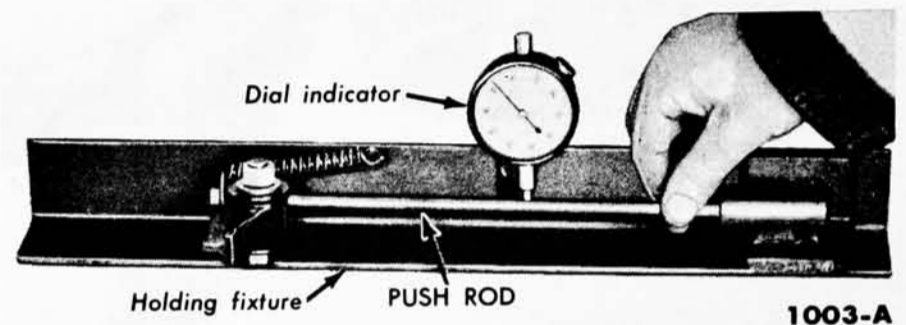


Fig. 3—Push Rod Runout—Typical

valves are removed, clean the valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove old gasket sealer, dirt, and grease.

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

### Cylinder Head Flatness

Check the flatness of the cylinder head gasket surface (Fig. 4). Specifications for flatness are 0.006 inch maximum over all, or 0.003 inch in any 6 inches.

### Valve Seat Runout

Check the valve seat runout with an accurate gauge (Fig. 5). Follow the instructions of the gauge manufacturer. The total runout should not exceed 0.0025 inch (wear limit).

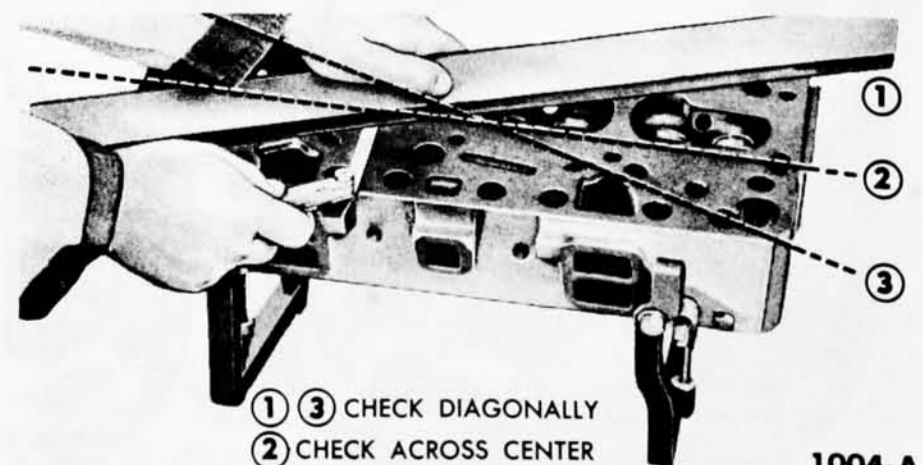


Fig. 4—Cylinder Head Flatness

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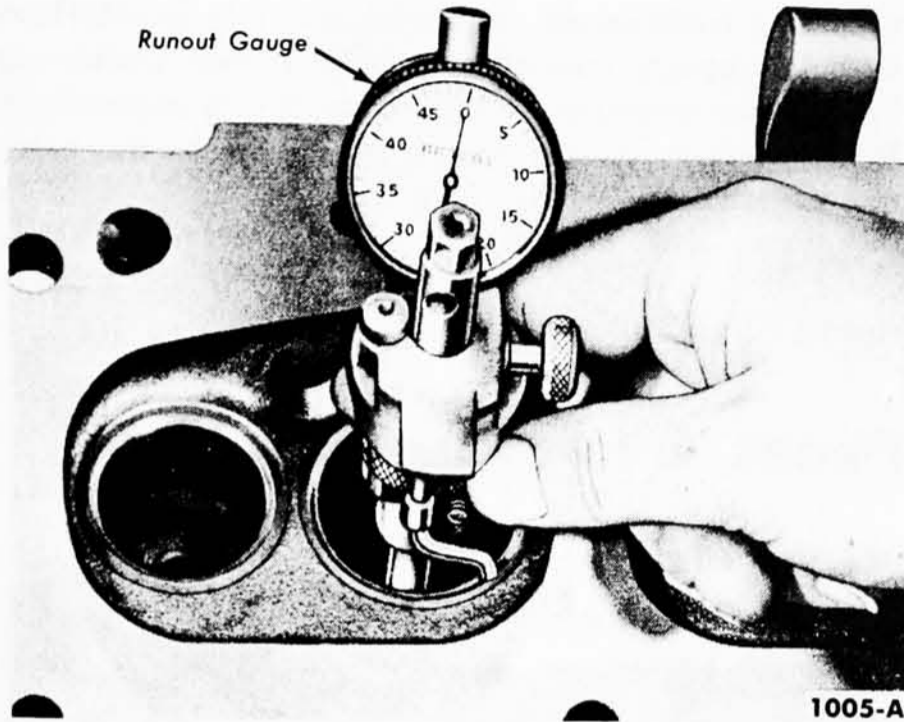


Fig. 5—Valve Seat Runout—Typical

**Valve Seat Width**

Measure the valve seat width (Fig. 6). The intake valve seat width limits are 0.060-0.080 inch and the exhaust valve seat width limits are 0.070-0.090 inch.

**REAMING VALVE GUIDES.** If it becomes necessary to ream a valve guide (Fig. 7) 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 O.S. reamer with a standard diameter pilot, a 0.015-inch O.S. reamer with a 0.003-inch O.S. pilot, and a 0.030-inch reamer with a 0.015-inch O.S. pilot

When going from a standard size valve to an oversize valve, always use the reamers in sequence. *Always grind the valve seat after the valve guide is reamed.*

**REFACING VALVE SEATS.** Refacing of the valve seats should be closely coordinated with the refacing of the valve face so the finished seat will match the valve face and be centered. This is important so that



Seat Width

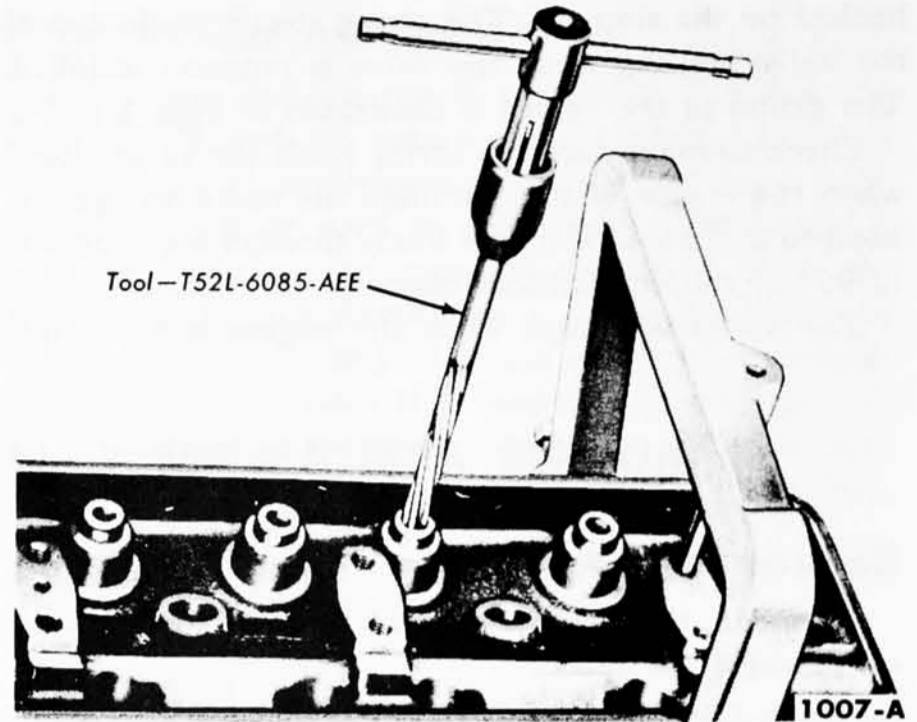


Fig. 7—Reaming Valve Guides

the valve and seat will have a good compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the valve seat to a true 45° angle (Fig. 8). Remove only enough stock to clean up pits, grooves, or to correct the valve seat runout. After the seat is ground, measure the seat width (Fig. 6). Narrow the seat, if necessary to bring it within limits.

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 (Fig. 8). Use a 30° angle grinding wheel to remove stock from the bottom of the seat (raise the seat). Use a 60° angle wheel to remove stock from the top of the seat (lower the seat).

The finished valve seat should contact the approximate center of the valve face. To determine where the valve seat contacts the face, coat the seat with Prussian blue, then set the valve in place. Rotate the valve with

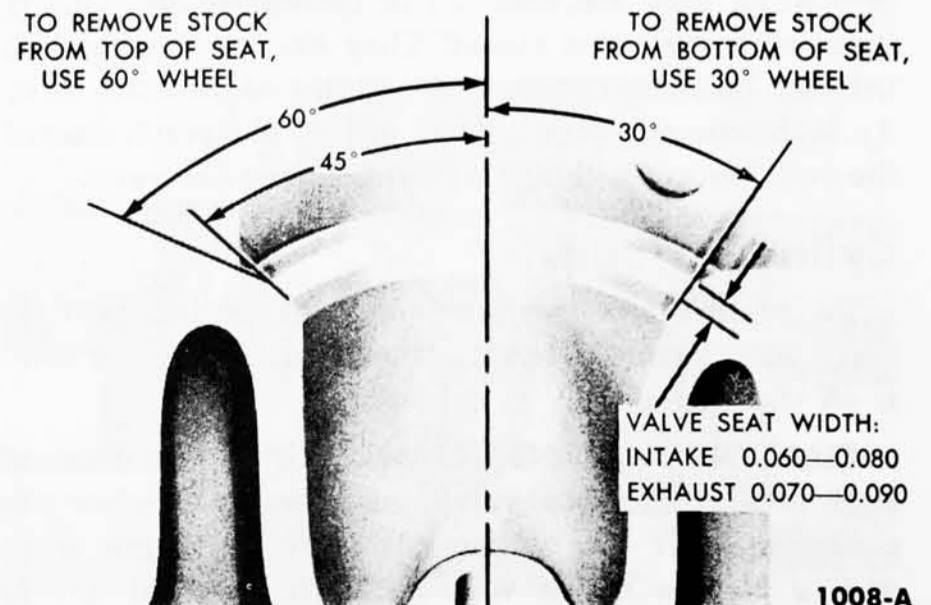


Fig. 8—Valve Seat Refacing

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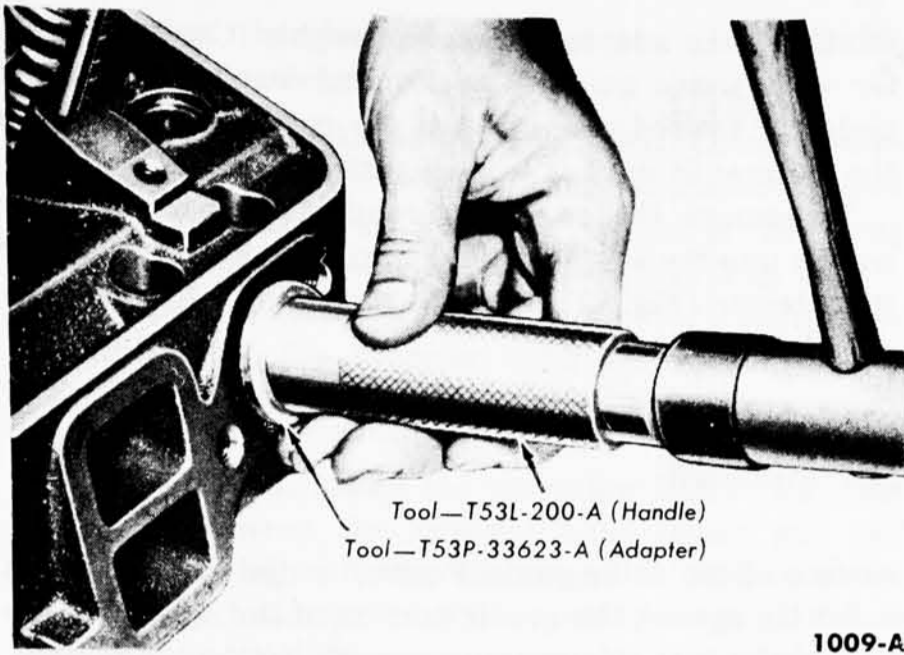


Fig. 9—Water Outlet Plug Installation—8-Cylinder Engines

light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

After refacing the valve seat, it is good practice to lightly lap in the valve with a medium grade lapping compound. Remove all the compound from the valve and seat after the lapping operation.

**WATER OUTLET CONNECTION —8- CYLINDER ENGINES.** The cylinder head assemblies of each particular engine are interchangeable from one cylinder bank to the other, provided a plug is installed in the water

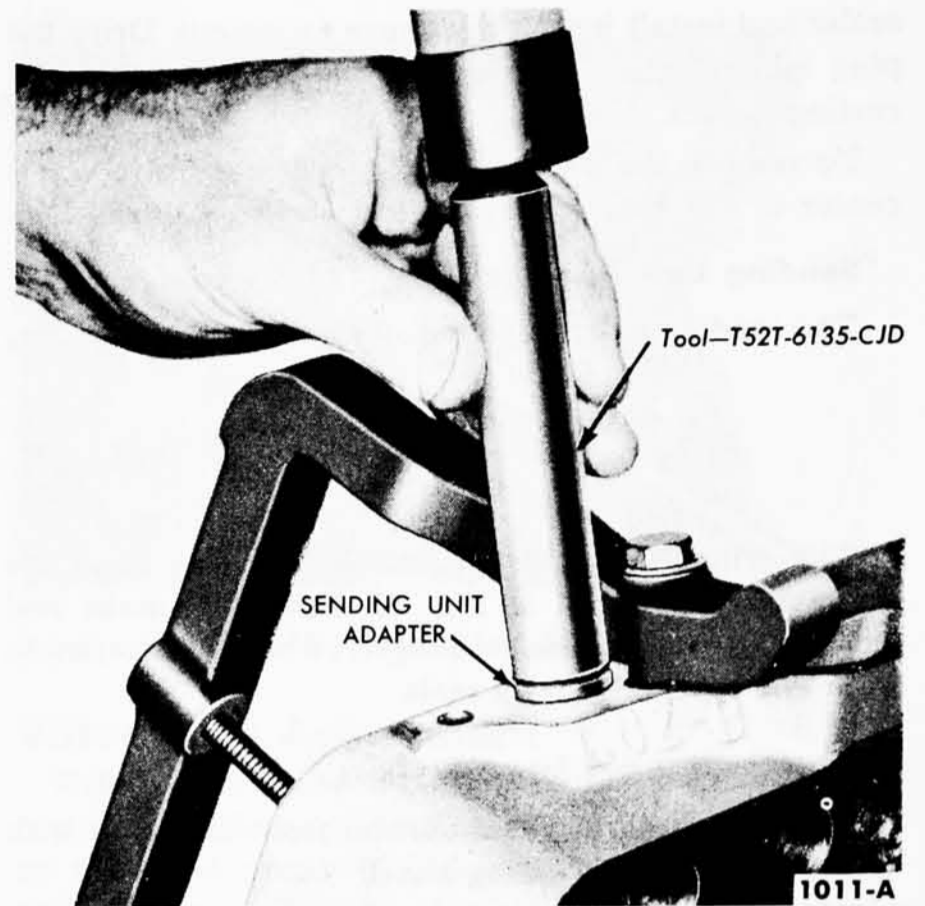


Fig. 11—Temperature Sending Unit Adapter Installation—8-Cylinder Engines

outlet at the rear of the right head and a water temperature sending unit adapter is installed in the water opening at the rear of the left head. Replacement cylinder heads do not have either the plug or adapter installed; therefore, they can be readily adapted for either right or left installations.

**Water Outlet Plug**

Install the plug (Fig. 9). Clean the plug recess thoroughly. Coat the flange of the plug with water resistant

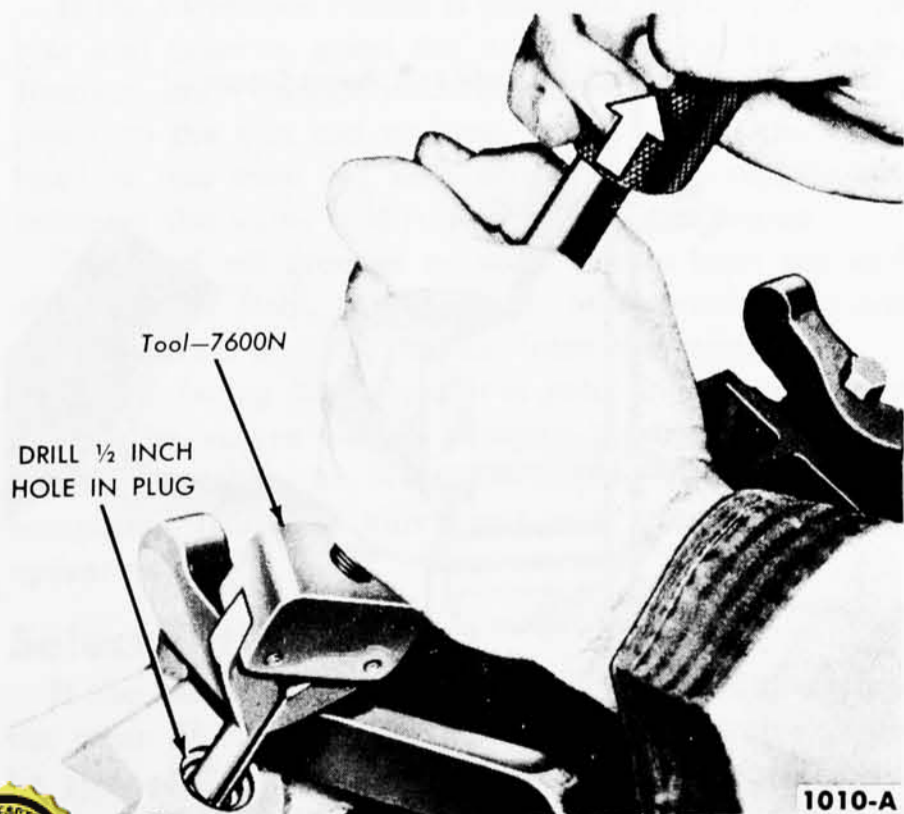


Fig. 10—Water Outlet Plug Removal—8-Cylinder Engines

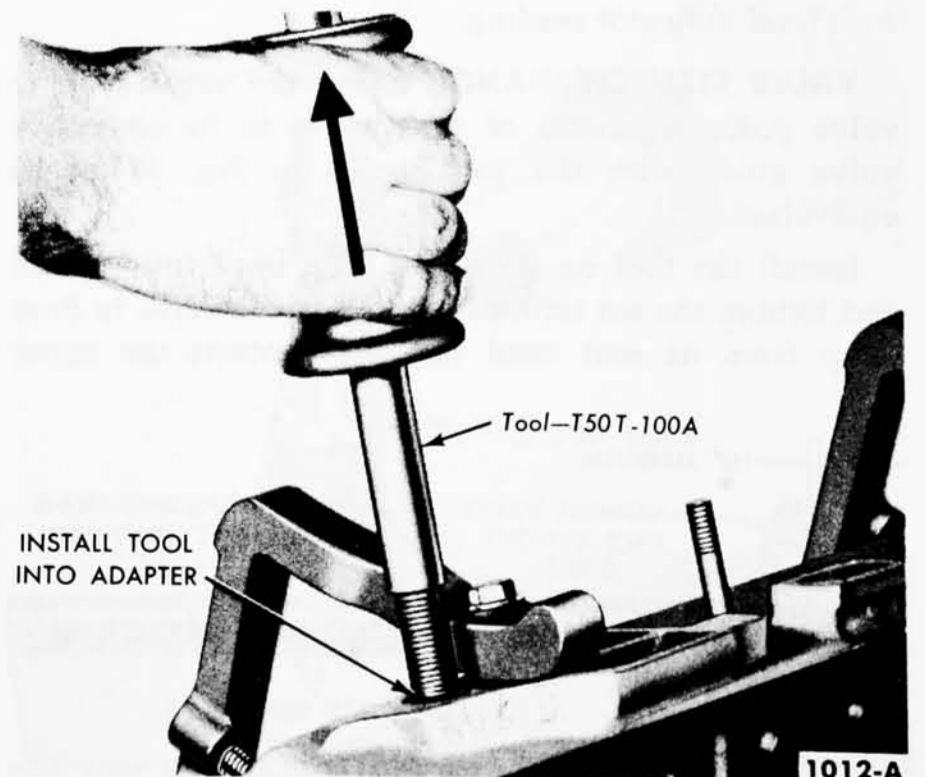


Fig. 12—Temperature Sending Unit Adapter Removal—8-Cylinder Engines

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sealer and install it with the flange facing out. Drive the plug in until the flange is flush or slightly below the casting surface.

To remove the water plug, drill a 1/2-inch hole in the center of the plug and remove it as shown in Fig. 10.

### Sending Unit Adapter

The sending unit adapter is installed as shown in Fig.

11. Clean the adapter recess thoroughly. Coat the adapter with water resistant sealer and install it with the undercut toward the inside of the cylinder head. Drive the adapter in until it is flush with the casting surface.

To remove the adapter, thread the impact hammer handle into the adapter, then tighten the lock nut against the adapter (Fig. 12). Remove the adapter by using the slide hammer.

## 5. VALVE MECHANISM

The critical inspection points and tolerances of the valve are illustrated in Fig. 13. Both the intake and exhaust valves are the rotating type which incorporate umbrella-type valve stem seals.

### Cleaning and Inspection

Remove all carbon and varnish from the valve with a fine wire brush or buffing wheel.

Inspect the valve face and the edge of the valve head for pits, grooves, scores, or other defects. 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. Defects, such as minor pits, grooves, etc., may be removed. Discard valves that are severely damaged.

Inspect the valve springs, valve spring retainers, locks, and sleeves for defects. Discard any defective parts.

**VALVE FACE RUNOUT.** Check the valve face runout (Fig. 14). The recommended limit for runout is 0.0015 inch total indicator reading. The wear limit is 0.002 inch total indicator reading.

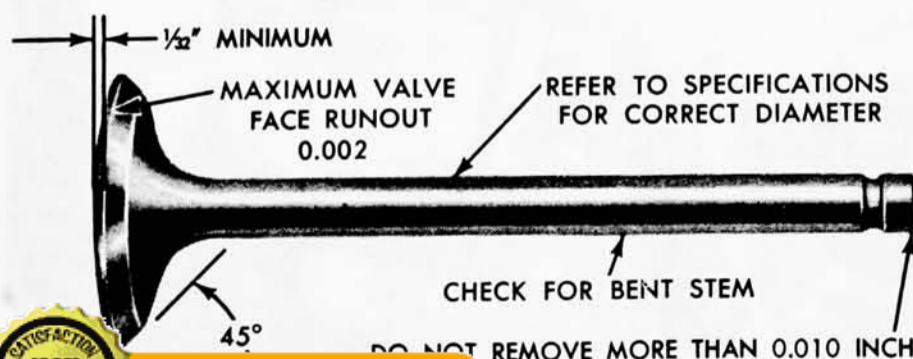
**VALVE STEM CLEARANCE.** Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Fig. 15 or its equivalent.

Install the tool on the valve stem until fully seated and tighten the set screw, then permit the valve to drop away from its seat until the tool contacts the upper

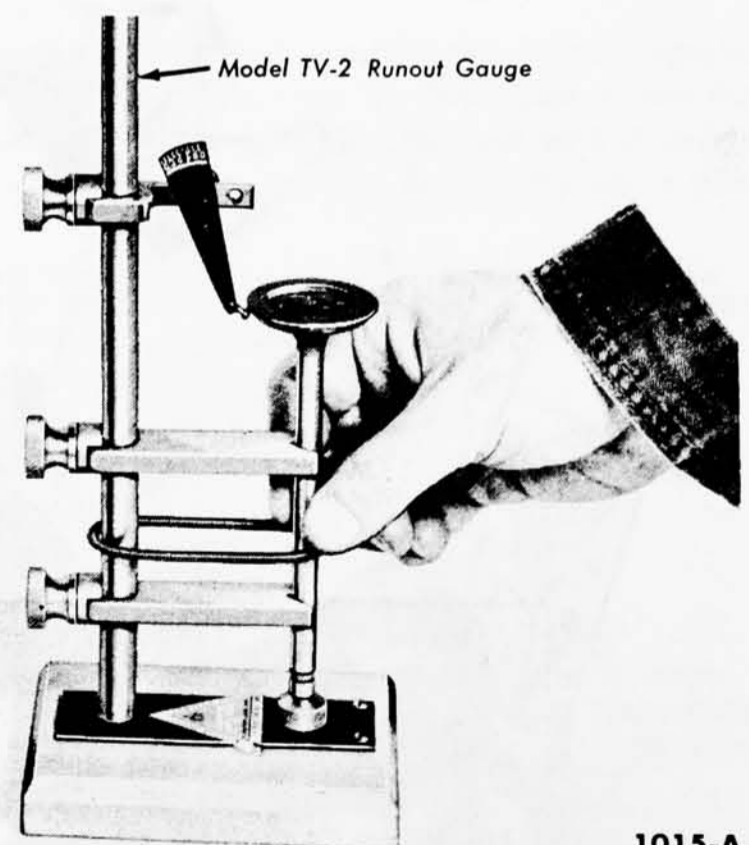
surface of the valve guide. Position a dial indicator with a flat tip against the center portion of the spherical section of the tool at approximately 90° to the valve stem. Move the tool back and forth on a plane that parallels normal rocker action and take the indicator reading without lifting the tool from the valve guide upper surface. Divide the indicator reading by 2 (division factor of the tool) to obtain the actual stem clearance.

The recommended intake valve stem clearance limits are 0.001-0.0024 inch. The wear limit is 0.0045 inch. The recommended exhaust valve stem clearance limits are 0.0023-0.0037 inch. The wear limit is 0.0065 inch. If the clearance approaches the wear limit, try a new valve.

**VALVE SPRING PRESSURE.** Check the spring for proper pressure (Fig. 16). The springs should exert a pressure of 71-79 pounds when compressed to 1.780 inches (wear limit 64 pounds) or a pressure of 161-177 pounds when compressed to 1.390 inches (wear limit 145 pounds). Weak valve springs cause poor engine



1014-A



1015-A

Fig. 14—Valve Face Runout

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Valve Tolerances

performance; therefore, if the pressure of any spring approaches the wear limit, replace the spring.

**VALVE SPRING ASSEMBLED HEIGHT.** Correct valve spring load is necessary for efficient high speed engine operation; therefore, the assembled height of the spring installed in the engine should be measured (Fig. 17).

Use dividers to measure the assembled height from the surface of the cylinder head spring pad to the underside of the spring retainer. Check the dividers against a scale. If the assembled height is  $1\frac{13}{16}$  inches or greater, 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 of  $1\frac{25}{32}$  -  $1\frac{13}{16}$  inches. *Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs which will lead to excessive load loss and spring breakage.*

**VALVE SPRING SQUARENESS.** Check each spring for squareness using a steel square and a surface plate (Fig. 18). 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 the square. If the spring is out of square more than  $\frac{1}{16}$  inch, replace it.

## Refacing Valves

The valve refacing operation should be closely coordinated with the valve seat refacing operation so that the finished angle of the valve face will match the valve seat. This is important so that the valve and seat will have a good compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

If the valve face runout is excessive and/or to remove pits and grooves, grind the valve to a true  $45^\circ$  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  $\frac{1}{32}$  inch after grinding, replace the valve as the valve will run too hot in the engine.

Grind off all grooves or score marks from the end of the valve stem, then chamfer as necessary. Do not remove more than 0.010 inch from the stem.

After refacing the valves, it is good practice to lightly lap in the valves with a medium grade lapping compound to match the seats. Be sure to remove all the compound from the valve and seat after the lapping operation.

## Select Fitting Valves

If the valve stem to valve guide clearance approaches the wear limit, it is recommended that the valve guide be reamed for the next oversized valve stem. Valves with oversized stem diameters of 0.003, 0.015, and 0.030 inch are available. *Always grind the valve stem before it is reamed.*

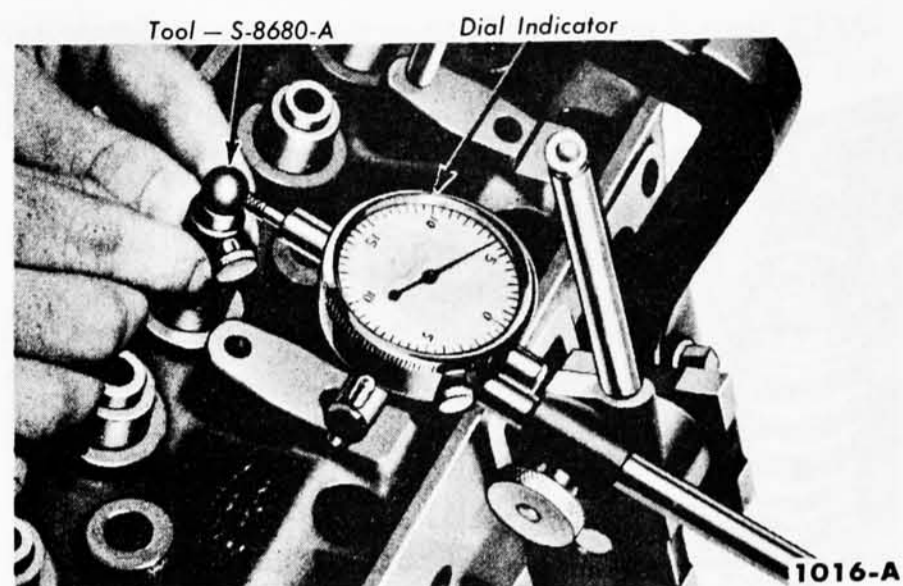


Fig. 15—Valve Stem Clearance

## Valve Lash Adjustment

Reference is made in the procedure for a preliminary (cold) valve lash adjustment to placing No. 1 piston on top dead center (T.D.C.) at the end of the compression stroke. Number 1 piston is on T.D.C. at the end of the compression stroke when both valves are closed and the timing mark on the crankshaft damper is in line with the timing pointer.

Step-type feeler gauges ("go" and "no go") can be used to obtain the proper clearance (Fig. 19).

Valve lash is adjusted by means of the self locking adjusting screw located on the push rod end of the rocker arm. The adjusting screw has an integral hex head and special threads which provide an interference fit in the rocker arm. The first three threads are lead threads. Interference is not reached until the center portion of the adjusting screw threads are in full con-

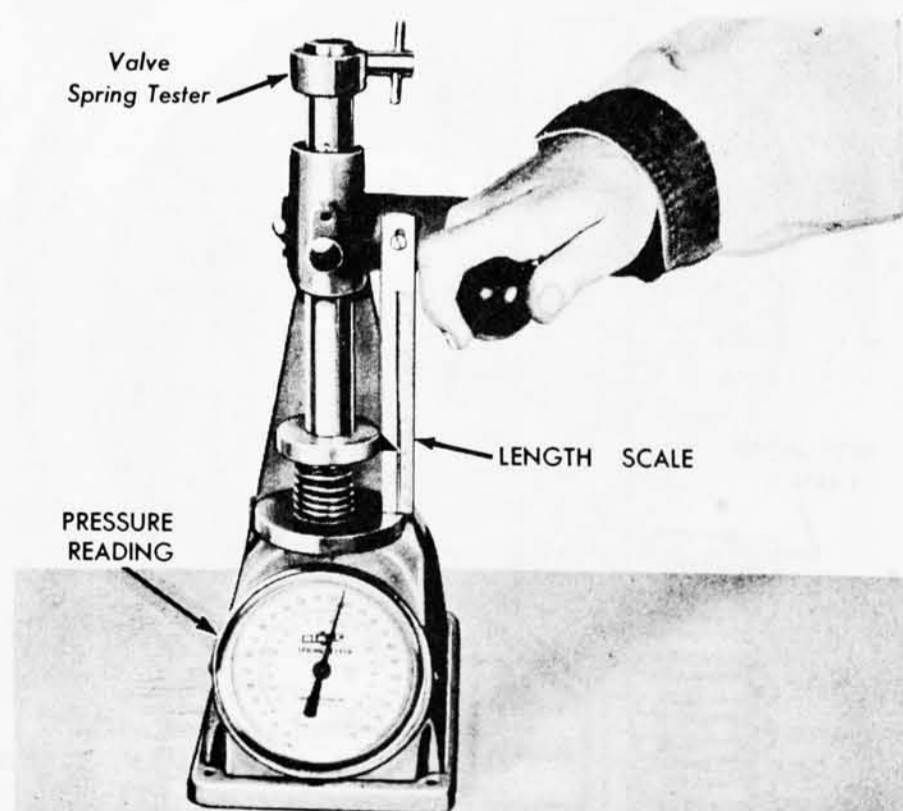


Fig. 16—Valve Spring Pressure

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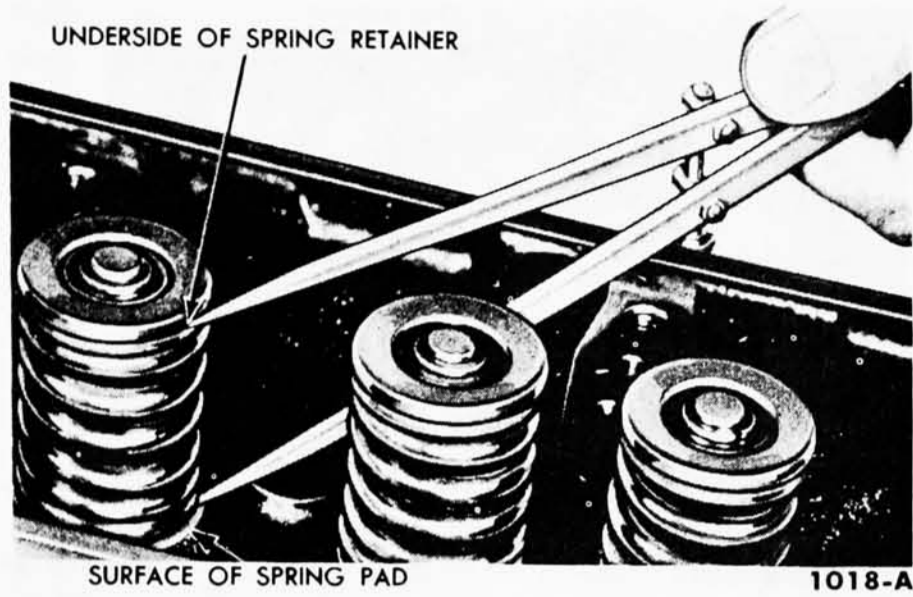


Fig. 17—Valve Spring Assembled Height

tact with the threads in the rocker arm. When the point of interference is reached, it should take a minimum of 3 foot-pounds (36 inch pounds) to turn the screw further.

It is very important that the valve lash be held as close as possible to the correct specifications. If the lash is set too close, the valve will open too early and close too late, thereby, resulting in rough engine idle. Also, burning and warping of the valve will occur because they cannot make firm contact with the seats long enough to cool properly. If the lash is excessive, it will cause the valve to open too late and close too early causing valve bounce. In addition, damage to the cam lobe is likely because the tappet foot will not follow the pattern of the cam lobe, thereby causing a shock contact between these two parts. Valve lash specifications are given in Table 4.

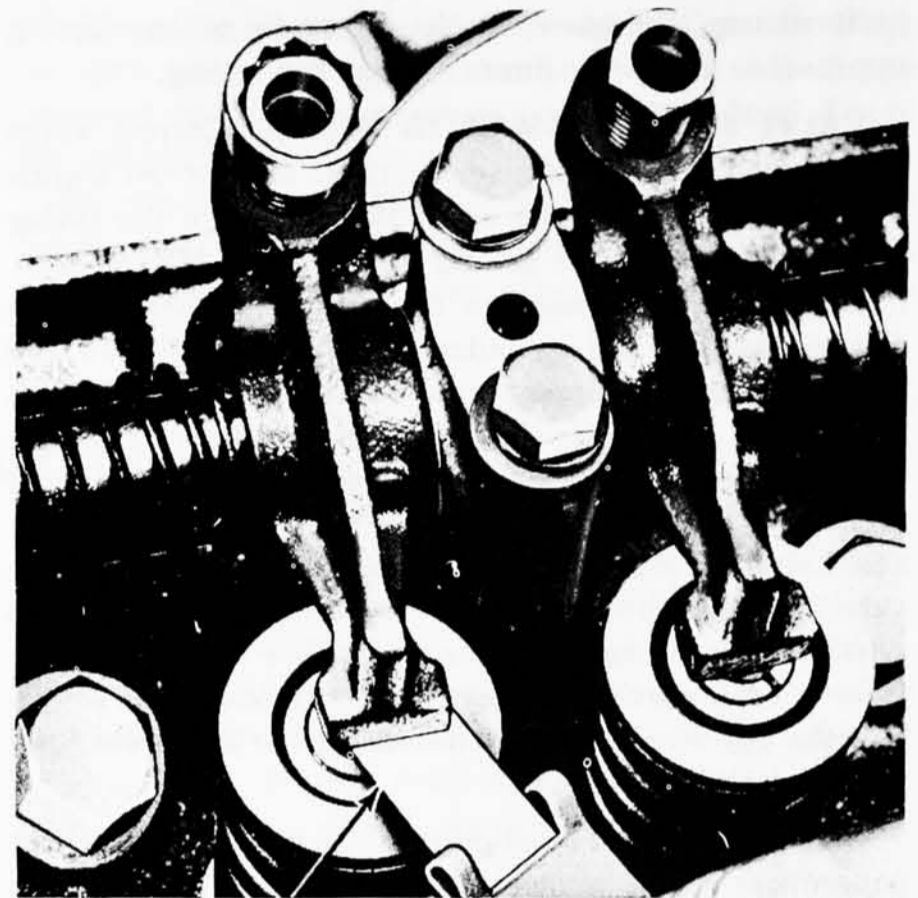


Fig. 19—Valve Lash Adjustment—Typical

If the cylinder head or the rocker mechanism has been removed and installed, it will be necessary to make a preliminary (cold) valve lash adjustment before starting the engine. If the adjustment is made for an engine tune-up, follow the final adjustment procedure.

**6-CYLINDER ENGINE.** The cylinders are numbered from front to rear, 1-2-3-4-5-6. The valves are arranged from front to rear, E-I-I-E-I-E-E-I-E-I-E.

**Preliminary Adjustment**

Turn all the adjusting screws until interference is noted, then check the torque required to turn the screw further. If the torque required to turn a screw is less than 3 foot-pounds (36 inch pounds), try a new self locking adjusting screw. If this is still unsatisfactory, replace the rocker arm and adjusting screw.

Make two chalk marks on the crankshaft damper (Fig. 20). Space the marks approximately 120° apart so that with the timing mark, the damper is divided into three equal parts (120° represents 1/3 of the distance around the damper circumference).

Rotate the crankshaft until No. 1 piston is near T.D.C. at the end of the compression stroke. Adjust the intake and exhaust valve lash for No. 1 cylinder.

Table 4—Valve Lash Specifications

Engine	Preliminary (Cold) Intake & Exhaust	Final (Hot) Intake & Exhaust
6-Cylinder Engine	0.019	0.019
8-Cylinder Engines	0.020	0.019

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Spring Squareness

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Repeat this procedure for the remaining set of valves, turning the crankshaft  $\frac{1}{3}$  turn at a time, in the direction of rotation, while adjusting the valves in the firing order sequence (1-5-3-6-2-4).

**Final Adjustment.**

Run the engine for a minimum of 30 minutes at approximately 1200 rpm to stabilize engine temperatures. With the engine idling, check the valve lash. Adjust the lash if necessary (Fig. 19).

**8-CYLINDER ENGINE.** The cylinders are numbered from front to rear—right bank, 1-2-3-4; left bank, 5-6-7-8. The valves are arranged from front to rear on both banks, E-I-I-E-E-I-I-E.

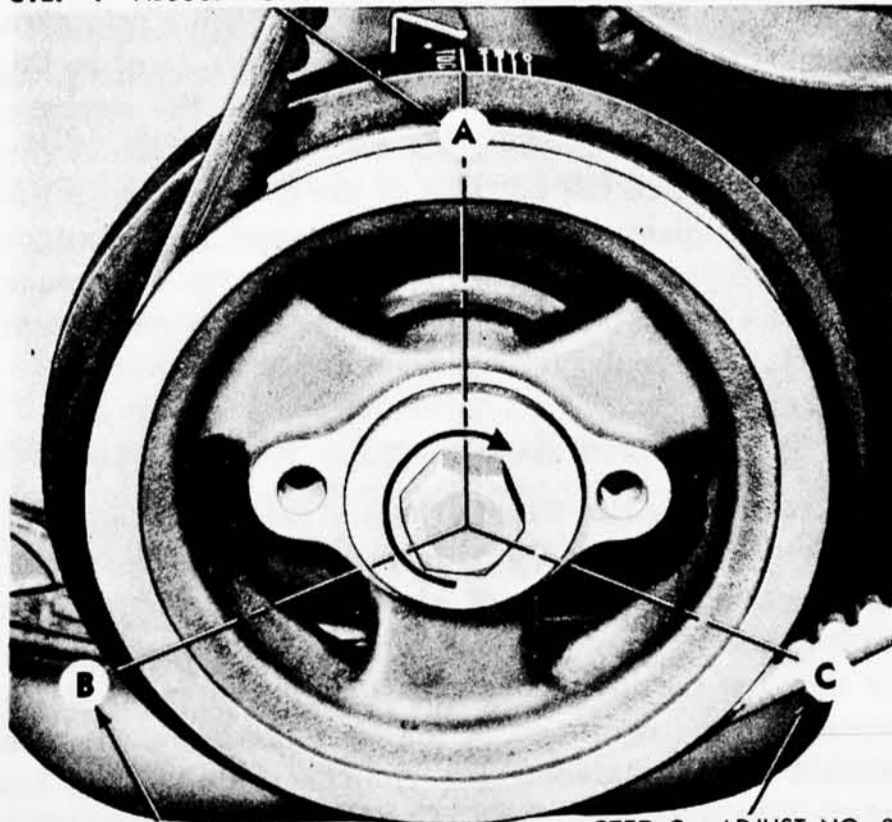
**Preliminary Adjustment**

Turn all the adjusting screws until interference is noted, then check the torque required to turn the screw further.

If the torque required to turn the screw is less than 3 foot-pounds (36 inch pounds), try a new self locking adjusting screw. If this is still unsatisfactory, replace the rocker arm and adjusting screw.

Make three chalk marks on the crankshaft damper (Fig. 21). Space the marks approximately  $90^\circ$  apart so that with the timing mark, the damper is divided into four equal parts ( $90^\circ$  represents  $\frac{1}{4}$  of the distance around the damper circumference).

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



- STEP 2—ADJUST NO. 5 INTAKE & EXHAUST
  - STEP 3—ADJUST NO. 3 INTAKE & EXHAUST
  - STEP 5—ADJUST NO. 2 INTAKE & EXHAUST
  - STEP 6—ADJUST NO. 4 INTAKE & EXHAUST
- 1021-A

Rotate the crankshaft until No. 1 piston is near T.D.C. at the end of the compression stroke, then adjust the following valves:

- No. 1—Exhaust
- No. 4—Exhaust
- No. 5—Exhaust
- No. 1—Intake
- No. 2—Intake
- No. 7—Intake

Rotate the crankshaft  $180^\circ$  or  $\frac{1}{2}$  turn (this puts No. 4 piston on T.D.C.), then adjust the following valves:

- No. 6—Exhaust
- No. 8—Exhaust
- No. 4—Intake
- No. 5—Intake

Rotate the crankshaft  $270^\circ$ , or  $\frac{3}{4}$  turn from  $180^\circ$  (this puts No. 3 piston on T.D.C.), then adjust the following valves:

- No. 2—Exhaust
- No. 3—Exhaust
- No. 7—Exhaust
- No. 3—Intake
- No. 6—Intake
- No. 8—Intake

**Final Adjustment**

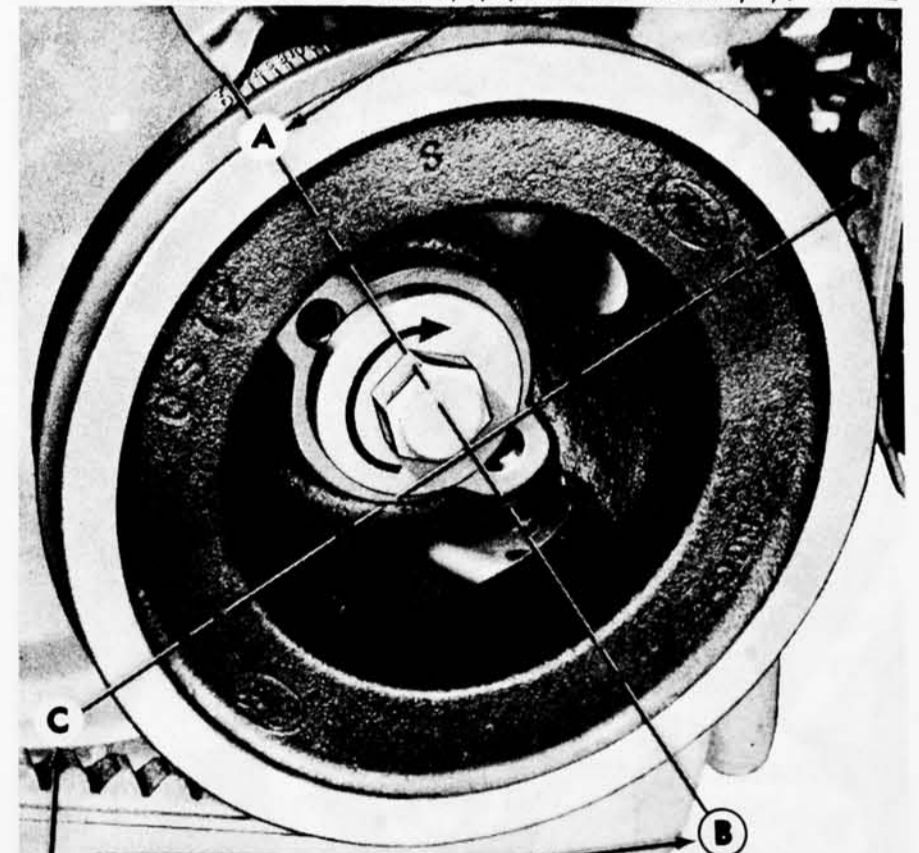
Run the engine for a minimum of 30 minutes at approximately 1200 rpm to stabilize engine temperatures. With the engine idling, check the valve lash. Adjust the lash if necessary (Fig. 19).

**Valve Timing**

The valve timing should be checked when poor engine performance is noted and all other checks, such as carburetion, ignition timing, etc. fail to locate the cause of the trouble.

Before the valve timing is checked, check for a bent

- STEP 1 — SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE—ADJUST NO. 1, 4, 5, EXHAUST & NO. 1, 2, 7 INTAKE



- STEP 2 — ADJUST NO. 6 & 8 EXHAUST & NO. 4 & 5 INTAKE
  - STEP 3 — ADJUST NO. 2, 3, 7 EXHAUST & NO. 3, 6, 8 INTAKE
- 1022-A

Fig. 21—Preliminary Valve Lash Adjustment—8-Cylinder Engine

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Valve Lash Adjustment—8-Cylinder Engine

timing pointer. Bring the No. 1 piston to T.D.C. on the compression stroke and see if the timing pointer is aligned with the T.D.C. mark on the damper.

If the valve timing is not within specifications, check the timing chain, camshaft sprocket, crankshaft sprocket, camshaft, and crankshaft in the order of accessibility.

To check the valve timing with the engine installed in the car, proceed as follows:

Install a quadrant on the crankshaft damper. Back off the No. 1 intake valve adjusting screw, then slide the rocker arm assembly to one side and secure it in this position. Make sure the push rod is in the tappet socket, then install a dial indicator in such a manner as to have

the actuating point of the indicator in the push rod socket and in the same plane as the push rod movement (Fig. 24). Turn the crankshaft damper slowly in the direction of rotation until the tappet is on the heel of the cam lobe. At this point the push rod will be in its lowest position. Zero the dial indicator and continue turning the crankshaft slowly in the direction of rotation until the dial indicator registers the specified cam lobe lift (Table 5).

Compare the crankshaft degrees indicated on the quadrant with specifications (Table 5). After the valve opening is checked, continue to rotate the engine to check the valve closing.

Table 5—Valve Timing Specifications

Engine	Intake Valve				Exhaust Valve			
	Opens		Closes		Opens		Closes	
	Crankshaft Degrees	Cam Lift	Crankshaft Degrees	Cam Lift	Crankshaft Degrees	Cam Lift	Crankshaft Degrees	Cam Lift
6-Cylinder	17° B.T.D.C.	0.016	53° A.B.D.C.	0.019	61° B.B.D.C.	0.016	9° A.T.D.C.	0.019
8-Cylinder	18° B.T.D.C.	0.015	58° A.B.D.C.	0.015	66° B.B.D.C.	0.013	10° A.T.D.C.	0.016

## 6. TIMING CHAIN, CAMSHAFT AND BEARINGS

### Timing Chain

**CLEANING AND INSPECTION.** Clean all parts in solvent and dry them with compressed air. Inspect the chain for broken links and the sprockets for cracks, worn



UP SLACK ON LEFT SIDE. ESTABLISH A REFERENCE POINT  
 MEASURE DISTANCE A. TAKE UP SLACK ON RIGHT SIDE  
 WITH THE FINGERS AND MEASURE  
 DISTANCE B. 1024-A

Chain Deflection

or damaged teeth. It is recommended that all the components be replaced if any one item needs replacement.

**DEFLECTION CHECK.** Rotate the crankshaft in a clockwise direction (as viewed from the front) to take up the slack on the left side of the chain. Establish a reference point on the block and measure from this point to the chain (Fig. 22). Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain, then force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements. If the deflection exceeds  $\frac{1}{2}$  inch, replace the timing chain and/or sprockets.

### Camshaft and Bearings

**CLEANING AND INSPECTION.** Clean the camshaft in solvent and wipe dry. Inspect the cam lobes for pitting, scoring, and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the nose portion of the lobe. This pitting is not detrimental to the operation of the cam, therefore, the cam should not be replaced until the cam lobe lift loss has exceeded 0.005 inch. The lift of suspected worn lobes should be checked by measuring over the top of the lobe with a micrometer and subtracting the measurement of the base circle diameter (Fig. 23).

Check the camshaft journal to bearing clearances by measuring the diameter of the journals and the I.D. of

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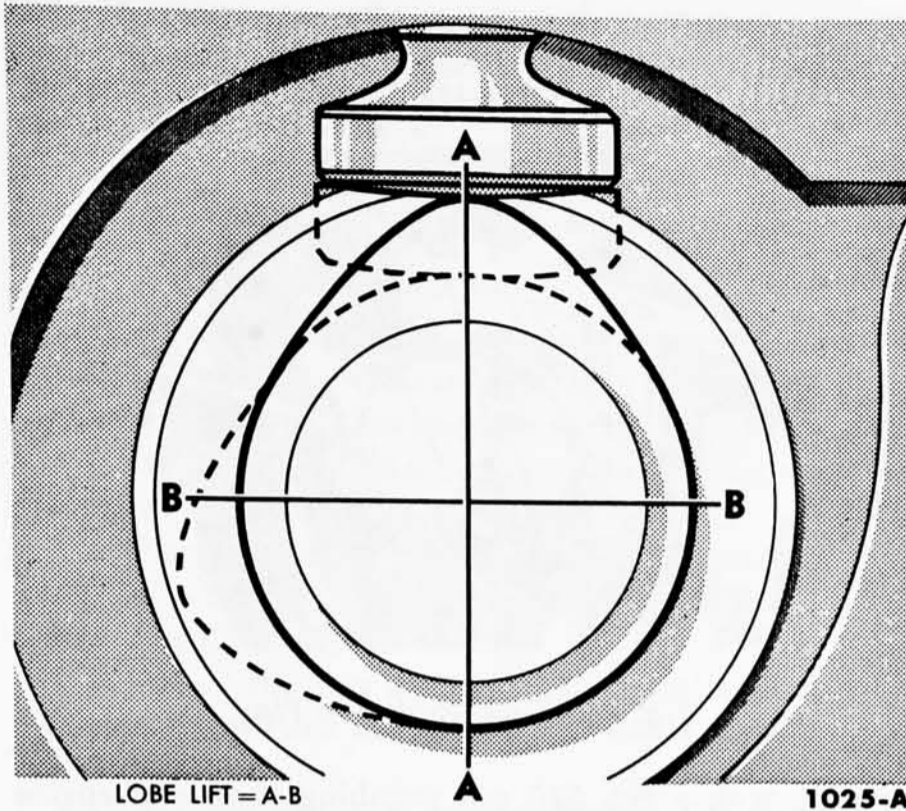


Fig. 23—Camshaft Lobe Lift Measurement

the bearings. The recommended clearance limits are 0.001-0.003 inch. The wear limit is 0.006 inch. If the clearance approaches the wear limit, the camshaft journals should be ground for undersize bearings or the camshaft replaced, and/or the bearings should be replaced. Bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters.

Check the distributor drive gear for broken or chipped teeth.

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

**CAMSHAFT LOBE LIFT (CAMSHAFT INSTALLED).** This procedure is similar to the procedure for checking valve

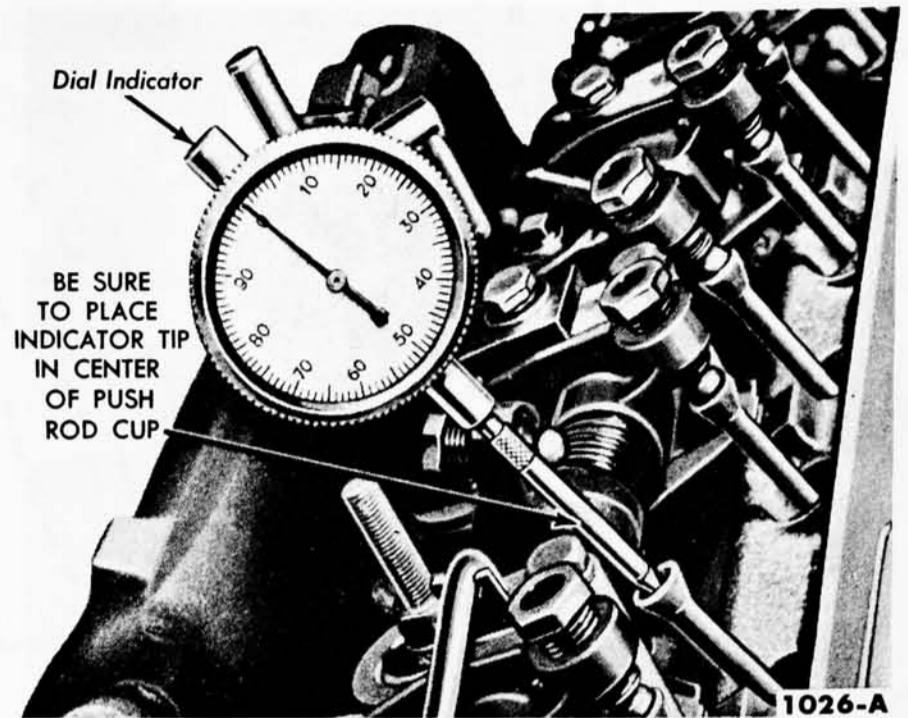


Fig. 24—Camshaft Lobe Lift

timing. Loosen the valve rocker arm adjusting screw, then slide the rocker arm assembly to one side and secure it in this position. Make sure the push rod is in the tappet socket, then install a dial indicator in such a manner as to have the actuating point of the indicator in the push rod socket and in the same plane as the push rod movement (Fig. 24). Turn the crankshaft damper slowly in the direction of rotation until the tappet is on the heel of the cam lobe. At this point the push rod will be in its lowest position. Set the dial indicator on zero, then continue to rotate the damper slowly until the push rod is in the fully raised position. Compare the total lift recorded on the indicator with specifications. Continue to rotate the engine until the indicator reads zero. This later step is a check on the accuracy of the original indicator reading.

## 7. CRANKSHAFT AND MAIN BEARINGS

The crankshaft is supported by five main bearings in 8-cylinder engines and by four main bearings in the 6-cylinder engine. Crankshaft end play in all engines is controlled by the No. 3 main bearing flanges.

### Crankshaft

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

**CLEANING AND INSPECTION.** Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Inspect main and connecting rod journals for cracks, pits, grooves, or scores. Dress minor imperfections on severely marred journals. Check each journal in at least four

places to determine out-of-round, taper, or undersize condition (Fig. 25).

The recommended limits for main and connecting rod journals are: 0.00025-inch out-of-round (wear limit 0.005 inch), and 0.0005-inch taper (wear limit 0.001 inch). If the journals approach the wear limits, they should be reground to size for the next undersize bearing.

**CRANKSHAFT END PLAY.** Force the crankshaft toward the rear of the engine. Install a dial indicator so the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Fig. 26). Set the dial on zero, then push the crankshaft forward and note the reading on the dial. The end play limits are 0.004-0.008 inch for the 6-cylinder engine



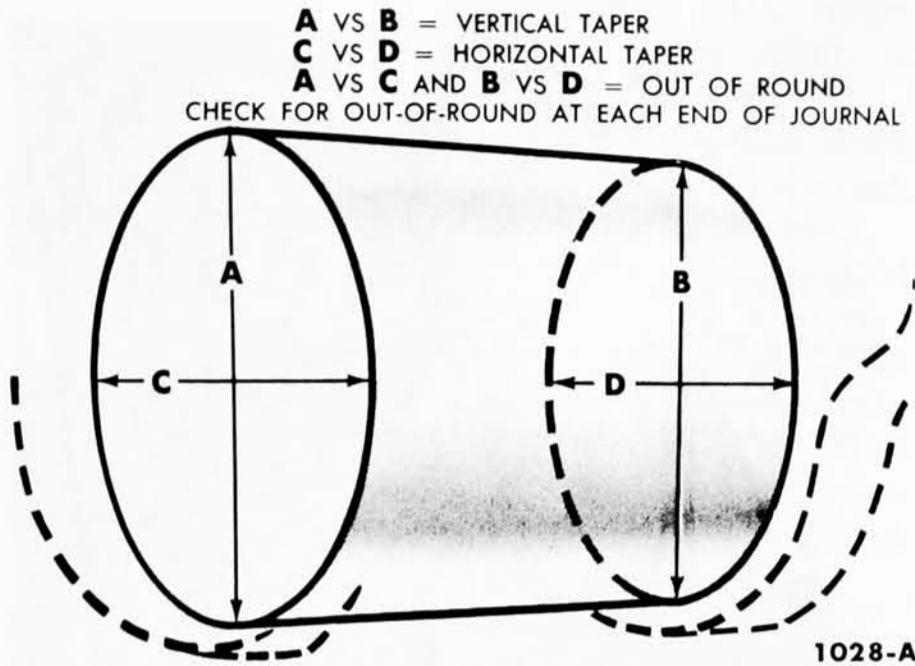


Fig. 25—Crankshaft Journal Measurements

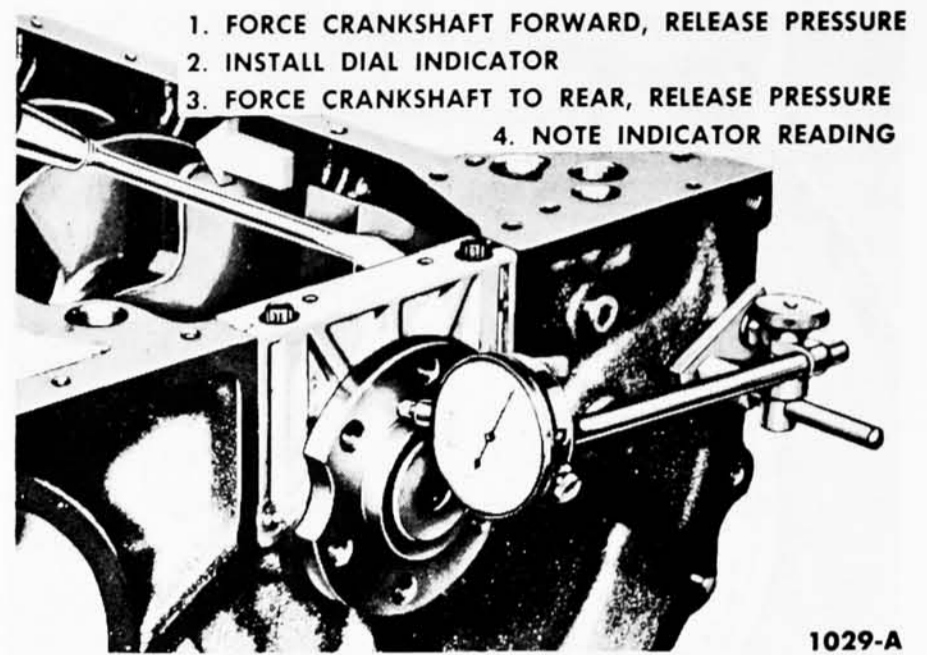


Fig. 26—Crankshaft End Play

(wear limit 0.012 inch) and 0.002-0.006 inch for the 8-cylinder engine (wear limit 0.010 inch).

If the end play approaches 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 dirt. If the thrust faces are not defective or dirty, they probably were not aligned properly. Install the thrust bearing and align the faces following the recommended procedure, then recheck the end play.

**REFINISHING JOURNALS.** Regrind the journal to give the proper clearance with the next undersize bearing. If the journal will not “clean up” to give the proper clearance with the 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 shaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After grinding, 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.

### Main Bearings

The main bearing inserts are selective fit and do not require reaming to size upon installation. *Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.*

Selective fit bearings are available for service in standard sizes only. Standard bearings are divided into two sizes and are identified by a daub of “red” or “blue” paint. *Red marked bearings increase the clearance; blue marked bearings decrease the clearance.* Undersize bearings, which are not selective fit, are available for use on journals that have been reground.

**CLEANING AND INSPECTION.** Clean the bearing inserts and cap thoroughly.

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced.

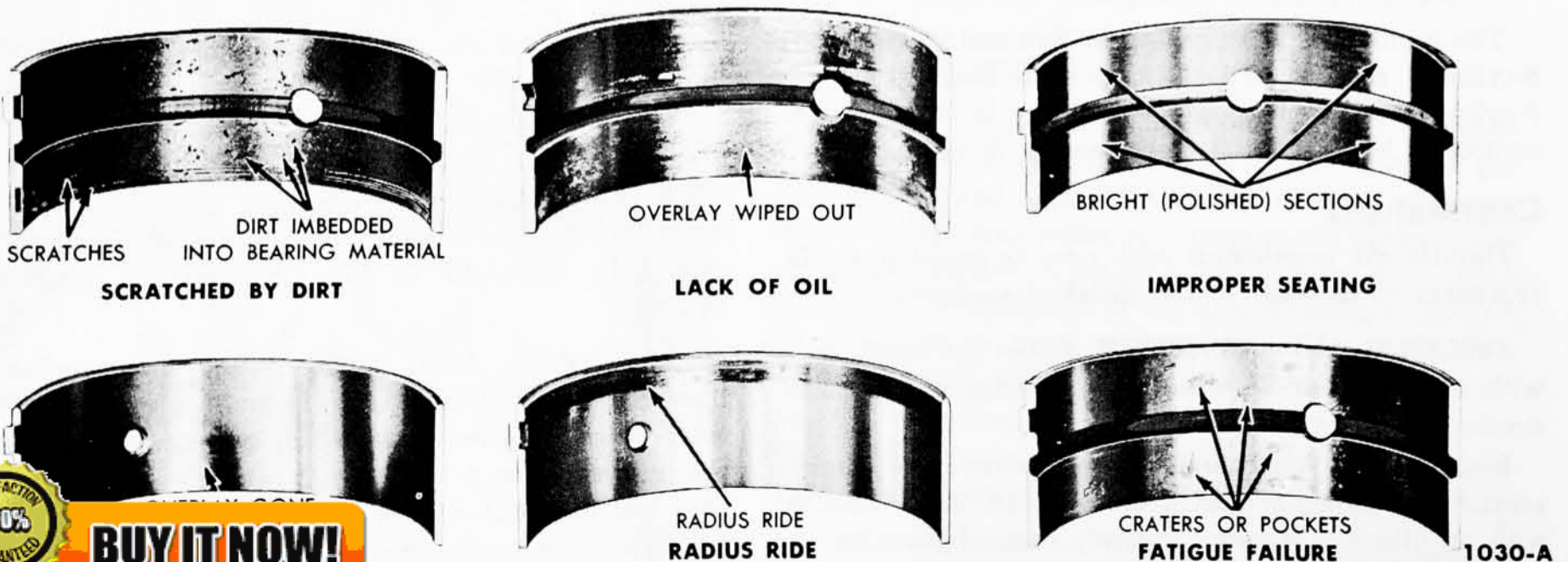


Fig. 27—Bearing Failures

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Typical examples of bearing failures and their causes are shown in Fig. 27. Check the clearance of bearings that appear to be satisfactory with Plastigage. Fit new bearings following the recommended procedure.

**CHECKING MAIN BEARING CLEARANCE**

**Engine On Workstand**

If the crankshaft has not been removed from the engine, check the clearance of one bearing at a time leaving the other bearings securely fastened.

1. Invert the engine, remove one bearing cap, then wipe all oil from the journal and bearing.

2. Place a piece of Plastigage on the crankshaft journal the full width of the bearing cap and about 1/4 inch off center (Fig. 28).

3. Install the cap and tighten the bolts to specifications. *Do not turn the crankshaft while the Plastigage is in place.*

4. Remove the cap, then using the Plastigage scale (Fig. 28) check the width of the Plastigage at the widest point in order to get the minimum clearance. Check the Plastigage at the narrowest point in order to get the maximum clearance. The difference between the two readings is the taper. If the clearance is not within limits, select fit a new bearing.

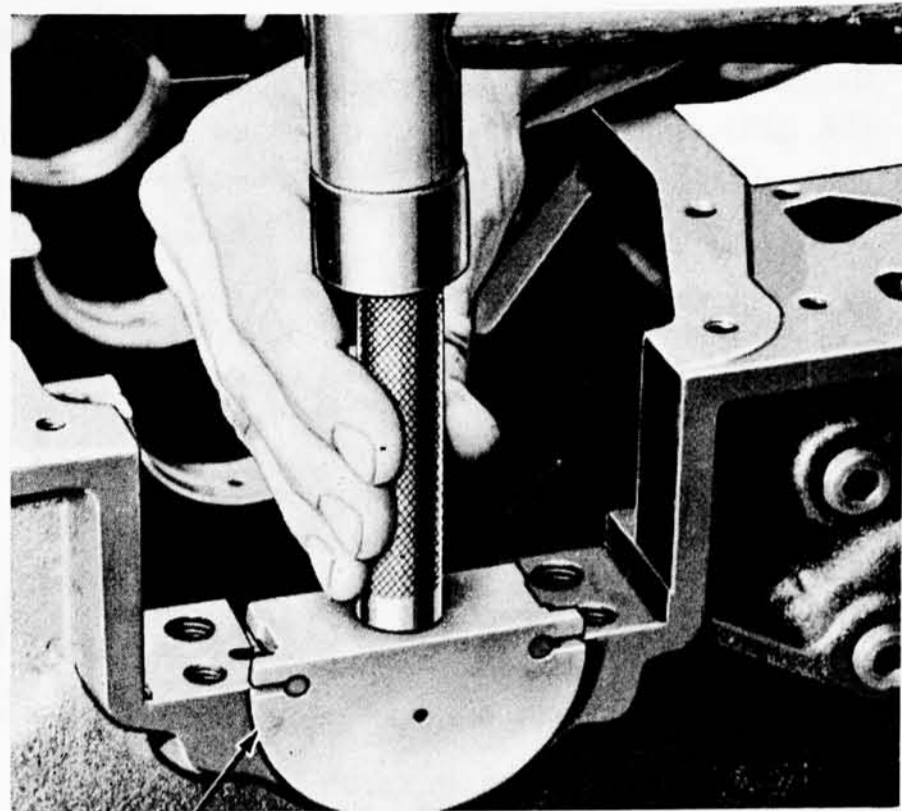
**Engine In Car**

Check the clearance of one bearing at a time, leaving the other bearings securely fastened.

1. Support the crankshaft so its weight will not compress the Plastigage and provide an erroneous reading. Position a small jack so it will bear against the counterweight adjoining the bearing which is being checked.

2. Follow steps 2-4 under "Checking Main Bearing Clearance—Engine on Workstand." In step 2, place the Plastigage on the bearing surface instead of on the journal.

**FITTING NEW BEARINGS.** *Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal, be sure to fit the bearing to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter with minimum clearance, inter-*



Tool—T52L-6701-AGD

1032-A

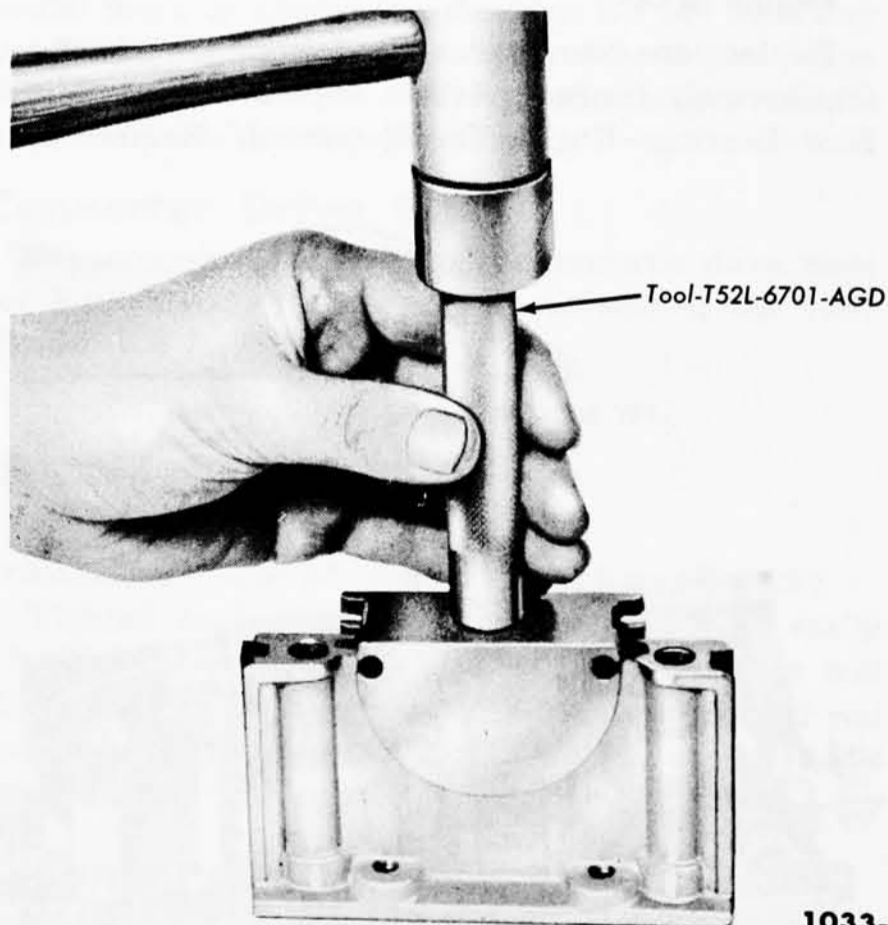
**Fig. 29—Seal To Block Installation**

*ference may result, causing an early failure. It is not recommended that bearings be fitted to a crankshaft journal which is more than 0.001 inch out-of-round.*

**Engine On Workstand**

If the crankshaft has not been removed from the engine, replace one bearing at a time leaving the other bearings securely fastened.

1. Invert the engine, remove the bearing cap and the



Tool—T52L-6701-AGD

1033-A

**Fig. 30—Seal To Retainer Installation—Typical**

PLACE PLASTIGAGE FULL WIDTH OF JOURNAL ABOUT 1/4 INCH OFF CENTER

CHECK WIDTH OF PLASTIGAGE

0.002" CLEARANCE

MEASURING PLASTIGAGE

1031-A

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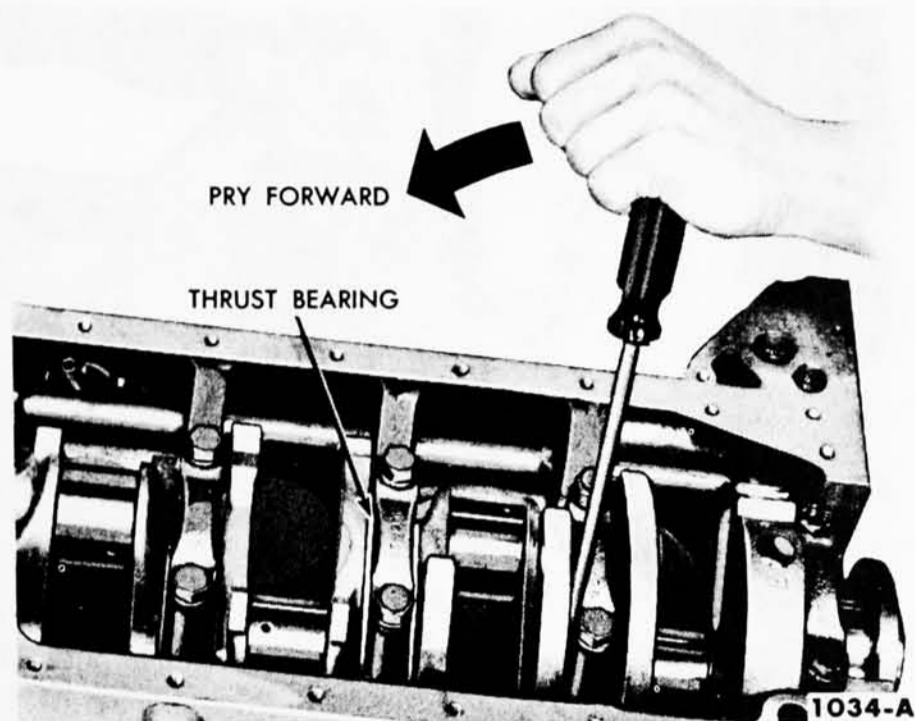


Fig. 31—Pry Crankshaft Forward

upper half of the bearing to which new bearings are to be fitted.

2. Install the new bearing inserts and check the clearance. *When replacing standard bearings, it is good practice to first try to obtain the proper clearance with two blue bearing halves.*

3. If the clearance is *less* than the specified limits, try two red bearing halves or a combination of red and blue.

4. If the standard bearings do not bring the clearance within the desired limits, *grind the crankshaft journal, then install undersize bearings.*

### Engine In Car

Replace one bearing at a time leaving the other bearings securely fastened. Follow steps 2-4 under "Fitting New Bearings—Engine On Workstand." Remember to



Pry Crankshaft Backward

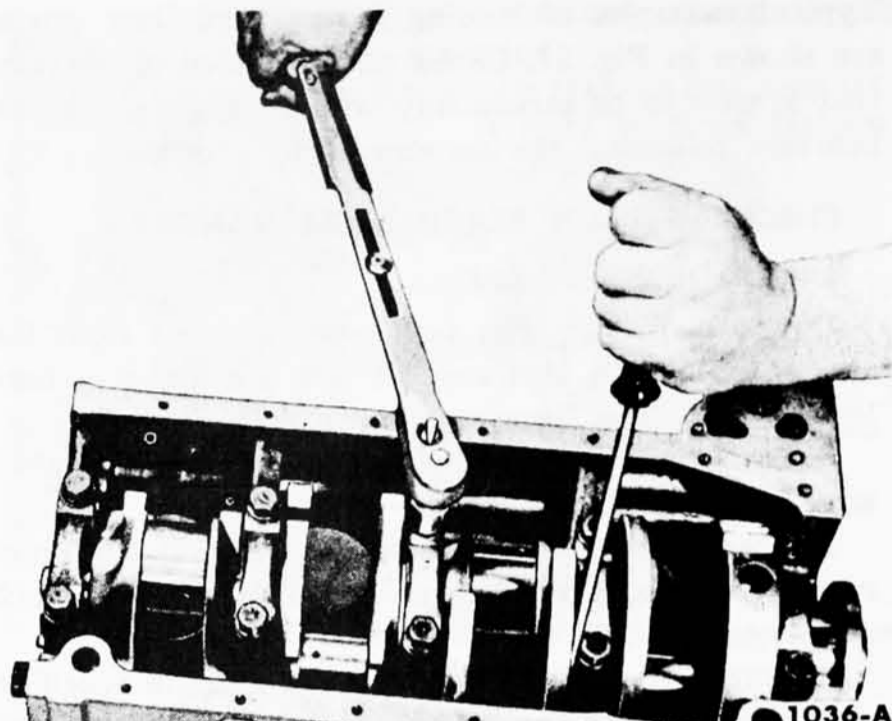


Fig. 33—Tighten Cap

support the crankshaft when checking the clearance of the new bearings.

## Rear Main Bearing Oil Seal Replacement

1. Remove the oil seals from the cylinder block and seal retainer or bearing cap. Clean the seal grooves.

2. Install the new seal in the cylinder block (Fig. 29). After installation, cut the seals flush without any frayed edges overlapping.

3. Install the new journal seal in the retainer or bearing cap (Fig. 30). After installation cut the seals flush.

4. Coat the rear oil seal retainer to block mating face with sealer, install the retainer and tighten the bolts to 23-28 foot-pounds torque.

5. Dip the retainer side seals in light engine oil, then immediately install them in the grooves. It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends. *Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion.*

6. Check the retainer or bearing cap side seals for leaks by squirting a few drops of oil into the parting lines between the cap or retainer and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. *The above test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.*

## Thrust Bearing Alignment

1. Install all the main bearing caps, except the thrust bearing cap, and tighten the bolts to specifications.

2. Install the thrust bearing cap with the bolts finger-

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tight, then pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 31).

3. Hold the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 32). This will align the

thrust surfaces of both halves of the bearing.

4. Retain the forward pressure on the crankshaft, and tighten the cap bolts to specifications (Fig. 33).

5. Check the crankshaft end play (page 1-19).

## 8. FLYWHEEL

### Conventional Flywheel

The flywheel and ring gear are a shrink fit and are replaceable as separate parts.

**INSPECTION.** Inspect the flywheel for cracks, heat check, or other defects 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.

**FLYWHEEL FACE RUNOUT.** Install a dial indicator so that the indicator point bears against the flywheel face (Fig. 34). 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 runout exceeds 0.010 inch, 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 face if the mounting flange runout is excessive.

**RING GEAR REPLACEMENT.** Heat the defective ring gear with a blow torch on the engine side of the gear, then knock it off the flywheel. *Do not hit the flywheel when removing the ring gear.*

Heat the new ring gear evenly until the gear expands enough to slip onto the flywheel. Make sure the gear is

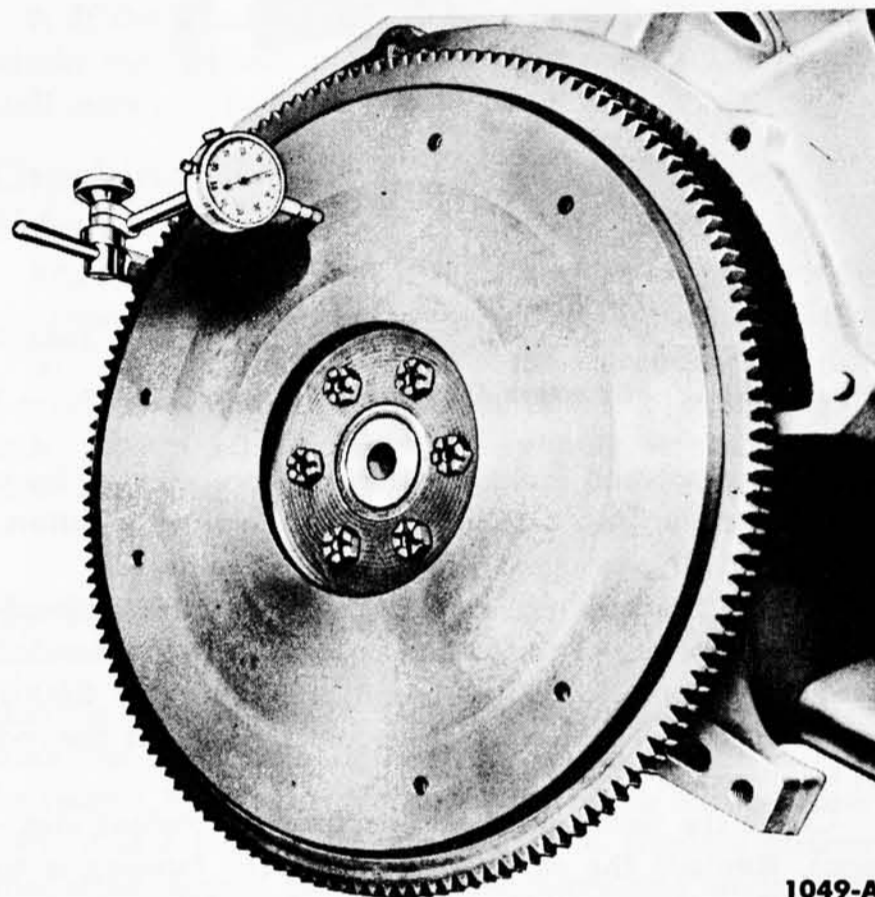


Fig. 34—Flywheel Face Runout—Typical

seated properly against the shoulder. *Do not heat any portion of the gear to a temperature higher than 500°F. If this limit is exceeded, the temper will be removed from the ring gear teeth.*

### Converter Drive Plate

The procedure for checking the converter drive plate for Fordomatic equipped cars is covered in the 1957 Fordomatic Shop Manual.

## 9. CONNECTING RODS AND BEARINGS

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 the pin boss side of the piston usually indicates that a connecting rod is bent or the pin hole is not in proper relation to the piston (Fig. 35).

Bearing wear can be caused by an improperly machined

crankpin, or a tapered connecting rod bore (Fig. 36).

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 rod assembly and may be the cause of excessive oil consumption.

### Cleaning and Inspection

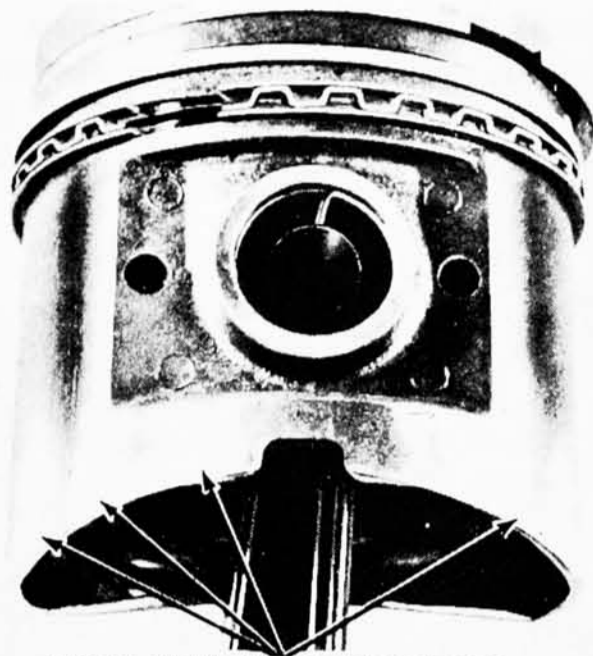
Remove the bearings from the rod and cap (identify them if they are to be used again). Clean the connect-

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PISTON WEAR CAUSED BY BENT ROD OR MISALIGNED PISTON PIN HOLE

1045-A

**Fig. 35—Wear Pattern On Piston Pin Boss Surface**

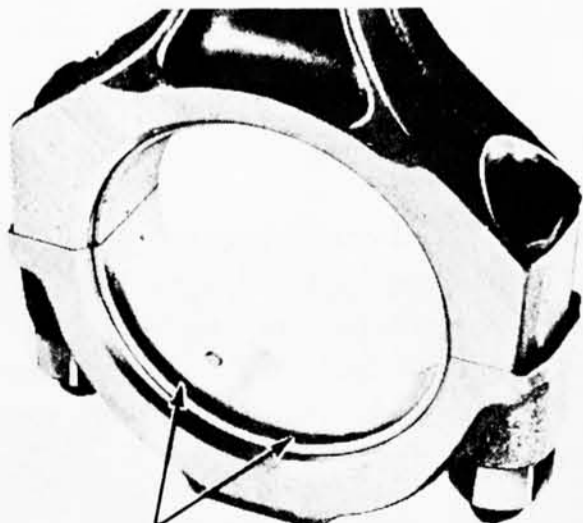
ing rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

Inspect the rods for signs of fractures and the bearing bores for out-of-round and taper. The recommended maximum limit for out-of-round and taper are 0.0004 inch. If the bore exceeds these limits and/or if the rod is fractured, it should be replaced.

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 over-size pin.

Replace defective connecting rod nuts and bolts.

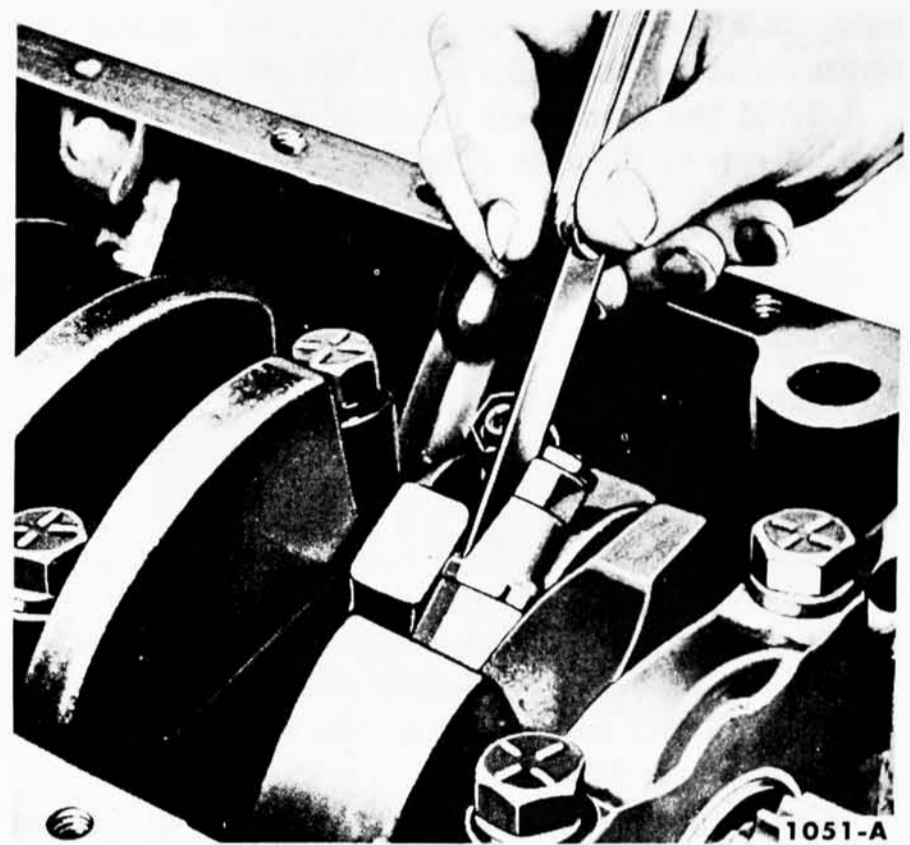
Inspect each connecting rod crankshaft journal for cracks, scratches, grooves, or scores. Dress minor imperfections with a smooth oilstone. Check each journal for out-of-round, taper, or undersize. If the journals exceed the maximum limits and/or if they are severely marred, they should be reground to size for the next undersize bearing.



WEAR CAUSED BY BENT ROD OR MISALIGNED PISTON PIN HOLE

1046-A

**Fig. 36—Wear Pattern On Crankshaft Journal**



**Fig. 37—Connecting Rod Side Clearance**

Inspect each bearing carefully. Replace bearings that have a scored, chipped, or worn surface. For the different types of bearing failures and their causes refer to Fig. 27. Check the clearance of bearings that appear to be satisfactory. Fit new bearings where necessary, following the recommended procedure.

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. The recommended maximum limit for twist total difference is 0.012 inch and 0.004 inch for bend total difference using an 8-inch arbor and measured on each side. If the bend and/or twist is excessive, the rod should be straightened or replaced.

## Checking Connecting Rod Bearing Clearance

1. Wipe all oil from the journal and bearing.
2. Place a piece of Plastigage on the lower bearing surface the full width of the cap and about  $\frac{1}{4}$  inch off center.
3. Install the cap and tighten the rod bolts to 45-50 foot-pounds torque. **Do not turn the crankshaft while the Plastigage is in place.**
4. Remove the cap, then using the Plastigage scale check the width of the Plastigage at the widest point in order to get the minimum clearance. Check the Plastigage at the narrowest point in order to get the maximum clearance. The difference between the two readings is the taper. If the clearance is not within limits, select fit a new bearing.

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## Fitting New Bearings

The connecting rod bearings are available for service in standard sizes and undersizes for use on journals that have been reground. Standard bearings are color coded red and blue. **Red marked bearings increase clearance; blue marked bearings decrease clearance.**

If the crankpin is out-of-round, be sure to fit the bearing to the maximum diameter of the crankpin. It is not recommended to use bearing shims of any type, or to file or lap the bearing caps in order to adjust the bearing clearance. When replacing standard bearings, it is good practice to first try to obtain the bearing clearance with two blue bearing halves.

1. Remove the rod cap, then remove the bearings from the cap and rod.
2. Clean the oil from the crankshaft journal, and the connecting rod bearing bores.
3. Install the upper bearing into the rod, then pull the rod assembly down firmly on the crankshaft journal.

Install the lower bearing in the rod cap. **When installing bearings, do not get dirt or other foreign matter under the inserts. In time, the dirt may distort the bearing and cause bearing failure.**

4. Check the bearing clearance.
5. If the clearance with two blue bearing halves is less than the specified limit try two red bearing halves or a combination of red and blue.
6. If the standard bearings do not bring the clearance within the desired limits, grind the crankpin, then install undersize bearings.

## Checking Connecting Rod Side Clearance

After the connecting rods are installed, check the side clearance between the connecting rods on each crankpin (Fig. 37). The recommended side clearance limits for 6-cylinder engines are 0.003-0.009 inch (wear limit 0.012 inch) or 0.006-0.016 inch on 8-cylinder engines (wear limit 0.019 inch).

## 10. PISTONS, PINS, AND RINGS

### Cleaning and Inspection

Remove carbon deposits from the piston surfaces and from the underside of the piston head. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean the ring grooves with a ring groove cleaner (Fig. 38). Make sure the oil ring slots (or holes) are clean.

Carefully inspect the pistons for fractures at the ring lands, skirt, 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.

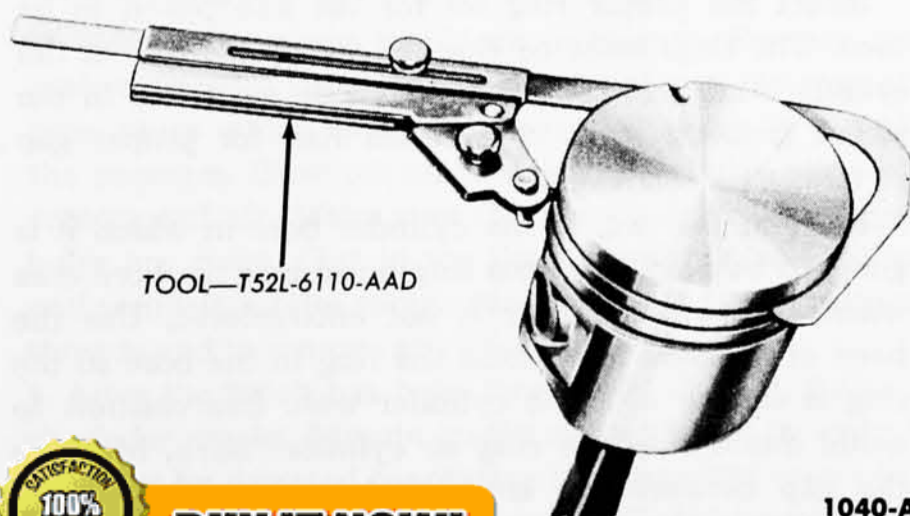
Spongy, eroded areas near the edge of the piston top are usually caused by detonation, or pre-ignition. A

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. The normal wear pattern of a piston is shown in Fig. 39. Replace pistons that show signs of excessive wear, wavy ring lands, fractures, and/or damage from detonation or pre-ignition.

Check the piston to cylinder bore clearance with a tension scale and ribbon and the ring side clearance following the recommended procedures.

Replace piston pins showing signs of fracture or etching and/or wear. Check the piston pin fit in the piston and rod bushing.

Replace all rings that are scored, chipped, or cracked.



Grooves—Typical

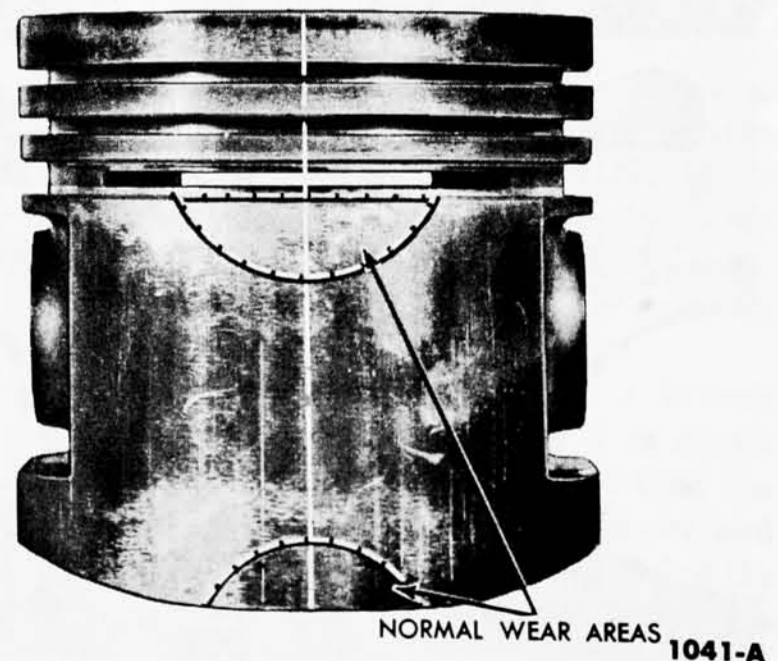


Fig. 39—Normal Piston Wear Pattern

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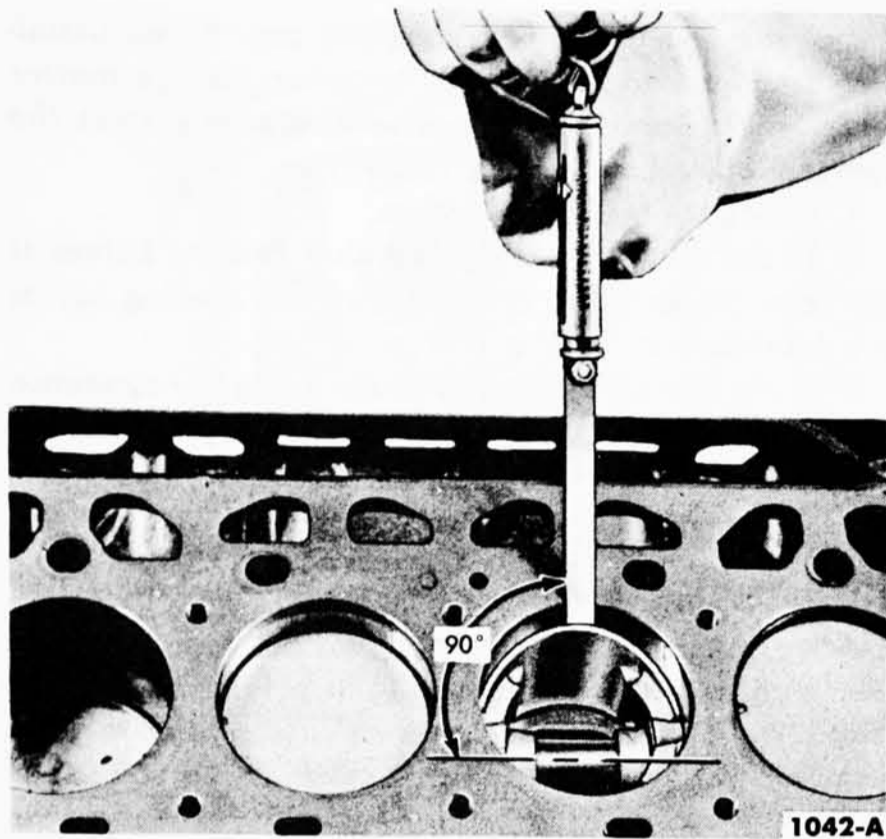
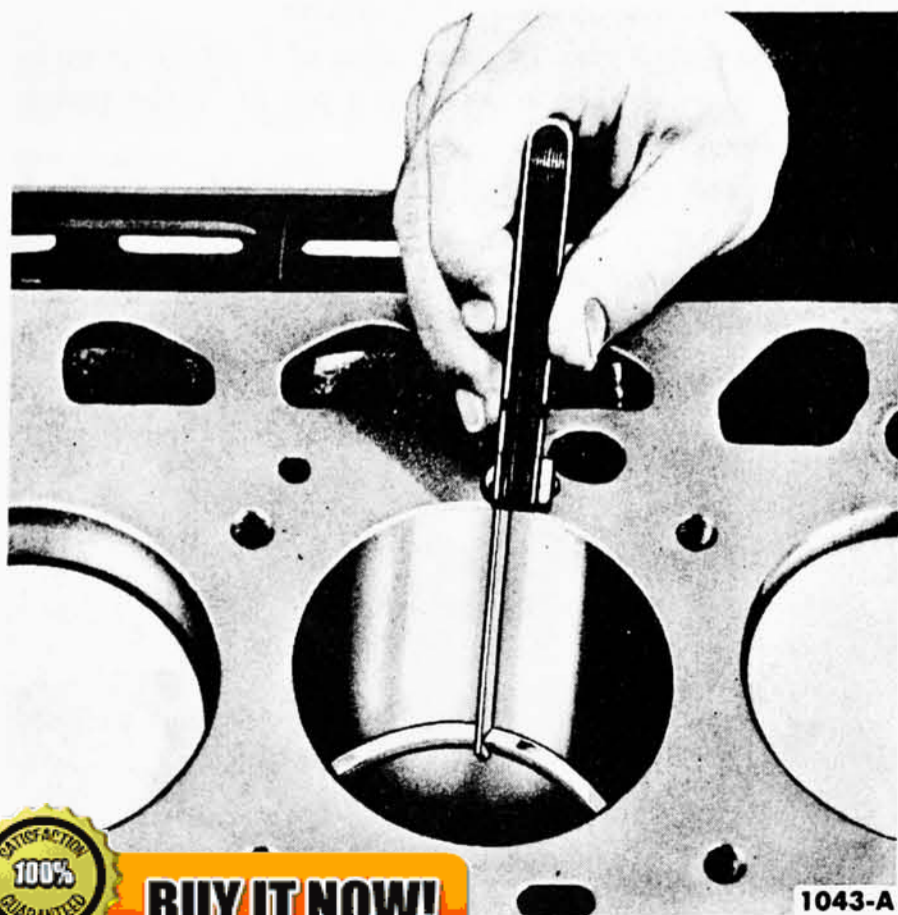


Fig. 40—Checking Piston Fit

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

## Fitting Pistons

Pistons are available for service in standard sizes and oversizes for use in cylinders that have been rebored. Pistons of 0.020, 0.030, 0.040, and 0.060-inch oversize



Typical Ring Gap—Typical

are available for most engines. Check the parts catalogue for sizes available.

The piston and cylinder block should be at room temperature (70°F) when the piston fit is checked. *After any refinishing operation, allow the cylinder bore to cool before the piston fit is checked.*

Calculate the size piston to be used by taking a bore check (Fig. 45), then select the proper size piston to provide the desired clearance.

Make sure the piston and cylinder bore are clean and dry. Attach a tension scale to the end of a feeler gauge ribbon that is free of dents or burrs. The feeler ribbon should be 1/2-inch wide and of the recommended thickness for the existing condition.

Position the ribbon in the bore so that it extends the entire length of the piston at 90° from the piston pin location. Invert the piston and install it in the bore so that the end of the piston is about 1 1/2 inches below the top of the block and the piston pin is parallel to the crankshaft axis.

Hold the piston and slowly pull the scale in a straight line with the ribbon, noting the pull required to remove the feeler ribbon (Fig. 40).

If the pull is within limits for the existing condition, the piston fit is satisfactory.

If the scale reading is greater than the maximum allowable pull, recheck calculations to be sure that the proper size piston has been selected, check for a damaged piston, then try a new piston.

If the scale reading is less than the minimum allowable pull, recheck calculations before trying another piston. If none can be fitted, refinish the cylinder for the next size piston.

*When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.*

If the taper and out-of-round conditions of the cylinder bore are within limits, new piston rings will give satisfactory service provided the piston clearance in the cylinder bore is within limits. If the new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall "glaze."

Select the proper ring set for the size piston to be used. The rings must be checked for proper gap in the cylinder bore and for the proper side clearance in the piston grooves. First, check each ring for proper gap as follows:

Position the ring in the cylinder bore in which it is going to be used. Push the ring down into the bore area where normal ring wear is not encountered. Use the head of a piston to position the ring in the bore so the ring is square with the cylinder wall. *Use caution to avoid damage to the ring or cylinder bore.* Measure the gap between the ends of the ring with a feeler gauge (Fig. 41). The gap should be within the limits of 0.010-0.027 inch for both compression rings (223, 272,

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292 cubic inch engines) or 0.012-0.029 (312 cubic inch engines). The gap of the steel rail sections of the oil ring should be within 0.015-0.062 inch.

If the gap is less than the lower limit, try another ring set.

After the gap has been checked, install the rings on the piston according to the instructions on the piston ring package using the approved tool. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Fig. 42). 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.* The gauge should slide freely around the entire ring circumference without binding. Because the recommended clearance limits vary according to the engine, refer to the specifications for the proper limits.

### Fitting Piston Pins

The piston pin fit should be a light thumb press fit at normal temperature (70°F). Standard piston pins are color coded green. Pins of 0.001 inch oversize (color coded blue) and 0.002 inch oversize (color coded yellow) are available.

If the pin hole in the piston must be reamed, use an expansion-type, piloted reamer. Place the reamer in a vise and revolve the piston around the reamer. Set the reamer to the size of the pin bore, then expand the reamer slightly and trial ream the pin bore. Take a light cut. Use a pilot sleeve of the nearest size to maintain alignment of the bores.

Check the hole size, using the new piston pin. If the bore is small, expand the reamer slightly and make



Fig. 42—Checking Ring Side Clearance—Typical

another cut. Repeat the procedure until the proper fit is obtained. Check the fitted piston pin for fit in the respective rod bushing. If necessary, ream or hone the bushing to fit the pin.

Install the piston pin in the piston and rod. Install a new retainer at each end of the pin to hold it in place. When the retainers are installed, make sure they are properly seated in the grooves provided in the piston pin bore.

## 11. CYLINDER BLOCK

During the disassembly of the cylinder block for engine overhaul, closely inspect the wear pattern on all parts to help diagnose the cause of wear.

### Cleaning and Inspection

Thoroughly clean the block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs which 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 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.

After the block has been thoroughly cleaned, make a check for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a solution of 1 part red lead and 75% light motor oil. Immediately apply a coating of

zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches, and scores. Remove minor imperfections with an oil stone. Check the flatness of the cylinder block gasket surface following the procedure and specifications recommended for the cylinder head (page 1-11).

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

To remove an expansion type plug, drill a 1/2-inch hole in the center of the plug and remove it as shown in Fig. 43. Clean the plug recess thoroughly. Coat the flange of the new plug with water resistant sealer and install it with the flange facing out (Fig. 44). Drive the plug in until the flange is flush or slightly below the casting surface.

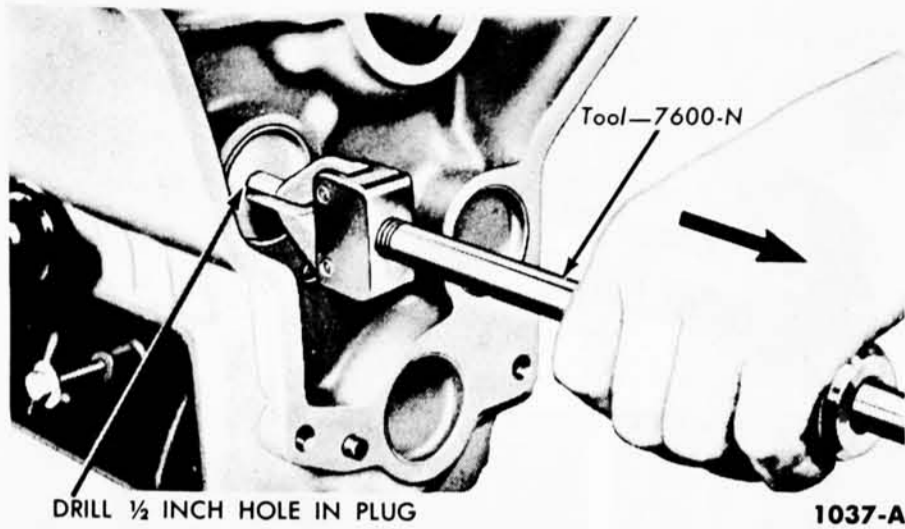
Inspect the cylinder walls for scoring, roughness, or

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**Fig. 43—Expansion-Type Plug Removal**

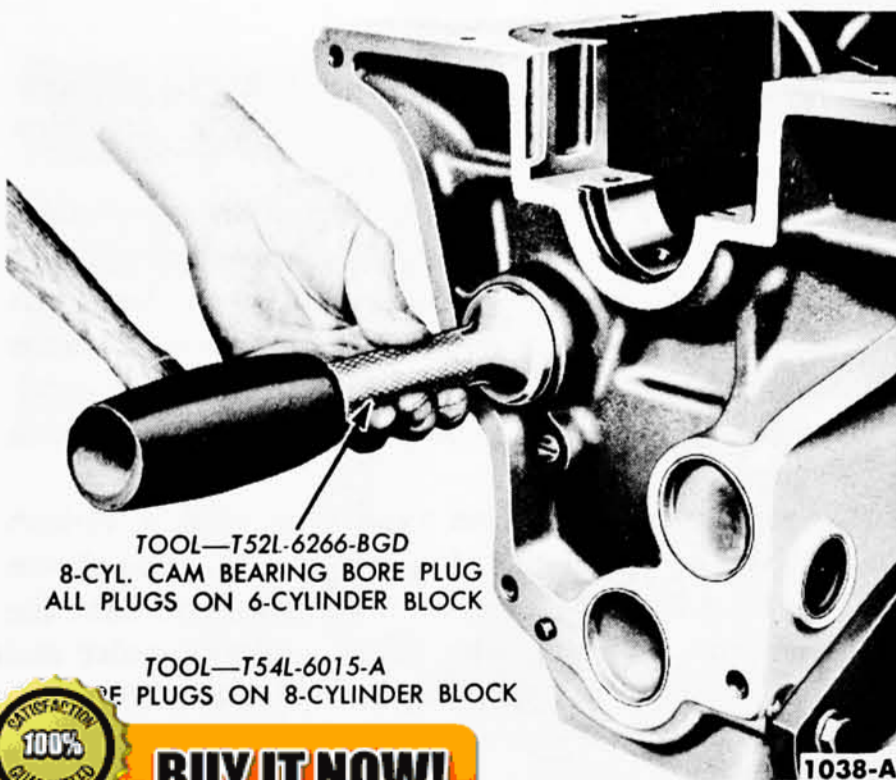
other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle, and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Fig. 45).

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

If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder wall and installing new service piston rings providing the piston clearance is within limits. Use the finest grade of honing stone for this operation.

### Refinishing Cylinder Walls

Honing is recommended for refinishing cylinder walls only when the walls have minor imperfections, such as light scuffs, scratches, etc. The grade of hone to be used



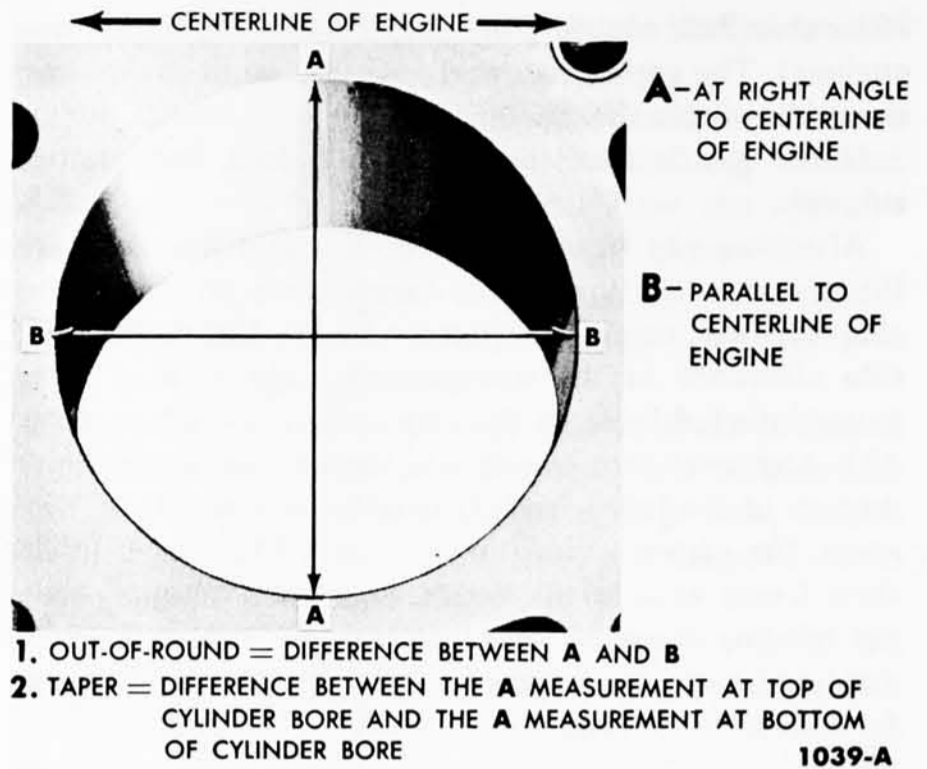
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the Plug Installation



**Fig. 45—Cylinder Bore Out-Of-Round And Taper**

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 rebored. Before any cylinder is rebored, 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 boring operation.

Rebore only the cylinder or cylinders that require it. *All pistons are the same weight, both standard and oversize; therefore, various sized pistons can be intermixed without upsetting engine balance.*

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

Rebore 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 the correct surface finish and pattern are obtained. Use clean sharp hones of No. 220-280 grit for this operation.

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

After the final operation in either of the two refinishing methods described above and prior to checking the piston fit, thoroughly wash the cylinder walls with solvent to remove all abrasive particles, then thoroughly dry. Check the piston fit (page 1-26). 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 fitted, thoroughly clean the entire block to remove all particles from the bearing bores, oil passages, head bolt holes, etc. Coat the cylinder walls with oil.

### Cylinder Wall "Glaze" Removal

When new piston rings are installed in a cylinder that

has not been refinished, remove the glaze from the cylinder walls to aid in ring seating.

Take all the necessary precautions to catch the grit. Pass a fine grit hone or glaze removal tool through the bore a few times. Do not hone more than enough to rough up the finish. Thoroughly clean the cylinder walls and block after the glaze is removed, then oil the walls.

## 12. OIL PAN AND OIL PUMP

### Oil Pan

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 matter is removed from below the baffle plate.

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

Repair any damage, or replace the pan if repairs cannot be made.

### Rotor-Type Oil Pump (8-Cylinder Engine)

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

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

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

Measure the outer race to housing clearance (Fig. 46). The clearance should be from 0.006-0.009 inch.

With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance between the straight edge and the rotor and outer race (Fig. 47). The recommended limits are 0.001-0.0035.

*The outer race, shaft and rotor are replaceable only as an assembly.*

Check the drive shaft to housing bearing clearance by measuring the O. D. of the shaft and the I. D. of the housing bearing. The recommended clearance limits are 0.0015-0.0029 inch.

Inspect the relief valve spring for a collapsed or worn condition.

Check the spring tension. The spring should exert 10.4 pounds at 0.80 inch. Check the spring specifications and/or

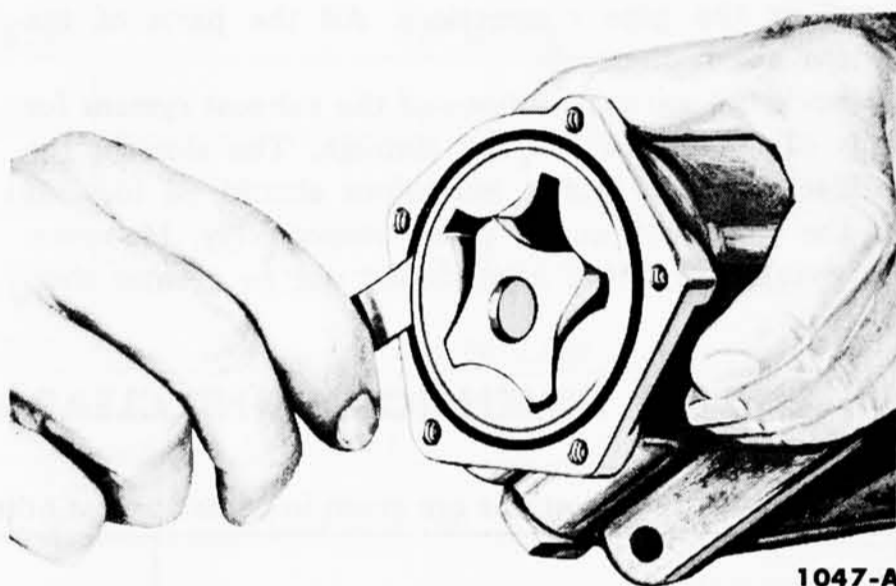


Fig. 46—Outer Race To Housing Clearance

the spring is defective, replace the spring.

Check the relief valve piston for scores and free operation in the bore. The specified piston clearance is 0.0015-0.0029 inch.

### Gear-Type Oil Pump (6-Cylinder Engine)

Wash all parts in a solvent and dry them thoroughly. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and chips are removed. Remove old gasket material from

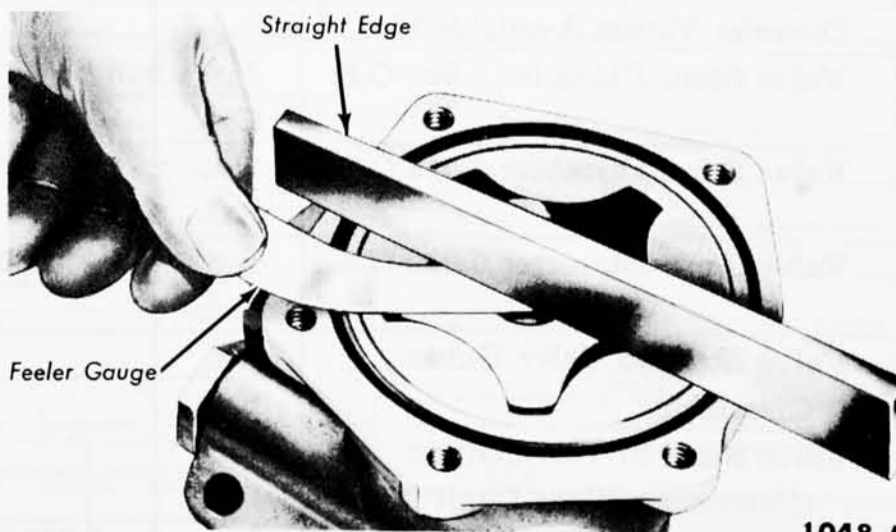


Fig. 47—Rotor End Play

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the pump body and cover.

Inspect the pump body and the gear teeth for damage or wear. Check the gear end clearance with a dial indicator or Plastigage. The Plastigage method is as follows:

Position the gasket on the housing, then place Plasti-

gase on the gears and install the cover. Remove the cover and check the Plastigage reading.

Check the gears for freedom of rotation. Check the compression of the oil pressure relief valve spring and check the clearance of the relief valve in the valve chamber.

### 13. EXHAUST SYSTEM

The exhaust system must be free of restrictions, leaks and excessive vibration. Leaks can usually be detected visually, or in some cases, a whistling noise may be heard at the pipe connections. All the parts of the system are replaceable.

Check the various sections of the exhaust system for signs of leaking or burning through. The slots in the muffler inlet and outlet extensions should be blocked by the inlet and outlet pipes, respectively. However, the overlap in either case should not be greater than

1 $\frac{3}{4}$  inches. To correct leakage at the muffler connections, position the inlet and outlet pipes as outlined in the respective engine chapter. Replace all sections that show signs of burning through.

Check for possible interference between the outlet pipe "kick-up" and the floor pan. If the clearance is insufficient, reposition the outlet pipe in the muffler.

Exhaust system vibrations are usually caused by broken or improperly aligned clamps. Align or replace clamps as necessary.

### 14. ENGINE DIMENSIONS, AND CLEARANCE AND ADJUSTMENT SPECIFICATIONS

NOTE: All specifications are given in inches unless otherwise noted.

Item	Engine Cubic Inch Displacement			
	223	272	292	312
<b>CYLINDER HEAD</b>				
Gasket Surface Flatness	0.003 in any 6 inches or 0.006 inch overall			
Valve Guide Bore Diameter (Int. & Exh.)	0.3433-0.3440			
Valve Seat Width	Int.	0.060-0.080		
	Exh.	0.070-0.090		
Valve Seat Angle	45°			
Valve Seat Runout—Maximum	0.002			
Valve Seat Runout—Wear Limit	0.0025			
<b>VALVE MECHANISM</b>				
Valve Lash (Cold) Int. & Exh.	0.019	0.020		
Valve Lash (Hot) Int. & Exh.	0.019			
Valve Stem Diameter—Standard	Int.	0.3416-0.3423		
	Exh.	0.3403-0.3410		
Oversize Valves Available (Int. & Exh.)	0.003, 0.015, 0.030			
Valve Stem Diameter 0.003 O.S.	Int.	0.3445-0.3455	0.3446-0.3453	
	Exh.	0.3435-0.3445		
Valve Stem Diameter 0.015 O.S.	Int.	0.3565-0.3575	0.3566-0.3573	
	Exh.	0.3555-0.3565		
Valve Stem Diameter 0.030 O.S.	Int.	0.3715-0.3725	0.3716-0.3723	
	Exh.	0.3705-0.3715		
Valve Stem to Valve Guide Clearance	Int.	0.001-0.0024		
	Exh.	0.0023-0.0037		
Valve Stem to Valve Guide Clearance—Wear Limit	Int.	0.0045		
	Exh.	0.0065		
Valve Stem to Valve Guide Clearance—Wear Limit	Int.	1.775-1.785	1.920-1.930	
	Exh.	1.505-1.515		



Item	Engine Cubic Inch Displacement			
	223	272	292	312
<b>VALVE MECHANISM (Cont'd)</b>				
Valve Seat Face Runout (Int. & Exh.)—Maximum	0.0015			
Valve Seat Face Runout (Int. & Exh.)—Wear Limit	0.002			
Int. Valve (Opens) Tappet Lift @ Degrees B.T.C.	17° @ 0.016	18° @ 0.015		
Int. Valve (Closes) Tappet Lift @ Degrees A.B.C.	53° @ 0.019	58° @ 0.015		
Exh. Valve (Opens) Tappet Lift @ Degrees B.B.C.	61° @ 0.016	66° @ 0.013		
Exh. Valve (Closes) Tappet Lift @ Degrees A.T.C.	9° @ 0.019	10° @ 0.016		
Int. Valve (Opens) Tappet Lift @ Degrees A.T.C.	25° @ 0.100	22° @ 0.100		
Int. Valve (Closes) Tappet Lift @ Degrees A.B.C.	11° @ 0.100	18° @ 0.100		
Exh. Valve (Opens) Tappet Lift @ Degrees B.B.C.	21° @ 0.100	27° @ 0.100		
Exh. Valve (Closes) Tappet Lift @ Degrees B.T.C.	33° @ 0.100	29° @ 0.100		
Valve Spring Free Length (Approximate)	2.09			
Valve Spring Out of Square (Maximum)	0.062			
Valve Spring Pressure (Lbs.) @ Specified Length (Valve Closed)	71-79 @ 1.780			
Valve Spring Pressure (Lbs.) @ Specified Length (Valve Closed)—Wear Limit	64 @ 1.780			
Valve Spring Pressure (Lbs.) @ Specified Length (Valve Open)	161-177 @ 1.390			
Valve Spring Pressure (Lbs.) @ Specified Length (Valve Open) Wear Limit	145 @ 1.390			
Valve Push Rod Length	9.62	7.98		
Valve Push Rod Runout (Maximum)	0.020			
Valve Tappet Diameter (Standard)	0.4989-0.4995			
Valve Tappet to Tappet Bore Clearance	0.0005-0.0021			
Valve Tappet to Tappet Bore Clearance—Wear Limit	0.0026			
Rocker Arm to Rocker Shaft Clearance	0.002-0.004			
Rocker Arm to Rocker Shaft Clearance—Wear Limit	0.006			
Rocker Arm Shaft O.D.	0.780-0.781			
Rocker Shaft Bore Diameter	0.783-0.784			
<b>CAMSHAFT AND TIMING CHAIN</b>				
Journal Diameter (Standard)	1.9255-1.9265			
Journal Runout (Maximum)	0.005			
Journal to Bearing Clearance	0.001-0.003			
Journal to Bearing Clearance—Wear Limit	0.006			
Undersize Bearing Available	0.015			
Camshaft Timing Sprocket Front Face Runout (Assembled) Maximum	0.008			
Timing Chain Deflection	1/2			
Camshaft Lobe Lift	Int.	0.273	0.272	
	Exh.	0.273	0.285	
Loss Int. & Exh.	0.005			



Item	Engine Cubic Inch Displacement			
	223	272	292	312
<b>FLYWHEEL</b> Con. and Overdrive Trans. Assembled Flywheel Clutch Face Runout (Max.)	0.010			
<b>CRANKSHAFT</b> Main Bearing Journal Dia. (Standard)	2.4980-2.4988			2.6235-2.6243
Main Bearing Journal Runout—Maximum	0.002	0.001		
Main Bearing Journal Runout—Wear Limit	0.004	0.003		
Connecting Rod and Main Bearing Journal Out-of-Round—Maximum	0.00025			
Connecting Rod and Main Bearing Journal Out-of-Round—Wear Limit	0.0005			
Connecting Rod and Main Bearing Journal Taper—Maximum	0.0005			
Connecting Rod and Main Bearing Journal Taper —Wear Limit	0.001			
Thrust Bearing Journal Length	1.359-1.361	1.124-1.126		
Main Bearing Journal Thrust Face Runout	0.001			
Connecting Rod Journal Diameter	2.2980-2.2988	2.1880-2.1888		
Crankshaft Free End Play	0.004-0.008	0.002-0.006		
Crankshaft Free End Play—Wear Limit	0.012	0.010		
Crankshaft (Flywheel Contact Face) Runout (Maximum)	0.002			
Crankshaft Sprocket Contact Face Runout (Maximum)	0.001			
<b>MAIN BEARINGS</b> Undersize Bearings Available	0.010, 0.020, 0.030			0.010, 0.020, 0.030, 0.040
Journal Clearance (Copper Lead)	0.0005-0.0025	0.006-0.0032		0.0008-0.0026
Journal Clearance—Wear Limit (Copper Lead)	0.0035	0.0042		0.0036
Bearing Wall Thickness— Copper Lead	Red	0.0958-0.0963	0.0955-0.0960	0.0951-0.0956
	Blue	0.0962-0.0967	0.0959-0.0964	0.0955-0.0960
Thrust Bearing Flange Length (Copper Lead)	1.353-1.355	1.120-1.122		1.118-1.120
Journal Clearance (Lead Babbit)	0.0005-0.0021			
Journal Clearance (Lead Babbit)— Wear Limit	0.0031			
Bearing Wall Thickness (Lead Babbit)	Red	0.09585-0.09625	0.09555-0.09595	
	Blue	0.09625-0.09665	0.09595-0.09635	
Thrust Brg. Flange Width—Lead Babbit	1.353-1.355	1.120-1.122		
<b>CONNECTING ROD</b> Piston Pin Bushing I.D. (Standard)	0.9122-0.9125			
Piston Pin Bushing Out-of-Round (Maximum)	0.0003			
Piston Pin Taper (Maximum)	0.0003			
Bearing Bore Diameter	2.4230-2.4238	2.3120-2.3128		
Bearing Bore Out-of-Round (Maximum)	0.0004			
Bearing Bore Taper (Maximum)	0.0004			
Bearing Bore Length	1.244-1.245	0.871-0.873		
Connecting Rod Length (Center to Center)	6.258-6.262	6.320-6.324	6.320-6.324	
Connecting Rod—Twist Total Difference	0.012			
Connecting Rod—Total Difference	0.004			



Item	Engine Cubic Inch Displacement			
	223	272	292	312
<b>CONNECTING ROD (Cont'd)</b>				
Connecting Rod Assembly (Assembled to Crankshaft) Side Clearance	0.003-0.009	0.006-0.016		
Connecting Rod Assembly (Assembled to Crankshaft) Side Clearance—Wear Limit	0.012	0.019		
*Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8 inches long bar measured 4 inches on each side of rod.				
<b>CONNECTING ROD BEARINGS</b>				
Undersize Bearings Available	0.010, 0.020, 0.030			
Bearing to Crankpin Clearance	0.0004-0.0023	0.0008-0.0027	0.0007-0.0026	
Bearing to Crankpin Clearance—Wear Limit	0.0033	0.0037	0.0036	
Bearing Wall Thickness—Red	0.06166-0.06205	0.06095-0.06145		0.07495-0.07545
	Blue	0.06195-0.06245	0.06135-0.06185	
<b>PISTON</b>				
Piston Dia. St'd—Spread for 8 grades	3.6241-3.6265		3.7491-3.7515	3.7990-3.8014
Oversize Pistons Available	0.020, 0.030, 0.040, 0.060			0.020, 0.030, 0.040
Piston to Bore Clearance—Bottom of Skirt	0.0009-0.0015			
Piston to Bore Clearance—Bottom of Skirt—Wear Limit	0.0045			
Top of Piston to Top of Cylinder Bore Clearance (Piston @ T.D.C.)	0.0235-0.0415	0.019-0.031		0.010-0.026
Fitting New Piston in New Bore	Gauge Size	0.0015 x 0.5		
	Pounds Pull	5-10		
Fitting New Piston in Used Bore	Gauge Size	0.002-0.5		
	Pounds Pull	5-10		
Fitting Used Piston in Used Bore	Gauge Size	0.0025 x 0.5		
	Pounds Pull	5-10		
<b>PISTON PIN</b>				
Piston Pin Diameter Standard (Color Coded Green)	0.9120-0.9123			
Oversize Pins Available	0.001, 0.002			
Piston Pin Diameter 0.001 O.S. (Color Coded Blue)	0.9130-0.9133			
Piston Pin Diameter 0.002 O.S. (Color Coded Yellow)	0.9140-0.9143			
Piston Pin Length	3.016-3.030			
Piston Pin to Piston Clearance (Loose)	0.0001-0.0003			
Piston Pin to Piston Clearance (Loose)—Wear Limit	0.0008			
Piston Pin to Connecting Rod Bushing Clearance (Loose)	0.0001-0.0003			
Piston Pin to Connecting Rod Bushing Clearance (Loose)—Wear Limit	0.0008			
<b>PISTON RINGS</b>				
Ring Width—Compression	Upper	0.0930-0.0935	0.0775-0.0780	
	Lower	0.0930-0.0935	0.0775-0.0780	0.0930-0.0940
Clearance—Compression	Upper	0.002-0.0035		
	Lower	0.002-0.0035		0.001-0.003



Item	Engine Cubic Inch Displacement			
	223	272	292	312
<b>PISTON RINGS (Cont'd)</b>				
Side Clearance—Compression— Upper & Lower—Wear Limit	0.006			
Piston Ring Gap Width—Compression (Upper and Lower)—Standard Bore	0.010-0.027			0.012-0.029
Piston Ring Gap Width—Oil (Steel Rails)	0.015-0.062			
Oversizes Available	0.020, 0.030, 0.040, 0.060			0.020, 0.030, 0.040
<b>CYLINDER BLOCK</b>				
Cylinder Bore Diameter Standard, spread for 8 grades	3.6250-3.6274		3.7500-3.7524	3.8000-3.8024
Minimum Cyl. Wall Thickness Std. Bore	0.170			0.145
Cylinder Bore Out-of-Round Maximum— New Bore	0.0005			
Cylinder Bore Out-of-Round—Wear Limit	0.005			
Cylinder Bore Taper Maximum—New Bore	0.001			
Cylinder Bore Taper—Maximum— Wear Limit	0.008			
Maximum Allowable O.S. Cyl. Bore	0.060			0.040
Head Gasket Surface Flatness	0.003 in any 6 inches or 0.006 inch overall			
<b>OIL PUMP (ROTOR TYPE)</b>				
Relief Valve Spring Tension (lbs) @ Specified Length	9.2-10.4 @ 0.80			
Drive Shaft to Housing Bearing Clearance	0.0015-0.0029			
Rotor Assembly End Clearance (Pump Assembled)	0.001-0.0035			
Outer Race to Housing—Radial Clearance	0.006-0.009			
Drive Shaft Length (Rotor Assembly Face to Shaft End)	3.36-3.38			
<b>OIL PUMP (GEAR TYPE)</b>				
Relief Valve Spring Tension (lbs.) @ Specified Length	9.76-9.84 @ 1.56			
Drive Shaft to Housing Bearing Clearance	0.0015-0.0029			
Gears End Clearance (Pump Assembled)	0.003-0.006			
Driven Gear to Shaft Clearance	0.001-0.002			
Gear to Housing Clearance	0.0015-0.006			



# Part 1—ENGINES

## Chapter 2

### 6-CYLINDER ENGINE

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The removal, disassembly, assembly, and installation procedures for the component parts of the 6-cylinder engine are covered in this chapter.

The cleaning, inspection, repair procedures, and engine overhaul instructions are covered in Chapter 1, "General Engine Service."

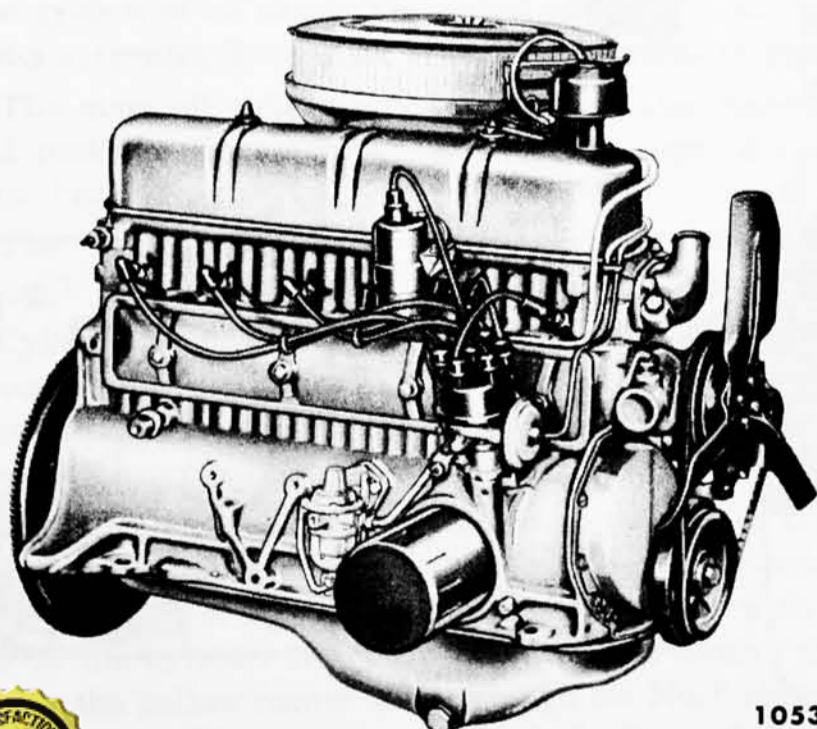
### 1. DESCRIPTION

The 6-cylinder, overhead valve engine (Figs. 1 and 2) has a displacement of 223 cubic inches with a bore of 3.62 inches and a stroke of 3.6 inches. The compression ratio is 8.6:1.

The cylinders are numbered from front to rear 1, 2, 3, 4, 5, and 6. The firing order is 1-5-3-6-2-4. The valves are arranged from front to rear—E-I-I-E-I-E-E-I-E-I-E.

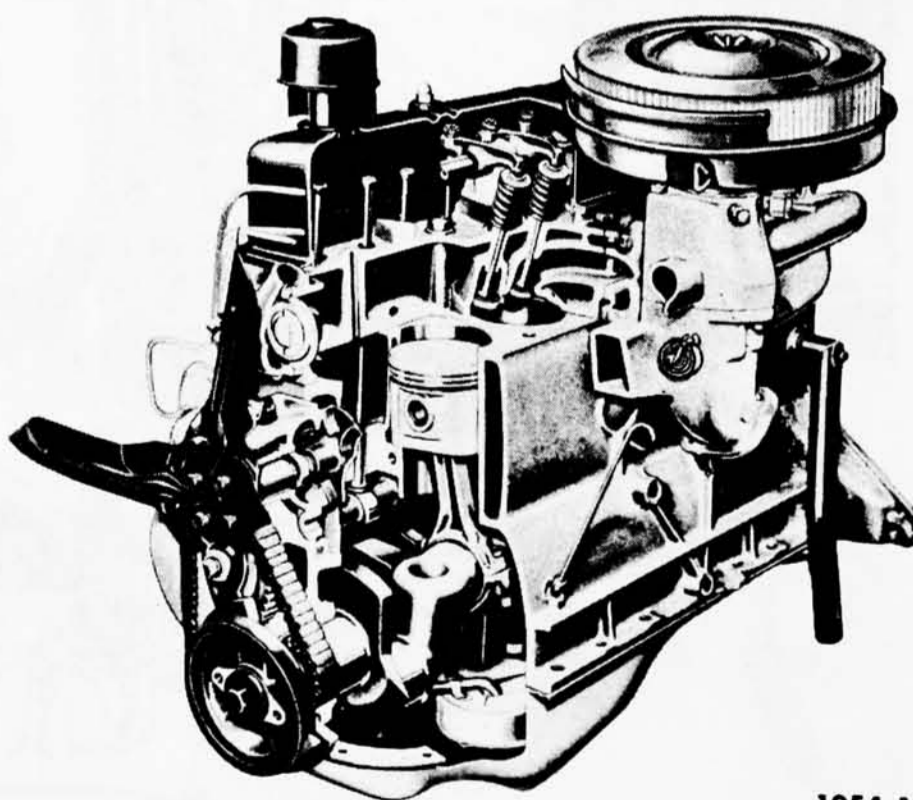
The cylinder head carries the valves, valve rocker

arm mechanism, manifold assembly, ignition coil, and the water outlet, thermostat and housing. Valve guides are cast integral in the head. Wedge-shaped, high turbulent combustion chambers provide a homogeneous mixture for efficient combustion.



1053-A

Fig. 1—223 Cubic Inch Engine— $\frac{3}{4}$  Right Front View



1054-A

Fig. 2—223 Cubic Inch Engine— $\frac{3}{4}$  Left Sectional View

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Both the intake and exhaust valve assemblies are the rotating-type which rotate each time the valve opens and closes. The rotation permits self cleaning action and better seating, minimizes valve warpage, wear, and sticking. Umbrella-type valve stem seals fit over the top of the valve stems and extend over the top of the valve guide opening. The seals control lubrication of the valve stems. The valve springs have equal coil spacing which provides more positive valve action at high engine speed. Easy maintenance of valve lash is afforded by self locking adjusting screws.

The cylinder block and crankcase are a one-piece casting. Full length water passages completely surround each cylinder to provide uniform cylinder temperatures.

The camshaft is supported by four steel-backed babbitt insert-type bearings pressed into the block. It is driven by a sprocket and timing chain in mesh with a sprocket on the crankshaft. Camshaft thrust is controlled by a thrust washer located between the camshaft sprocket and the front journal of the camshaft. An eccentric, made integral with the camshaft, operates the fuel pump. The tappets are the solid steel, mush-

room-type. They are located in bores in the cylinder block tappet chamber and are lubricated by overflow from the oil gallery. The push rods are one-piece tubular steel with oil cushioned sockets.

The crankshaft is supported by four main bearings. The bearings are the steel-backed, copper lead or lead babbitt, insert-type. Crankshaft end thrust is controlled by the No. 3 main bearing flanges. Oil slingers are provided to prevent leakage by directing the oil away from the front and rear oil seals. The front slinger is assembled to the crankshaft between the damper and crankshaft sprocket and throws the oil onto the timing chain, then into the oil pan. The rear slinger is made integral with the crankshaft and deflects the oil into the slinger trough which empties back into the oil pan. A single sheave damper and pulley assembly is keyed to the crankshaft. On cars equipped with power steering, an additional single sheave pulley is bolted to the damper to drive the power steering pump.

On cars equipped with a conventional or overdrive transmission, the rear face of the flywheel is used as a friction surface which is engaged by the clutch disc.

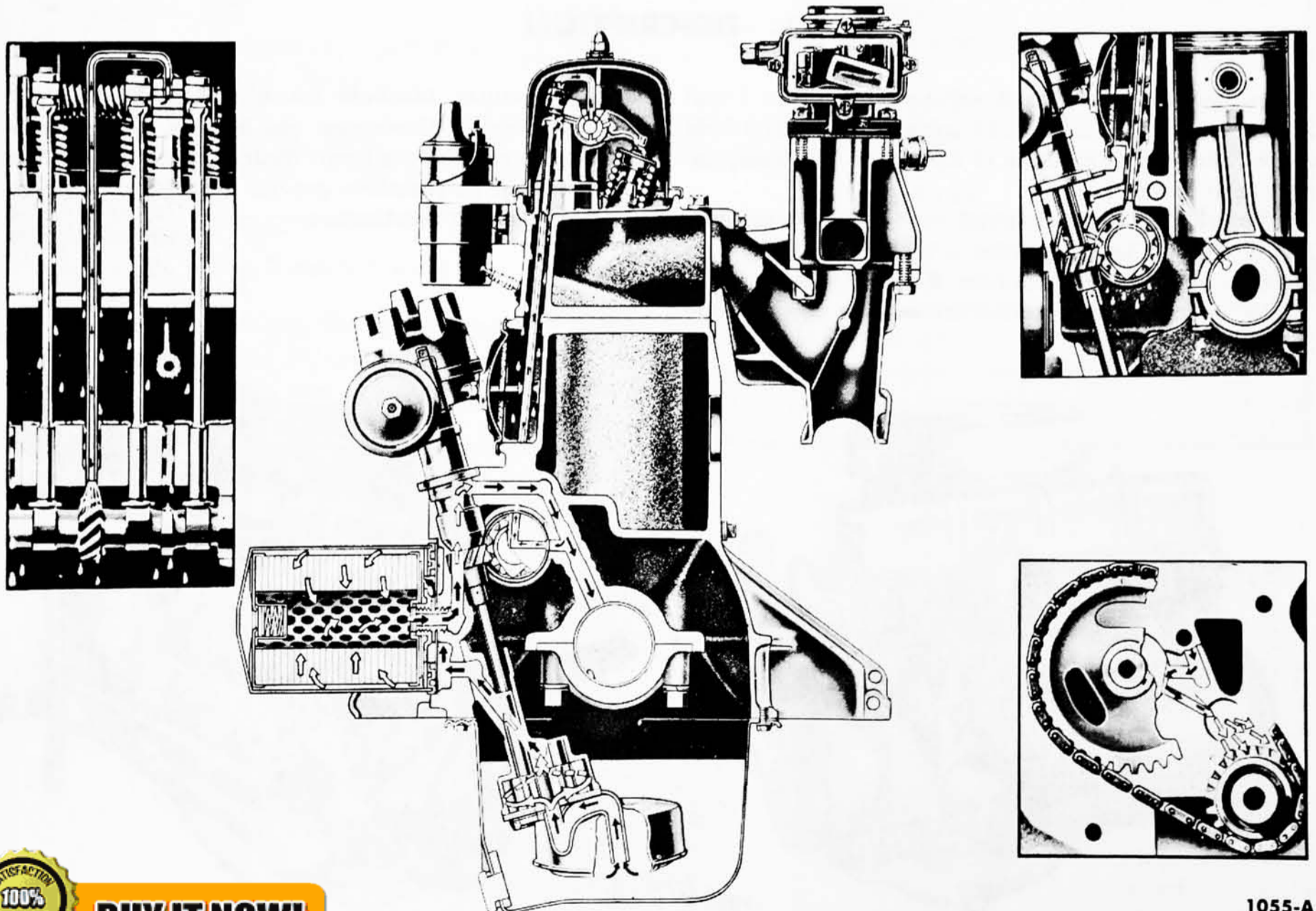


Fig. 3—Engine Lubrication System

1055-A

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The flywheel assembly is piloted on a shoulder and bolted to the crankshaft. The ring gear is a shrink fit on the flywheel.

The flywheel used on Fordomatic equipped cars has two laminated spring-steel drive plates riveted to the outer edge 180° apart, to which the converter cover is attached.

The forged steel, "I" section connecting rods contain a bronze piston pin bushing. The connecting rod bearings are the steel-backed, copper-lead, two piece-type.

The aluminum alloy, three ring, flat head-type pistons are of the autothermic design. This design provides controlled piston expansion which allows closer initial piston fits without binding or excessive friction. The top compression ring is chrome-plated and the lower compression ring is phosphate-coated for extra protection against wear and scuffing. The oil control ring assembly consists of a serrated spring and two chrome-plated steel rails.

## Engine Lubricating System

Oil from the oil pan sump is forced through the pressure-feed lubricating system (Fig. 3) by a gear-type pump mounted inside the crankcase. The pump is driven by the distributor through an intermediate drive shaft. A spring loaded relief valve in the pump limits the maximum pressure of the system. The oil relieved by the valve is directed back to the intake side of the pump.

A full flow-type oil filter filters the entire output of the pump before the oil enters the engine. The filter has an integral relief valve, anti-drain back diaphragm and mounting gasket. The relief valve permits oil to bypass the filter if the element becomes clogged, thereby maintaining an emergency supply of oil to the engine lubrication system at all times. The anti-drain diaphragm prevents a reverse flow of oil when the engine is stopped.

The main oil gallery supplies oil to all the camshaft and main bearings through a drilled passage in each main bearing web.

The timing chain and sprockets are lubricated through a flat on the No. 1 cam bearing.

Cylinder walls, pistons and piston pins are lubricated through a drilled hole on the crankpin end of each connecting rod which indexes with a drilled hole in the crankpin.

Oil under reduced pressure is fed to the rocker arm assembly through a drilled passage in the cylinder block at the No. 3 cam bearing which indexes with a hole in the cylinder head. An oil feed tube directs the oil to the hollow rocker shaft through the No. 6 rocker bearing. The oil then flows through the shaft to lubricate each

rocker arm bushing and the valve and ball end of the rocker arm. The excess oil spirals down the rotating push rod and assists in lubricating the tappet and push rod seat. An overflow tube exhausts excess oil from the rocker shaft to lubricate the distributor lower bushing and distributor drive gears. The overflow tube is located at the No. 1 support bracket. The oil from each rocker arm drains into the push rod chamber through holes provided in the cylinder head.

The oil in the push rod chamber drains back into the pan through an opening at the back of the block.

## Crankcase Ventilation

Ventilating air (Fig. 4) is provided by the combination oil filler and breather cap located on the front of the valve rocker arm cover. The filler cap contains a maze filtering element.

From the filler cap the filtered air flows into the front section of the valve rocker arm chamber. There are few gases at this point and the air has a chance to normalize its temperature before contacting contaminating vapors originating in the crankcase. This warm ventilating air minimizes the formation of crankcase sludge. The ventilating air moves down past the push rods into the engine crankcase. Air is diverted from the front section of the engine crankcase through holes in the front of the cylinder block wall to ventilate the camshaft sprocket chamber. The air from the crankcase is then directed into the road draft outlet tube by rotating action of the crankshaft.

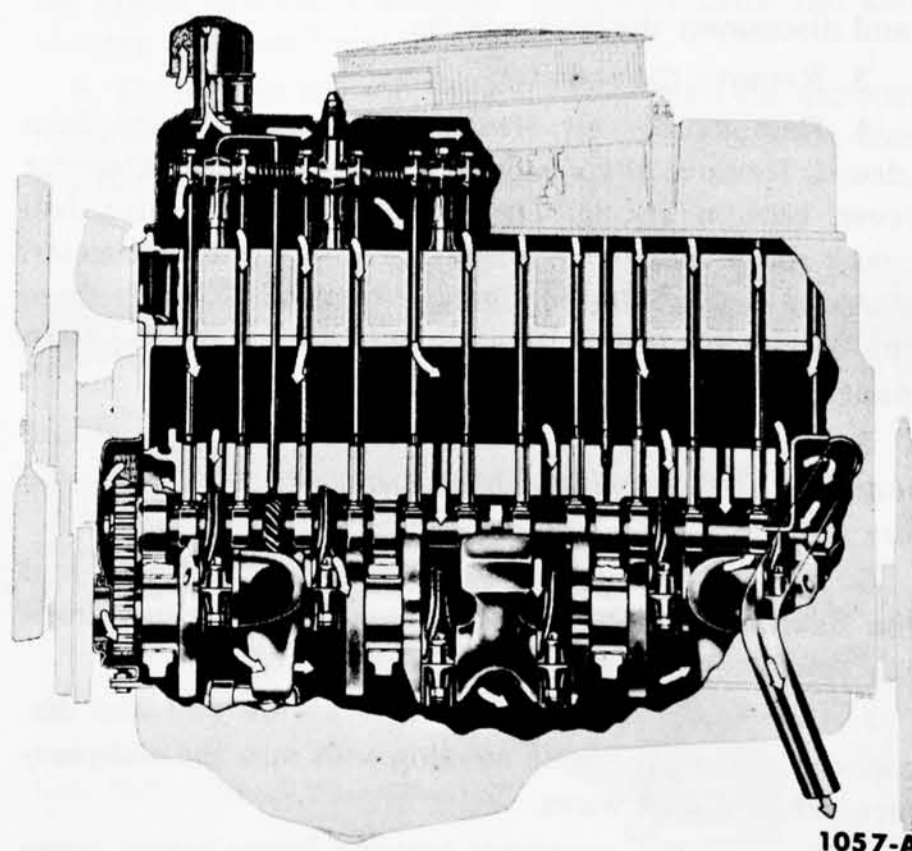


Fig. 4—Crankcase Ventilating System



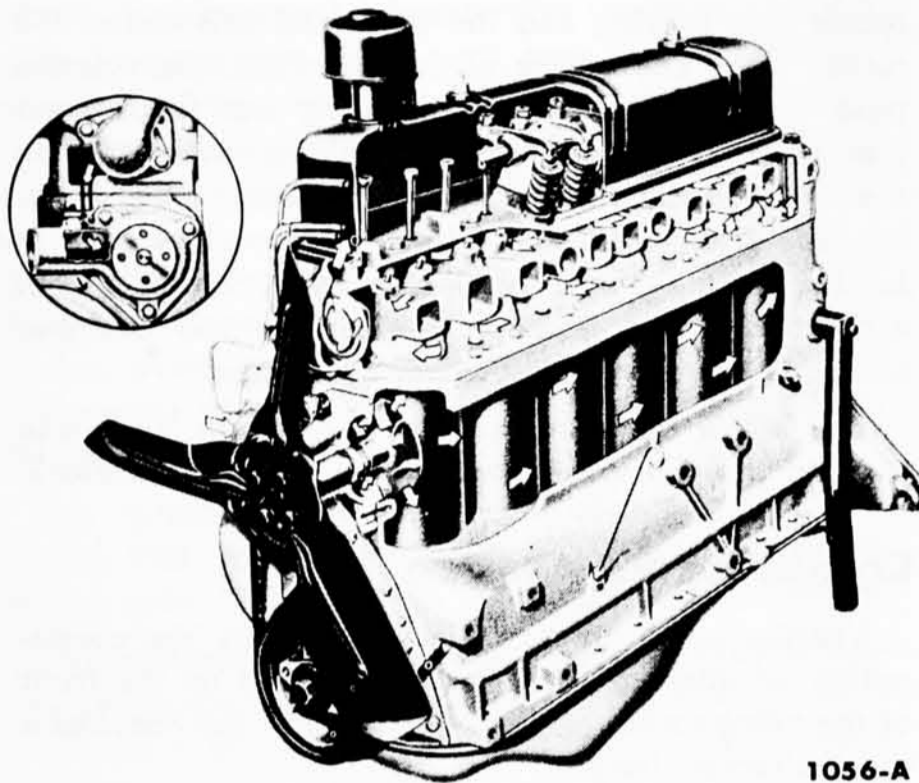


Fig. 5—Engine Cooling System

## Cooling System

The coolant is drawn from the lower tank of the radiator by the water pump which delivers the coolant to the cylinder block (Fig. 5).

As the coolant enters the block, it travels through cored passages to cool the entire length of each cylinder wall. Upon reaching the rear of the cylinder block, the coolant is directed upward into the cylinder head where it cools the combustion chambers, valves, and valve seats on its return to the front of the engine.

At this point, the coolant flows into the water outlet connection past the water thermostat if it is open, into the upper tank of the radiator. If the thermostat is closed, a small portion of the coolant is bypassed through a pipe which returns the coolant to the water pump for recirculation. The entire system is pressurized to 13-15 psi with the use of a pressure-type radiator cap.

## 2. ENGINE REMOVAL AND INSTALLATION

The procedures given are for the engine only, without the transmission attached. Engine compartment tolerances make it impractical to remove or install the engine with the transmission attached.

### Fordomatic Equipped Cars

#### REMOVAL

1. Drain the cooling system and the crankcase.
2. Disconnect the battery ground cable at the battery and disconnect the heater hoses.
3. Remove the radiator.
4. Remove the air cleaner, then tape the air horn closed. Remove the accelerator bell crank to carburetor lever tension spring. Disconnect the accelerator bell crank rod and the choke control cable at the carburetor. Remove the accelerator linkage bracket assembly from the intake manifold, then tie the bracket to the dash panel.
5. Disconnect the muffler inlet pipe from the exhaust manifold, the generator wires from the generator, and the engine ground strap at the converter housing.
6. Disconnect the windshield wiper vacuum hose and the flexible fuel line at the fuel pump, and disconnect the starter cable at the starter.
7. Disconnect the primary wire at the coil and disconnect the oil pressure sending unit and the tempera-

ture lower retaining bolts.

9. Turn the flywheel until one flex plate is in a position so that the three flywheel to converter bolts can be removed, then remove the bolts. Turn the flywheel 180° and remove the other three bolts. Secure the converter assembly in the housing. *After the bolts are removed from the flex plates, turn the flywheel 90° so the flex plates will not catch on the converter housing when the engine is removed.*

10. Remove the converter housing to engine lower retaining bolts and remove the left rear splash shield. Remove the oil cooler lines retaining clip from the engine right insulator support bracket. Remove the starter lower retaining bolts and remove the Fordomatic filler tube bracket.

11. Support the transmission with a jack. Remove the engine right and left insulator to support bracket bolts.

12. Remove the starter upper bolts, then remove the starter. Remove the remaining engine rear plate retaining bolts and the converter housing to engine upper bolts.

13. Attach the engine lifting hook (Fig. 6). Raise the engine slightly, then carefully pull it from the converter housing. Lift the engine out of the engine compartment, then install it on a workstand (Fig. 7).

#### INSTALLATION

1. Install the engine lifting hook, then remove the engine from the work stand. Place a new gasket over

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housing lower access cover y. Remove the engine rear

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the exhaust manifold to inlet pipe threads. **Make sure the flywheel is turned so that the flex plates will not catch on the converter housing.**

2. Lower the engine carefully into the engine compartment. Make sure the studs on the exhaust manifold are aligned with the holes in the muffler inlet pipe and the dowels in the block engage the holes in the converter housing. Start the converter pilot into the crankshaft.

3. Install the engine to converter housing upper bolts. Position the starter and install, but do not tighten the upper retaining bolts.

4. Remove the transmission support. Install the engine left and right insulator to support bracket bolts. Tighten the bolts to 45-50 foot-pounds torque.

5. Remove the retainer securing the converter in the housing, then position the flywheel until one flex plate is in position to install the three flywheel to converter bolts. Tighten the bolts to 25-28 foot-pounds torque. Turn the flywheel 180°, then install the other three bolts.

6. Install the converter lower access cover and the housing cover plate. Install the engine rear plate lower retaining bolts. Position the left rear splash shield and install the converter housing to engine lower retaining bolts. Position the Fordomatic filler tube bracket and install the starter lower retaining bolts, then tighten them to 15-20 foot-pounds torque.

7. Position the Fordomatic cooler tubes bracket and install the engine right support bracket to engine bolt. Tighten the bolt to 45-50 foot-pounds torque.

8. Install the exhaust manifold to muffler inlet pipe retaining lockwashers and nuts, then tighten the nuts to 23-28 foot-pounds torque. Install the generator wires and the engine ground strap.

9. Install the accelerator linkage bracket on the intake manifold. Connect the accelerator bell crank rod. Install the accelerator bell crank to carburetor lever tension spring. Connect the choke control cable.

10. Connect the flexible fuel line and the windshield wiper vacuum hose. Connect the coil primary wire and connect the oil pressure sending unit and the temperature sending unit wires.

11. Install the starter upper retaining bolts and tighten them to 15-20 foot-pounds torque. Install the starter cable and the battery ground cable.

12. Install the radiator and connect the heater hoses. Fill the cooling system.

13. Fill the crankcase with the proper grade and quantity of engine oil. Remove the tape from the car-

or air horn, then install the air cleaner. Run the engine at idle and check all gaskets and seals.

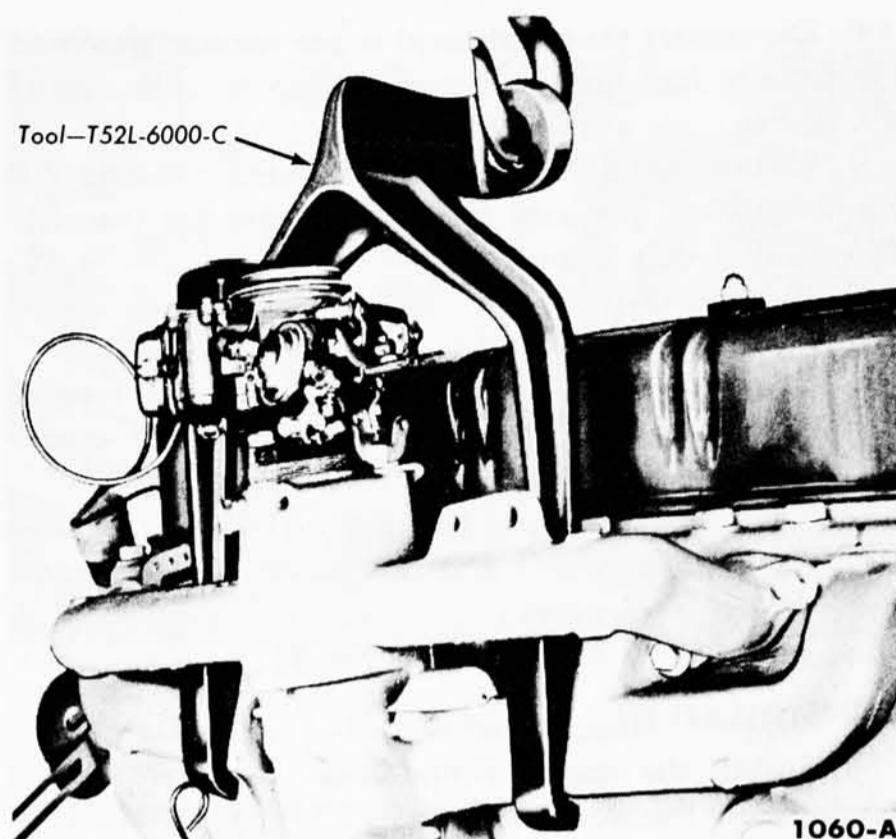


Fig. 6—Engine Lifting Hook

## Conventional Or Overdrive Transmission

### REMOVAL

1. Drain the cooling system and the crankcase.
2. Disconnect the battery ground cable at the battery and disconnect the heater hoses.
3. Remove the radiator.
4. Remove the air cleaner, then tape the air horn closed. Disconnect the accelerator linkage. Disconnect the clutch bracket spring and release rod, then remove the clutch bracket. Disconnect the choke cable rod and bushing at the carburetor.
5. Disconnect the muffler inlet pipe from the exhaust manifold, the generator wires from the generator, and the engine ground strap from the engine.

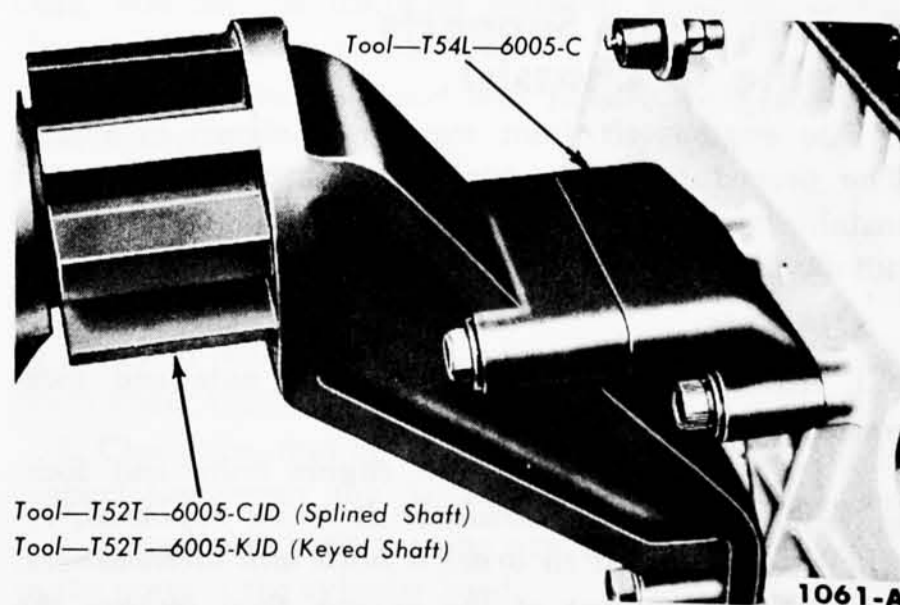


Fig. 7—Engine Mount

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6. Disconnect the windshield wiper vacuum hose and the flexible fuel line at the fuel pump, and disconnect the starter cable at the starter.

7. Disconnect the primary wire at the coil and disconnect the oil pressure sending unit and the temperature sending unit wires.

8. Remove the starter.

9. Remove the flywheel housing upper bolts.

10. Remove the flywheel housing cover, then remove the flywheel housing lower bolts. Remove the engine right and left insulator to support bracket bolts.

11. Attach the engine lifting hook (Fig. 6). Raise the engine slightly, then carefully pull it from the transmission. Lift the engine out of the engine compartment, then install it on a workstand (Fig. 7).

### INSTALLATION

1. Install the engine lifting hook, then remove the engine from the work stand.

2. Lower the engine carefully into the engine compartment. Jack up the transmission, then start the transmission main drive gear into the clutch disc. *It may be necessary to adjust the position of the transmission input shaft will not enter the clutch disc. If the engine "hangs up" after the shaft enters, turn the crankshaft slowly (with the transmission in gear) until the shaft splines mesh with the clutch disc splines.* Make sure the studs on the exhaust manifold are aligned with the holes in the muffler inlet pipe and the dowels in the block engage the holes in the flywheel housing. Remove the jack from the transmission.

3. Install the flywheel housing lower bolts and tighten them to 40-50 foot-pounds torque, then install the flywheel housing cover.

4. Install the engine left and right insulator to support bracket bolts, then tighten them to 45-50 foot-pounds torque.

5. Install the flywheel housing upper bolts, then tighten them to 40-50 foot-pounds torque.

6. Install the starter, then tighten the bolts to 15-20 foot-pounds torque.

7. Connect the coil primary wire, the oil pressure sending unit and the temperature sending unit wires, and the starter cable.

8. Connect the windshield wiper vacuum hose and the flexible fuel line.

9. Install the exhaust manifold to muffler inlet pipe lockwashers and nuts, then tighten the nuts to 23-28 foot-pounds torque.

10. Connect the generator wires and the engine ground strap.

11. Install the clutch bracket. Connect the choke cable rod and bushing, the clutch bracket spring and release rod, and the accelerator linkage. Remove the tape from the carburetor air horn, then install the air cleaner.

12. Install the radiator. Connect the heater hoses and the battery ground cable.

13. Fill the cooling system. Fill the crankcase with the proper grade and quantity of engine oil. Run the engine at fast idle and check all gaskets and hose connections for leaks.

## 3. ENGINE SUPPORTS

The front supports are located on each side of the crankcase and the rear support is located at the transmission extension housing.

### Engine Front Supports (Engine In Chassis)

The engine left front support is shown in Fig. 8. The procedures given apply to either a right or left installation. If only one support is to be removed, do not disturb the other support.

#### REMOVAL

1. Remove the insulator to frame nuts and lockwashers.

2. Remove the bracket to engine bolts and lockwashers. *If only the insulator is to be replaced, remove the bracket bolts and lockwashers.*

3. Lower the engine, then remove the support assembly.

#### INSTALLATION

1. Position the bracket and/or insulator assembly in place.

2. Lower the engine slightly.

3. Install, but do not tighten the bracket lockwashers and bolts (or the insulator to bracket lockwashers and bolts if only the insulator was removed). *If both supports have been removed, install the bolts on the opposite side before proceeding with step 4.*

4. Lower the engine, then install, but do not tighten the insulator to frame lockwashers and nuts.

5. Tighten the bracket bolts to 45-50 foot-pounds torque (or the insulator to bracket bolts to 50-60 foot-pounds torque). *If both supports have been removed, install the bolts on the opposite side before proceeding with step 6.*

6. Tighten the insulator to frame nuts to 45-50 foot-pounds torque.



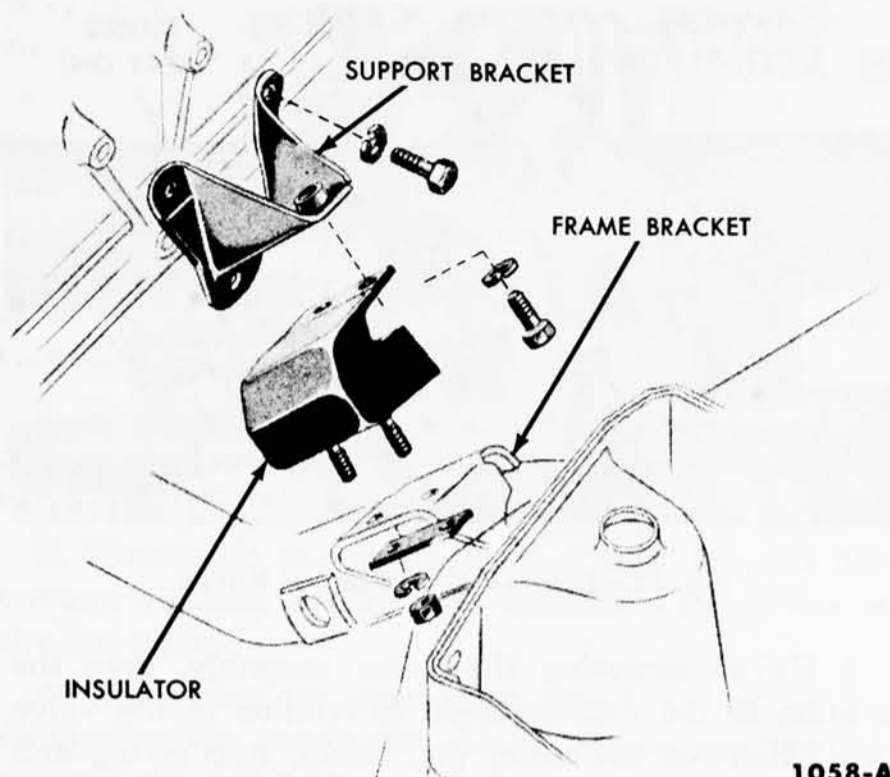
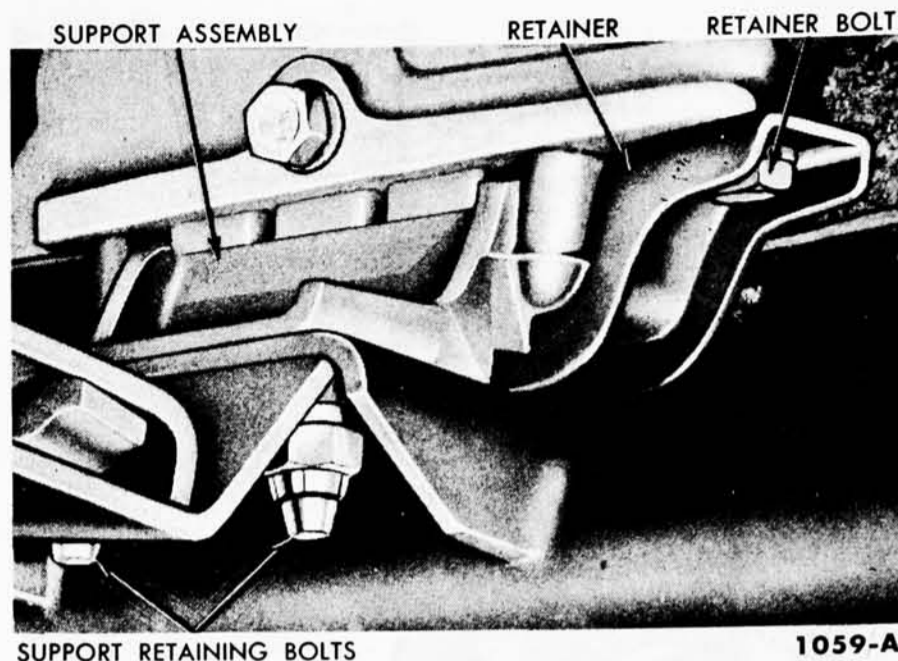


Fig. 8—Engine Front Support

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1059-A

Fig. 9—Engine Rear Support

## Engine Rear Support (Engine In Chassis)

The engine rear support is shown in Fig. 9.

### REMOVAL

1. Remove the support retainer to extension housing bolts and washers.
2. Remove the support assembly to frame nuts, lockwashers, and bolts.
3. Jack up the extension housing slightly to relieve

the pressure on the support assembly.

4. Remove the retainer and support assembly.

### INSTALLATION

1. Jack up the extension housing just enough to position the support assembly and retainer.
2. Install, but do not tighten the support retainer to extension housing flat washers, lockwashers, and bolts.
3. Install, but do not tighten the support assembly to frame bolts, lockwashers, and nuts.
4. Remove the jack from the extension housing.
5. Tighten the support retainer bolts to 23-28 foot-pounds torque and tighten the support assembly nuts to 50-60 foot-pounds torque.

## 4. MANIFOLDS AND EXHAUST GAS CONTROL VALVE

The manifold assembly is shown in Fig. 10.

### Manifolds

A chamber (heat riser) is cast into the intake manifold center section where the carburetor and exhaust manifold are attached. A thermostatically controlled valve, located in the exhaust manifold, directs exhaust gases into this area to provide the necessary heat required by the intake manifold to assist in vaporizing the incoming fuel mixture.

### REMOVAL

1. Remove the air cleaner, then tape the carburetor air horn closed. Remove the carburetor. Disconnect the vacuum line at the intake manifold.

3. Disconnect the muffler inlet pipe from the exhaust manifold.

4. Remove the bolts fastening the manifold to the head, and lift the manifold assembly from the head. Remove the gaskets and sleeves.

5. Remove the nuts and bolt joining the manifolds, then separate the manifolds.

### INSTALLATION

1. Place the intake manifold over the studs on the exhaust manifold.
2. Install the lockwashers, nuts and bolts, then tighten them finger tight.
3. Clean the mating surface of the cylinder heads. Inspect and repair any damage at the mating surfaces.
4. Install new gaskets using new sleeves, if necessary, in the ports of the cylinder head.
5. Coat the mating surfaces lightly with graphite

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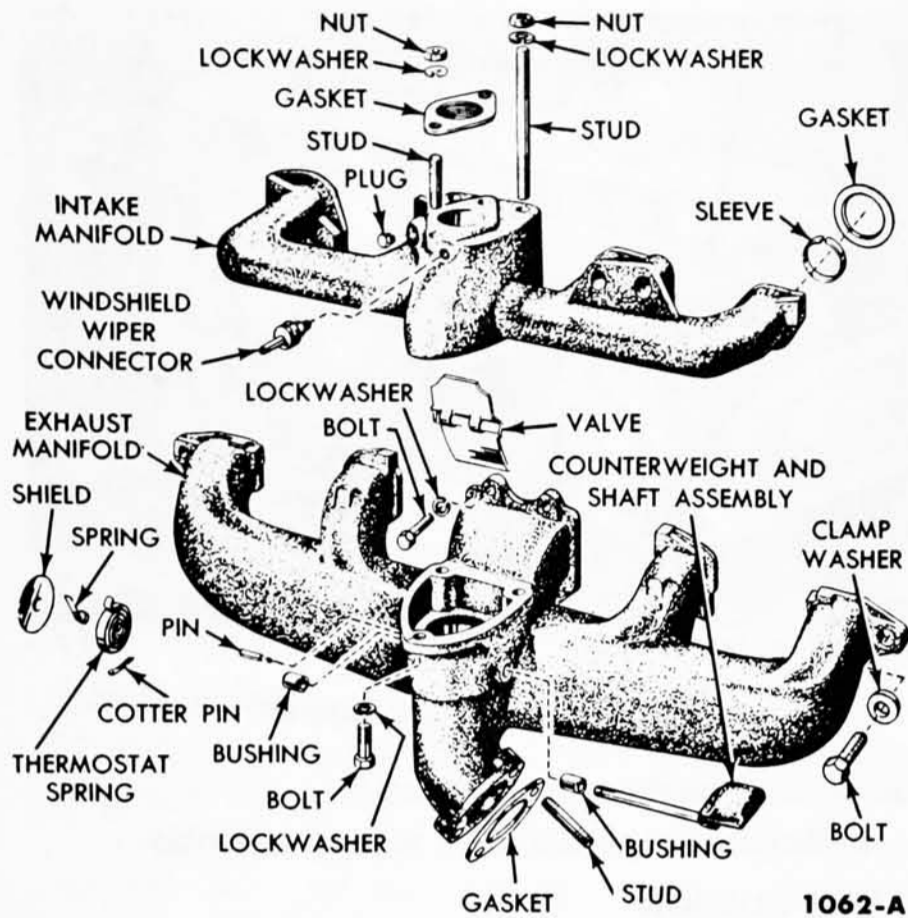


Fig. 10—Manifold Assembly

grease, then place the manifold assembly in position against the head. **Make sure the port openings in the manifold assembly are aligned with the port openings in the cylinder head and that none of the steel gaskets have become dislodged.**

6. Install the attaching washers and bolts, then tighten the bolts to 23-28 foot-pounds torque, tightening from the center to the ends.

7. Tighten the bolt and nuts joining the intake and exhaust manifolds to 23-28 foot-pounds torque.

8. Install a new exhaust outlet flange gasket, and position the muffler inlet pipe over the studs. Install the nuts and lockwashers, then tighten the nuts to 23-28 foot-pounds torque.

9. Connect the throttle linkage. Connect the vacuum line to the intake manifold. Install the carburetor and connect the carburetor linkage.

10. Remove the tape from the carburetor air horn, then install the air cleaner.

## Exhaust Gas Control Valve Replacement

The exhaust gas control valve is located in the outlet of the exhaust manifold. Normally, it does not require replacement unless it becomes inoperative due to excessive corrosion or damage.

assembly and separate the

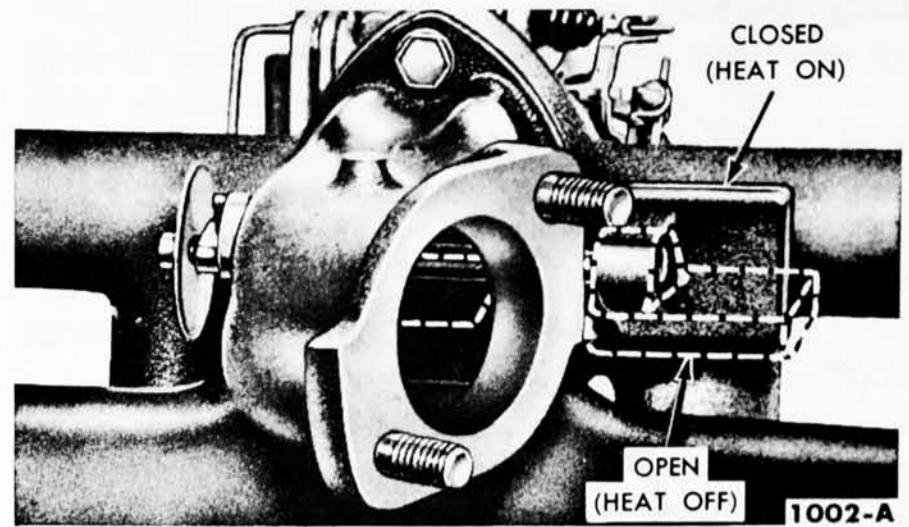


Fig. 11—Exhaust Gas Control Valve

2. Before removing the valve assembly, note the position of the counterweight in relation to the valve plate. Remove the cotter pin, shield, stop spring and thermostat spring from the front end of the shaft.

3. Using an acetylene torch in the inside of the manifold, cut the shaft on both sides of the valve plate. **Use caution to avoid damage to the shaft bearing bores.**

4. Remove the valve and shaft pieces.

5. Clean the bushings of corrosion and repair any damage that may have occurred. Replace the bushings if necessary. When new bushings are installed, there should be a distance of  $2\frac{3}{8}$  inches from the inside edge of one bushing to the inside edge of the other bushing. The bushing should be equally spaced within the counterbores. After installation, ream the bushings with a  $\frac{5}{16}$ -inch reamer.

6. Lubricate the new shaft and bushings with a penetrating oil and graphite mixture.

7. Insert the shaft through the bushings and valve plate. Rotate the shaft in the valve plate until the counterweight is in the normal "up" (heat on) position (Fig. 11).

8. Weld the valve to the shaft in the original manner. The shaft and valve are stainless steel to minimize corrosion and/or damage by excessive heat.

9. Install the thermostat spring in the shaft slot.

10. Wind the spring  $\frac{3}{4}$  turn and hook the open end of the spring over the stop pin. The thermostat spring should hold the valve in the closed or "heat on" position (i.e. in the proper position to direct the flow of gases into the heat riser).

11. Install the stop spring, shield, and cotter pin.

12. Lubricate the shaft bushings while operating the valve manually to replace the original lubricant lost by the welding operation.



## 5. CYLINDER HEAD AND VALVES

### Cylinder Head Removal

1. Drain the cooling system. Remove the radiator upper hose and heater hose. Disconnect the battery cable at the cylinder head and disconnect the temperature sending unit wire.

2. Remove the air cleaner, then tape the air horn closed. Disconnect the accelerator rod and the choke cable.

3. Disconnect the carburetor fuel inlet line, the distributor vacuum line, and the manifold vacuum line at the fuel pump.

4. Disconnect the carburetor fuel inlet line at the carburetor, the distributor vacuum line at the distributor, and the manifold vacuum line at the manifold, then remove the three lines as an assembly.

5. Disconnect the coil from the head and move it to one side. Remove the spark plug wires, then remove the spark plugs. Remove the rocker arm cover.

6. Remove the cap screw and clip from the No. 6 rocker arm support bracket. Pull the oil feed line out of the bracket, then pull it out of the block with pliers (Fig. 12). Be careful not to damage the line.

7. Loosen all rocker arm adjusting screws to remove the valve spring load from the rocker arms, then remove the rocker arm shaft assembly. Remove the valve push rods in sequence. Identify them so they can be installed in their original positions (Fig. 13).

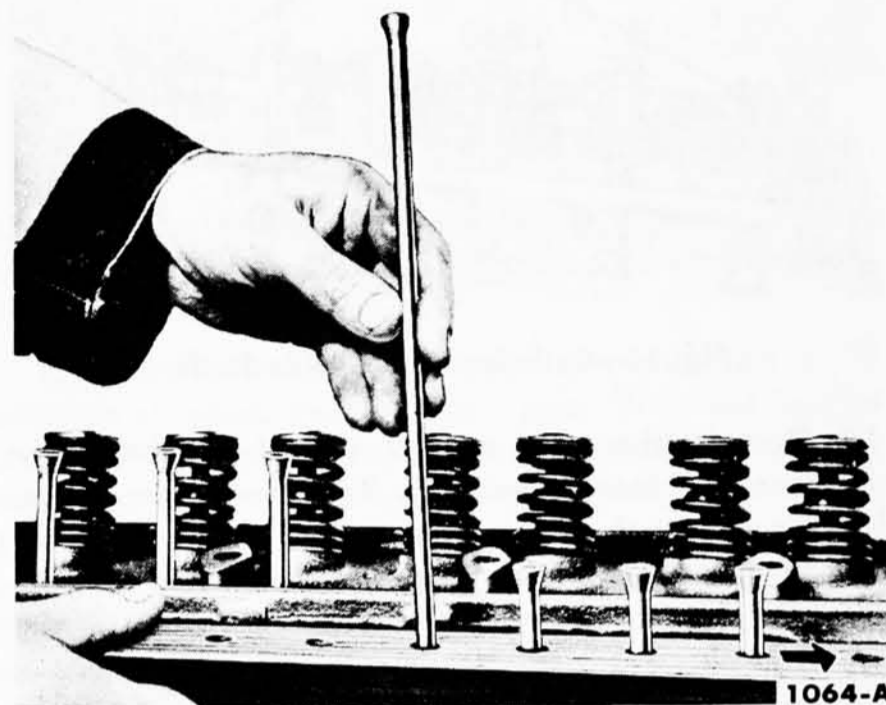


Fig. 13—Valve Push Rod Removal

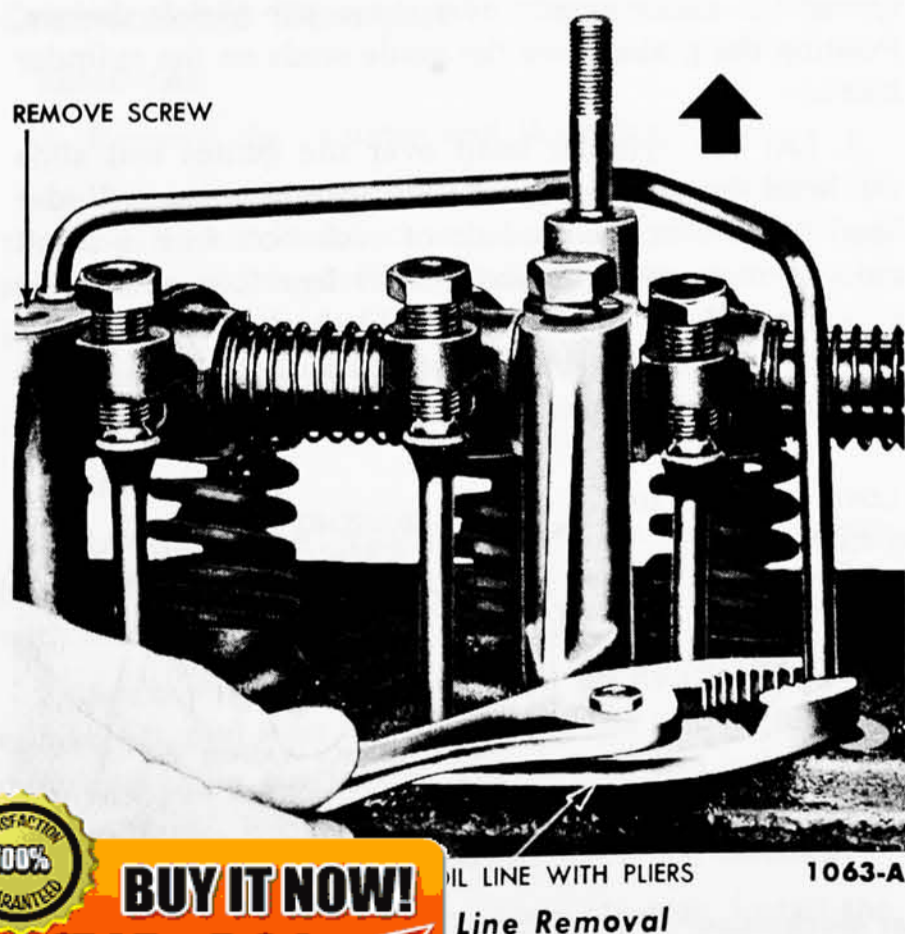
8. Remove the manifold to head bolts, and pull the manifold assembly away from the head. Brace the assembly so the inlet pipe will not be damaged. Install the cylinder head holding fixtures for convenience in lifting the head and to protect the gasket surfaces (Fig. 14).

9. Remove all cylinder head bolts. Install the cylinder head guide studs (Fig. 15). Lift the cylinder head assembly off the engine. *Do not pry between the head and block as the gasket surfaces may become damaged.*

### Rocker Arm Mechanism Disassembly

1. Pull the oil drain line and clip out of the No. 1 support bracket.

2. Remove the cotter pins at each end of the rocker arm shaft, and remove the flat washers and spring washers.



OIL LINE WITH PLIERS

1063-A

Line Removal

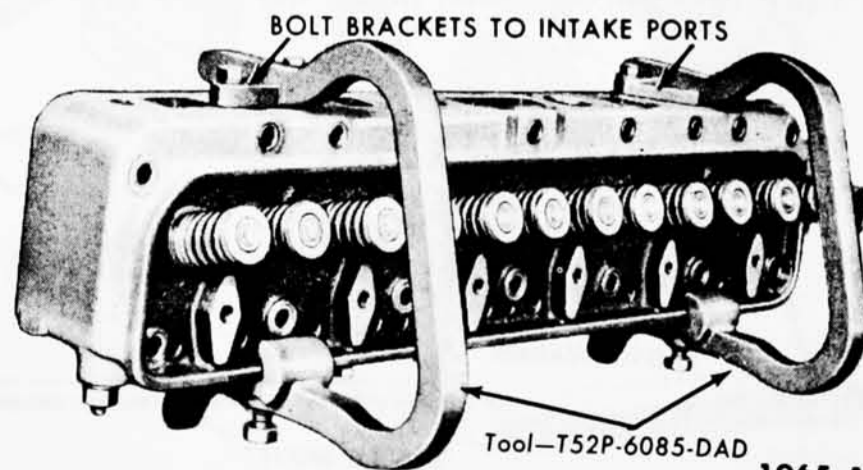


Fig. 14—Cylinder Head Holding Fixture

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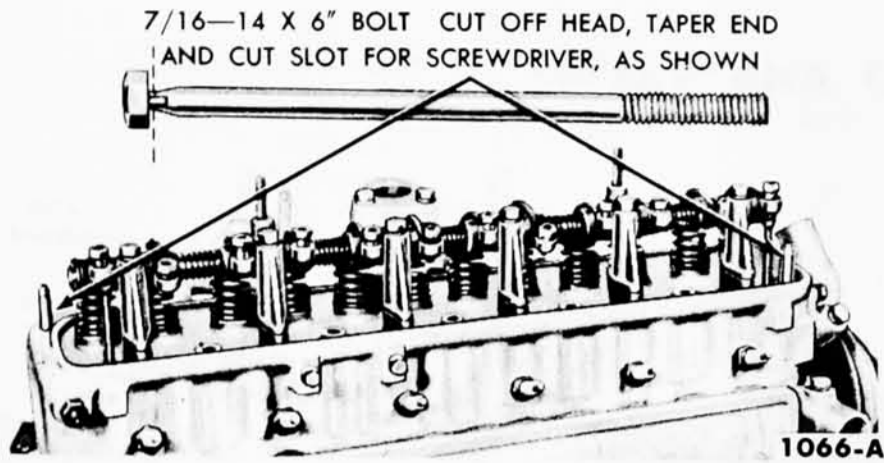


Fig. 15—Cylinder Head Guide Studs

3. Remove the plugs at each end of the shaft. *The plugs are an interference fit. To remove the plugs, drill or pierce the plug on one end, then use a steel rod to knock out the plug on the opposite end. Working from the open end, knock out the remaining plug.*

4. Slide the rocker arms, springs, and brackets off the shaft. Be sure to identify the parts.

## Cylinder Head Disassembly

1. Clean the carbon out of the combustion chambers before removing the valves.

2. Compress the valve springs (Fig. 16), then remove the valve retainer locks and release the spring. Remove the sleeve, spring retainer, spring, stem seal, and valve. Discard the valve stem seals. Identify all valve parts.

## Rocker Arm Mechanism Assembly

1. Oil all moving parts with engine oil.

2. Using a blunt tool or large diameter pin punch, install a plug, cup side out, in each end of the rocker shaft.

3. Install a flat washer, spring washer, another flat washer, and a cotter pin on one end of the shaft. Install the rocker arms, support brackets, and springs (Fig. 17). Install the remaining flat washers with the spring washer between them, and install the cotter key.

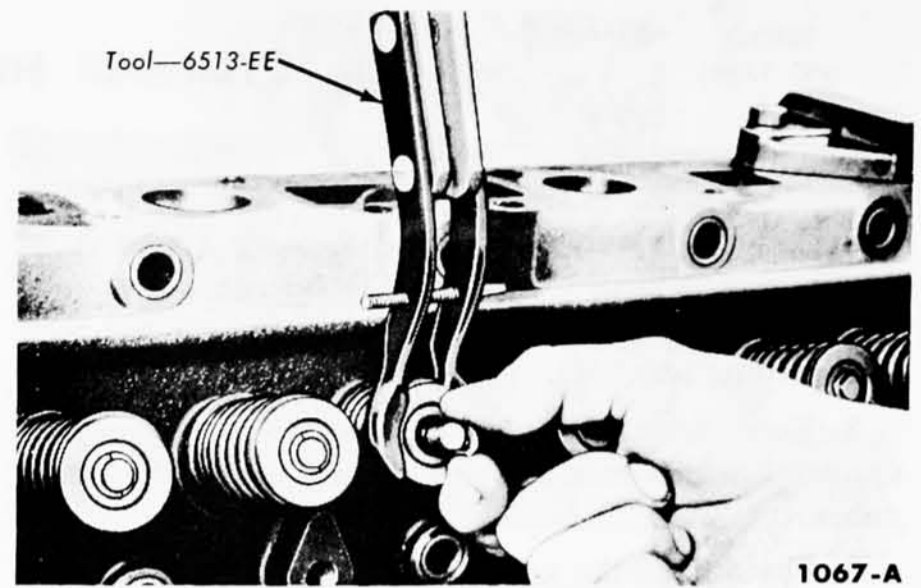


Fig. 16—Valve Stem Lock Removal or Installation

## Cylinder Head Assembly

1. Install each valve in the port from which it was removed or to which it was fitted. Install a new stem seal on the valve.

2. Install the valve spring, then install the valve spring retainer, and sleeve. Compress the spring, and install the retainer locks (Fig. 16). Measure the valve spring assembled height.

## Cylinder Head Installation

1. Clean carbon deposits and gasket sealer residue from the head and block gasket surfaces. Inspect the head for any damage and repair as necessary.

2. Apply a coating of cylinder head gasket sealer to both sides of a new gasket. Use the brush furnished to spread the sealer evenly over the entire gasket surface. Position the gasket over the guide studs on the cylinder block.

3. Lift the cylinder head over the guides and slide the head down carefully. Before installing the cylinder head bolts, coat the threads of each bolt with a small amount of water resistant sealer. Install two bolts at opposite ends of the head to hold the head and gasket in position. Remove the guides, then install the remaining bolts. Remove the cylinder head holding fixtures.

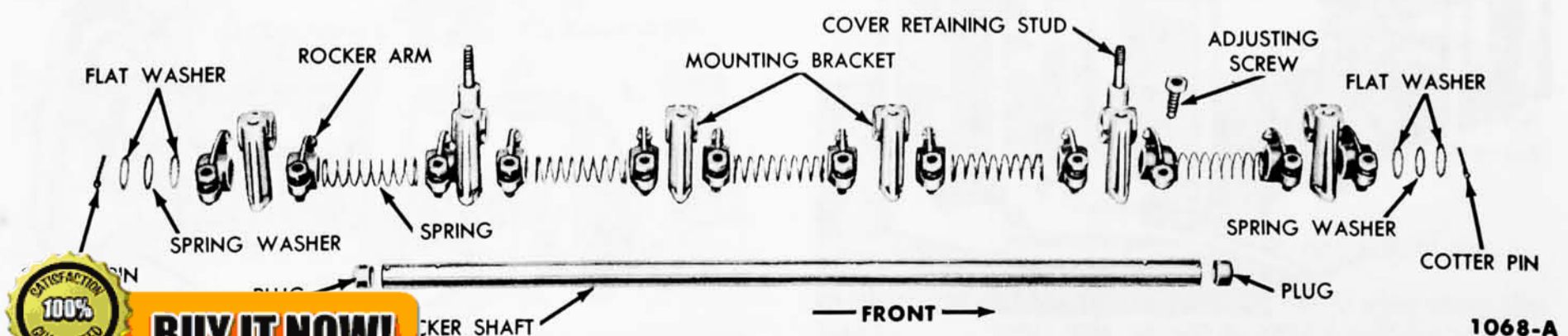


Fig. 17—Rocker Arm Mechanism



4. The cylinder head bolt tightening procedure is performed in three progressive steps. First, tighten the bolts to 55 foot-pounds torque (cold) in the proper sequence (Fig. 18), then tighten them to 65 foot-pounds torque (cold) in the same sequence. Tighten the bolts again after the engine has been warmed up (Step 13).

5. Install the push rods in their proper sequence. Position the lower end of the rods in the tappet sockets.

6. Position the valve rocker arm assembly on the head, then install the oil drain line, clip, and retaining screw on the No. 1 bracket. Make sure the oil line enters the shaft locating hole.

7. Position the oil feed line on the No. 6 bracket. Make sure the lower end of the oil line "O" ring seal is in the oil supply counterbore, then install the bolt.

8. Tighten all the retaining bolts to 45-55 foot-pounds torque. Perform a preliminary (cold) valve lash adjustment.

9. Install the manifold to head bolts and tighten them to 23-28 foot-pounds torque.

10. Position the two vacuum lines and the carburetor fuel inlet line on the engine, then connect the lines. Connect the accelerator rod and the choke cable.

11. Install the ignition coil and the spark plugs. Connect the spark plug wires.

12. Install the radiator upper hose and heater hose.

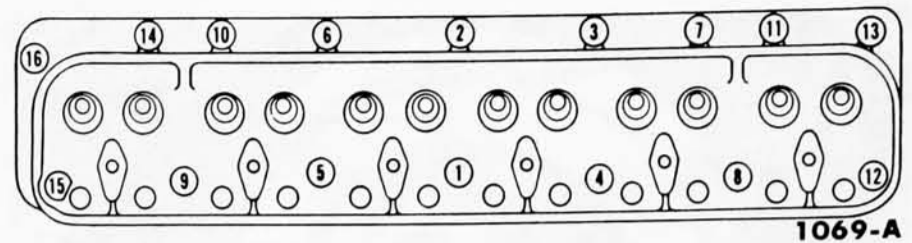


Fig. 18—Cylinder Head Bolt Tightening Sequence

Connect the battery ground cable. Fill the cooling system. Remove the tape from the carburetor air horn, then install the air cleaner.

13. Start the engine and run it for a minimum of 30 minutes at approximately 1200 rpm. With the engine warmed up, tighten the cylinder head bolts, in proper sequence to 75 foot-pounds torque (hot), then check the valve lash with the engine idling and adjust it if necessary. *After the cylinder head bolts have been tightened to specifications, the bolts should not be disturbed.*

14. Coat one side of the rocker arm cover gasket with oil resistant sealer, and lay the cemented side of the gasket in place in the cover. Install the rocker arm cover, making sure that the gasket seats evenly all around the head. Install the rubber seals on the studs making sure they are centered in the cover openings. Tighten the retaining nuts to 2.0-2.5 foot-pounds torque.

## 6. CRANKSHAFT DAMPER, CYLINDER FRONT COVER, AND CRANKSHAFT OIL SEAL

### Crankshaft Damper

#### REMOVAL

1. Remove the radiator and the drive belts.
2. On cars equipped with power steering, remove the two bolts and lockwashers that fasten the power steering pump pulley to the crankshaft damper, then remove the pulley.
3. Remove the cap screw and washer from the end of the crankshaft, then remove the damper (Fig. 19).

#### INSTALLATION

1. Lubricate the crankshaft with an oil and white lead mixture and lubricate the oil seal rubbing surface with grease.
2. Align the damper keyway with the key on the crankshaft, and start the damper on the shaft. Press the damper on the shaft (Fig. 20). Install the lockwasher and cap screw, then tighten the capscrew to 85-95 foot-pounds torque. If the car has power steering, install the

power steering pump pulley on the crankshaft damper. Tighten the retaining bolts to 23-28 foot-pounds torque. Install and adjust the power steering pump belt.

4. Install the radiator.

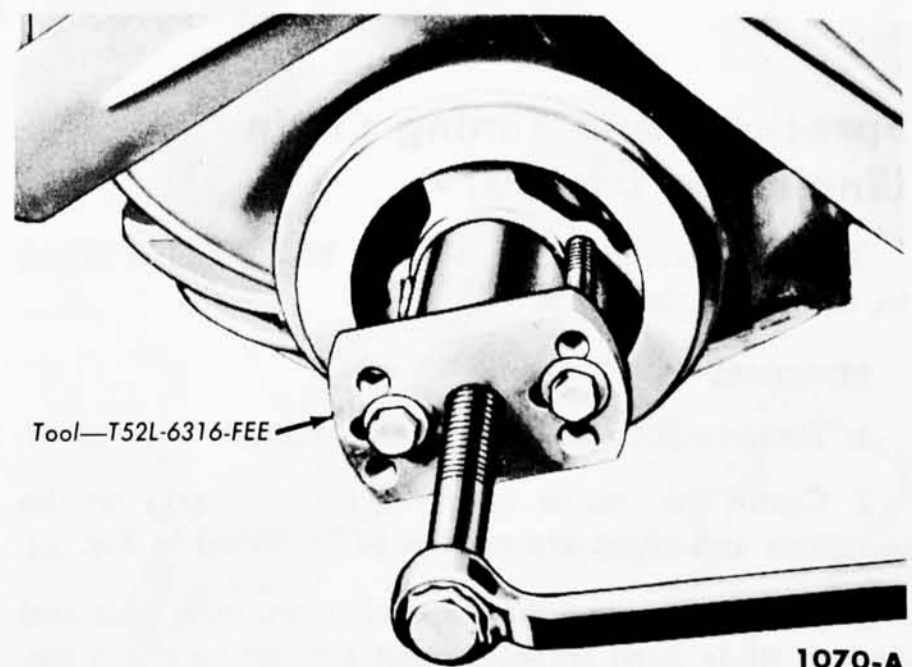


Fig. 19—Damper Removal

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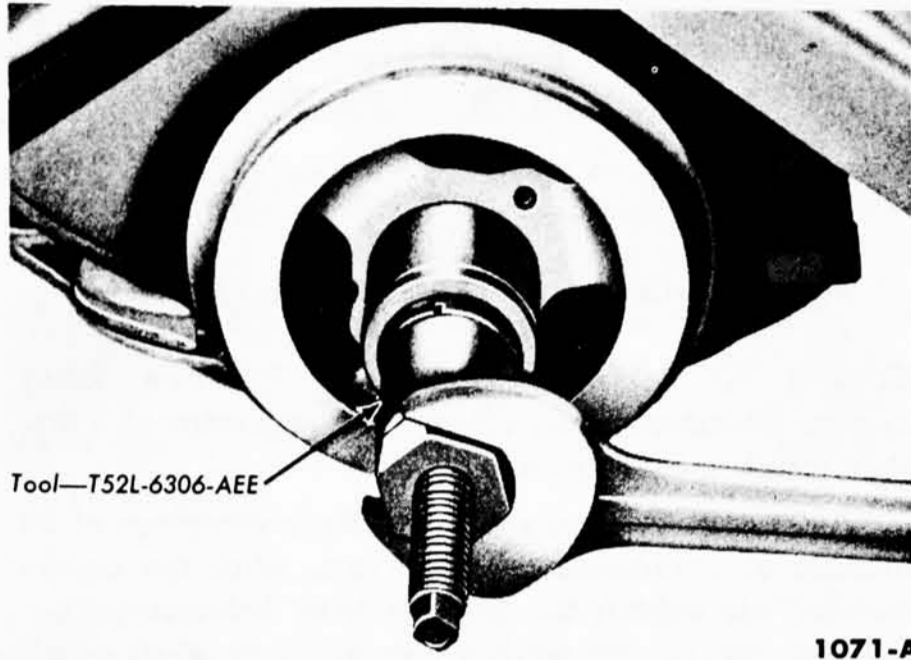


Fig. 20—Damper Installation

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## Cylinder Front Cover and Crankshaft Oil Seal

*It is good practice to replace the front oil seal each time the cylinder front cover is removed.*

**CYLINDER FRONT COVER REMOVAL (ENGINE IN CHASSIS).** Remove the radiator, the crankshaft damper, and the oil pan. Remove the cover retaining screws, the cover and the gasket.

### OIL SEAL REPLACEMENT

1. Drive out the old seal with a pin punch, then clean out the recess in the cover.
2. Coat a new seal with grease, then install the seal (Fig. 21). Drive the seal in until it is fully seated in the recess. Check the seal after installation to be sure the spring is properly positioned in the seal.

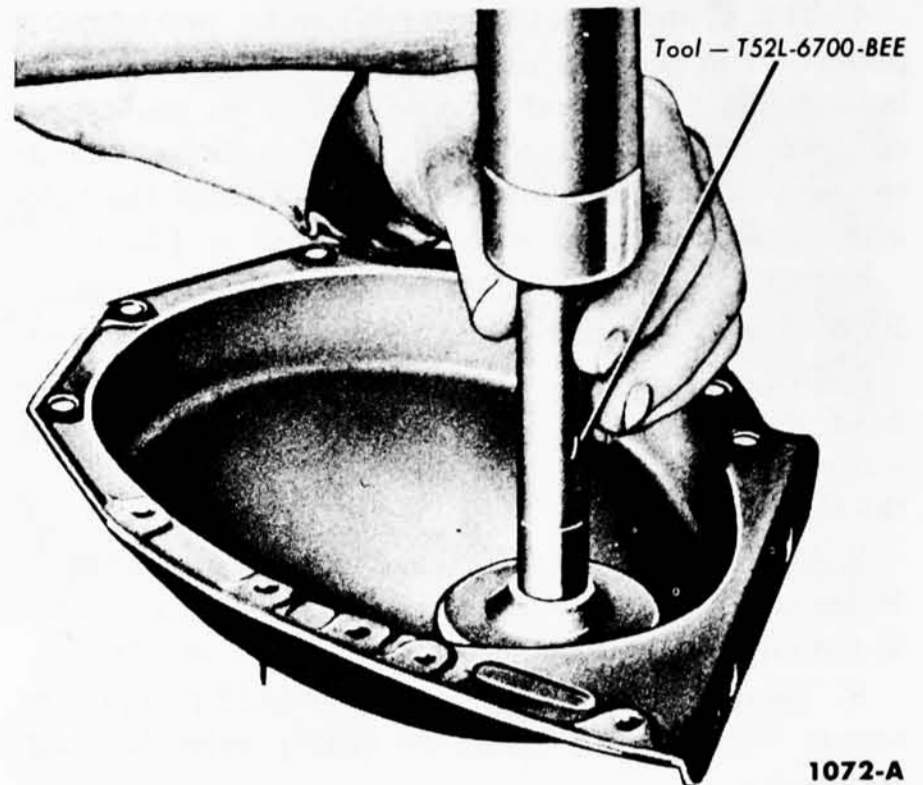


Fig. 21—Oil Seal Installation

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### CYLINDER FRONT COVER INSTALLATION (ENGINE IN CHASSIS)

1. Clean the cylinder front cover and the gasket surface of the cylinder block. Coat the gasket surface of the block and the cover with sealer, then position a new gasket on the block.
2. Place the cover on the block and install the retaining screws. Tighten the screws to 6-9 foot-pounds torque.
3. Install the oil pan, the crankshaft damper, and drive belt. On cars equipped with power steering, install the power steering pump pulley and belt.
4. Install the radiator.

## 7. SPROCKETS AND TIMING CHAIN, CAMSHAFT, BEARINGS, AND TAPPETS

### Sprockets And Timing Chain (Engine In Chassis)

The camshaft sprocket is a slip fit on, and is keyed to, the end of the camshaft.

#### REMOVAL

1. Remove the radiator and the cylinder front cover.
2. Crank the engine until the timing marks on the sprockets and chain are positioned as shown in Fig. 22.

sprocket retaining bolt and s and the timing chain for-assembly.

#### INSTALLATION

1. Place the keys in position in the slots on the crankshaft and camshaft.
2. Position the sprockets and timing chain on the camshaft and crankshaft. Be sure the timing marks on the sprockets and chain are positioned as shown in Fig. 22. There are 12 timing chain link pins between the timing marks on the sprockets.
3. Install the camshaft sprocket washer and retaining bolt. Tighten the bolt to 45-50 foot-pounds torque.
4. Install the cylinder front cover, crankshaft damper, (power steering pump pulley, if applicable) drive belt(s), and radiator.



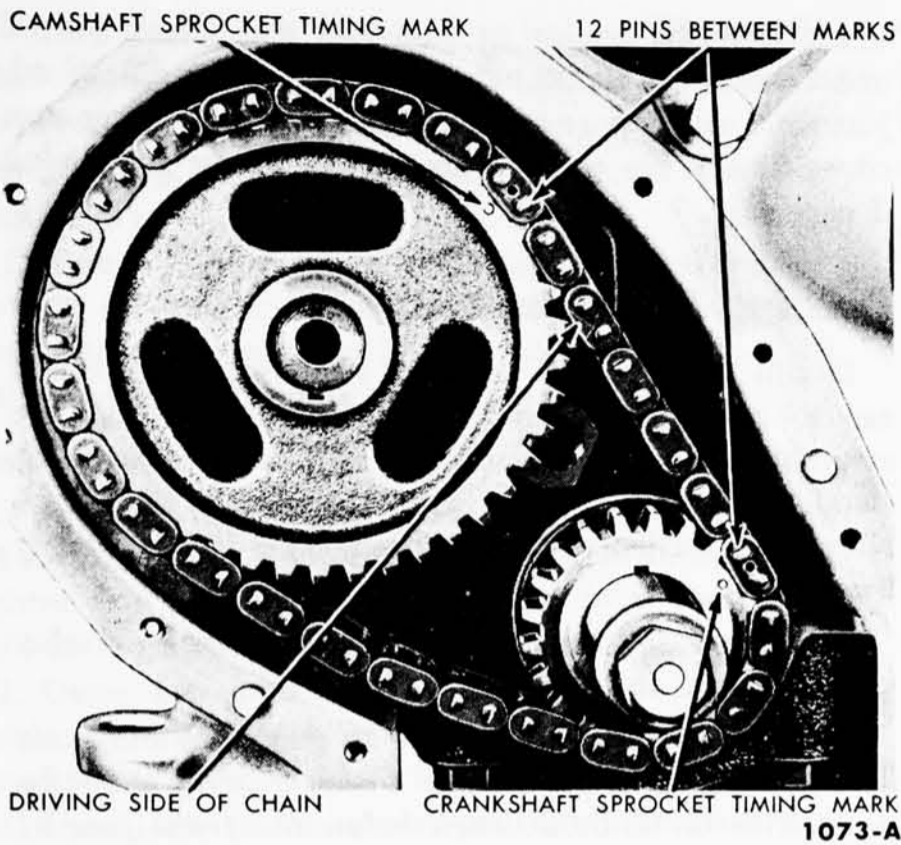


Fig. 22—Aligning Timing Marks

### Camshaft (Engine In Chassis)

The camshaft and related parts are shown in Fig. 23.

#### REMOVAL

1. Remove the air cleaner and tape the air horn closed. Remove the distributor cap.
2. Disconnect the high tension wire from the coil and disconnect the spark plug wires. Remove the fuel pump.
3. Disconnect the ignition switch to coil wire from the engine clips, then remove the push rod chamber cover. Remove the rocker arm mechanism, the valve push rods in sequence, the radiator support bar, the radiator, and the radiator grille assembly. Remove the cylinder front cover, and the oil pan to cylinder block two front bolts.
4. Crank the engine until the timing marks on the sprocket and chain are positioned as shown in Fig. 22. Remove the camshaft sprocket bolt.

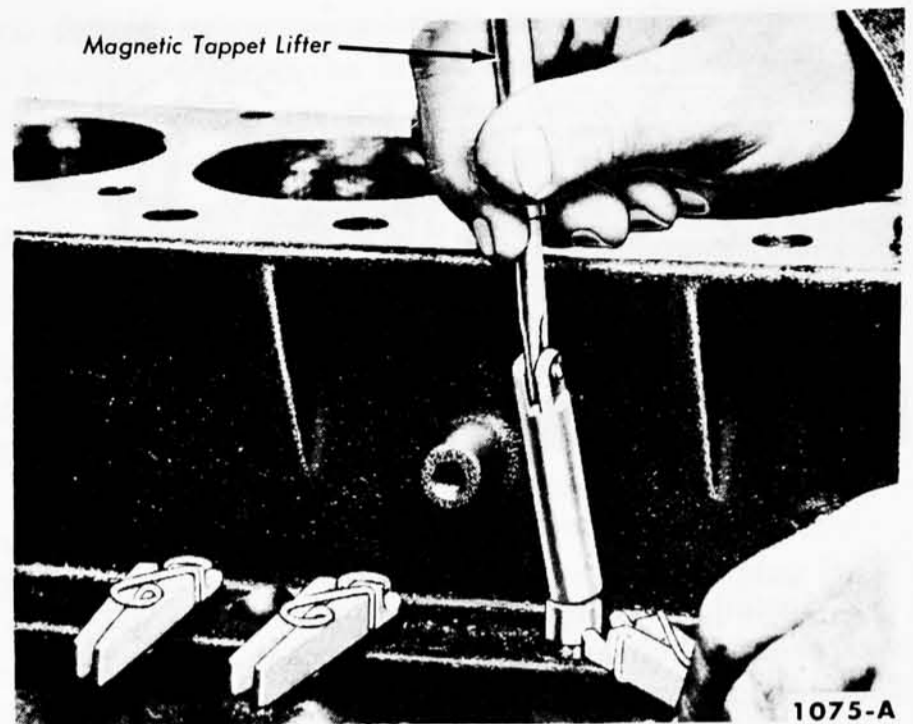
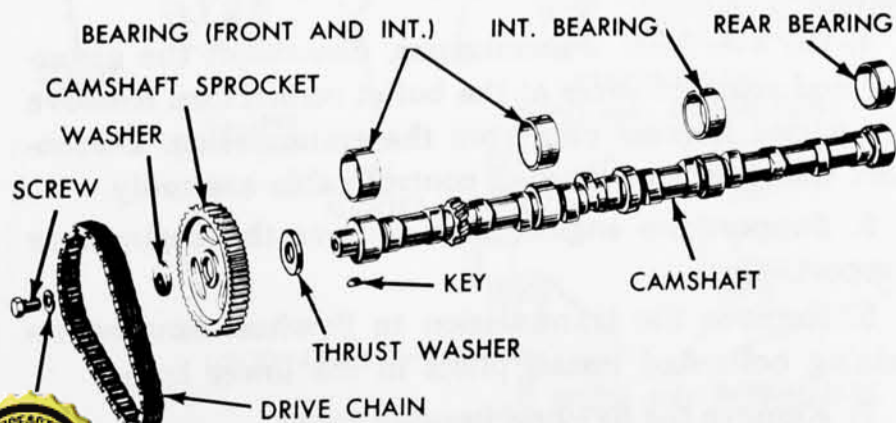


Fig. 24—Lifting and Securing Valve Tappets

5. Scribe a line on the distributor housing and cylinder block to mark the position of the rotor and distributor housing for installation, then remove the distributor.

6. Remove the sprockets and timing chain, the woodruff key and camshaft thrust washer.

7. Turn the camshaft until the tappets can be lifted with either a magnet (Fig. 24), or the fingers. Raise the tappets clear of the camshaft lobes and secure them with spring-type clothes pins or window regulator spring clips (Figs. 24 and 25).

8. Carefully remove the camshaft by pulling it toward the front of the engine. *Exercise the necessary caution to avoid damaging the camshaft bearings.*

#### INSTALLATION

1. Oil the camshaft and carefully slide it through the bearings. Install the thrust washer and woodruff key. *Be sure the chamfer on the thrust washer is to the rear or faces the camshaft journal.*

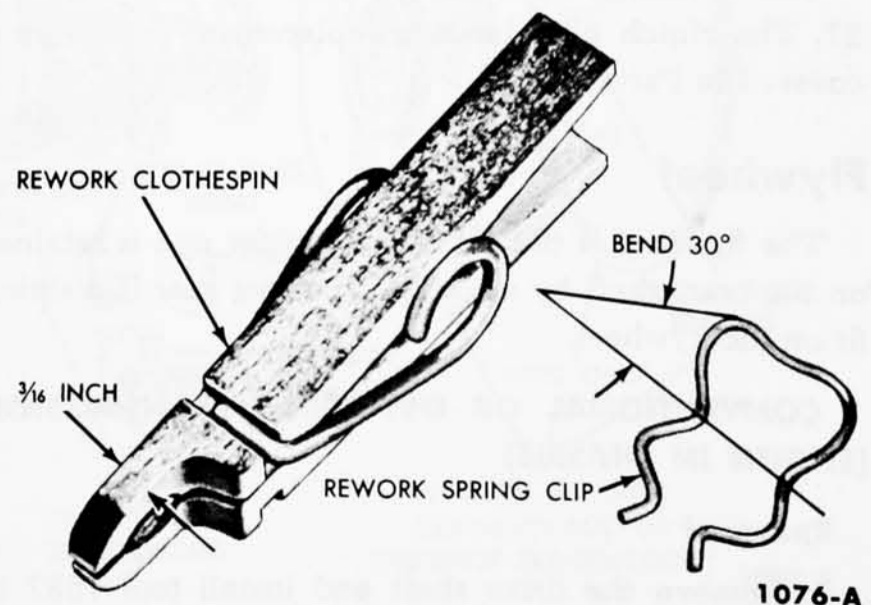


Fig. 25—Tappet Retainers

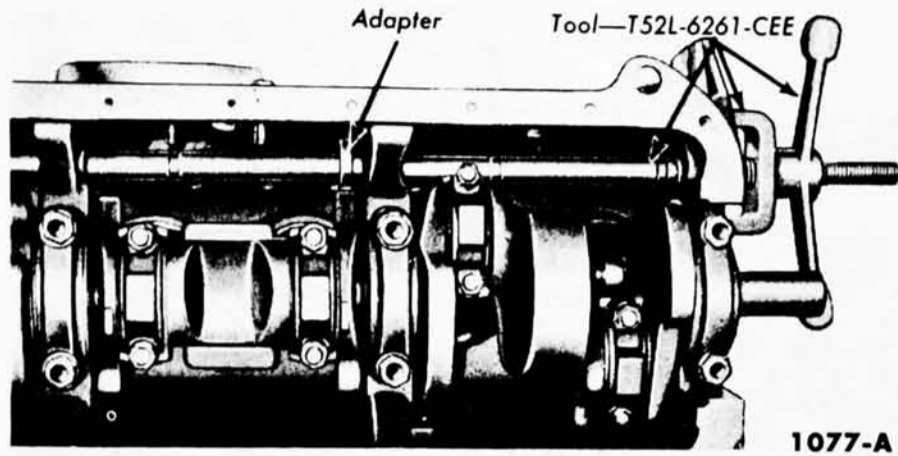
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and Related Parts



**Fig. 26—Camshaft Bearing Replacement**

2. Install the sprockets and timing chain, sprocket washer and bolt. Tighten the sprocket bolt to 45-50 foot-pounds torque.
3. Install the cylinder front cover, the oil pan to block two front bolts, the drive belts and fan assembly.
4. Install the radiator grille assembly, radiator, and radiator support bar.
5. Release the tappets and install the push rods, then install the rocker arm assembly.
6. Perform a preliminary valve lash adjustment.
7. Install the distributor, using the scribed lines as guides to properly position the rotor and housing.
8. Cement the gasket to the push rod chamber cover and install the cover. Tighten the retaining screws to 15-20 inch-pounds torque.
9. Connect the ignition switch to coil wire on the engine clip. Install the distributor cap. Connect the spark plug wires and the coil high tension wire. Install the fuel pump.
10. Remove the tape from the carburetor air horn, then install the air cleaner.

11. Run the engine at fast idle and check for oil and coolant leaks. Make a final (hot) valve lash adjustment with the engine idling. Install the rocker arm cover. Check the ignition timing and adjust the timing if necessary.

## Bearing Replacement

It will be necessary to remove the engine from the car to replace camshaft bearings. The bearings are available pre-finished to size and require no reaming for standard and 0.015-inch undersize journal diameters. Number 3 bearing is not interchangeable with the other bearings.

1. Remove the camshaft, the camshaft rear bearing bore plug, and the camshaft bearings (Fig. 26).
2. Position the bearing at the bearing bore and press it in place (Fig. 26). *Number 1 cam bearing must be pressed in 0.005-0.020 inch below the front face of the bearing bore. Press the remaining bearings in sufficiently to align the oil supply holes.* Install the camshaft.

## Tappet Replacement (Engine in Chassis)

1. Remove the camshaft.
2. Remove the oil pan.
3. Remove and install one tappet at a time through the bottom of the block. A flexible-type holding tool can be used if desired. As each tappet is installed, secure it in the up position.
4. After the tappets are installed, install the camshaft.

## 8. FLYWHEEL, CRANKSHAFT, AND MAIN BEARINGS

The crankshaft and related parts are shown in Fig. 27. The clutch pilot bushing replacement procedure is covered in Part 3.

### Flywheel

The flywheel is piloted on a shoulder and is retained on the crankshaft by six bolts. The ring gear is a shrink fit on the flywheel.

### CONVENTIONAL OR OVERDRIVE TRANSMISSION (ENGINE IN CHASSIS)

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and install tool 7657 in

2. Remove the speedometer cable from the transmission extension housing and secure it on the frame.
3. Disconnect the gear shift rods and transmission levers.
4. On overdrive transmissions, disconnect the governor and solenoid wires at the bullet connectors. Remove the wiring harness clip from the transmission. Disconnect the overdrive manual control cable assembly.
5. Support the engine, then remove the engine rear support.
6. Remove the transmission to flywheel housing retaining bolts and install pilots in the lower holes.
7. Remove the flywheel housing cover.
8. Slide the transmission far enough to the rear to clear the flywheel housing.

9. Mark the clutch assembly so that it can be installed the same position, then remove the clutch release rod, spring, and bearing.

10. Remove the clutch pressure plate and disc (Tool-7563).

11. Remove the flywheel retaining bolts and pry the flywheel off the crankshaft. Remove it through the housing lower access opening. Do not get grease or oil on the clutch components.

### Installation

1. Position the flywheel on the crankshaft flange and align the bolt holes, then install the mounting bolts. Tighten the bolts in sequence across from each other to 75-85 foot-pounds torque.

2. Using a pilot shaft (Tool-6392-N) to locate the clutch disc, install the pressure plate and disc. Tighten the retaining bolts to 17-20 foot-pounds torque.

3. Install the clutch release rod, bearing, spring, and hub.

4. Slide the transmission forward on the pilots and install the transmission to flywheel housing upper bolts. Remove the pilot studs and install the lower retaining bolts. Tighten the bolts to 45-50 foot-pounds torque.

5. Install the engine rear support, then remove the jack supporting the engine.

6. Connect the gear shift rods and transmission levers.

7. Install the speedometer cable and drive gear.

8. Install the clutch retracting spring and adjust the clutch pedal free travel ( $1\frac{1}{8}$ - $1\frac{3}{8}$  inches).

9. Install the flywheel housing cover.

10. Remove the tool from the transmission extension housing and install the drive shaft.

11. On overdrive transmissions, connect the governor and solenoid wires at the bullet connectors. Install the wiring harness clip on the transmission. Connect the overdrive manual control cable assembly.

### FORDOMATIC TRANSMISSION (ENGINE IN CHASSIS).

#### Removal

1. Remove the converter housing to engine block upper bolts.

2. Remove the transmission control linkage shield, the torque converter lower access plate, and the torque converter front access plate.

3. Turn the torque converter until the drain plug is at the lower edge. Drain the transmission and torque converter.

4. Remove the drive shaft.

5. Disconnect the speedometer cable and transmission control rod at the transmission.

6. Remove the cable from the starter, then remove the starter.

7. Remove the transmission oil level dip stick.

8. Install the drain plug in the torque converter.

9. Position a jack under the transmission.

10. Remove the transmission support bolts.

11. Remove the frame cross member at the rear of the transmission.

12. Remove the two lower bolts securing the torque converter housing to the engine block.

13. Move the transmission back far enough to clear the flex drive plate. Secure the torque converter to the housing. *If the torque converter is not secured, it will slide off the splines.*

14. Remove the flywheel from the crankshaft.

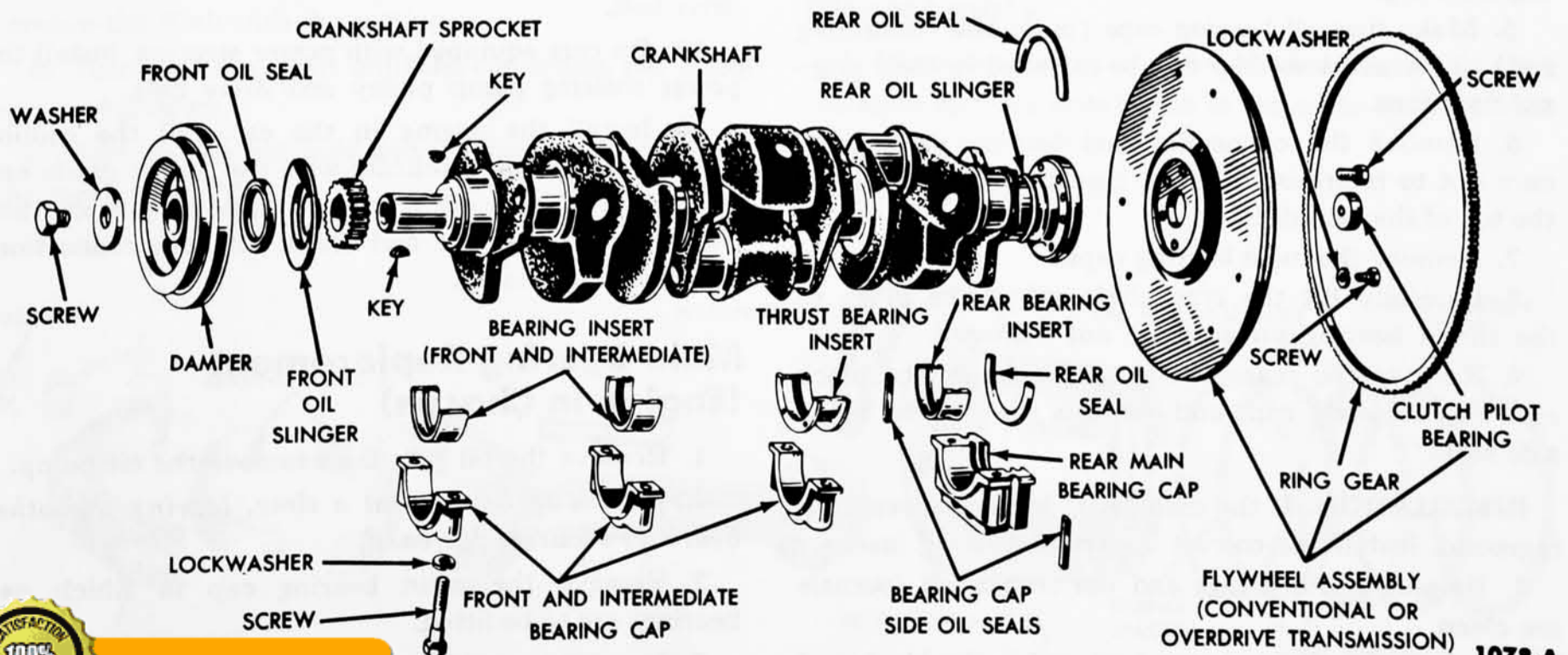


Fig. 27—Crankshaft and Related Parts

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### Installation

1. Position the flywheel on the crankshaft and align the bolt holes, then install the mounting bolts. Tighten the bolts to 75-85 foot-pounds torque.
2. Align the converter pilot and the housing dowel holes, then install the converter housing to engine block lower bolts.
3. Install the flex plate to converter bolts.
4. Install the frame cross member.
5. Remove the jack from the transmission.
6. Install the transmission rear support bolts.
7. Connect the transmission throttle control linkage, the manual control linkage, and the speedometer cable.
8. Install the control linkage shield, converter housing front access cover, the lower access cover, and the transmission oil level dip stick.
9. Install the starter, then connect the starter cable.
10. Install the drive shaft.
11. Remove the safety stands and lower the car.
12. Install the converter housing to engine bolts.
13. Fill the transmission with fluid.
14. Start the engine to fill the converter, then add fluid until the proper level is reached on the dip stick.
15. Check for leaks.
16. Check and adjust the manual control, the neutral switch, and the throttle linkage.

## Crankshaft

### REMOVAL

1. Remove the engine and install it on a work stand.
2. Remove the flywheel, and the engine rear plate.
3. Remove the crankshaft damper, cylinder front cover, sprockets and timing chain.
4. Remove the oil pan and the oil pump screen housing assembly.
5. Make sure all bearing caps (main and connecting rod) are marked so they can be installed in their original locations.
6. Remove the connecting rod bearing caps, using care not to intermix the caps, then push the pistons to the top of the cylinders.
7. Remove the main bearing caps.
8. Carefully lift the crankshaft out of the block so the thrust bearing surfaces are not damaged.
9. Remove the rear journal oil seal from the block and rear bearing cap, and remove the cap to block side seals.

**INSTALLATION.** If the crankshaft journals have been reground, install the correct undersize bearing inserts.

Be sure the bearings and the crankshaft journals

al oil seal in the block and

3. Carefully lower the crankshaft into place. *Be careful not to damage the bearing surfaces.*

4. Check the clearance of each main bearing.
5. After the clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journals and bearings, then install all the bearing caps except the thrust bearing cap. Tighten the cap bolts to 95-105 foot-pounds torque. Install new side seals when the rear main bearing cap is installed.
6. Install the thrust bearing cap and draw the cap bolts up lightly, then align the thrust bearing.
7. Tighten the cap bolts to 95-105 foot-pounds torque. Check the crankshaft end play.
8. Install the connecting rod caps in their original positions.
9. Check the clearance of each bearing.
10. After the clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journals and bearings, then install the rod caps. Tighten the nuts to 45-50 foot-pounds torque.
11. Install the pal nuts and tighten them to 3-4 foot-pounds torque.
12. Check the side clearance of each connecting rod.
13. Install the engine rear plate.
14. Install the flywheel.
15. On standard or overdrive equipped cars, align the clutch disc (Tool 6392-N), compress the clutch pressure plate springs, and install the pressure plate assembly.
16. Install the flywheel housing covers.
17. Install the sprockets and timing chain.
18. Install the cylinder front cover, oil pump screen assembly and oil pan, the crankshaft damper, and drive belt.
19. On cars equipped with power steering, install the power steering pump pulley and drive belt.
20. Install the engine in the car. Fill the cooling system and fill the crankcase with the proper grade and quantity of engine oil. Run the engine at fast idle and check for oil pressure and check all hose connections and gaskets for leaks.

## Main Bearing Replacement (Engine in Chassis)

1. Remove the oil pan, then remove the oil pump. *Replace one bearing at a time, leaving the other bearings securely fastened.*
2. Remove the main bearing cap to which new bearings are to be fitted.
3. Insert the upper bearing removal tool (Tool 6331) in the oil hole in the crankshaft. Rotate the crankshaft



in the opposite direction to engine rotation to force the bearing out of the block.

*When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with two blue bearing halves.*

4. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block. Using the same tool, rotate the crankshaft in the direction of engine rotation until the bearing seats itself. Remove the tool.

5. Clean the crankshaft journal and bearings.

6. Check the bearing clearance.

7. After the clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journals and bearings, then install the bearing cap. Tighten the bolts to 95-105 foot-pounds torque.

8. If the rear main bearing is replaced, replace the journal oil seals and the side seals.

9. Install the oil pump and oil pan.

10. Fill the crankcase with the proper grade and quantity of engine oil, then start the engine and check for oil pressure and oil leaks.

## 9. CONNECTING RODS AND BEARINGS, PISTONS, PINS, AND RINGS

The piston and connecting rod assemblies are shown in Fig. 28.

### Piston and Connecting Rod Removal (Engine In Chassis)

1. Remove the oil pan.

2. Remove the cylinder head.

3. Before removing the piston assemblies, remove any ridge and/or carbon deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. *Never cut into the ring travel area in excess of  $\frac{1}{32}$  inch when removing ridges.*

4. After the ridge has been removed, remove the cutter from the cylinder bore, then turn the crankshaft until the piston is at the top of its stroke and carefully remove the cloth with the cuttings.

5. Turn the crankshaft until the connecting rod being removed is down.

6. Remove the pal nuts and the hex head nuts from the connecting rod bolts.

7. Pull the cap off the rod, then push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. *Avoid damage to the crankpin or the cylinder wall when removing the piston and rod.*

8. Remove the glaze from the cylinder wall.

9. Repeat the above procedure on each assembly.

*Each rod and bearing cap is numbered from 1 to 6 from the front to the rear of the engine. The numbers on the rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted, and the rod should be numbered to correspond with the new cylinder number.*

### Piston and Connecting Rod Disassembly

1. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.

2. Remove the piston rings.

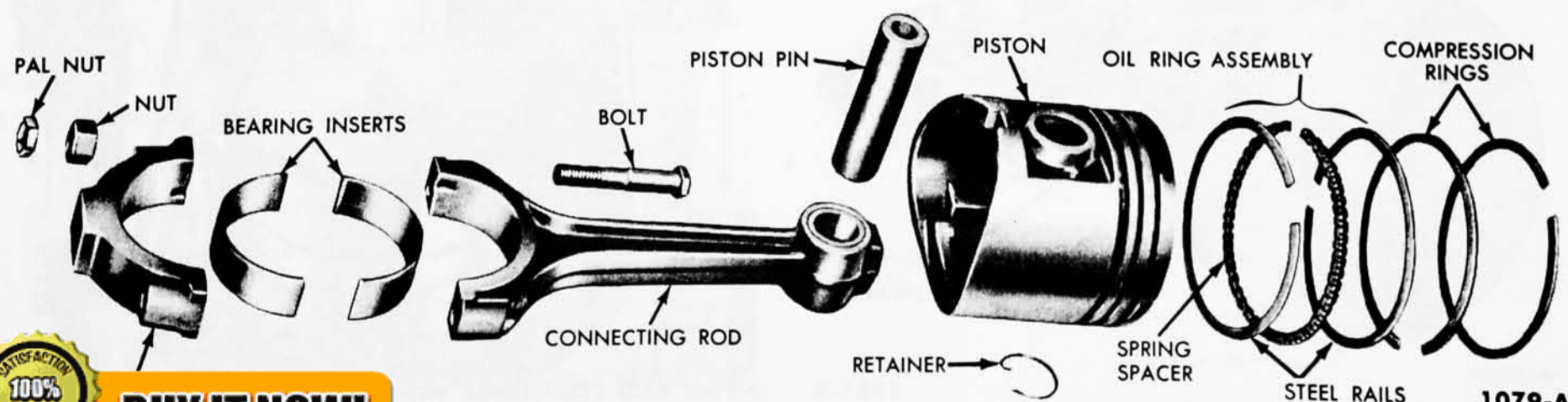


Fig. 28—Piston and Connecting Rod Assemblies

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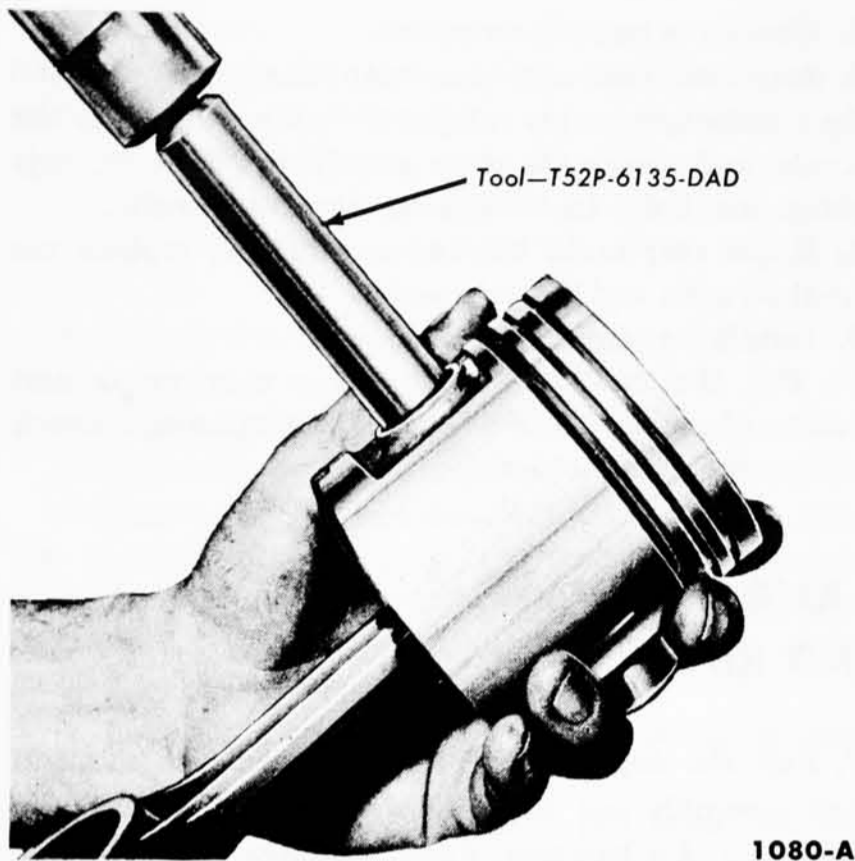
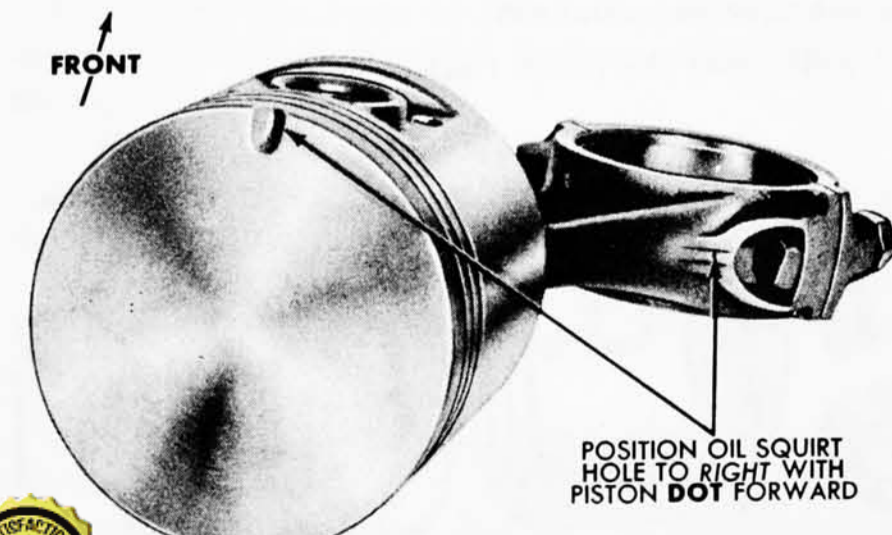


Fig. 29—Piston Pin Removal

3. Remove the piston pin retainers, then drive the pin out of the piston and rod (Fig. 29).
4. Discard the retainers.

### Piston and Connecting Rod Assembly

1. Lubricate all parts with light engine oil.
2. Position the connecting rod in the piston and push the pin into place. *Assemble the piston and connecting rod with the oil squirt hole in the rod positioned as shown in Fig. 30.*
3. Insert new piston pin retainers by spiraling them into the piston with the fingers. Do not use pliers.
4. Follow the instructions contained on the piston ring package and install the piston rings.



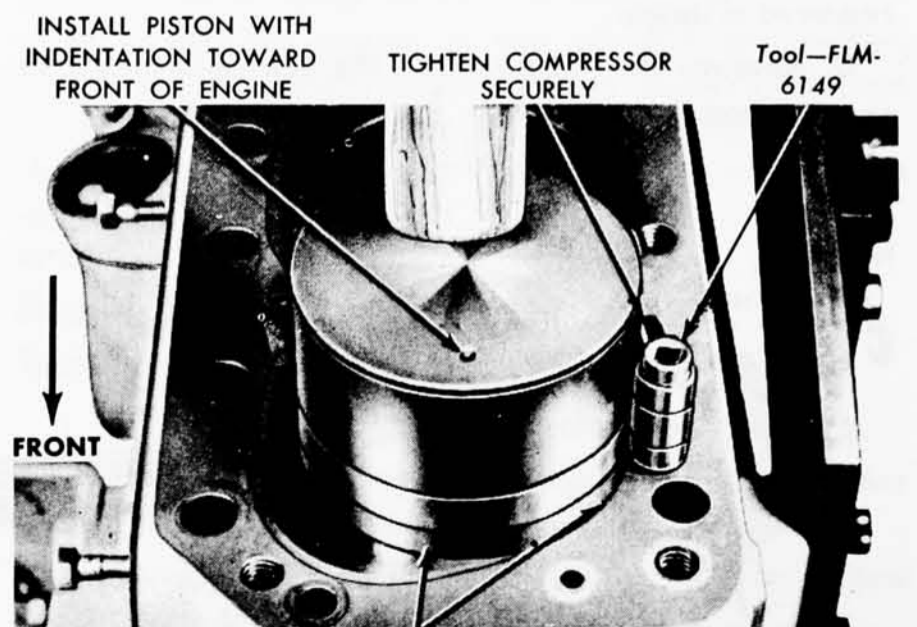
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5. Check the side clearance of the rings.
6. Be sure the bearings and journals are clean. If it is necessary to replace the connecting rod bearings, replace them at this time.

### Piston and Connecting Rod Installation (Engine In Chassis)

*Be sure to install the pistons in the same cylinder from which they were removed, or to which they were fitted.*

1. Oil the piston rings, pistons, and cylinder walls with light engine oil.
2. Make sure the ring gaps are properly spaced around the circumference of the piston. Install a piston ring compressor on the piston and push the piston in with the handle end of a hammer until it is slightly below the top of the cylinder (Fig. 31). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. *Install the piston with the indentation in the piston head toward the front of the engine.*
3. Check the bearing clearance using Plastigage.
4. After the clearance has been checked, and found satisfactory, apply a light coat of engine oil to the journals and bearings.
5. Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the rod bearing seats on the crankpin.
6. Install the rod cap, then tighten the bolts to 45-50 foot-pounds torque.
7. Install the pal nuts and tighten them to 3-4 foot-pounds torque.
8. After all the piston and rod assemblies have been installed, check the side clearance of the connecting rods.



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Fig. 31—Piston Installation

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Position of Oil Squirt Hole

9. Install the oil pan.
10. Install the cylinder head.
11. Fill the crankcase with the proper grade and quantity of engine oil.
12. Fill the cooling system.
13. Run the engine at fast idle. Make sure there is sufficient oil pressure and the engine does not overheat. Check for oil and coolant leaks.

### Connecting Rod Bearing Replacement (Engine In Chassis)

1. Remove the oil pan, then remove the oil pump.
2. Remove the connecting rod bearing caps to which new bearings are to be fitted.
3. Push the piston up in the cylinder, then remove the upper and lower bearings.

4. Clean the crankshaft journal, the cap, and the upper half of the bearing bore.

5. Install the new bearings in the rod and cap. *When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with two blue bearing halves.*

6. Check the bearing fit using Plastigage.

7. After the bearing fit has been checked and found to be satisfactory, apply a light coat of engine oil to the journals and bearings, then install the rod cap.

8. Tighten the bolts to 45-50 foot-pounds torque.

9. Install the pal nuts, and tighten them to 3-4 foot-pounds torque.

10. Repeat the above procedure for the remaining bearings that need replacing.

11. After all the bearings have been replaced, install the oil pump and oil pan.

## 10. OIL PAN, OIL FILTER, AND OIL PUMP

### Oil Pan

#### REMOVAL

1. Drain the crankcase.
2. Remove the oil level dip stick.
3. Remove the engine left and right front splash aprons.
4. Remove the stabilizer bar.
5. Remove the flywheel housing inspection cover.
6. Remove the oil pan retaining screws and remove the pan and gasket.

#### INSTALLATION

1. Make sure the gasket surfaces of the block and pan are clean and free from burrs.
2. Coat the block surface and oil pan gasket surface with sealer and position the gasket on the oil pan.
3. Hold the pan in place against the block and install a screw, finger tight, at each end of the pan.
4. Install the remaining screws, then tighten the screws from the center outward in each direction to 12-15 foot-pounds torque.
5. Install the flywheel housing inspection cover.
6. Install the stabilizer bar.
7. Install the engine right and left front splash aprons.
8. Install the oil level dip stick.

Fill the crankcase with the proper grade and quantity of engine oil and run the engine and check for

### Oil Pump

The oil pump is shown in Fig. 32.

#### REMOVAL

1. Remove the distributor, oil level dip stick, and the oil pan.
2. Remove the two nuts and lockwashers retaining the pump to the cylinder block.

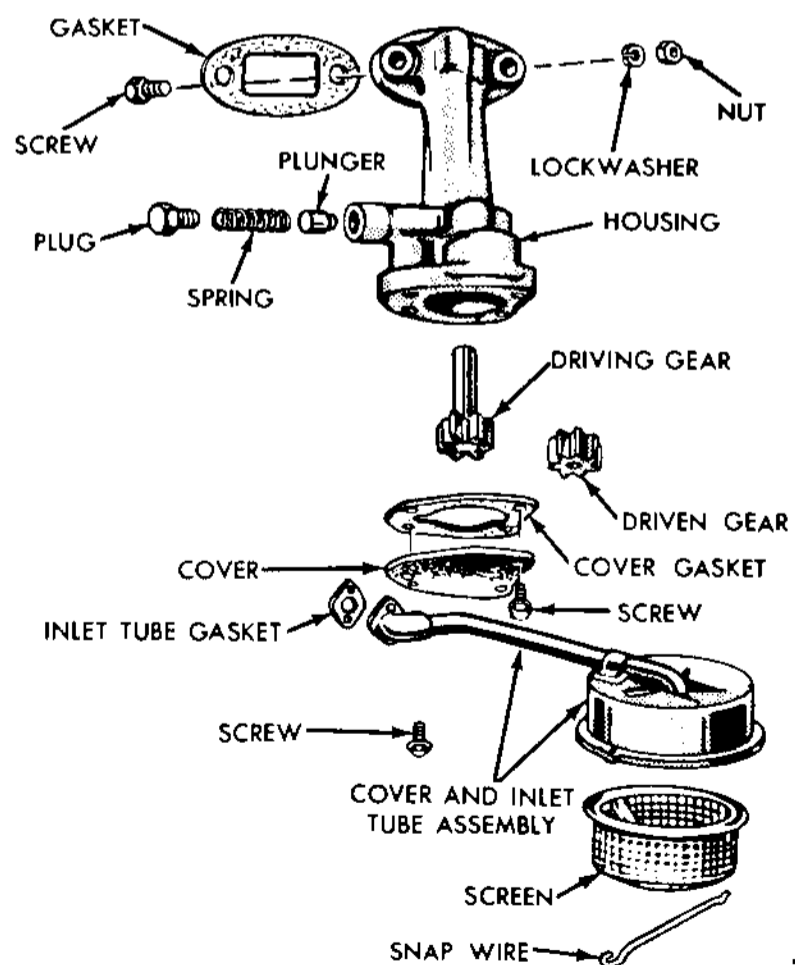


Fig. 32—Oil Pump

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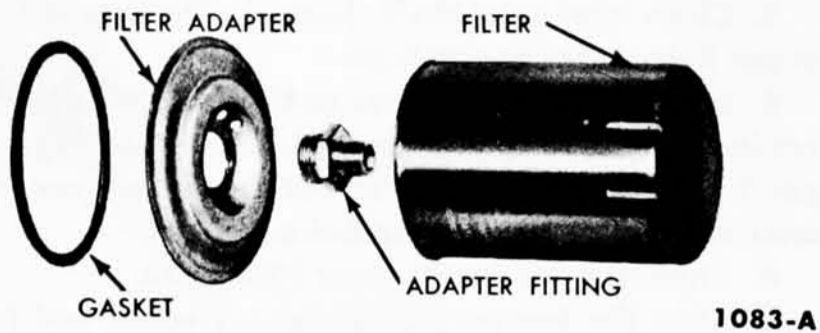


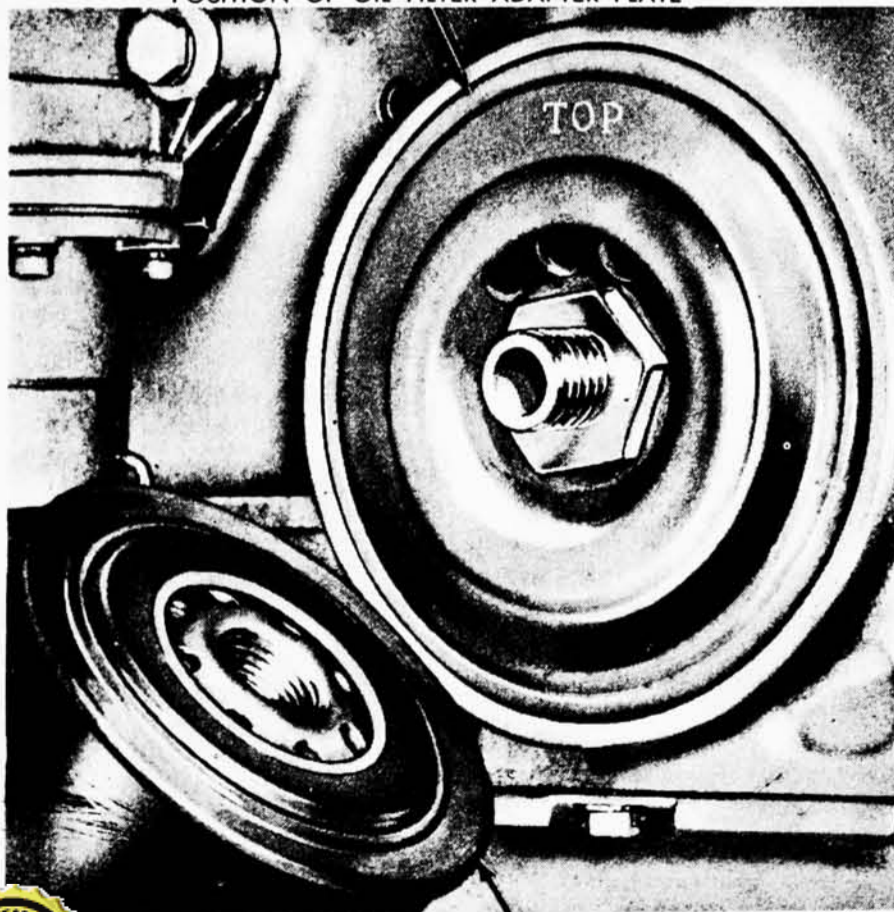
Fig. 33—Oil Filter Assembly

3. Remove the pump and gasket.
4. Thoroughly clean the old gasket material from the mounting pad on the block and pump.

#### DISASSEMBLY

1. Remove the cover inlet tube assembly retaining screws, then remove the tube assembly, and gasket. Remove the cover retaining screws, cover, and gasket.
2. Push the pump drive shaft and drive gear assembly from the pump housing. Remove the driven gear.
3. Remove the oil pressure relief valve chamber plug, spring, and plunger.
4. Remove the snap wire retaining the pump screen, and remove the screen from the housing.

POSITION OF OIL FILTER ADAPTER PLATE



OIL FILTER ELEMENT

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#### ASSEMBLY

1. Apply a light coat of engine oil to all moving parts.
2. Install the pressure relief valve plunger, spring, and plug. Tighten the plug to 33-38 foot-pounds torque.
3. Slide the drive gear and shaft assembly into the housing. Install the driven gear. Check the end play of the gears.
4. Apply sealer to both sides of the pump cover gasket, then position the gasket on the pump. Install the pump cover, but do not tighten the retaining screws.
5. Install the screen in the screen cover and secure it with the retainer.
6. Install the inlet tube gasket, and the inlet tube assembly on the pump cover. Tighten the retaining screws to 12-15 foot-pounds torque. Rotate the pump shaft by hand to make sure it turns freely.

#### INSTALLATION

1. Place a new gasket on the retaining bolts, slide the pump mounting flange over the retaining bolts, and install the lock washers and nuts. Tighten the nuts to 30-35 foot-pounds torque. Install the distributor and the oil pan.
2. Fill the crankcase with the proper grade and quantity of oil. Run the engine at fast idle and check for oil pressure and oil leaks.

### Oil Filter Replacement

The oil filter assembly is shown in Fig. 33.

The filter is removed from the bottom of the car as follows:

1. Place a drip pan under the filter. Unscrew the filter from the cylinder block.
2. Check to see if the filter adapter plate is properly positioned (Fig. 34). Clean the cylinder block filter recess.
3. Coat the gasket on the filter with oil, then place the filter in position on the block. Hand tighten the filter until the gasket contacts the adapter face, then advance it 1/2-turn.
4. Operate the engine at fast idle, and check for leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

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Oil Filter Replacement

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## 11. EXHAUST SYSTEM

The exhaust system consists of a muffler, a muffler outlet pipe, and a muffler inlet pipe (Fig. 35). These parts are provided as individual service parts. *When replacing any part of the exhaust system, loosen all the frame attaching bracket clamps to relieve twists in the system, then tighten the clamps after the part is installed.*

### Inlet Pipe Replacement

1. Remove the two nuts fastening the inlet pipe to the exhaust manifold. Loosen the outlet pipe clamps and the muffler inlet pipe clamp. Slide the muffler to the rear, then separate the muffler and inlet pipe. Remove the inlet pipe and gasket.

2. Slide the clamp on the new inlet pipe, then slide the inlet pipe into the muffler extension until the slots in the extension are blocked. Do not slide the pipe into the muffler more than 1 $\frac{3}{4}$  inches.

3. Install a new gasket on the exhaust manifold outlet flange studs, then connect the inlet pipe to the exhaust manifold.

4. Tighten the bolts to 23-28 foot-pounds torque.

5. Position the muffler, then tighten the outlet pipe clamps. Rotate the inlet pipe clamp downward ap-

proximately 45 degrees so the clamp opening is not positioned directly opposite the slots in the muffler extension, then tighten the clamp.

### Muffler Replacement

1. Remove the lower half of the outlet pipe to muffler clamp, and the lower half of the outlet pipe rear clamp. Separate the outlet pipe from the muffler.

2. Loosen the inlet pipe to muffler clamp and slide it away from the muffler. Remove the muffler to outlet pipe upper clamp and frame bracket from the frame. Remove the muffler assembly from the inlet pipe.

3. Position the new clamp and muffler on the inlet pipe. Slide the muffler forward on the inlet pipe until the slots in the muffler extension are blocked. Do not slide the muffler on the inlet pipe more than 1 $\frac{3}{4}$  inches.

4. Rotate the inlet pipe clamp downward approximately 45° so the clamp opening is not positioned directly opposite the slots in the muffler extension.

5. Install the outlet pipe upper clamp and frame assembly. Slide the outlet pipe forward into the muffler extension until the slots in the muffler extension are blocked. Do not slide the pipe into the muffler more than 1 $\frac{3}{4}$  inches.

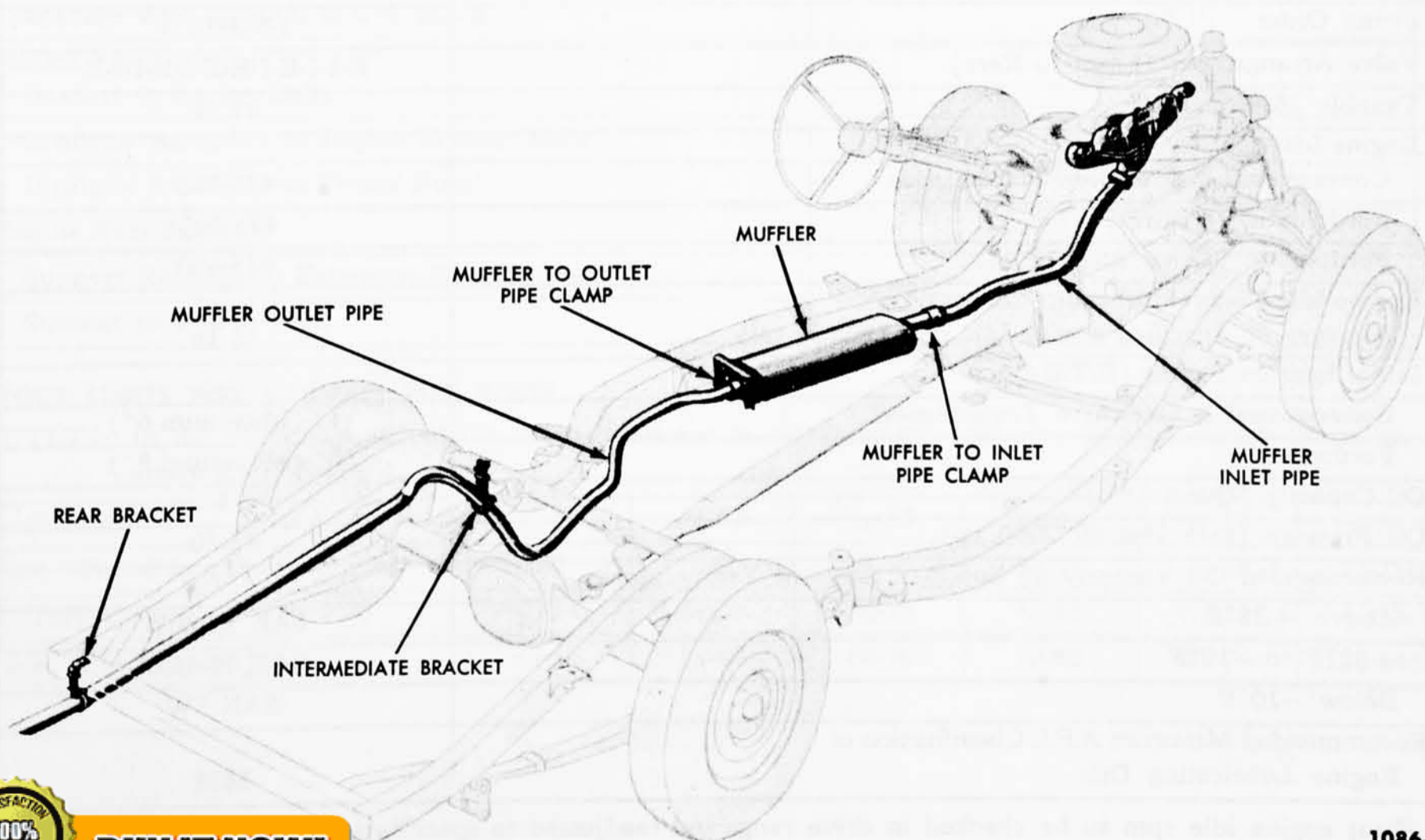


Fig. 35—Exhaust System

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6. Connect, but do not tighten, the lower half of the outlet pipe front and rear clamps.

7. Check for possible interference between the outlet pipe "kick-up" and the floor pan. Reposition the outlet pipe if necessary. Tighten the outlet pipe clamps.

## Outlet Pipe Replacement

1. Remove the lower half of the clamp at the rear of the muffler, then remove the rear clamp from its support.

2. Separate the muffler and outlet pipe, then remove

the outlet pipe.

3. Slide the new outlet pipe into the muffler extension until the slots in the muffler extension are blocked. However, do not slide the pipe into the muffler more than 1 3/4 inches.

4. Slide the rear clamp on the outlet pipe and connect, but do not tighten it to its support.

5. Connect, but do not tighten, the lower half of the clamp at the rear of the muffler.

6. Check for possible interference between the outlet pipe "kick-up" and the floor pan. Reposition the outlet pipe if necessary. Tighten the outlet pipe clamps.

## 12. GENERAL SPECIFICATIONS 6-CYLINDER ENGINE

Note: The engine fits, tolerances, and adjustment specifications are listed at the end of Chapter 1—GENERAL ENGINE SERVICE.

All specifications are given in inches unless otherwise noted.

Piston Displacement (cubic inches)	223
Bore and stroke	3.62 x 3.60
Compression Ratio	8.6:1
Engine Fuel Requirements	Regular
Compression Pressure-Sea Level @ Cranking Speed	150
Brake Horsepower @ Specified rpm	144 @ 4200
Torque—(Foot-Pounds) at Specified Engine rpm	212 @ 2400
Firing Order	1-5-3-6-2-4
Valve Arrangement (Front to Rear)	E-I-I-E-I-E-E-I-E-I-E
Taxable Horsepower	31.54
Engine Idle rpm:	
Conventional & Overdrive Transmission	475-500
Fordomatic (Neutral)	475-500
Fordomatic (Drive range)*	425-450
Engine Idle Manifold Vacuum—Inches of Mercury @ Specified Engine Idle rpm (Sea Level)	18-19
Initial Ignition Timing (B.T.D.C.)	
Conventional & Overdrive Transmission	4° (Maximum 6°)
Fordomatic	6° (Maximum 8°)
Oil Capacity (Quarts)**	4
Oil Pressure (psi) Hot @ 2000 rpm	45-50
Recommended Oil Viscosity @ Specified Ambient Temperature:	
Above +32°F	SAE 20-20W
+32°F to -10°F	SAE 10-10W
Below -10°F	SAE 5W
Recommended Minimum A.P.I. Classification of Engine Lubricating Oils	MM

\*to be checked in drive range and readjusted to specifications if necessary  
\*\*range



**TORQUE LIMITS (Foot-Pounds)**

Main Bearing Cap Bolts	95-105
Cylinder Head Bolts (Hot)	75
Oil Pan to Cylinder Block	12-15
Flywheel to Crankshaft	75-85
Exhaust Manifold to Cyl. Hd.	23-28
Intake Manifold to Cyl. Hd.	23-28
Oil Pump to Cyl. Block	30-35
Oil Pump Cover Plate	12-15
Cyl. Front Cover	6-9
Water Outlet Housing	23-28
Rocker Arm Cover	2.0-2.5
Cam Sprocket to Cam	45-50
Damper to Crankshaft	85-95
Connecting Rod Nuts	45-50
Connecting Rod Pal Nuts	3-4
Rocker Shaft Support to Cyl. Hd.	45-55
Valve Rocker Arm Adj. Screw (Self Locking) Minimum Torque to Rotate	3
Push Rod Chamber Cover	12-15 (Inch-Pounds)
Water Pump to Cyl. Block	23-28
Fuel Pump to Cyl. Block or Cyl. Front Cover	12-15
Crankcase Vent Adapter to Cyl. Block	8-10
Engine Front Support Bracket to Engine Bolts	45-50
Insulator Assembly to Engine Bracket Bolts	50-60
Insulator Assembly to Frame Nuts	45-50
Engine Rear Support	
Support Retainer to Extension Housing Bolts	50-60
Support to Frame Nuts	23-28

**TORQUE LIMITS FOR VARIOUS SIZE BOLTS**

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

Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Foot-Pounds)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Foot-Pounds)	45-50	50-60	60-70	70-80	85-95	130-145



# Part 1—ENGINES

## Chapter 3

### 8-CYLINDER ENGINES

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The removal, disassembly, assembly, and installation procedures for the component parts of the 8-cylinder engine are covered in this chapter. The procedures are the same for all the 8-cylinder engines unless other-

wise noted.

The cleaning, inspection, and repair procedures and engine overhaul instructions are covered in Chapter 1, "General Engine Service."

## 1. DESCRIPTION

All the 8-cylinder engines have the same basic design. The various engine models differ only in piston displacement, bore diameter, length of stroke, compression ratio, power output, and carburetor equipment.

A typical 8-cylinder engine is shown in Figs. 1 and 2. The differences between the engine models and their application are listed in Table 1.

The cylinders are numbered from front to rear on the right bank 1, 2, 3, and 4 and on the left bank 5, 6, 7, and 8. The firing order is 1-5-4-8-6-3-7-2. The valves are arranged from front to rear on both banks E-I-I-E-E-I-I-E.

The cylinder head assemblies contain the valves and the valve rocker arm mechanism. Valve guides are an integral part of the head.

Both the intake and exhaust valve assemblies are the rotating-type which rotate each time the valve opens and closes. The rotation permits self cleaning and better seating, minimizes valve warpage, wear, and sticking. An umbrella-type valve stem seal fits over the top of the valve stem and extends over the top of the valve guide opening. The seal controls lubrication of the valve stem. The valve springs have equal coil spacing which provides more positive valve action at high engine

Table 1—Engine Model Application

Engine Prefix	Piston Displacement (Cubic Inches)	Compression Ratio	Type Transmission	Type Carburetor	Fuel Required	Car Model Application
EGG	272	8.6:1	All	2-Barrel	Regular	Custom
EDB	292	9.1:1	All	2-Barrel	Regular	Fairlane, Station Wagons, Thunderbird*
ECJ	312	9.7:1	All	4-Barrel	Premium	All**
ECJ	312	9.7:1	All	Dual 4-Barrels	Premium	Fairlane, Station Wagons, Thunderbird and Police Interceptor



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