SERVICE MANUAL

SECTION V

ENGINE

Packard Motor Car Company
Detroit 32, Michigan

INDEX

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INTRODUCTION

This section of the Service Manual primarily is a reference book on the repair, servicing, and adjustment of the engines used throughout the "Clipper" Series (1941-1947) and the engines used in the 22nd Series "6", "8", "Super 8", and "Custom 8" models (1948).

A reference section of limits, tolerances, torque tightening, and tune-up specifications is given at the back of this manual. This reference section will serve as a ready guide when the serviceman is performing an operation in which the limits for the particular engine he is servicing differ from those of the other engines.

In form, this manual is designed for rapid reference and does not give a detailed description of various procedures which have been substantially unchanged since earlier models and which are familiar to Packard servicemen and to those who are familiar with general automobile servicing. However, where servicing procedures differ on the various engines, the differences will be covered in those operations involved.

GENERAL ENGINE DESCRIPTION

Packard engines are of the in-line, vertical L-head type with cylinders and crankcase cast-en-bloc. Cast iron cylinder heads having high turbulence combustion chambers are used on all engines.

All engines are mounted in front in a live, resilient rubber block which attaches to the cylinder block at a point below the water pump. Inclined blocks of live rubber on each side of the transmission case form the cushioned mounting at the rear. See figure 1.

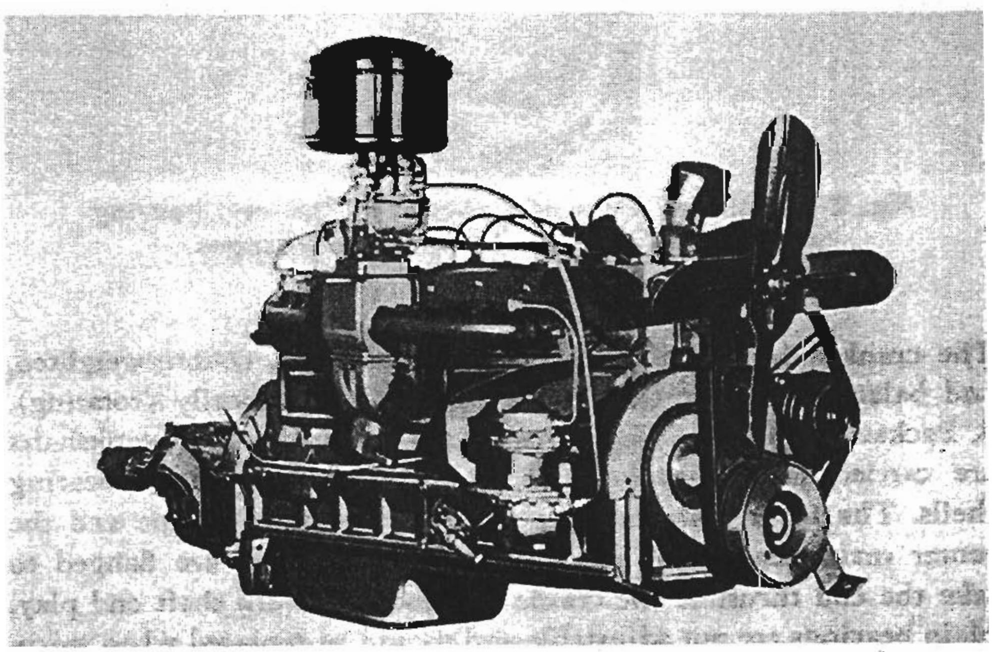


Fig. 1—Packard Eight Engine.

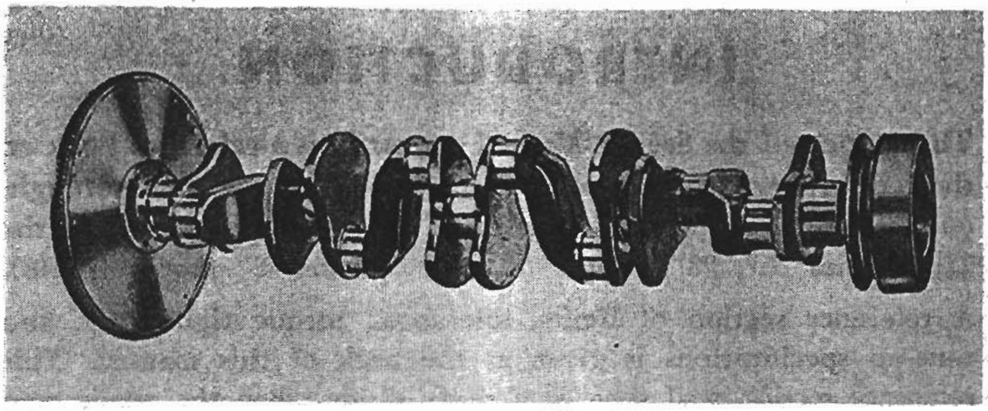


Fig. 2—Packard Eight Crankshaft with Flywheel and Vibration Damper Attached.

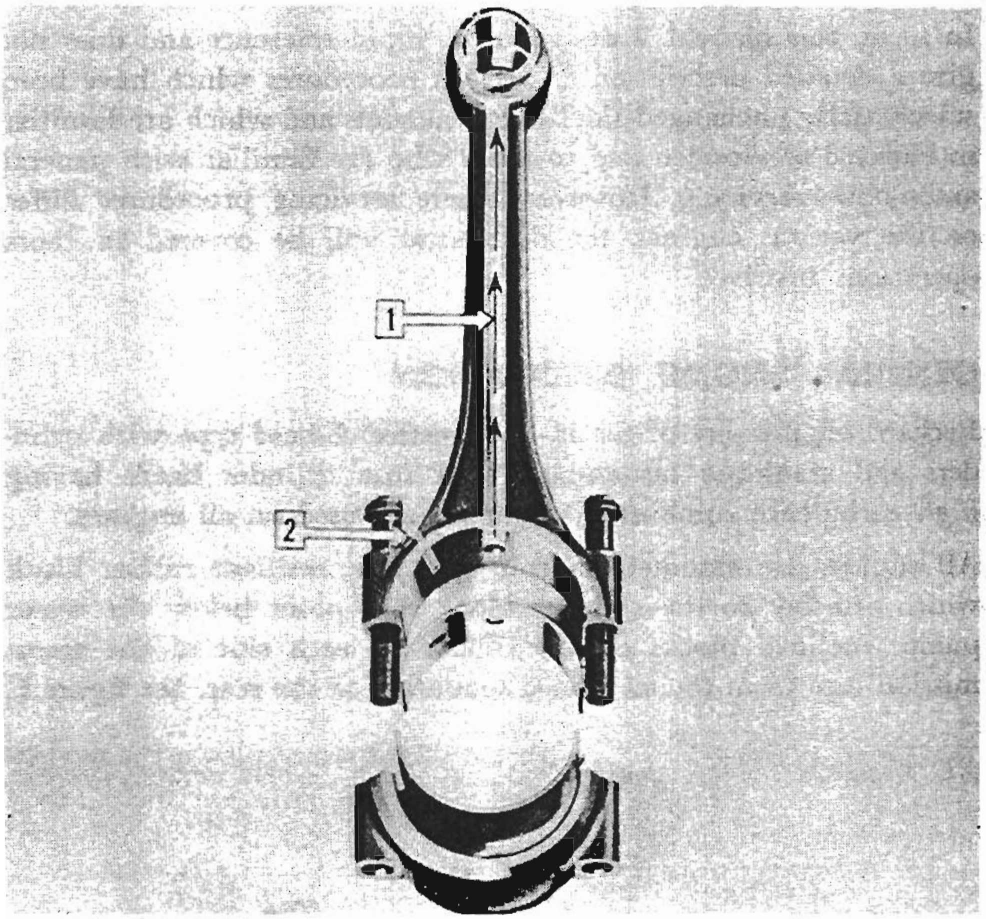


Fig. 3—Exploded View of Connecting Rod and Bearing Assembly. Note the Drilled Oil Passages.

The crankshafts are high carbon steel forgings, counterweighted, and balanced both statically (at rest) and dynamically (rotating). A Packard Eight crankshaft is shown in figure 2. The crankshafts are carried in steel-backed, babbitt-lined precision type bearing shells. The front main bearing of the six-cylinder engine and the center main bearing of the eight-cylinder engines are flanged to take the end thrust of the crankshaft and to govern shaft end play. Main bearings are not adjustable and should be replaced when worn.

Steel forged connecting rods on all models have rifle-drilled passages (1, figure 3) to provide pressure lubrication for the piston pin bushings. All connecting rods are fitted with steel-backed, babbitt-lined precision type bearing shells which bear on the crankshaft and with bronze bushings in which the piston pins float. Connecting rod bearings are not adjustable. A small oil hole (2) is located in the lower end of the connecting rod and the stream of oil from this hole provides spray lubrication for the piston.

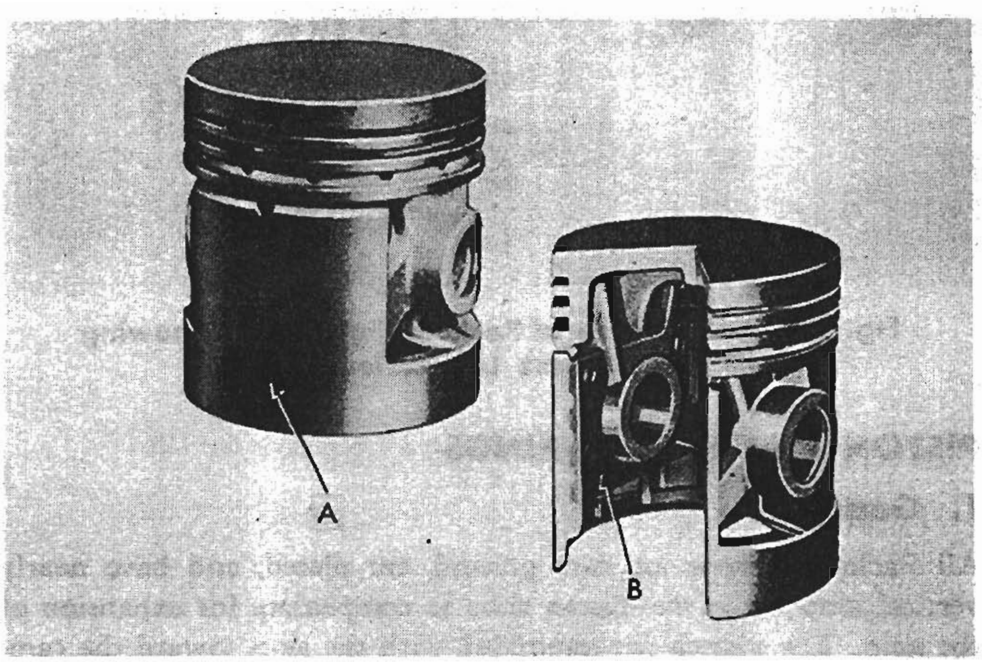


Fig. 4—Packard Piston. Slot "A" Compensates for Skirt Expansion. Strut "B" Thermostatically Controls Expansion.

Pistons are of the cam ground, autothermic aluminum alloy type with two compression rings and one oil ring above the piston pin. The pistons are tin plated and nearly vertical slots (A, figure 4) are cut in the piston skirt to compensate for expansion of the skirt. Steel plates or struts (B) imbedded in the aluminum alloy of the piston skirt thermostatically control expansion. Contrary to common practice in the industry, the slotted side of the piston is assembled toward the camshaft side of the engine.

The chain driven camshafts are steel drop forgings with the cams forged as an integral part of the shaft. Camshafts are carried in steel-backed, removable precision type bearings. In all engines the camshaft bearings are pressure lubricated.

A full pressure lubrication system is used in all engines. See figure 5. Oil is delivered from a gear type, high capacity pump having a built-in relief valve or pressure regulator to control the oil pressure in the system.

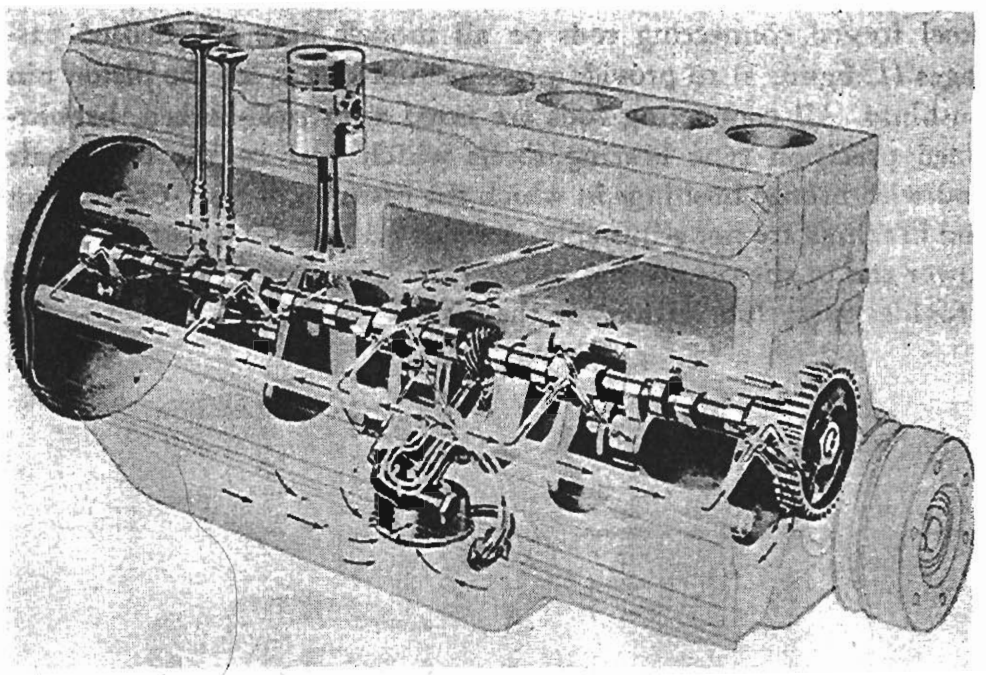


Fig. 5—Cutaway View of Packard Eight Engine Showing the Full Pressure Lubrication System.

PISTONS, PINS, AND RINGS

1. General

All Packard pistons are cam ground, tin plated, and have nearly vertical slots cut in the piston skirt to compensate for expansion of the skirt. The pistons are assembled with the slots toward the camshaft side of the engine.

A star after the engine serial number indicates that the cylinder bores are .020 inch oversize.

Pistons are available in standard size and oversizes of .005, .020, .030, and .040 inch.

Piston pins are supplied in standard size and oversizes of .003 and .006 inch.

Piston ring sets are available in standard size and oversizes of .020, .030, and .040 inch.

2. Removing Piston and Rod Assemblies

Piston and rod assemblies are removed from above after removing the cylinder head and oil pan.

NOTE

If a deep ridge is present at the top of the cylinder bores, it should be removed as outlined under "Removing Cylinder Wall Ridges" before attempting to remove the pistons and rods.

Before starting to remove the oil pan, it is advisable to have the car under a chain fall since it may be necessary to slightly raise the front of the engine to obtain sufficient clearance to remove the pan.

After the car has been placed in position, remove the cylinder head, if it has not been removed, and then detach the steering idler lever support from the frame side rail to lower the steering linkage.

Remove the flywheel housing lower cover and the oil pan retaining screws and then lower the pan. The crankshaft may be in such a position that the counterweights interfere with the pan while it is being removed. If so, turn the crankshaft with a bar or a long screw driver in the teeth of the flywheel while using the edge of the flywheel housing as a fulcrum.

If it is necessary to raise the front of the engine to obtain additional clearance, attach a chain fall to the front of the cylinder block using a suitable strap or piece of flat stock over two of the cylinder head front studs. It is not necessary to loosen the front motor support bolts prior to raising the front of the engine to obtain this additional clearance. Simply relieving the load of the engine in the chassis will provide the necessary clearance.

When pushing the rod and piston assemblies upward and out through the top of the cylinder bores, care should be exercised to avoid scratching and possibly damaging the walls.

3. Removing Cylinder Wall Ridges

After the cylinder head and oil pan have been removed, the ridge at the top of each worn cylinder must be removed before attempting to remove the piston and rod assembly. This is necessary because the piston rings very likely will strike the ridge and bend or break the ring lands of the piston if the ridge is not removed first.

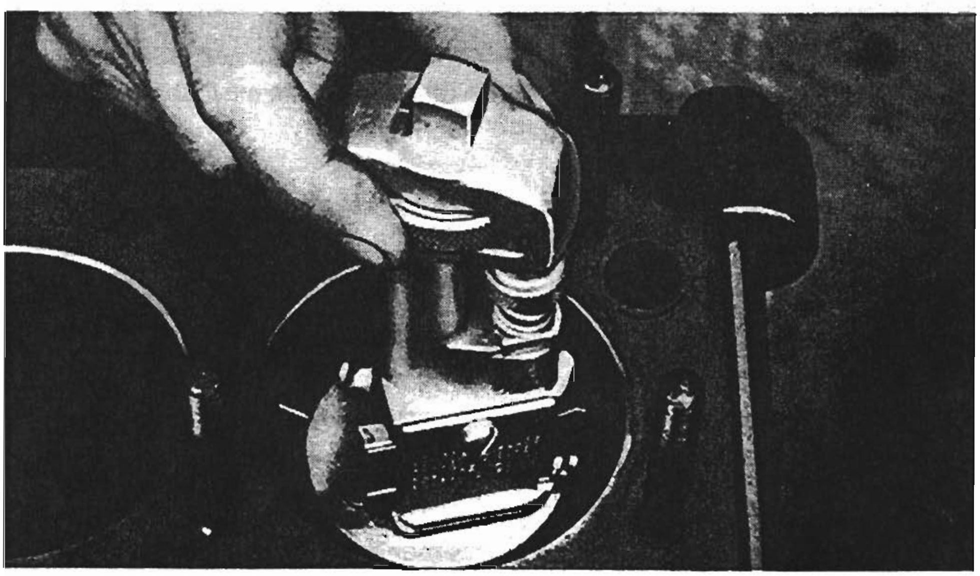


Fig. 6—Turn Large Knurled Knob Clockwise Until Jaws of Centering Head Support the Weight of the Tool.

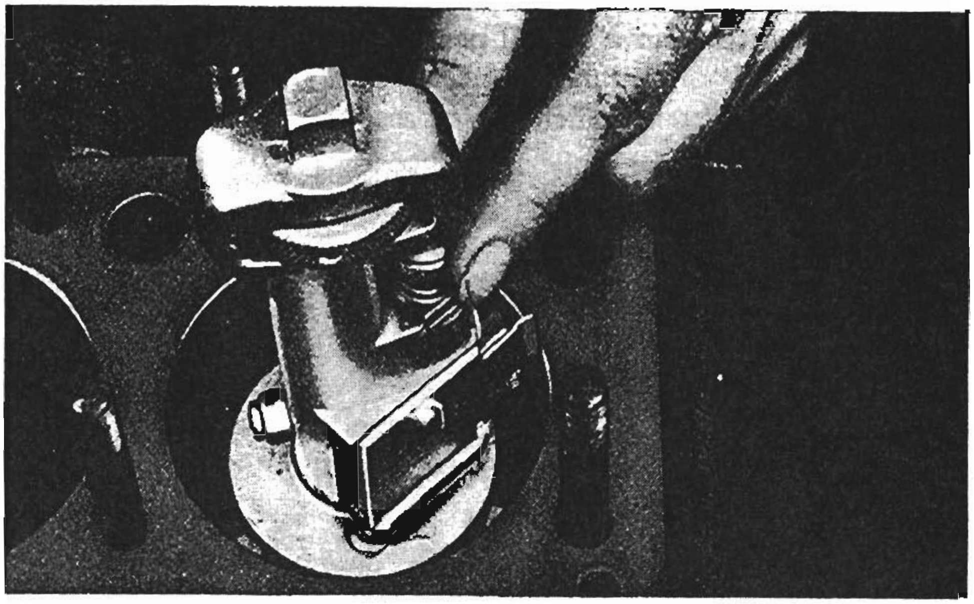


Fig. 7—Turning the Small Knurled Knob Clockwise Advances the Cutting Blade.

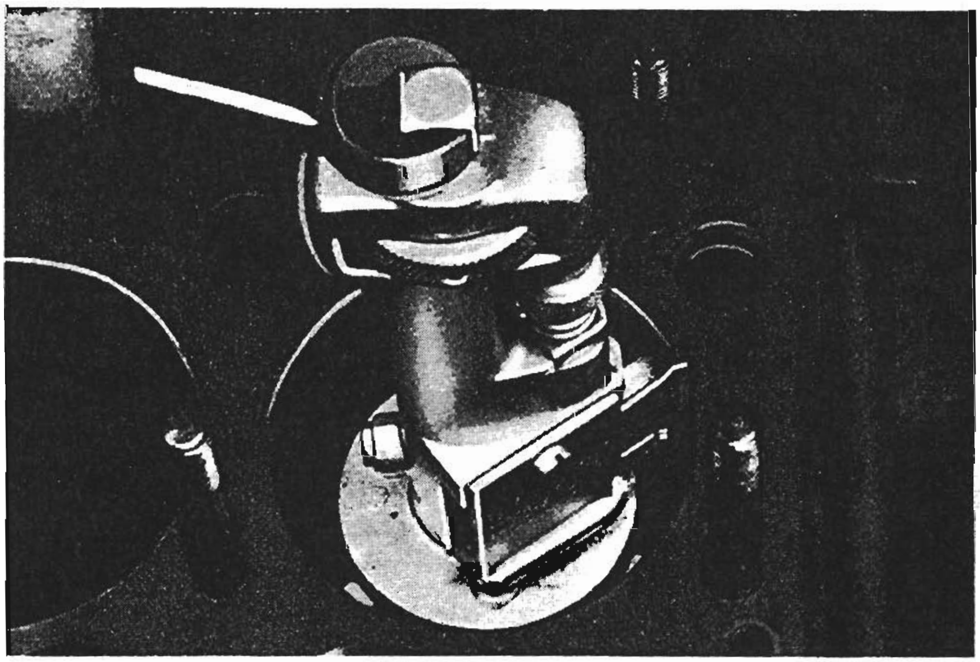


Fig. 8—Rotate the Tool Clockwise to Cut Down the Ridge at the Top of the Cylinder.

The ridge can be removed with any good ridge reamer. The following paragraphs describe the use of the adjustable Cylinder Ridge Cutter KMO-638.

Rub an oily rag over the ridge. Insert the reamer into the cylinder with the stop screw under the blade ¼ inch below the ridge. Turn the large knurled knob to the right (clockwise) until the jaws of the centering head support the weight of the tool. See figure 6.

Be sure that the blade and the blade stop screw are at least ⅛ inch from the cylinder wall so that the reamer will lock up true with the cylinder bore. Lock the tool in place using the pin in the large knurled knob.

Turn the small knurled knob to the right (clockwise) to advance the blade to contact the ridge. See figure 7. Continue turning the small knob to compress the blade feed spring all the way to the automatic stop. With a wrench on the square drive of the tool, rotate the tool to the right (clockwise) until the blade stop screw is against the cylinder wall. See figure 8.

NOTE

Do not back up the tool when cutting out the ridge.

To remove the reamer from the cylinder, first back off the small knurled knob to retract the cutting blade and then release the tool by backing off the large knurled knob.

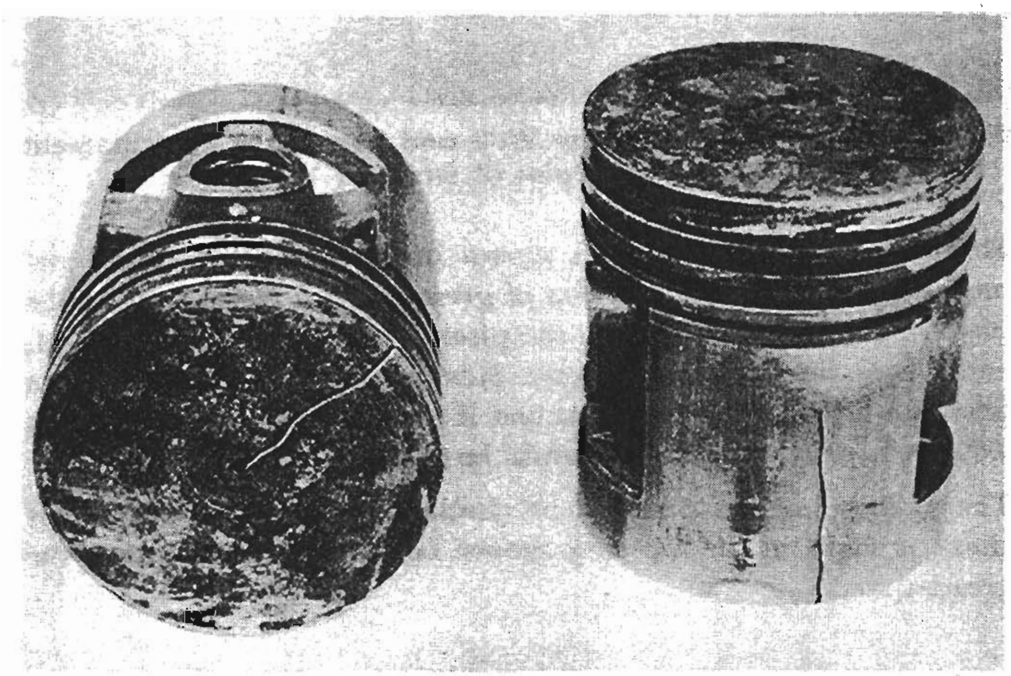


Fig. 9—Pistons Should Be Closely Inspected After Cleaning. Note the Cracks in the Piston Head and the Skirt.

4. Inspection

After the pistons have been cleaned, inspect for cracked or worn ring lands, scores, corrosion, and collapsed skirts. See figure 9.

Measure the cylinder wall taper. If the taper is more than .007 to .010 inch, it is recommended that the cylinder block be rebored and new pistons installed. However, if an owner desires a dependable job but wants to hold the cost to a minimum, new rings may be installed without reconditioning the block if the taper is no greater than .014 inch.

Whenever a re-ring job is done, the pistons and cylinder walls should be checked to determine whether the pistons require skirt expanders. If new rings are installed on a piston with a collapsed skirt, the piston will rock and the ring faces will soon wear oval and lose their ability to scrape oil.

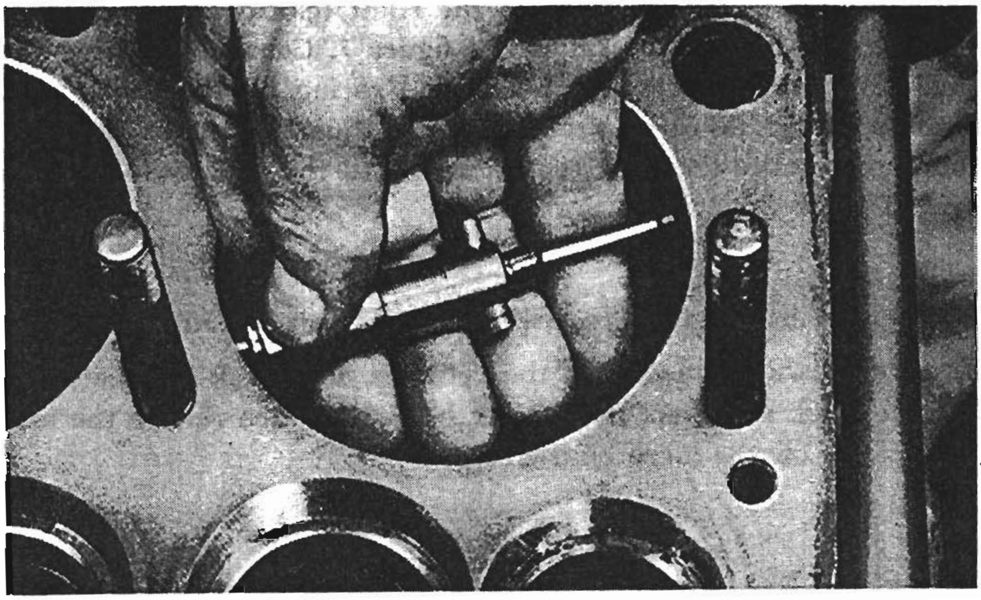


Fig. 10—Measure the Cylinder Wall and Record the Measurement Found at the Point of Greatest Wear.

Measure the cylinder wall, as shown in figure 10, and record the measurement found at the point of greatest wear. Next, measure the piston skirt at right angles to the piston pin, as shown in figure 11, and record the smallest diameter. Subtract the piston measurement from the cylinder measurement and if the difference is greater than .006 inch, piston expanders should be installed.

The piston ring lands should be checked for excessive wear. This check is made in the top ring groove because it usually shows the greatest wear.

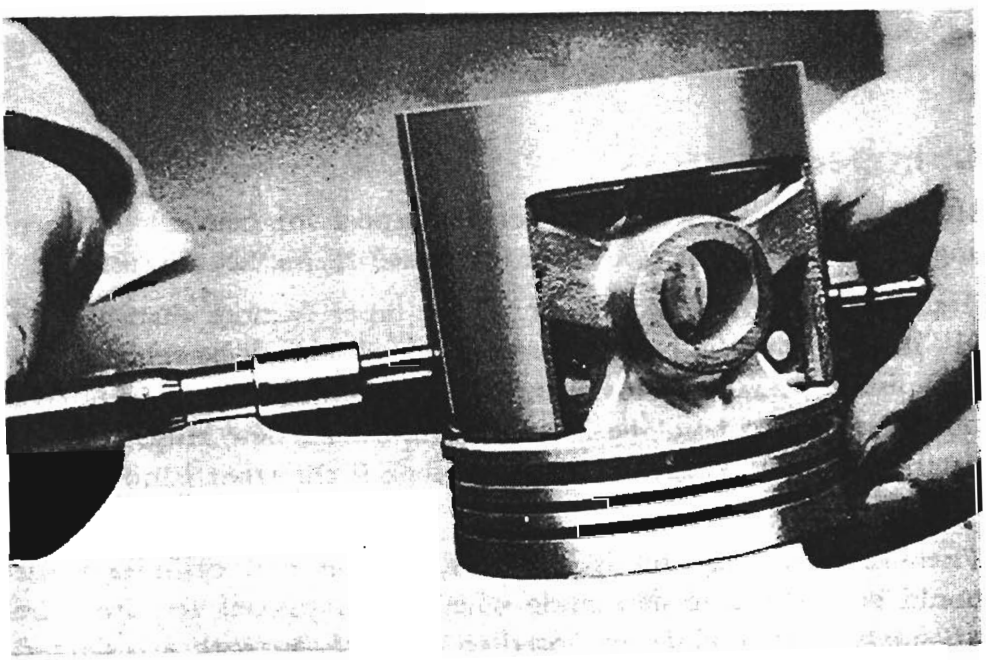


Fig. 11—The Piston Skirt Should Be Measured at Right Angles to the Piston Pin Holes as Shown.

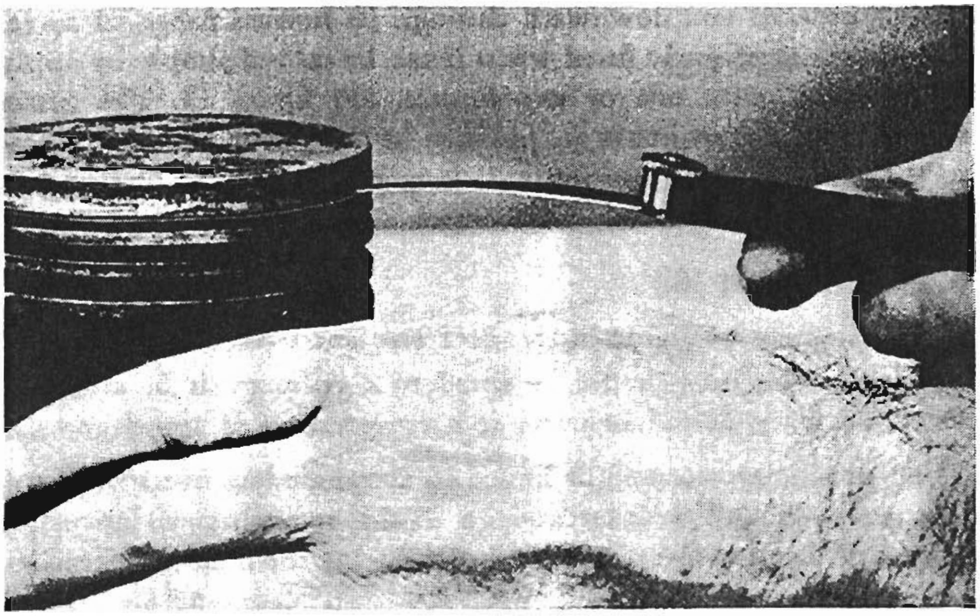


Fig. 12—Install a New Ring in the Top Groove and Check the Clearance Between the Ring and the Top Land.

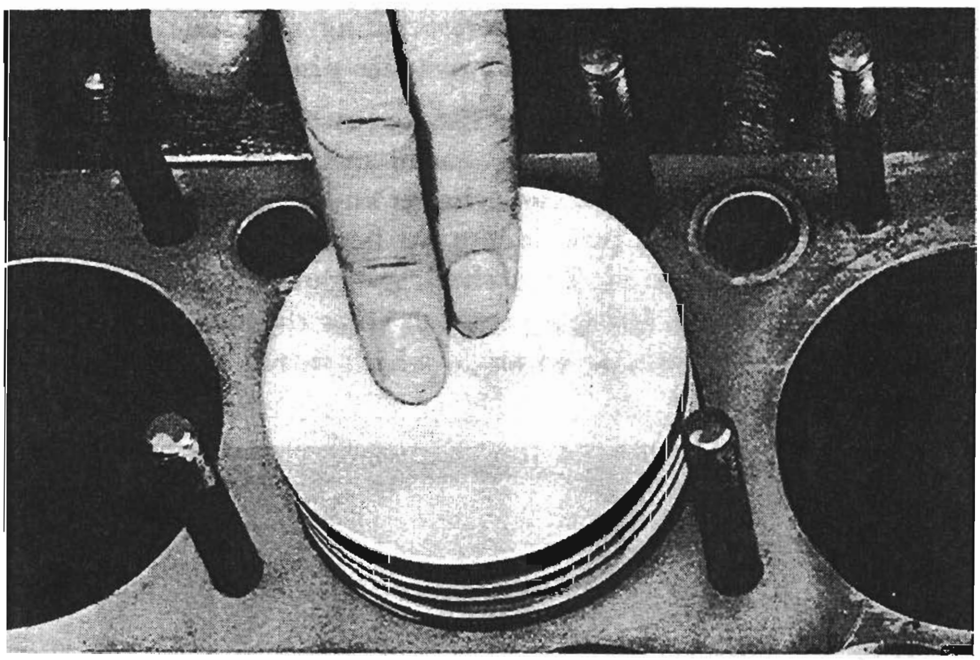


Fig. 13—Piston Fit in Rebored Cylinders Should Be Checked by Applying Pressure with Two Fingers as Shown.

Install a new top ring on the piston and check the clearance between the ring and the top land. If a .006 inch feeler can be inserted 1/16 inch, as shown in figure 12, the wear is excessive and the piston should be replaced.

5. Piston Fit In Rebored Cylinders

Piston fit in rebored cylinders should be checked with the cylinder block in an upright or in an inverted position with the cylinders vertical. The piston then should be inserted into its cylinder and moved upward and downward through its normal range of travel. The piston is properly fitted when it can be moved simply by applying pressure with one or two fingers. See figure 13. The piston should stop and maintain its position at any point where the pressure is released. If the piston will drop through the cylinder of its own weight, the cylinder is too large.

6. Piston Pin Fit

Piston pins are available in standard size and oversizes of .003 and .006 inch. The pins should be fitted to a palm push fit after the piston has been heated in water to a temperature of 160 degrees.

When pistons are reamed or honed to accommodate oversize piston pins, care should be exercised to avoid removing an excessive amount of stock in the piston pin holes during the honing operation.

7. Piston Ring Size and Fit

When cylinders have been rebored to .020, .030, or .040 inch oversize, pistons and rings of the corresponding size should be used. Standard rings are used when .005 oversize pistons are installed.

Piston ring gaps always should be checked at the bottom or unworn part of the cylinder. The recommended method for checking the gap is to insert the ring into the cylinder and, using the head of the piston to align the ring, push it into the bottom or unworn part of the cylinder. See figure 14. Then check the gap with a feeler gauge as shown in figure 15. Using a piston to align the ring will prevent it from being positioned at an angle which would result in a false gap measurement.

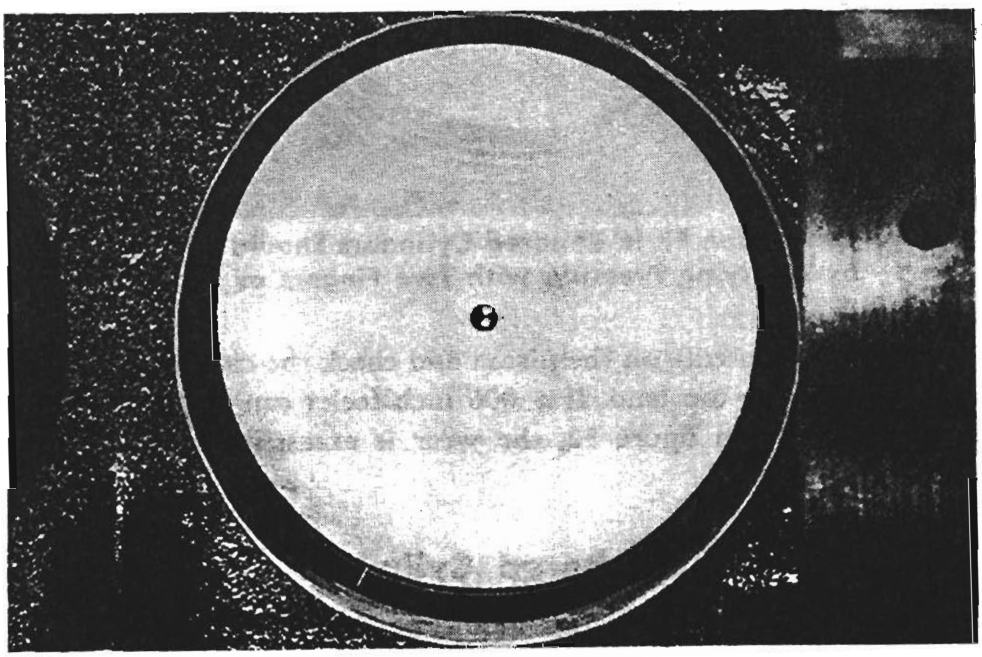


Fig. 14—Using a Piston to Align the Ring Will Prevent It from Being Positioned at an Angle.

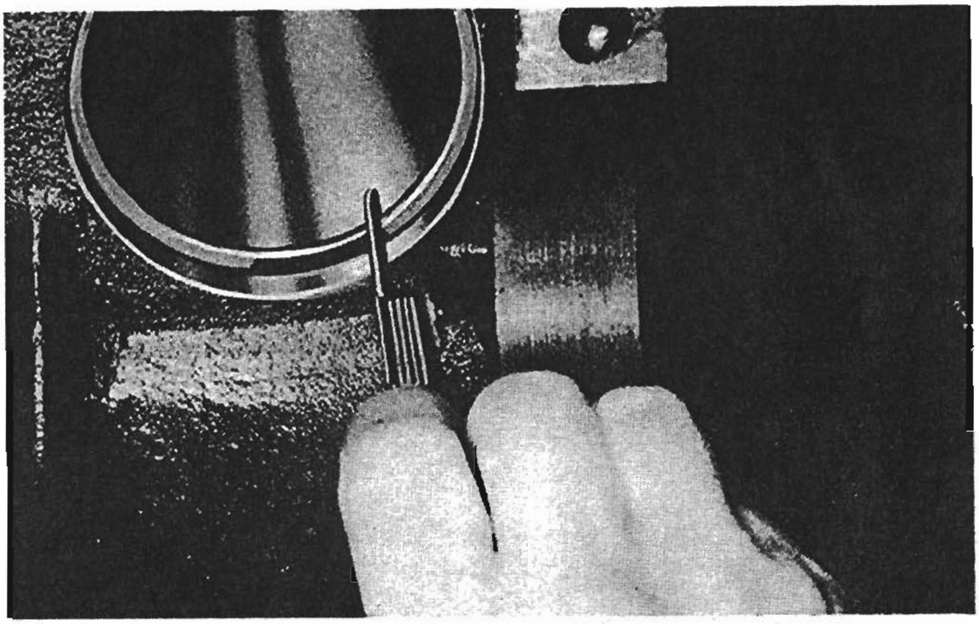


Fig. 15—Checking Piston Ring Gap. Ring Gap Should Be Checked at the Bottom or Unworn Part of the Cylinder.

When the rings are installed on the pistons, the Piston Ring Expander, KMO-297-A, should be used to prevent over-expanding or twisting the rings. See figure 16.

Assemble the top compression ring and the oil ring with the ring gaps opposite the slotted side of the piston and midway between the piston pin bosses. See figure 17. The No. 2 compression ring is assembled with the gap toward the slotted side of the piston and midway between the piston pin bosses.

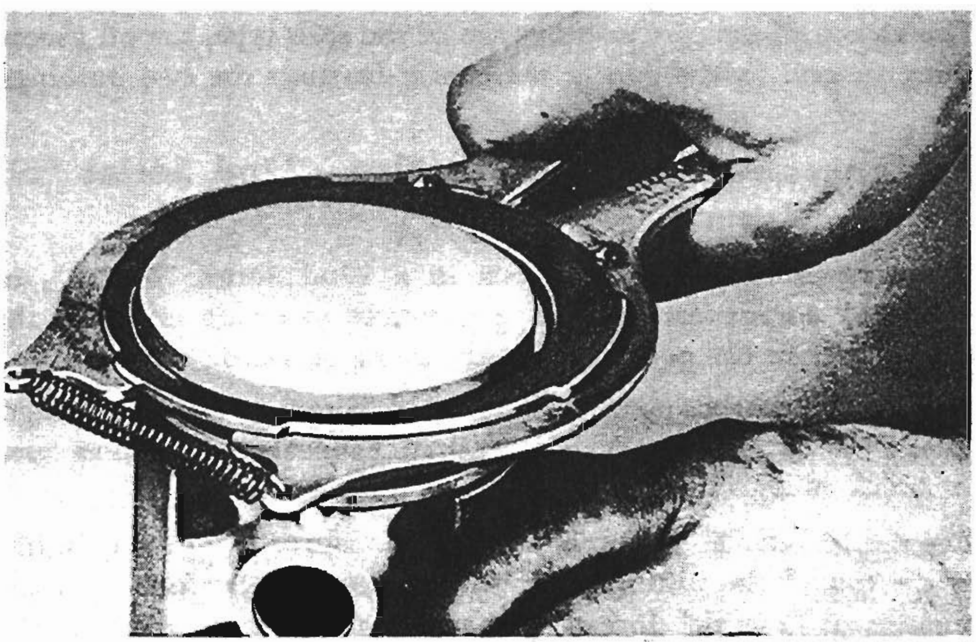


Fig. 16—A Piston Ring Expander Should Be Used to Prevent Over-Expanding or Twisting the Rings.

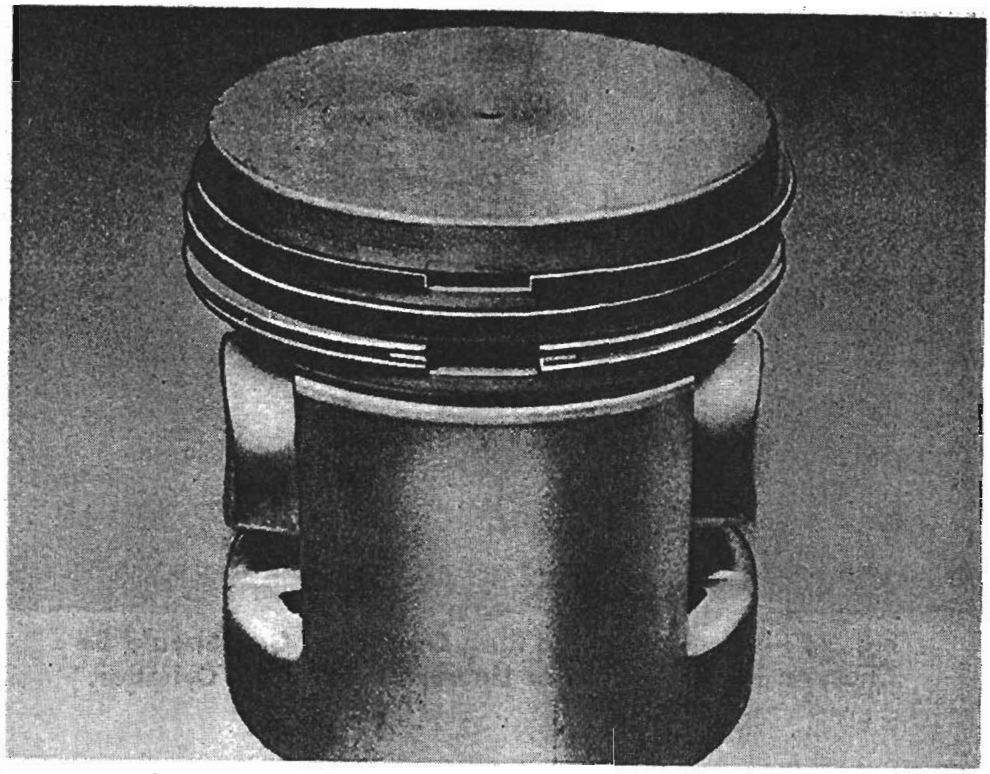


Fig. 17—The Top Compression Ring and the Oil Ring Are Installed with the Gaps Opposite Slotted Side of Piston.

CONNECTING RODS

1. General

All connecting rods are rifle-drilled to provide pressure lubrication for the piston pin bushings. A small hole in the lower end of the rod provides spray lubrication for the piston.

The bronze piston pin bushings are of the split type, the oil groove being formed by the gap in the center between the two bushings.

2. Connecting Rod Identification—22nd Series "6", "8", "Super 8"

When replacing connecting rods in a 22nd Series "6", "8", or "Super 8" engine, care should be exercised to insure installing the proper rods in the particular engine being serviced.

The connecting rods used in the "6" and "Super 8" are interchangeable. However, these rods are not interchangeable with those used in the "8" due to their difference in length. See figure 18.

The rod for the "8" is 8⅜ inches long, measured from the split line to the top of the piston pin bushing bore, and has one spherical segment or "pimple" forged in the I-beam section of the rod. The rod for the "6" and "Super 8" is 8⅛ inches long, measured from the split line to the top of the bushing bore and carries two "pimples".

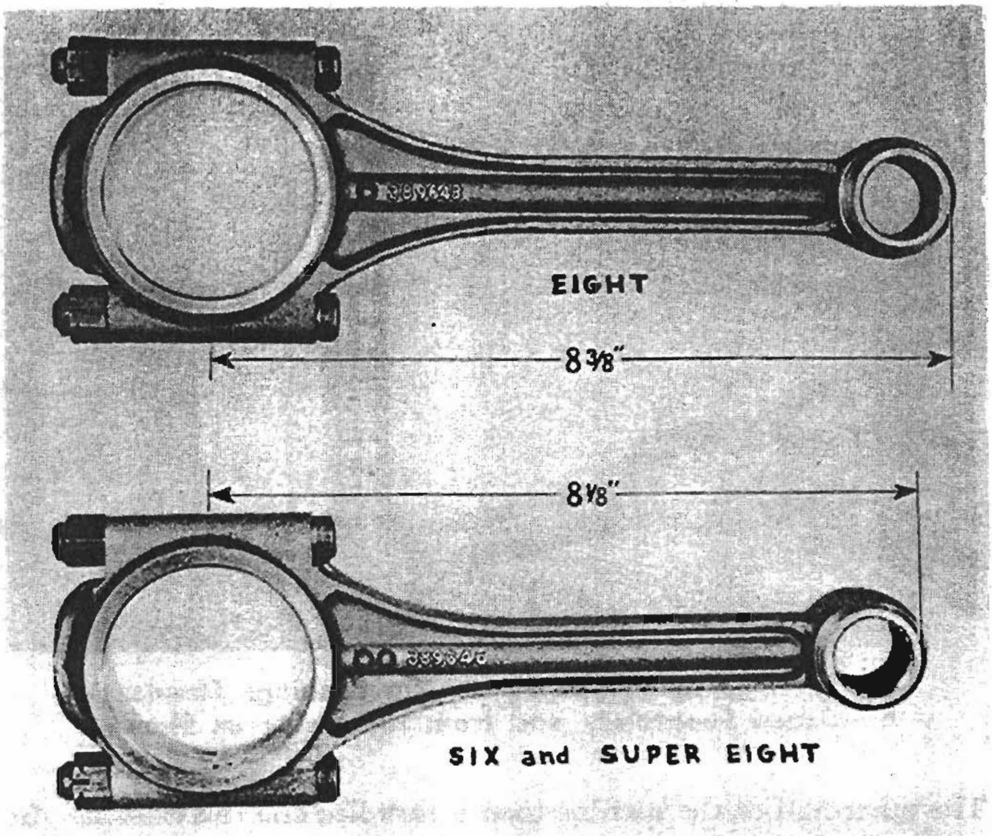


Fig. 18—Connecting Rods for 22nd Series "Six" and "Super Eight" Are Not Interchangeable with Those for the "Eight".

3. Piston Pin Bushing Replacement

These thin bronze bushings must be expanded tightly into the bushing bore before they can be successfully reamed. If the bushings are not burnished or expanded into the rod, they may become loose and restrict the oil path in the rod resulting in burned out bushings and scored piston pins.

When replacing these split type bushings, each half should be burnished separately. Both halves should *not* be burnished in a single operation since the bushing into which the burnisher entered first would have a tendency to creep toward the center of the rod when pressure was applied. If this occurred the oil groove might be partially or entirely closed and the oil hole in the rod restricted. Bushings may be replaced using the Piston Pin Bushing Replacement Set, J-2555 which consists of a Remover, Replacer, Plate, and Burnisher.

After pressing the old bushings out of the rod using an arbor press and the remover tool, install one of the new bushings so the outer edge of the bushing is flush with the outer end of the rod.

Next, insert the burnisher into the inner end of the bushing and, using the plate of the tool under the end of the rod, push the burnisher through the bushing from the inside. See figure 19.

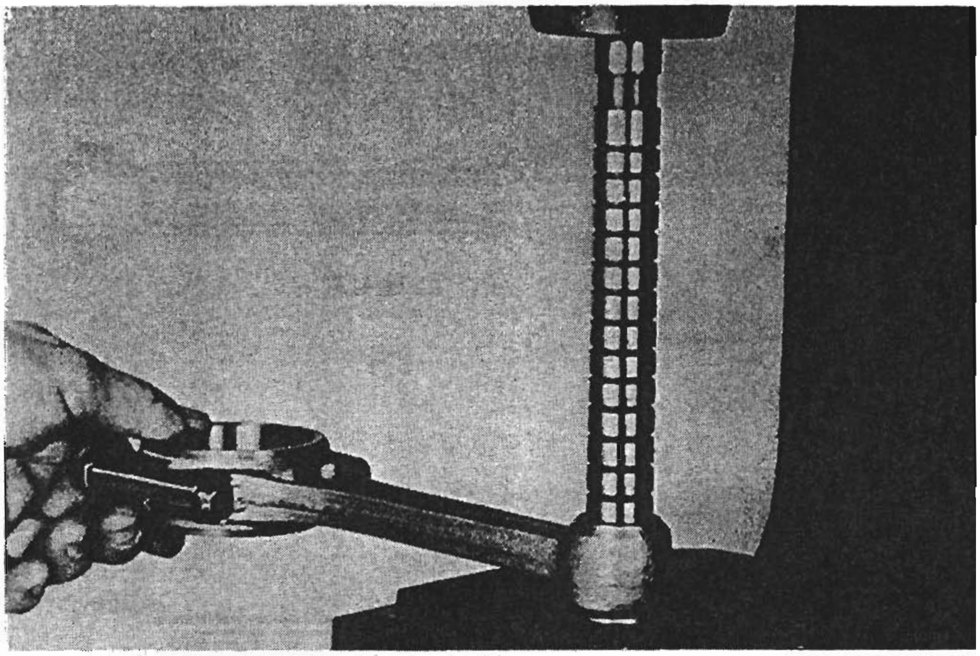


Fig. 19—The Split Type Piston Pin Bushings Should Be Burnished Separately and from the Inside as Shown.

The other half of the bushing then is installed and this bushing also is burnished from the inner end, the burnisher passing through the previously burnished bushing.

4. Piston Pin Fit

After the bushings have been burnished, they should be reamed to the proper size using the Piston Pin Bushing Reamer, J-874-18. See figure 20. Piston pins are a size-to-size fit in the bushings. The fit of the pin in the rod may be checked by inserting the pin in the rod and then holding the pin in a vise using lead jaws to prevent damaging the pin. Place the rod in a horizontal position where it should remain until tapped downward by hand. See figure 21. After being tapped, the rod should slowly fall downward of its own weight.

5. Connecting Rod Alignment

It is important that connecting rods be in proper alignment before being installed in the engine. The following paragraphs describe the aligning procedure using the Connecting Rod Aligning Jig, J-874-PA, and the Connecting Rod Bending Bar, HM-3-12.

NOTE

Always bend the rod beyond the straight position and then bend back until straight so as to relieve the strains that are set up by bending. If this is not done the rod may not remain straight after it is installed in the engine.

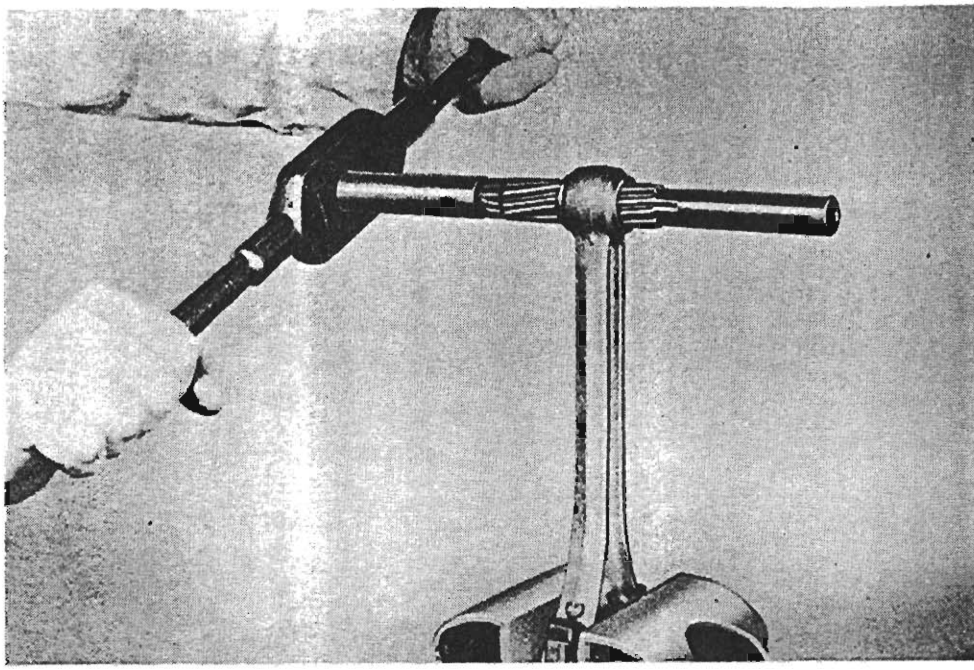


Fig. 20—Piston Pin Bushings May Be Reamed to the Proper Size Using the Reamer J-874-18.

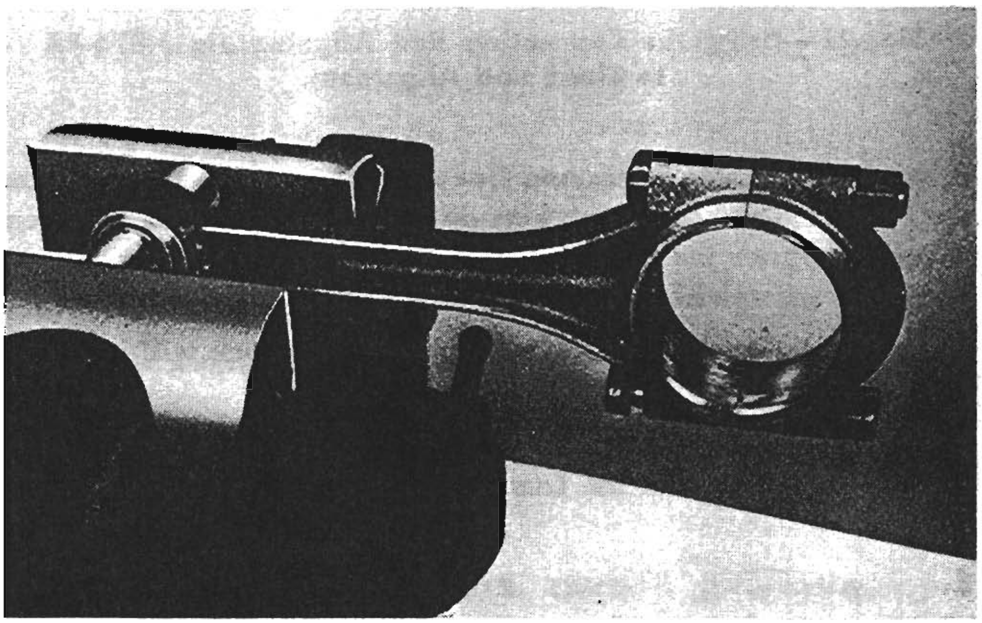


Fig. 21—The Connecting Rod Should Remain in a Horizontal Position Until Tapped Downward by Hand.

To check the rod for twist, insert the piston pin in the rod and assemble the rod (without bearings) to the arbor in the aligning jig. Place the "V" block on the pin and move the arbor and rod toward the face plate. See figure 22.

The four pins in the face of the "V" block are used to indicate a bent or twisted rod.

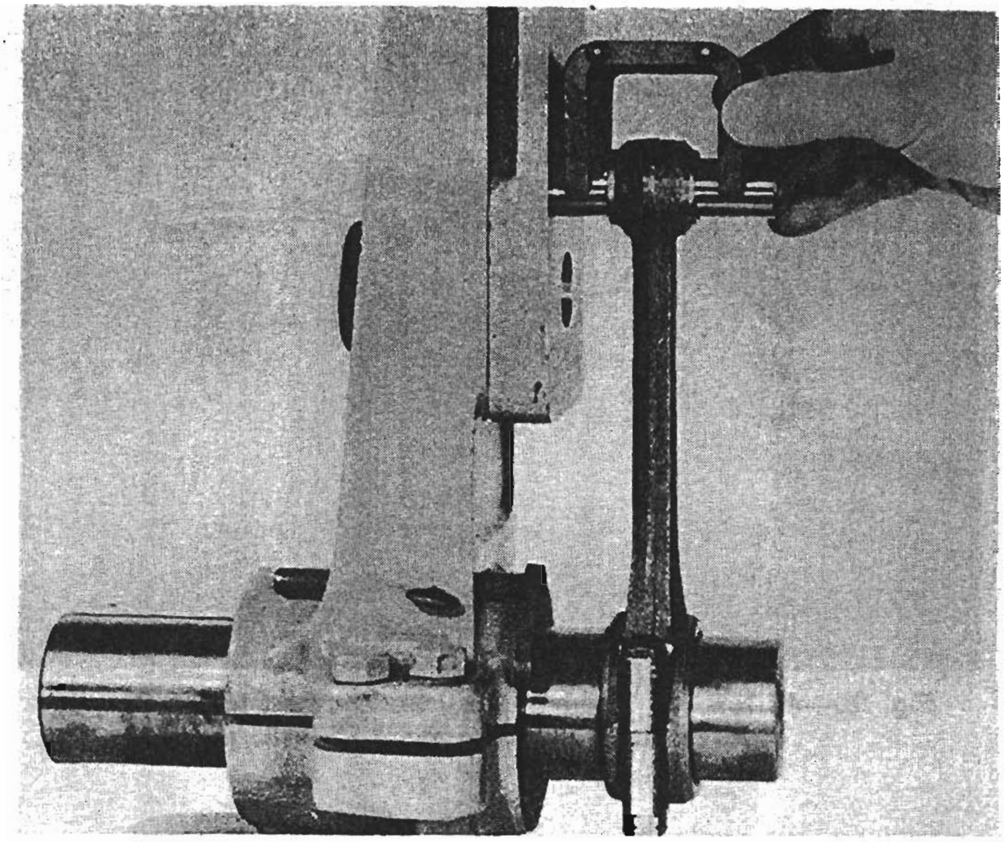


Fig. 22—Using the Connecting Rod Aligning Jig J-874-PA to Check Rod Alignment.

If the two pins in a horizontal line at the top of the block contact the face plate and the lower pins do not, the rod is cocked or bent. If the two lower pins rest against the plate and the upper pins are away from the plate, the rod is bent in the opposite direction.

The pins in a vertical line on each side of the block will indicate a twisted rod.

When the rod is straight, and no twist exists, all four pins in the "V" block will contact the face plate of the aligning jig.

6. Assembling Pistons and Pins

The piston and piston pins may be assembled to the rod using the Piston Pin Assembly Pilot, J-4561. The use of this tool eliminates the danger of scuffing the bushings when the pin is installed.

Place the connecting rod in a vise and then heat the piston in water to a temperature of 160 degrees.

With the slot in the piston skirt on the same side as the small oil hole in the lower end of the rod, insert the piloting tool through the piston pin holes in the piston and the connecting rod. Place the piston pin on the pilot and push into place as shown in figure 23. Install the piston pin locks.

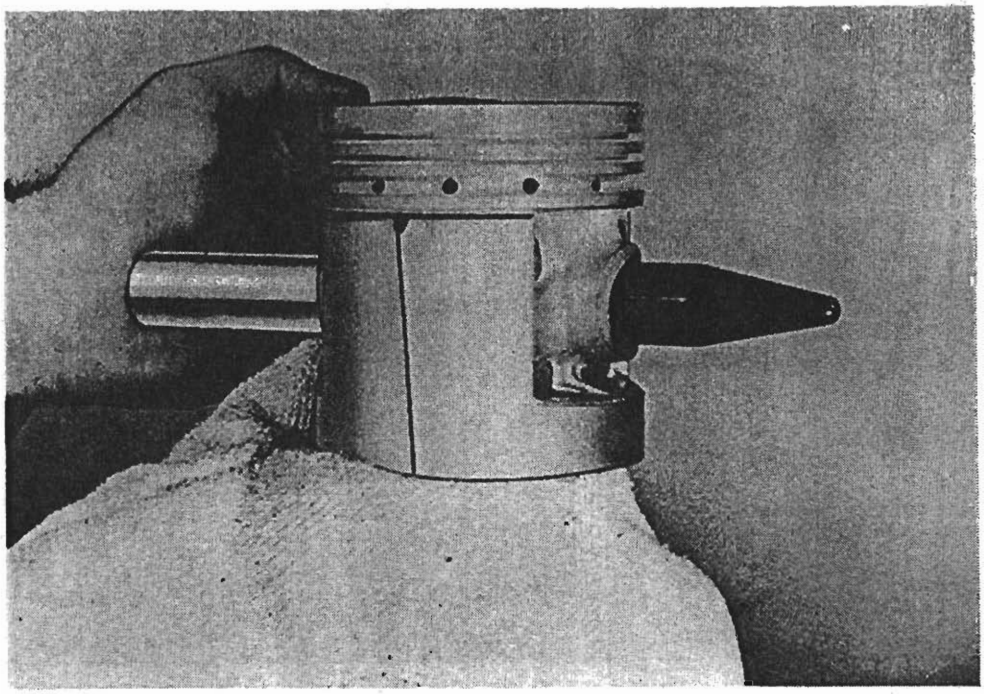


Fig. 23—Place the Piston Pin on the Assembly Pilot and Push into Place as Shown.

MAIN AND CONNECTING ROD BEARINGS

1. General

The crankshaft main bearing shells and the connecting rod bearing shells are of the steel-backed, babbitt lined precision type. These bearings are non-adjustable and should be replaced when excessively worn. Replacement bearings are available in standard size and undersizes of .001, .002, and .020 inch. The front main bearing of the six-cylinder engine and the center main bearing of the eight-cylinder engines are flanged to take the end thrust of the crankshaft and to govern crankshaft end play.

Bearings stamped "MD" on the back of the bearing shells have a distinctively different appearance after use than other bearings. These bearings will show an intricate pattern of tiny surface cracks and an area at both sides that does not show wear. See figure 24. These are normal conditions, characteristic of the bearing and do not indicate an early bearing failure.

In these bearings, a spongelike layer of powdered metal serves as a matrix or bonding medium between the outer steel shell and the babbitt bearing surface. In service, the bearing quickly develops thousands of small surface cracks which follow the intricate pattern of the matrix surface. The surface cracks will cause no trouble and never should occasion bearing replacement. The rough porous surface of the matrix retards the progress of the fatigue cracks and prolongs the time necessary for small pieces of babbitt metal to

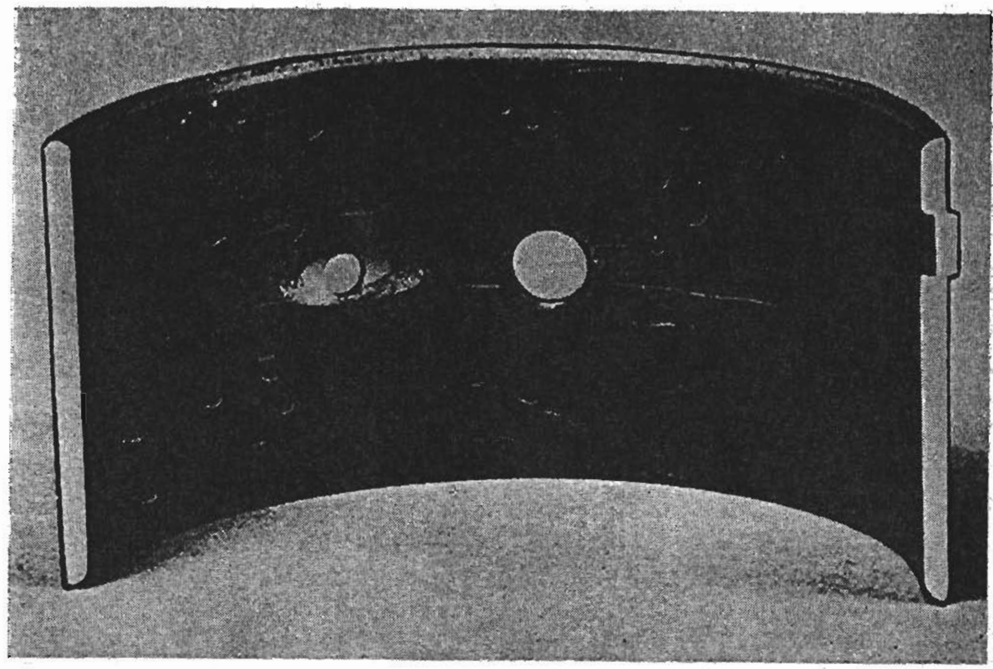


Fig. 24—The Intricate Pattern of Tiny Surface Cracks Is Characteristic of This Type Bearing Shell After Use.

become isolated. Even when finally isolated, the interlocking surface of the matrix prevents the pieces from being lifted from the outer steel shell. In some cases the babbitt may wear away to the point where the matrix is visible on the bearing surface. However, these composite-type bearings in this condition will continue to operate in a satisfactory manner as long as the clearance is not too great.

The area at each side of both bearing halves that does not show wear or contact with the shaft is also normal. These bearings are made with a relief at the split line to prevent pinching the shaft when the bearing caps are tightened. This gives a used bearing the appearance of being out of round.

2. Bearing Fit

Various procedures may be followed to determine the clearance between the crankshaft main bearings and journals and the connecting rod bearings and crank pins. The following procedure describes the use of the Plastigage, part number 410172.

NOTE

When checking main bearing clearances and the engine is in such a position that the bearing caps support the weight of the crankshaft and flywheel, keep all main bearing caps tight except the one being checked.

Remove the bearing cap and wipe the oil from the bearing shell and the crankshaft. Place a strip of Plastigage across the full width of the bearing shell, parallel to the length of the crankshaft. See figure 25. Reinstall the bearing caps and, using a torque wrench for accuracy, tighten as follows:

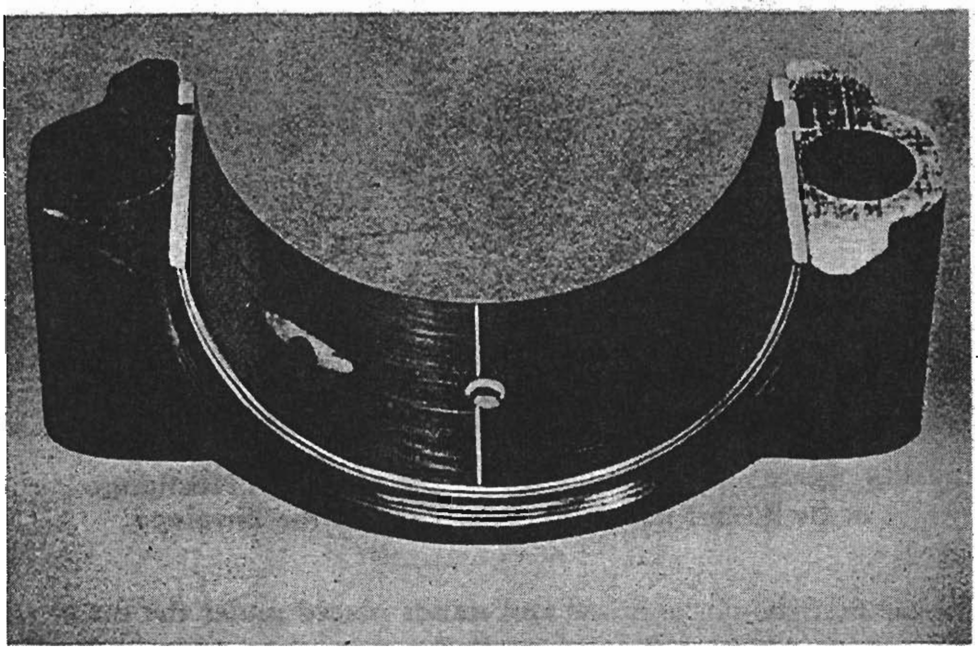


Fig. 25—Place a Strip of Plastigage Across the Full Width of the Bearing Shell as Shown.

Main Bearing Caps—All Models....................................90-95 ft. lbs.
Connecting Rod Caps—Rods having 3/8 inch bolts.........45-46 ft. lbs.
Connecting Rod Caps—Rods having 7/16 inch bolts.....60-65 ft. lbs.

Remove the bearing cap and compare the width of the flattened Plastigage at its widest point with the scale printed on the envelope in which the stick was enclosed. See figure 26. The number within the graduations on the scale indicates the clearance in thousandths of an inch.

If the clearances are less than .0005 inch or more than .0025 inch, select a new bearing shell to provide the desired clearance.

At final assembly, install the connecting rods with the oil hole in the lower end of the rod toward the camshaft side of the engine. Tighten the cap retaining nuts to the torque previously specified for checking bearing clearances.

3. Rear Main Bearing Oil Seal Replacement

The rear main bearing oil seals may be changed while the engine is in the car. However, extreme care should be exercised in those steps which pertain to the lowering and raising of the crankshaft as described among the following paragraphs.

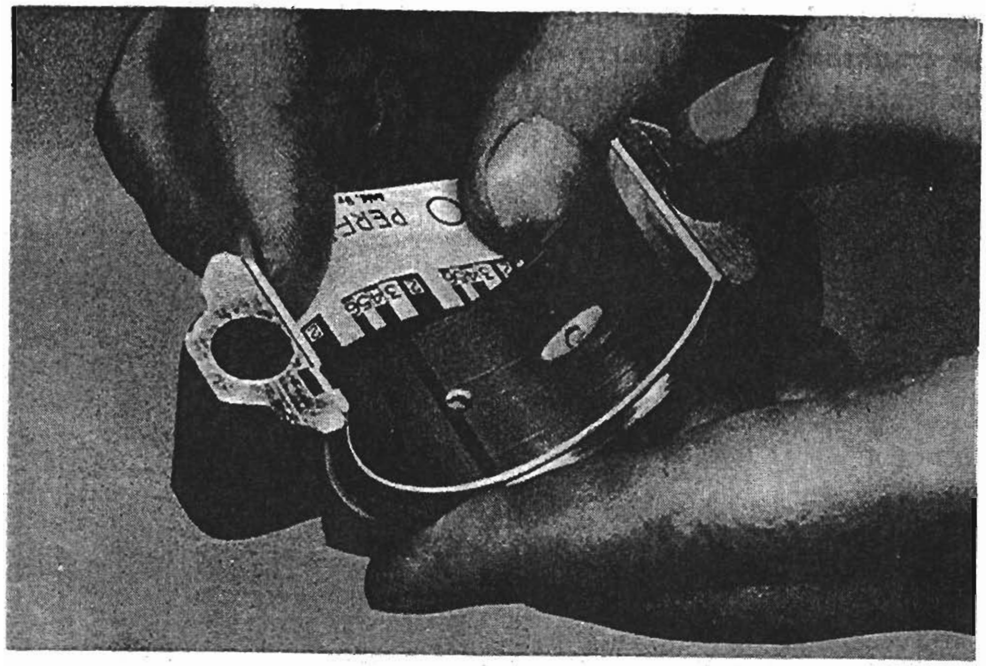


Fig. 26—Compare the Width of the Flattened Plastigage at Its Widest Point with the Scale on the Envelope.

The car first should be raised and stands placed under the car at all four corners keeping the engine in its normal position and on a level plane. Next, remove the oil pan and then remove the rear main bearing cap. Do not remove any main bearing caps other than the rear one.

NOTE

> The following steps should be performed carefully and exactly as described, otherwise the main bearings may be distorted and severely damaged.

Bend over the locking tabs of the remaining bearing cap retaining screw locks. Loosen each retaining screw approximately ¼ turn or, in other words, just enough to "break loose" each screw from its fully tightened position.

When all of the retaining screws have been "broken loose", back out each screw ½ turn. This will permit the crankshaft to lower itself slowly and evenly. Continue backing out each retaining screw ½ turn at a time while making sure that the crankshaft is being supported by all main bearing caps while being lowered. The crankshaft may be lowered approximately ½ inch in this manner and the upper rear seal may then be removed from its groove in the cylinder block using a pointed tool such as an awl or an ice-pick.

Before starting to install the upper seal, it first should be pressed into the form or shape it assumes when it is in its groove in the cylinder block. This may be done by pressing the seal into the

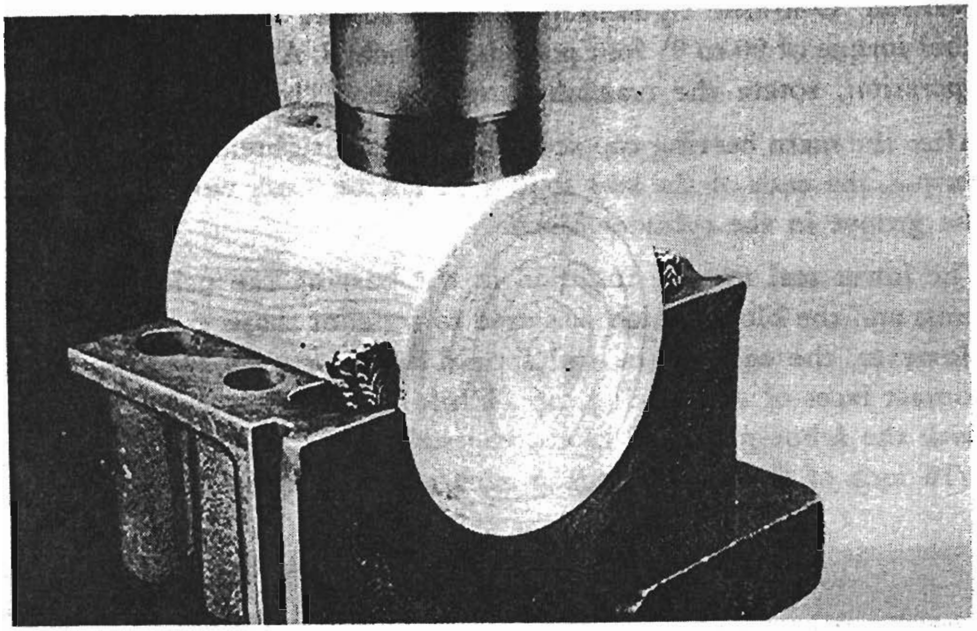


Fig. 27—Pressing the Rear Main Bearing Oil Seal into the Bearing Cap Using an Arbor Press.

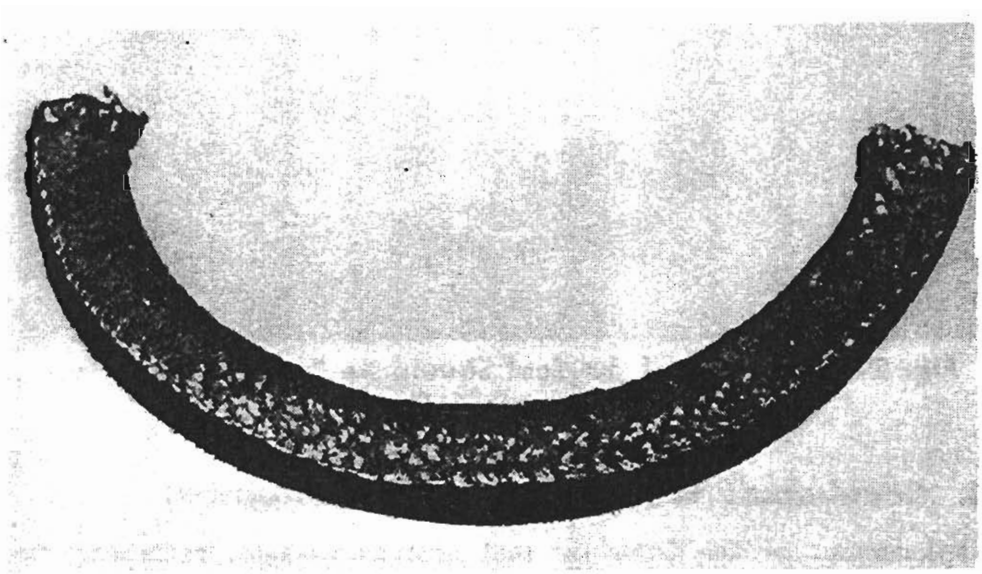


Fig. 28—After the Seal Is Formed as Shown, It May Be Fed into Its Groove in the Cylinder Block.

groove in the bearing cap using an arbor press and a block having the same diameter as the crankshaft main bearing journal. See figure 27.

After the seal has been formed or shaped, as shown in figure 28, it may be fed up around the crankshaft and into its groove in the cylinder block. When the seal is properly positioned, tighten each bearing cap retaining screw ½ turn at a time to raise the crankshaft slowly and evenly. Tighten the cap screws by ½ turn stages until the screws are snugly tightened and then turn the crankshaft over two or three revolutions. This will tend to burnish the seal into position. Continue tightening the cap screws by stages until the final torque of 90 to 95 foot pounds is reached. After each tightening operation, rotate the crankshaft to further "burnish-in" the seal.

After the main bearing cap screws have been tightened to their final torque, the ends of the seal should be cut off flush with the ends of the groove in the cylinder block.

The lower seal may be installed in the bearing cap using an arbor press and the block which was used to form or shape the upper seal. However, the ends of the seal should not be cut off flush with the contact faces of the bearing cap. While holding the seal in position with the arbor press and block, the seal should be trimmed so that 1/16 inch of the seal extends at each end. See figure 29.

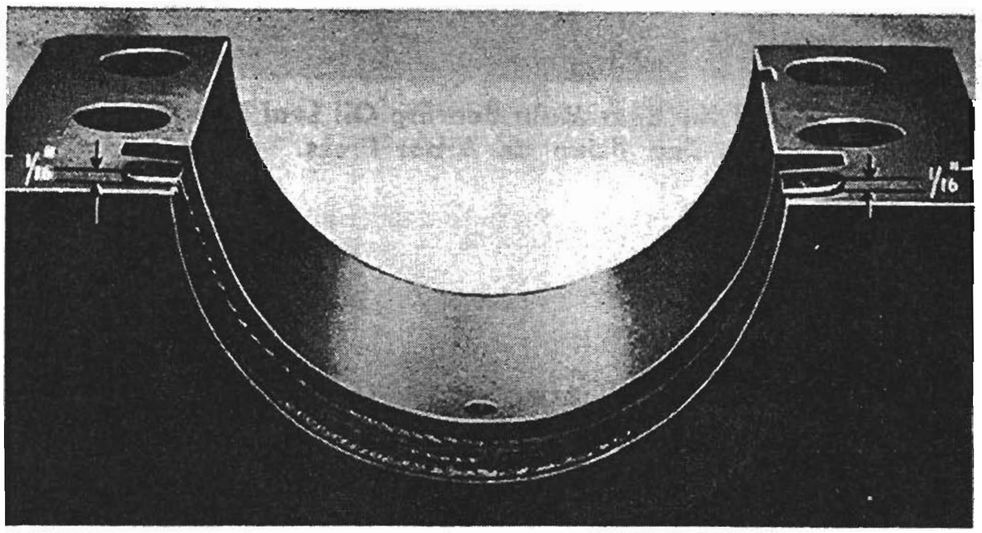


Fig. 29—Each End of the Seal Should Be Trimmed to Obtain the Dimensions Shown.

4. Crankshaft Front Oil Seal Replacement

Replacement of the front oil seal first necessitates removing the radiator core if the seal is to be replaced while the engine is in the car. The vibration damper, on all engines except the late 22nd Series "Six" and "Eight", then may be removed using the Vibration Damper Puller J-2582. See figure 30. On the late 22nd Series "Six" and "Eight", use Puller J-2636. See figure 31. The gear cover now may be removed.

After the old seal has been removed from the end of the crankshaft, place the new seal in position on the shaft and then place the Gear Cover Aligning Arbor J-2572 over the end of the shaft. See figure 32.

Next, install the gear cover and tighten the retaining screws snugly. Run a feeler gauge around the aligning arbor and between the arbor and the hole in the gear cover. See figure 33. If necessary, shift the cover to obtain approximately the same clearance around all sides of the arbor and then tighten the cover retaining screws.

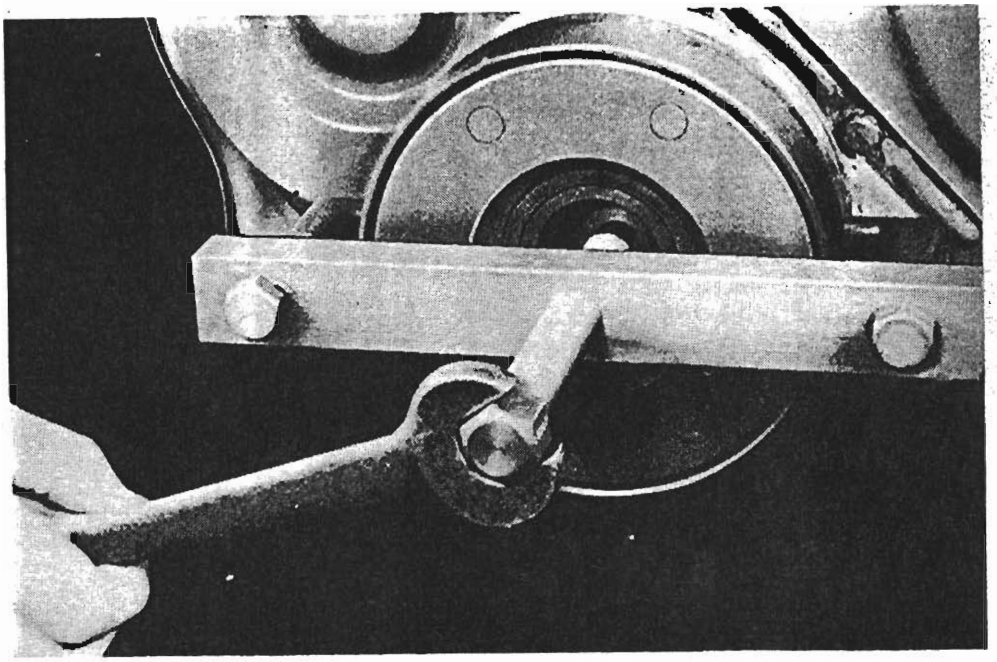


Fig. 30—Vibration Damper Puller J-2582 Is Used to Remove Friction Disc Type Dampers.

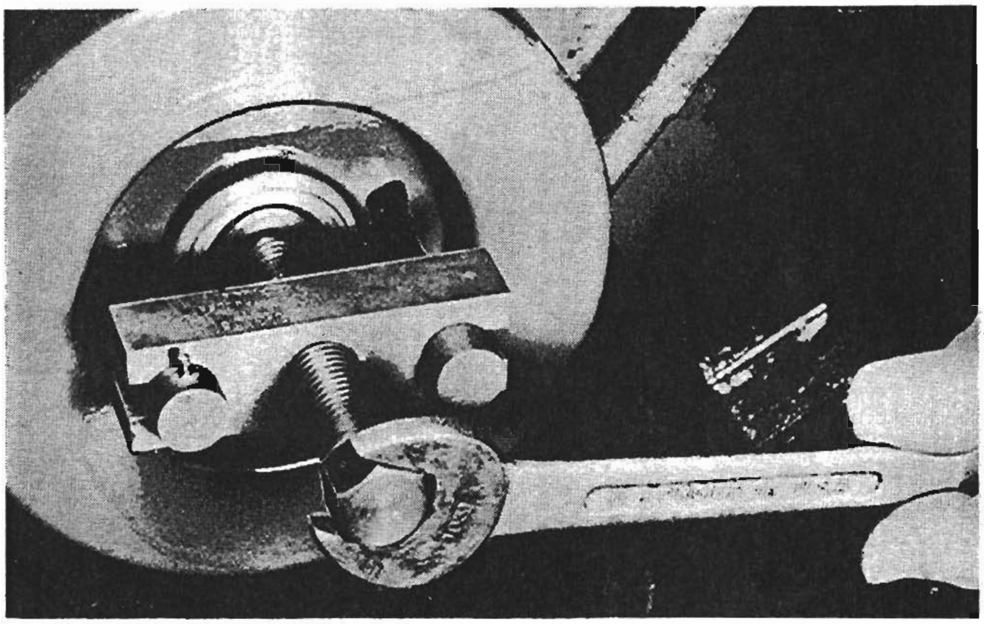


Fig. 31—Vibration Damper Puller J-2636 Is Used to Remove Fluid Suspension Type Dampers.

VALVES, GUIDES, AND TAPPETS

1. General

Inlet valves for all models are made of chrome-nickel steel with seating faces ground to a 30-degree angle. Exhaust valves are of austenitic steel with seating faces ground to a 45-degree angle. Valve springs are the single coil type and are retained by means of split-cone type keepers. Shakeproof type lockwashers are used between the top of the spring and the seat in the cylinder block to reduce spring rotation.

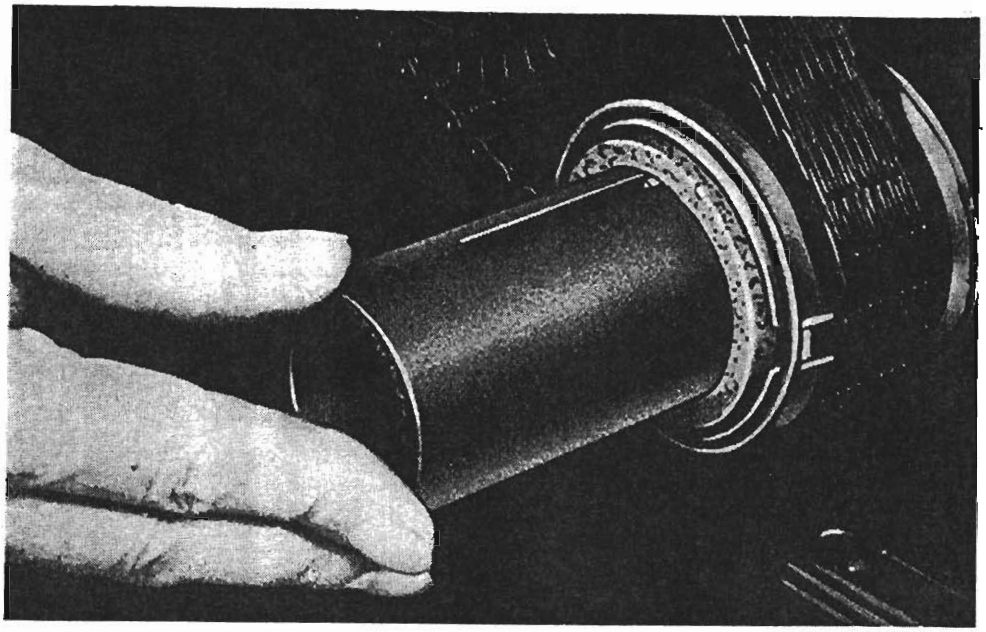


Fig. 32—Gear Cover Aligning Arbor J-2572 Should Be Used When Replacing a Crankshaft Front Oil Seal.

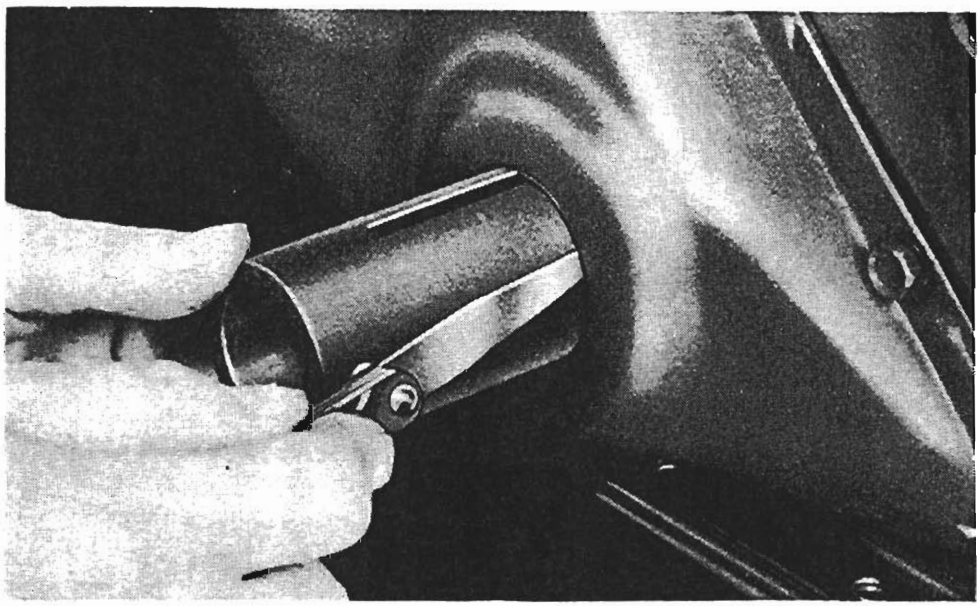


Fig. 33—The Gear Cover Should Be Shifted to Obtain the Same Clearance Around all Sides of the Arbor.

NOTE

A limited number of 22nd Series engines were equipped with valve guides having a larger outside diameter than is standard. Engines so equipped may be identified by the letter "A" stamped on the cylinder block at the rear edge of the raised engine number pad. These guides differ from the standard guides in their outer diameter only.

Service replacement guides for these engines may be ordered under part number 412006 for exhaust valve guides and part number 412007 for inlet valve guides.

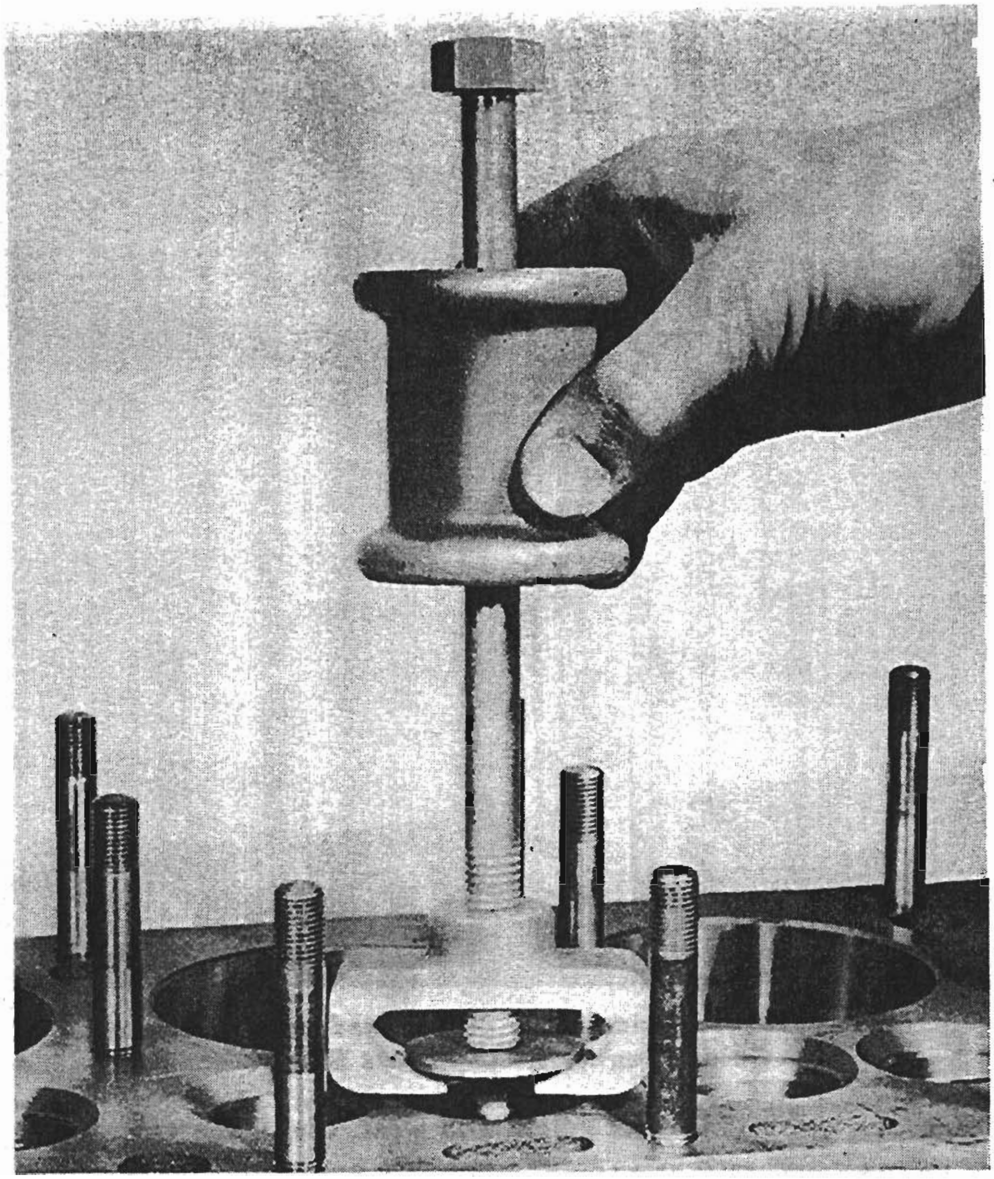


Fig. 34—Tight Valve Remover J-2153 Will Facilitate Removal When Valves Have a Carbon, Gum, or Rust Build-Up.

2. Valve Removal

Occasionally valves are difficult to remove due to the accumulation of sludge, carbon, gum, or rust. The use of the Tight Valve Remover, J-2153, will facilitate valve removal when these conditions exist. See figure 34. When the valves have been removed, the valve guides may be cleaned with the Valve Guide Cleaner, KMO-122. See figure 35.

3. Inspection

After the valves and the valve guides have been cleaned, carefully inspect the valve stems for scores and wear and the valve stem ends for pitting or cupping due to contact with the tappet head.

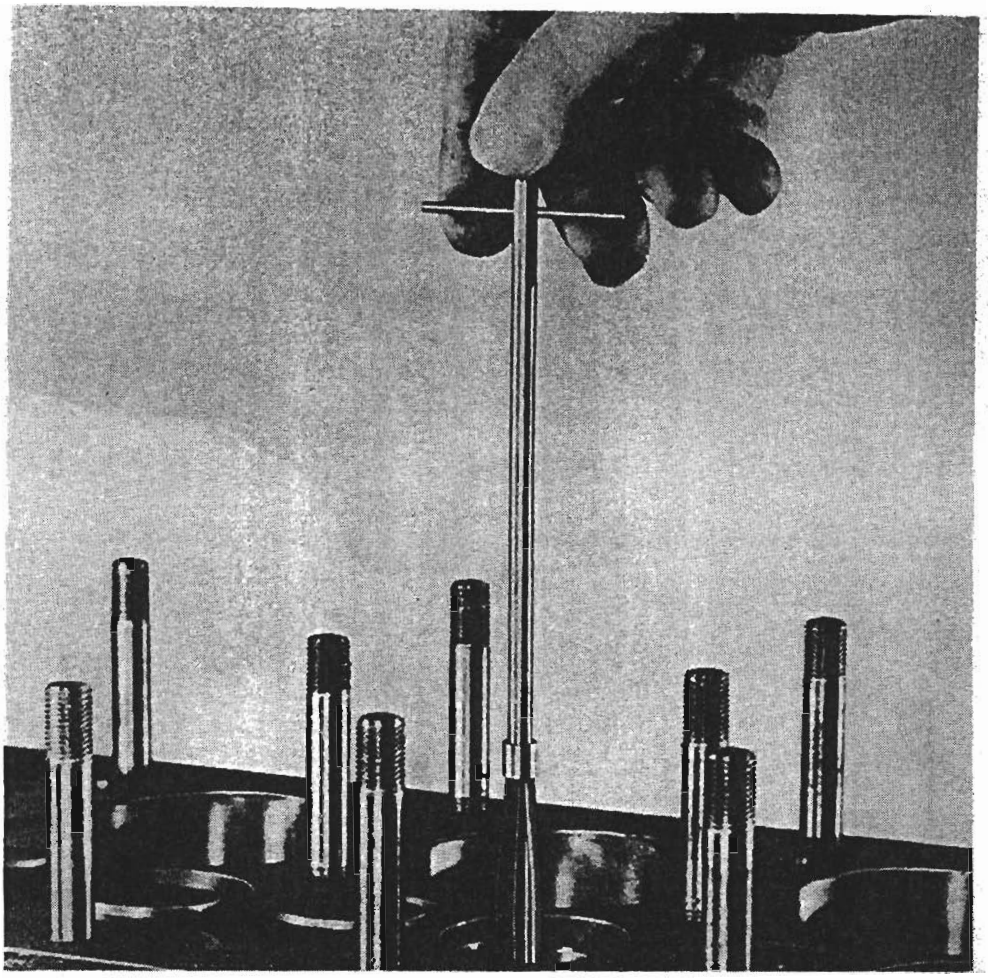


Fig. 35—Valve Guides May Be Cleaned with the Valve Guide Cleaner KMO-122 as Shown.

Inspect all valve guides for cracks and wear. Check the valve guide wear by placing each valve in its respective guide and check for side play. If the wear is excessive or irregular (side to side wear), mark the worn guides for replacement.

4. Replacing Valve Guides

Valve Guide Remover, J-2580, and Valve Guide Driver and Depth Gauge, J-2577, should be used to replace valve guides.

To remove valve guides with the tappet assemblies in the cylinder block, first drive the guides downward with the remover tool (figure 36) until they just clear the tappet heads when the tappets are at the base of their respective lobes on the camshaft. Score the guides using a chisel inserted through the valve ports, break off the lower section, and then drive the remaining parts out of the block.

If the tappets have been removed, the guides may be driven directly out of their bores in the block.

Both the inlet and the exhaust valve guides can be installed to their proper depth with the driver and depth gauge tool. See figure 37.

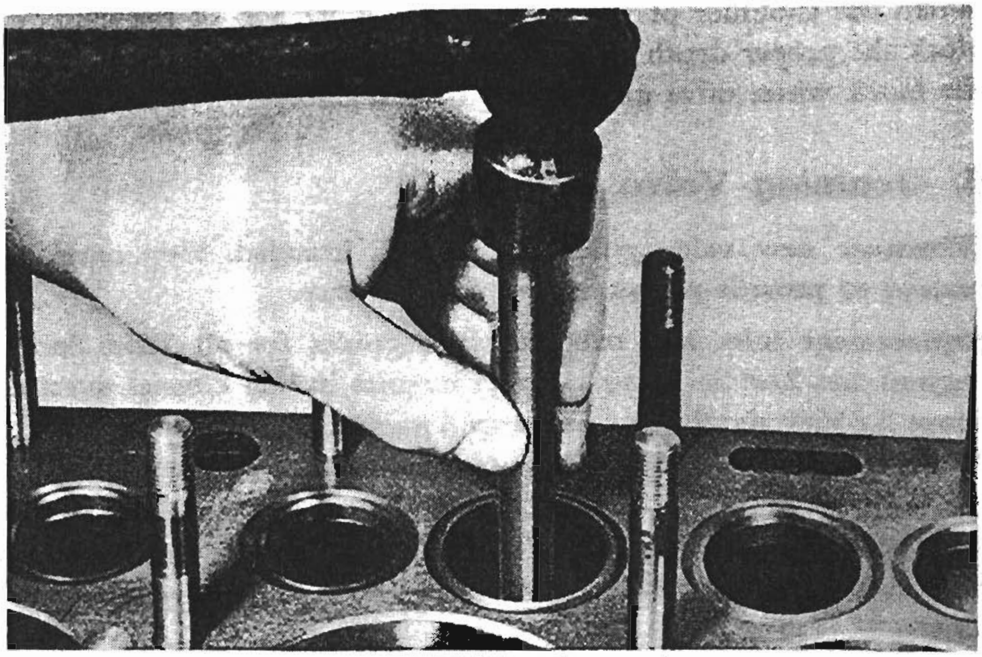


Fig. 36—Drive the Valve Guide Downward with Valve Guide Remover J-2580 as Shown.

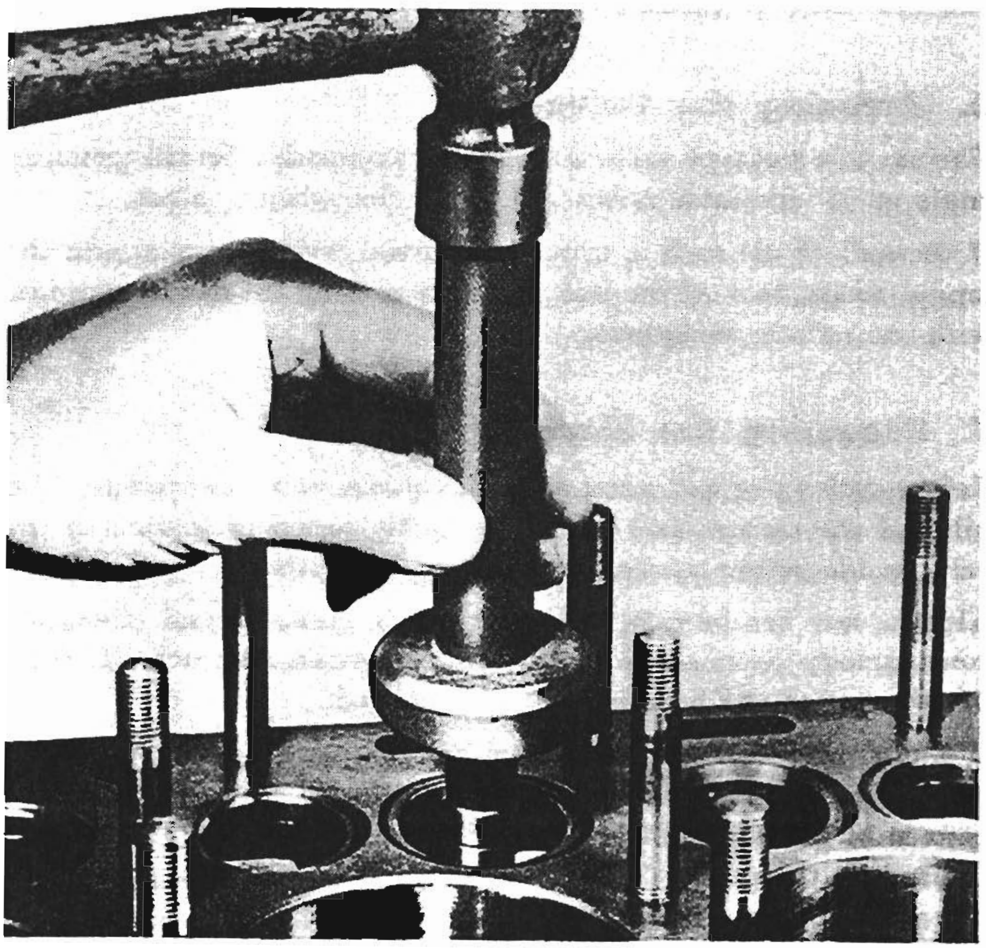


Fig. 37—Both the Inlet and the Exhaust Valve Guides Can Be Driven to Their Proper Depth with the Tool Shown.

When the shoulder of the driver contacts the top of the cylinder block the proper depth has been reached. Do not overlook reseating the block when valve guides have been replaced.

5. Reaming Valve Guides

Whenever new valve guides have been installed, they must be reamed to provide proper valve stem clearance.

Replacement inlet and exhaust valve guides for all 22nd Series engines and 21st Series six-cylinder engines having a serial number above F 35000 should be reamed with a standard 11/32 inch reamer. This reamer will provide the desired clearance of .002 inch between the inlet valve stem and guide and .004 inch between the exhaust valve stem and guide. The difference in clearances is due to the difference in valve stem diameters, the exhaust valve stem being larger.

Special reamers are required to ream the guides in engines for the 1951 model, 20th Series, and all 21st Series cars except those Sixes which have an engine number above F 35000. These reamers are available in the two sizes necessary, .343 inch for inlet valve guides and .345 inch for exhaust valve guides.

6. Refacing the Valves

The use of a wet type valve refacer is recommended. Set the grinding angle at 30° for inlet valves and at 45° for exhaust valves.

If the end of the stem is cupped or pitted, due to contact with the tappet heads, face off the end of the stem using the details supplied with the refacer equipment.

7. Reseating the Block

Reface each valve seat using a suitable power valve seat refacer. The pilot of the refacer tool should be firmly seated or located in the valve guide before starting the refacing operation.

After a seat has been refaced, use a dial indicator and check for concentricity. Seats should be concentric within .001 inch. "Bluing-in" the valves and seats is not recommended.

When a valve and seat are "blued-in," the pattern of the blue will indicate either a full or partial seating of the valve. However, the pattern of the blue will not indicate whether the valve stem is centralized in the guide. In other words, the seat may be ground off center enough to permit the valve stem to contact the guide at the top and bottom on opposite sides even though the seat is in perfect contact with the valve. For example, with a valve stem clearance of

.004 inch the seat could be out of concentricity by .004 inch. When this condition exists, the stem is not operating freely in the valve guide but is actually cocked each time the valve closes. This uneven wear will finally result in valve noise and loss of compression.

The use of a dial indicator will show the actual relationship which exists between the valve guide bore and the valve seat circle.

8. Valve Installation

NOTE

> Before installing valves and springs in "Super Clipper" and "Custom 8" engines, see "Adjusting Tappet Clearance (Hydraulic Type)."

The 20th and 21st Series "Super Clipper" engines are equipped with flat type lockwashers between the top of the valve spring and the seat in the cylinder block to reduce spring rotation. Other "Clipper" engines and all 22nd Series engines are equipped with cup-shaped type lockwashers.

These cup-shaped lockwashers may be used to replace the flat type in early "Super Clipper" engines. It will be necessary to slightly enlarge the hole in the washer when this is done. The use of the cup-shaped washers will greatly reduce the possibility of valve springs being cocked.

When installing the valves and springs, be sure that all of the split cone keepers are in place and that the spring seats are level to prevent excessive wear in the guides.

9. Adjusting the Tappets (Mechanical Type)

The conventional mechanical type tappets should be adjusted after the engine is thoroughly warmed up. The inlet valve tappets should be set at .007 inch and the exhaust valve tappets at .010 inch.

10. Adjusting Tappet Clearance (Hydraulic Type)

The take-up reserve of each hydraulic unit should be checked whenever the valves and valve seats have been refaced or when new valves are to be installed. This may be done using the Hydraulic Tappet Gauge Set, J-2553.

Lift the hydraulic take-up assemblies out of the tappet bodies and place them on the bench in the order in which they are removed from the engine. Install the valves without springs. Bring the No. 1 piston to the top of its compression stroke. At this time the No. 1 cylinder inlet and exhaust valve lifter bodies will be at the base of their respective lobes on the camshaft. Place the plug gauge of the

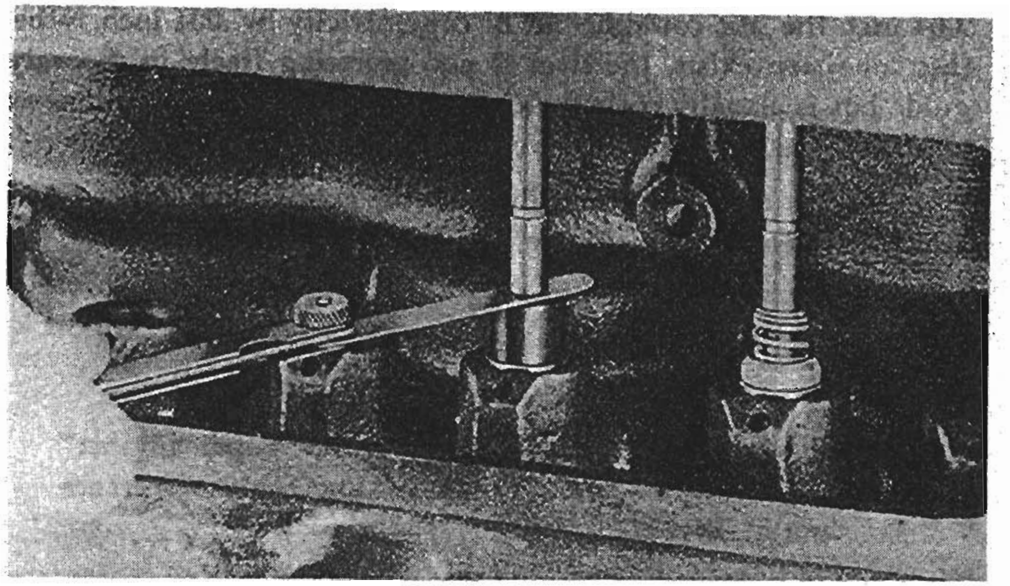


Fig. 38—While Holding the Valve Down on Its Seat, Check the Clearance Between the Valve Stem and the Plug Gauge.

gauge set in the lifter body and, while holding the valve down on its seat, check the clearance between the plug and the valve stem using the feeler gauges supplied with the gauge set. See figure 38. The clearance should be between .030 inch and .070 inch. If less than .030 inch, face off the end of the valve stem with the valve refacer until the desired clearance is obtained. Repeat this operation on all valves. Do not overlook having each piston at the top of its compression stroke when checking the corresponding valves for clearance.

Before reinstalling the hydraulic units in the lifter bodies, it is advisable to disassemble each unit and to thoroughly wash the plunger and the cylinder to remove any dirt or particles of sludge which may be present.

NOTE

> Plungers and cylinders are very carefully matched and must not be interchanged. When cleaning these units, disassemble one at a time, clean, and reassemble before starting on another.

To remove the plunger from the cylinder, twist the plunger and spring in the direction that would "wind up" the spring and pull outward at the same time. See figure 39. Thoroughly wash both parts and then shake the cylinder to be sure that the ball check valve is free. Reassemble the unit by inserting the plunger into the cylinder. The ball check should be airtight causing the plunger to "bounce" when pushed inward and quickly released. If the plunger does not "bounce", a new unit should be installed. If the ball is seating properly, turn the unit upside down and push the plunger in while twisting in the direction in which the spring is wound.

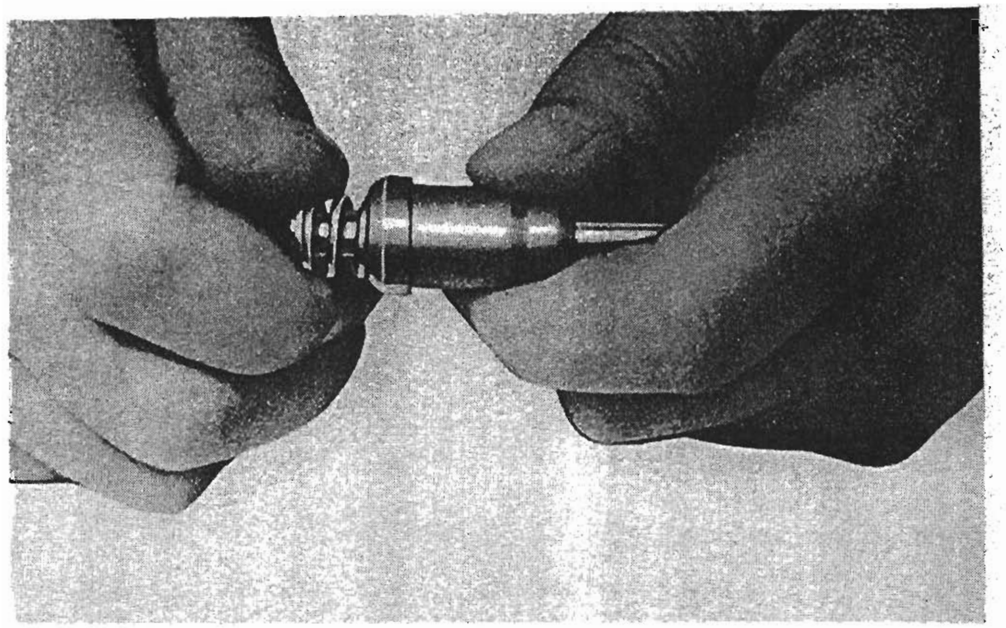


Fig. 39—Twist the Plunger in the Direction That Would "Wind Up" the Spring and Pull Outward.

11. Servicing Noisy Tappets (Hydraulic Type)

When the engine is started for the first time after the tappets have been removed and reinstalled, all tappets will undoubtedly be noisy. However, after the tappets fill with oil all noise should disappear. Do not remove any lifters due to noise until the engine has been run for at least one hour.

When hydraulic tappets become noisy after operating satisfactorily in an engine in service, the trouble usually may be traced to the following causes.

1. When one or two tappets are noisy, the usual cause is dirt between a plunger and its cylinder or under the ball check valve. A damaged ball seat or excessive clearance between the plunger and its cylinder also will cause a unit to be noisy.
2. When all lifters are noisy, the usual cause is an insufficient supply of oil reaching the tappets.

To determine whether a lifter assembly is operating properly, the plunger should be removed from its cylinder by twisting the plunger and spring in the direction which would "wind up" the spring while pulling outward at the same time. Next, both parts should be washed thoroughly and all traces of oil removed.

Hydraulic Tappet Checking Tool J-3176, a container filled with clean kerosene, and a piece of cardboard holding a thin nail upright may be used to check lifter assemblies. A suitable container and a nail punched through a cardboard base are shown in figure 40.

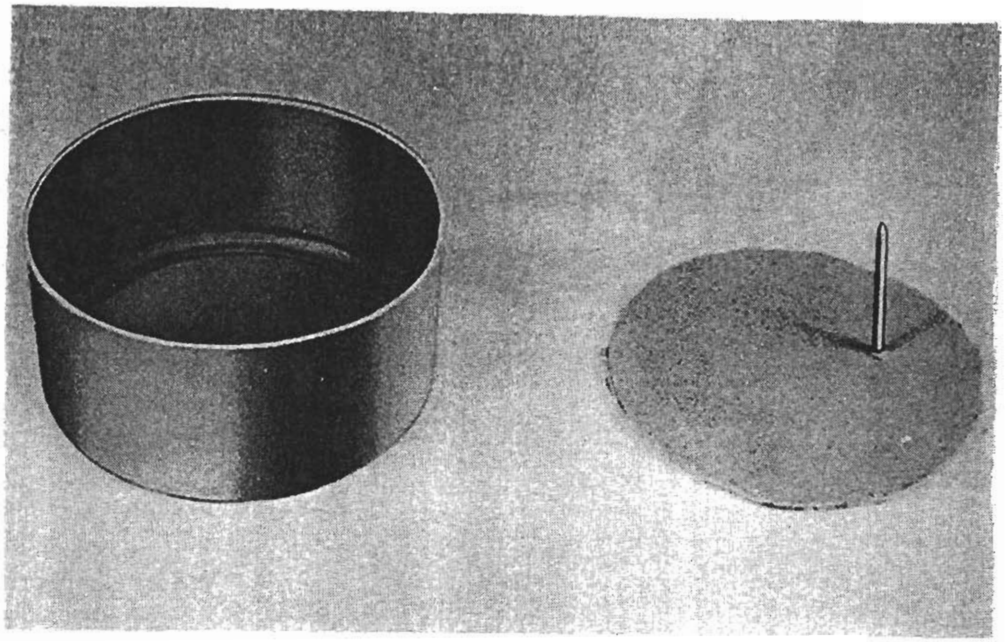


Fig. 40—Showing a Suitable Container, Base, and Nail Used When Checking Hydraulic Valve Lifters.

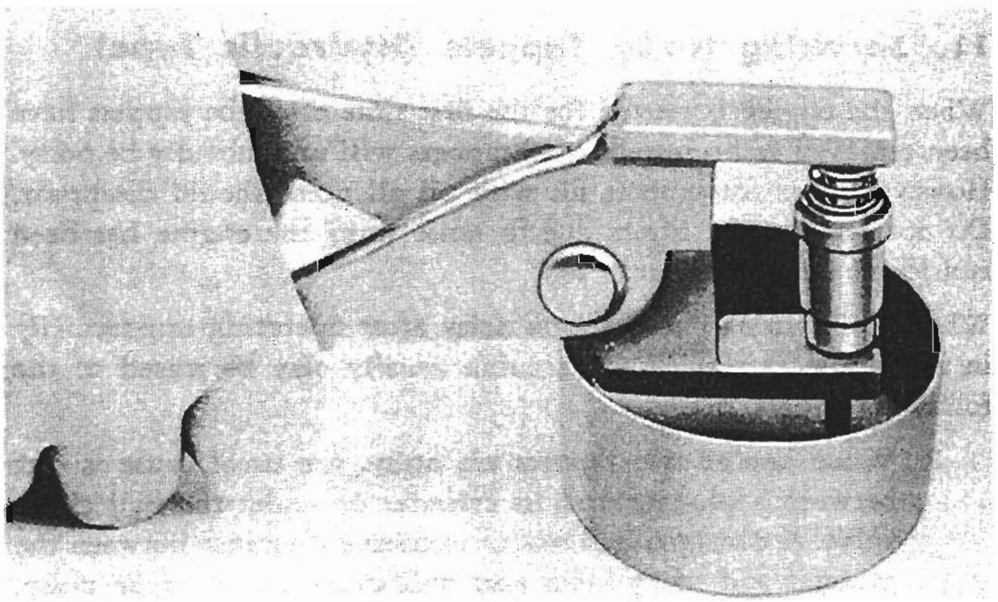


Fig. 41—While Holding the Ball Check Valve Off Its Seat, Depress and Release the Plunger Four or Five Times.

To check a lifter assembly, place an assembly between the jaws of the checking tool and, with the nail extending up into the oil inlet tube to unseat the ball check valve, depress and release the plunger four or five times to fill the lifter cylinder. See figure 41. With the plunger in its extended or released position, lift the assembly off the nail and then depress the plunger as shown in figure 42. A slight seepage (three or four drops) out of the oil inlet tube is permissible. However, if the leakage is excessive, the plunger and cylinder assembly should be replaced. If the ball check valve is seating prop-

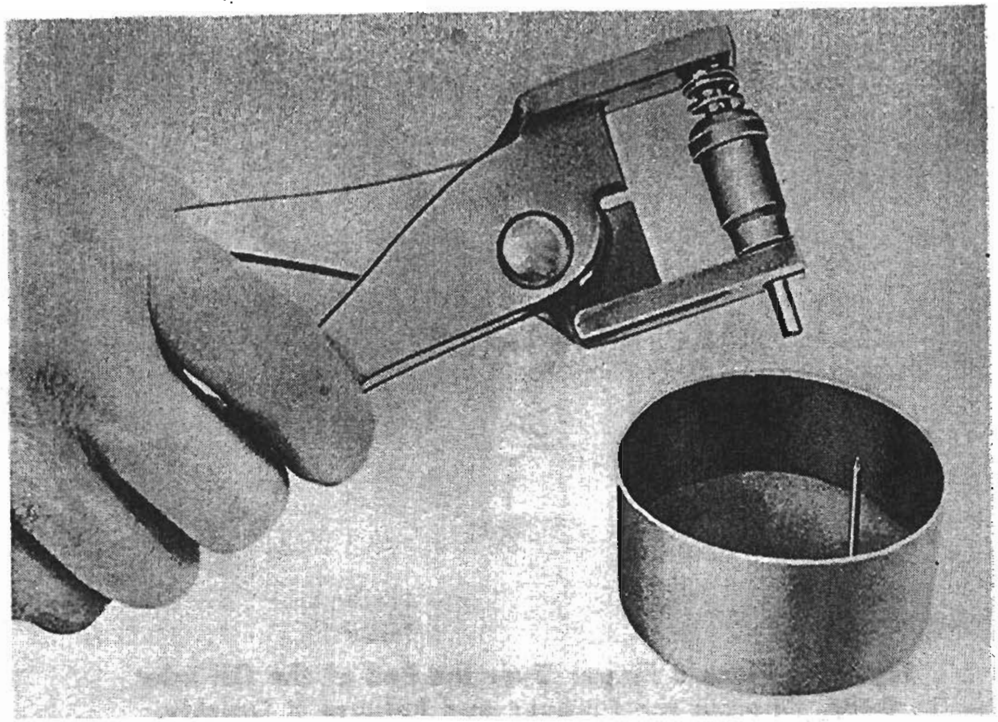


Fig. 42—Depress the Plunger and Check for Leakage After the Cylinder Has Been Filled.

erly, but excessive kerosene is escaping betweeen the plunger and the cylinder, the plunger and cylinder assembly should be replaced. A leak at this point may be considered excessive when no appreciable resistance is felt when the tool is compressed.

In the event a checking tool is not available for checking lifter assemblies, the following procedure may be used.

The ball check valve may be tested by starting the plunger into its cylinder. Depress the plunger and release it *quickly*. The plunger should "kick back" upon release of the pressure. If no "kick back" occurs, place a finger over the end of the oil inlet in the cylinder, as shown in figure 43, again press the plunger inward and release it quickly. If it kicks back properly, the check valve is at fault and the unit (plunger and cylinder) should be replaced.

If there is no "kick back" even when the finger is held over the oil inlet hole, it is an indication that too much leakage is occurring between the plunger and cylinder wall. In this case, the complete unit (plunger and cylinder) should be replaced.

When all tappets are noisy, the first step is to get an accurate check of the oil pressure in the tappet oil system and the main engine oil system. For this check a testing rig may be made up using a 30-pound direct reading oil pressure gauge, two pieces of oil resistant hose, and the fittings necessary for attachment to the oil passage connection and the sending unit tee.

To check the pressures, start the engine and allow it to warm up.

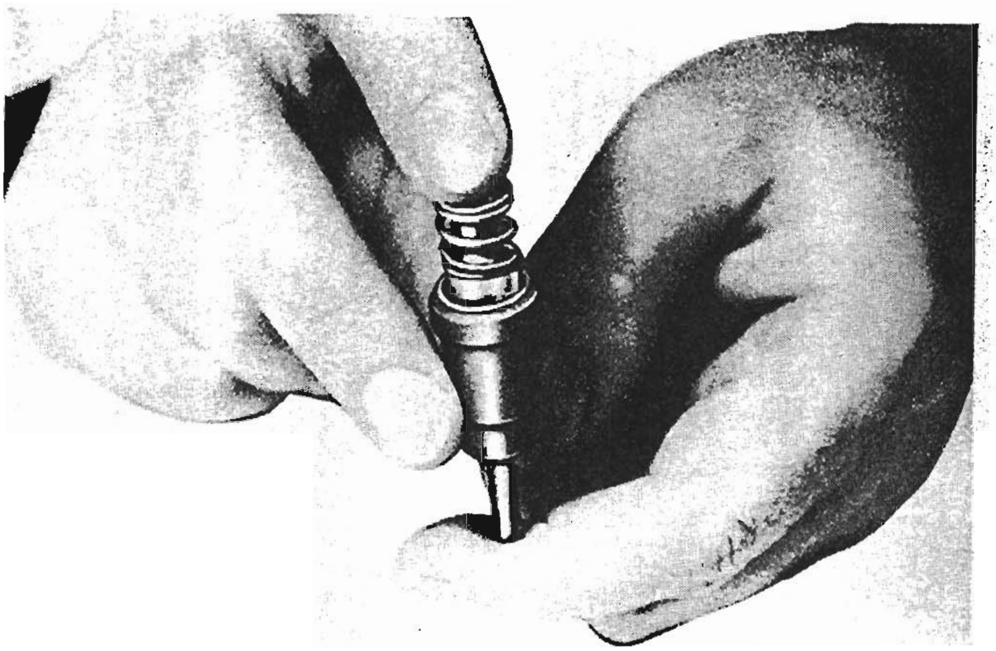


Fig. 43—Place a Finger Over the End of the Oil Inlet Tube, Depress the Plunger and Release It Quickly.

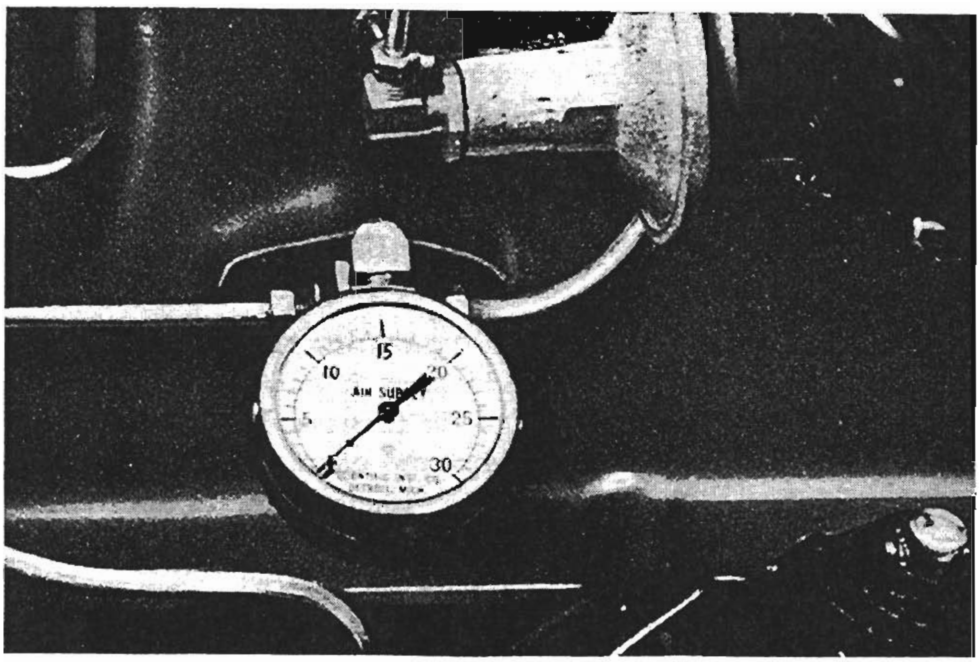


Fig. 44—A Direct Reading Pressure Gauge Installed in Place of the Sending Unit to Check Oil Pressure.

Stop the engine when the temperature reaches 180°F. To offset any possible error in the electric gauge in the instrument panel, a direct reading gauge should be installed in place of the sending unit.

If two gauges are not available, remove the gauge from the testing rig and install it in place of the sending unit. See figure 44. Start the engine and with the idling speed set at approximately 10 mph, check the idling pressure to see if it is normal.

If the gauge from the testing rig is used, stop the engine, remove the gauge from the tee, reinstall the sending unit, and attach the pressure gauge to the testing rig.

To test the hydraulic tappet system pressure, remove the cylinder oil passage connecting tube ("pigtail") and attach one of the hose connections of the testing rig to the sending unit tee. To prevent forcing air into the tappet oil system, turn the engine with the starter until oil flows from the other hose. Then connect this hose to the oil passage connection on the side of the cylinder block. See figure 45.

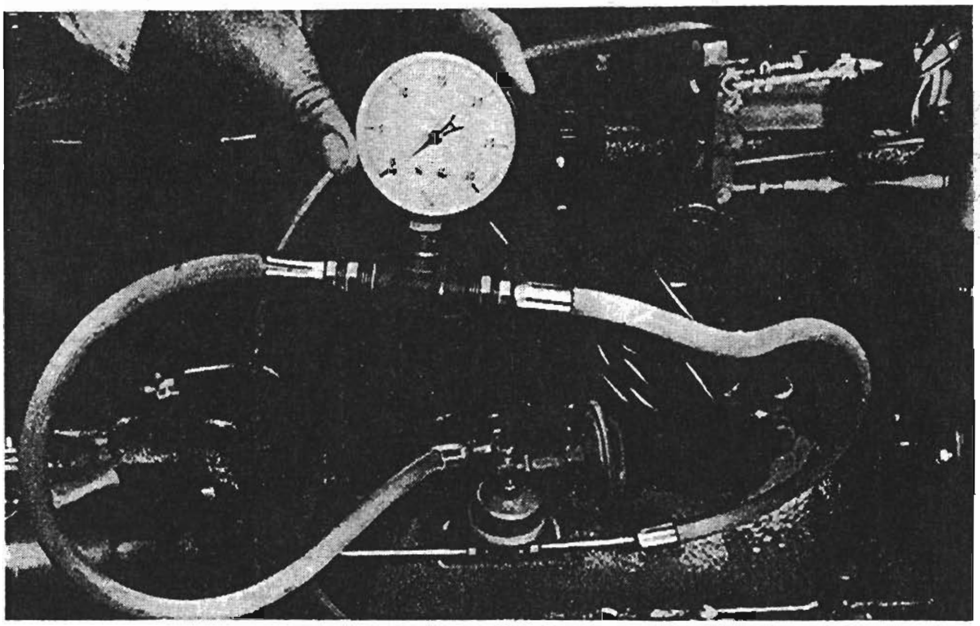


Fig. 45—Check the Hydraulic Tappet System Pressure Using a Testing Rig as Shown.

With the engine running at an idling speed of approximately 10 mph, check the pressure shown on the test gauge. The reading must not be less than 5 pounds.

If the main oil system shows normal pressure and the test gauge shows less than 5 pounds pressure, the restriction in the tee connection may be partially blocked. The 20th and 21st Series engines have an oil regulating valve at each end of the tappet oil gallery. If the restriction in the tee connection is not blocked, the trouble may be caused by either of these valves.

The 22nd Series "Custom 8" engines do not have regulating valves at the ends of the oil gallery. In these engines, oil is by-passed to the No. 1 and the No. 8 camshaft bearings through a drilled passage at each end of the oil gallery.

If both the main oil system and the tappet oil system show less than normal pressures, the fault lies in the main oil supply system. This may be due to the normal "opening up" of bearing clearances caused by wear or due to a worn oil pump.

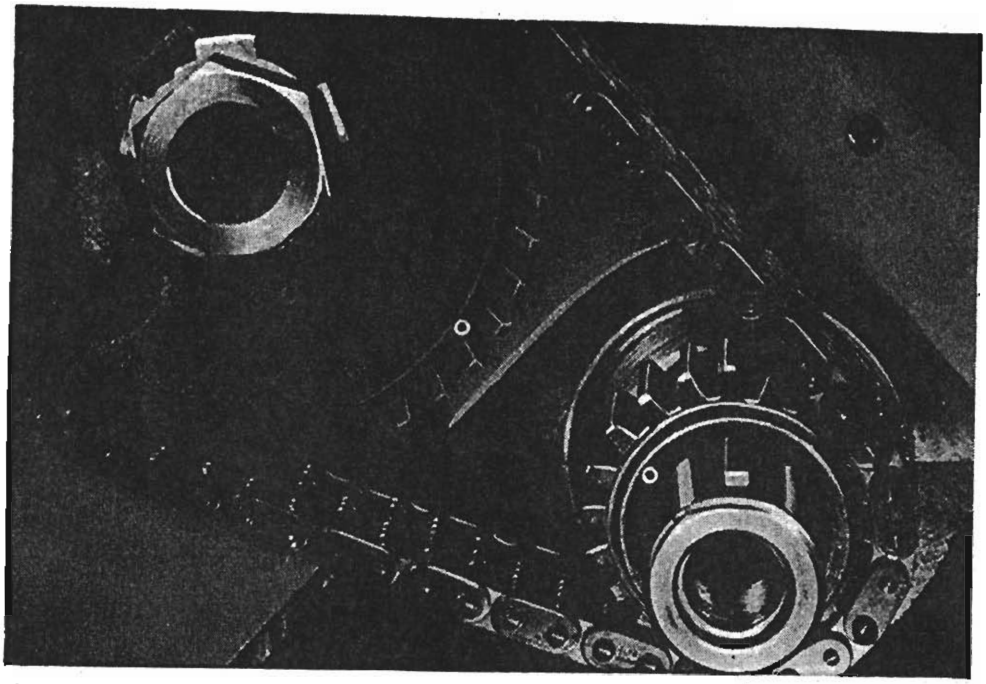


Fig. 46—Crankshaft Sprocket and Camshaft Sprocket Are Properly Related When the "O" Marks Are in Position Shown.

VALVE TIMING

1. General

Valve timing is a means for determining whether the crankshaft sprocket and the camshaft sprocket are in proper relationship with one another. Both the camshaft and the crankshaft sprockets are stamped with the letter "O" for timing the camshaft and the valves when installing the timing chain. The "O" marks should be together and aligned through the center of the sprockets when the chain is installed. See figure 46. If either sprocket is off one tooth in relation to the other, the opening and closing cycle of the valves will be advanced or retarded and the valves then will be improperly timed.

The No. 1 inlet valve is used to check valve timing on all engines equipped with the conventional mechanical type tappets. When the engine is turned over to bring the No. 1 piston near its upper dead center position, the piston may be on its compression stroke at which time the valves remain closed. It then will be necessary to turn the engine over one full revolution before checking the valve opening.

When checking the valve timing on engines equipped with hydraulic tappets, the No. 8 exhaust valve is used when the No. 8 piston is completing its exhaust stroke.

NOTE

When the lash or free movement of the timing chain increases, due to normal wear, the opening and closing cycle of the valves will be slightly retarded and this should be taken into consideration when making the following checks. However, if the valves open or close in excess of 8 degrees before or after their specified opening or closing positions, the camshaft and crankshaft sprockets are not properly related.

2. Six Cylinder and Clipper "8" Engines

Set the No. 1 inlet valve tappet to .0125 inch (cold) and turn the engine over until the No. 1 inlet valve just begins to open. The valves are properly timed and the camshaft and crankshaft sprockets properly related when the No. 1 intake valve starts to open at one degree before upper dead center as indicated on the timing scale on the vibration damper.

Do not overlook resetting the No. 1 intake valve tappet to .007 inch after the engine is thoroughly warmed up.

3. 22nd Series "8" and "Super 8" Engines

The procedure as described for the six-cylinder engines and Clipper "Eights" also applies to the 22nd Series "Eight" and "Super 8" except that the No. 1 inlet valve should begin to open at 10 degrees before upper dead center. See figure 47.

4. Hydraulic Tappet Equipped Engines

Turn the engine over until the No. 8 exhaust valve has fully opened and continue turning the engine until the valve is nearing its closed position. At this time, the tappet plunger should not turn when finger pressure is applied.

While maintaining steady finger pressure to turn the plunger, turn the engine over until the plunger suddenly "breaks loose", or in other words, until the plunger can be turned at the point where the valve has seated. At this point, the indicator should register at 10 degrees after top dead center as noted on the vibration damper.

OILING SYSTEM

1. General

A full pressure oiling system is used in all engines. Oil pressure is regulated by a non-adjustable oil relief valve built into the oil pump assembly. Oil under pressure is conducted to the camshaft bearings and crankshaft main bearings by means of drilled passages in the cylinder block. Drilled passages in the cheeks of the crankshaft conduct oil to the connecting rod bearings from which point rifle-

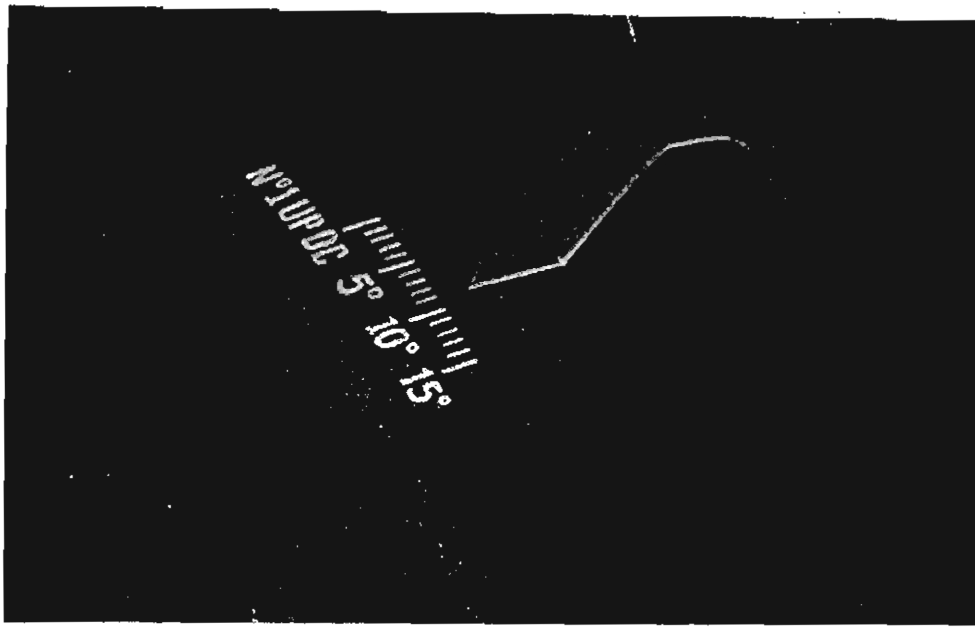


Fig. 47—The Number 1 Inlet Valve Should Begin to Open at 10 Degrees Before Upper Dead Center as Shown

drilled holes in the connecting rods carry oil to the piston pin bushings. Cylinders are lubricated by splash and by a spray from a hole in the lower end of each connecting rod on the camshaft side of the engine.

On the "Super Clipper" and "Custom 8" engines, an additional oil passage in the cylinder block conducts oil under pressure to the hydraulic valve tappets.

2. Oil Pressure

At normal driving speeds oil pressure is maintained at 50 pounds on the "Super Clipper" and "Custom 8" and at 40 pounds on all other "Clippers" and 22nd Series models.

If the oil pressure is too high or too low, remove the oil regulator spring and piston from the oil pump. Inspect the piston for scores and proper seating and the pump housing seat for dirt. Clean all parts thoroughly and reassemble using new parts where necessary. If the oil pressure still is incorrect, install a new pump as outlined under "Oil Pump" and recheck the pressure. If the pressure is too low with a new pump installed, the trouble may be due to excessive main and connecting rod bearing clearances.

3. Oil Pump

Before removing the oil pump, turn the engine over until the No. 1 piston is 6 degrees before top dead center on its compression stroke as indicated by the timing marks on the vibration damper and the

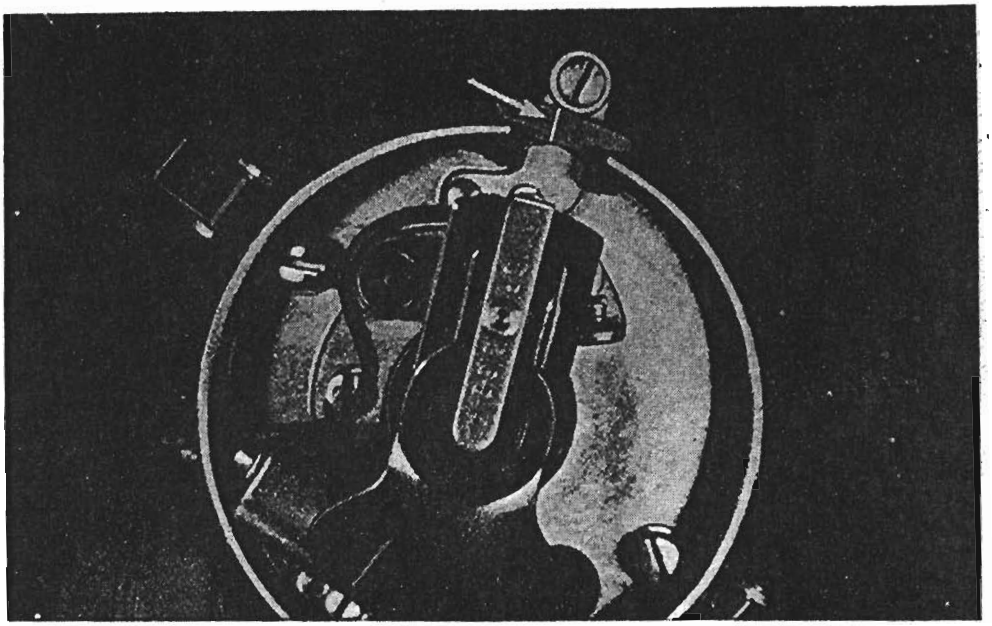


Fig. 48—Mark Distributor Housing to Indicate Position of Rotor Before Removing Oil Pump.

position of the distributor rotor. Mark the distributor housing to indicate the position of the rotor in the event the rotor is turned with the oil pump removed. See figure 48.

NOTE

On 22nd Series "8" and "Super 8" engines, it is necessary to rotate the pump body 180 degrees in order to clear the frame when removing the oil pump assembly. When this is done the pump driving gear should be marked in relation to the pump body to avoid timing difficulties at reassembly.

When reinstalling the pump on a six-cylinder engine, position the drive gear so the punch mark on the gear is toward the bottom of the pump and the driving blade as near parallel as possible with the centerline of the camshaft. See figure 49. On the eight-cylinder engines, the punch mark on the drive gear should be toward the top and the driving blade parallel with the camshaft. See figure 50. If the blade does not engage the slot in the distributor shaft, back out the pump, turn the pump drive gear one tooth and reinstall. Check the position of the rotor in relation to the mark on the distributor housing to make sure the rotor and shaft did not turn from its No. 1 spark plug firing position while the pump was being installed.

If the engine was turned while the oil pump was removed, reset the No. 1 piston to 6 degrees before top dead center on the compression stroke and then install the pump as outlined in the preceding paragraph.

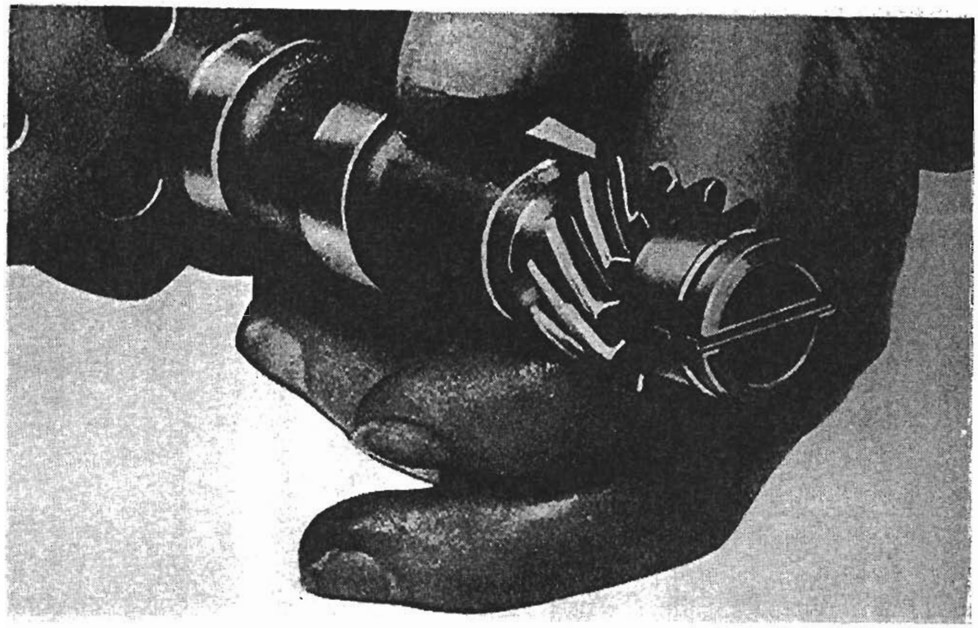


Fig. 49—Showing Position of Drive Gear Prior to Installing Oil Pump on Six Cylinder Engine. Note Punch Mark.

Fig. 50—Showing Position of Drive Gear Prior to Installing Pump on Eight Cylinder Engine. Note Punch Mark.

SERVICING AND ADJUSTMENTS

1. Manifold Heat Control Valve Adjustment

Adjustment of the control valve spring thermostat should be made when the manifold is cold or at room temperature.

On the "Custom 8" and "Super Clipper" engines, the spring thermostat should be wound counterclockwise until the counterweight is in the up position and then given an additional ½ turn of the wind-up.

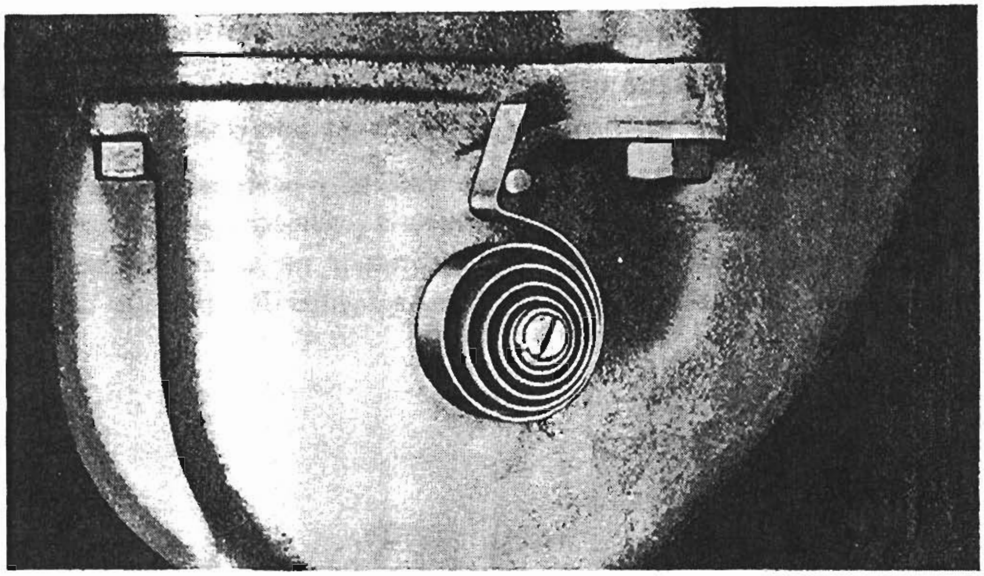


Fig. 51—The Spring Thermostat Should Hold the Counterweight Firmly in the Up Position When the Manifold Is Cold.

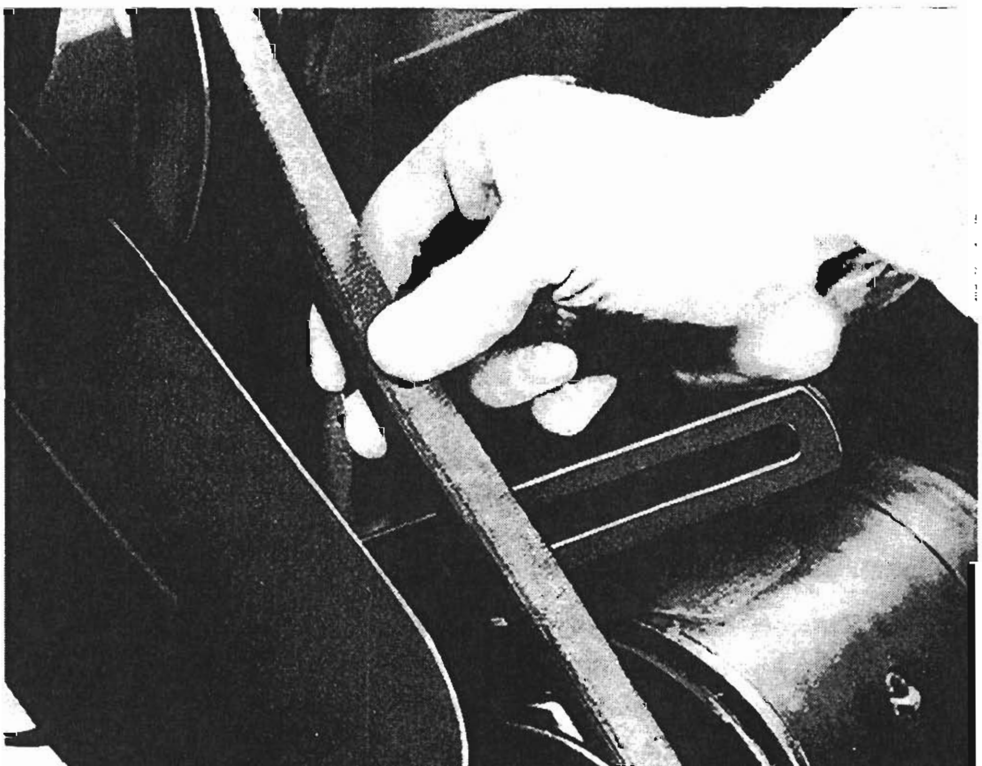


Fig. 52—The Fan Belt Is Properly Adjusted When It Can Be Depressed from ¼ Inch to ½ Inch as Shown.

On those engines where the free end of the thermostat hooks over an anchor pin, as shown in figure 51, the thermostat should hold the counterweight firmly in the up position with approximately ½ turn of the spring from its position when unhooked. If the valve does not seat firmly, shorten the thermostat by bending the free end and then recheck.

2. Servicing Sticking Heat Control Valves

The most frequent cause of sticking heat controls is rust caused by the condensation of moisture in the exhaust manifold.

A valve shaft that is sticking due to rust may be freed up by using a mixture of kerosene and graphite as a lubricant while opening and closing the valve. An oil-base lubricant never should be used on the valve shaft as the heat of the manifold will carbonize the oil and cause sticking.

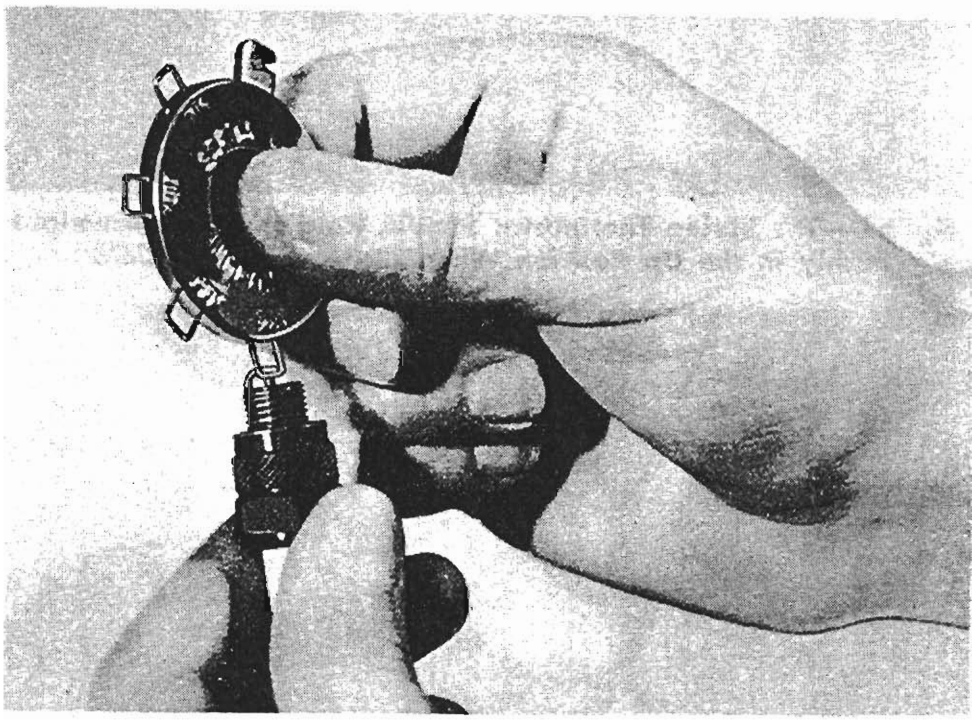


Fig. 53—The Spark Plug Gap Should Be Checked with a Round Wire Gauge Tool.

3. Fan Belt Adjustment

The fan belt is properly adjusted when it can be depressed from ¼ inch to ½ inch when thumb pressure is applied midway between the generator and fan pulleys as shown in figure 52. Care should be exercised to avoid overtightening the belt. In many cases noisy water pump and generator bearings may be traced to overtightening of the fan belt.

4. Spark Plug Gap

The spark plug gap should be checked with a round wire gauge tool as shown in figure 53. All gap adjustments should be made by bending the side electrode only.

When spark plugs are cleaned in a machine which employs the use of an air blast and a cleaning compound, it is important that all particles of the cleaning compound be removed before installing the spark plugs in the engine. The plugs should be tapped lightly against a solid object to remove any particles which may have lodged or packed between the insulator and the steel shell and then they should be "blown-out" with compressed air.

5. Compression Test

Remove all spark plugs and take a compression reading of each cylinder using a suitable compression gauge as shown in figure 54. The cylinder with the lowest reading should not vary more than 10 lb. per square inch below the average reading of the other cylinders.

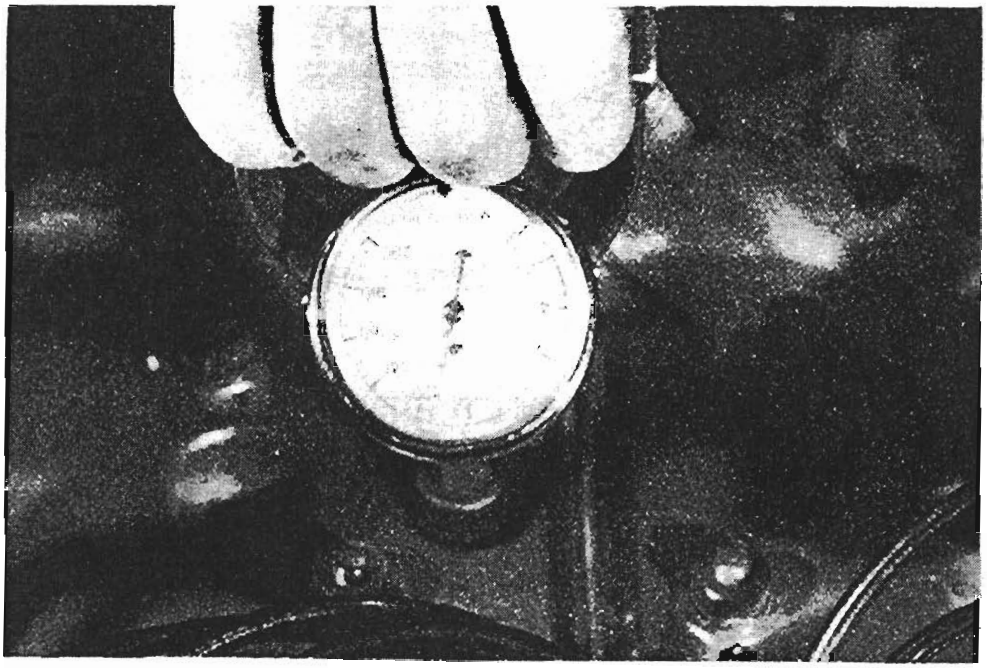


Fig. 54—Check the Compression of Each Cylinder Using a Suitable Gauge and all Spark Plugs Removed.

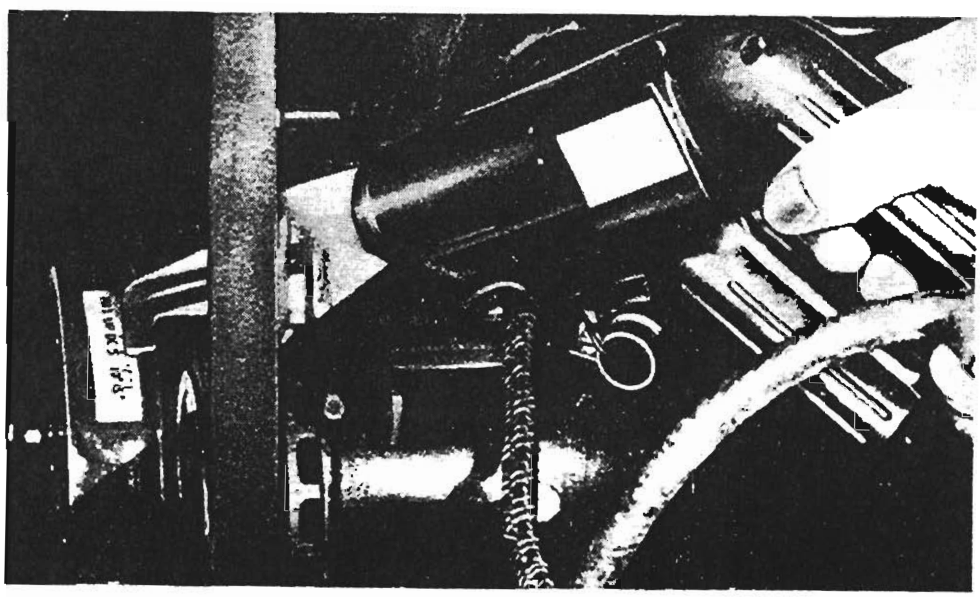


Fig. 55—Using a Power Timing Light to Check Ignition Timing.

When making the compression test, the throttle should be wide open and the crankshaft should be rotated at least five or six revolutions using the starting motor.

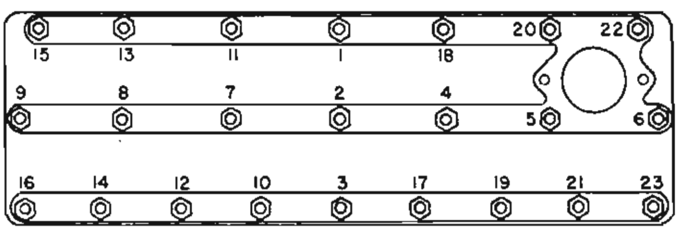
6. Ignition Timing

Various procedures may be followed to check ignition timing. One of the more acceptable methods is to use a power timing light as shown in figure 55.

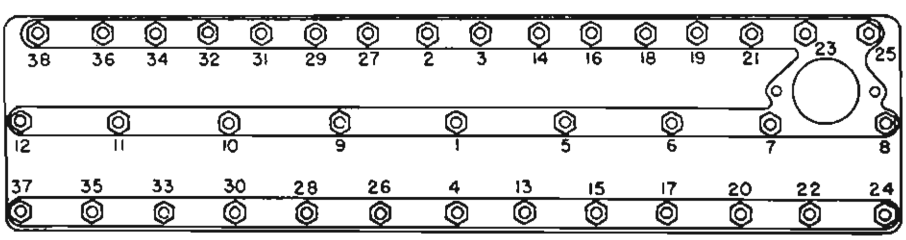
Before checking or resetting the ignition timing, the engine should be thoroughly warmed up and the engine idle set at 450 to 500 rpm. This is equivalent to a road speed of approximately 8 to 10 miles per hour. An engine that is operating above 500 rpm may cause the distributor centrifugal advance to come into operation and give an inaccurate timing setting.

CYLINDER HEAD NUT TIGHTENING SEQUENCE

SIX CYLINDER ENGINES



EIGHT CYLINDER ENGINES



ENGINE TIGHTENING TORQUE SPECIFICATIONS

Part Description	Thread Size	Torque Ft. Lbs.
Camshaft sprocket—nut	1"-14	140-160
Camshaft thrust plate—screw	5/16-18	15-18
Connecting rod bolt—nut	7/16-28	60-65
Connecting rod bolt—nut	3/8-24	45-46
Crankshaft bearing—cap screw	1/2-13	90-95
Crankshaft counterweight—screw	3/8-24	48-55
Cylinder head stud—nut	7/16-20	60-62
Flywheel to crankshaft—screw	1/2-20	70-80
Flywheel to crankshaft—screw	7/16-20	55-60
Gear cover—screw	5/16-18	15-18
Gear cover screw—nut	5/16-18	15-18
Spark plug	10mm.	10-14
Exhaust and intake manifold—screw	3/8-16	25-30
Exhaust and intake manifold stud—nut	3/8-24	25-30
Oil pan—screw	5/16-18	15-18
Oil pan stud—nut	5/16-24	15-18
Oil pan drain—plug	5/8-18	25-30
Oil pump—screw	3/8-16	25-30
Oil pump cover—screw	1/4-20	7½-8½
Oil pump cover—screw	3/8-16	25-30
Vibration damper—screw	3/4-16	130-150
Water pump—screw	3/8-16	25-30
Water pump cover screw—nut	5/16-24	15-18

SPECIFICATIONS—SIX

Models	21st Series After Engine F35000	20th Series and 21st Series Before Engine F35000	22nd Series
ENGINE GENERAL			
A.M.A. Horsepower	29.4	29.4	2.94
Maximum Brake Horsepower	105 @ 3600 rpm	105 @ 3600 rpm	105 @ 3600 rpm
Firing Order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Bore	3½″	3½″	3½″
Stroke	4¼″	4¼″	4¼″
Piston Displacement	245 cu. in.	245 cu. in.	245 cu. in.
Compression Ratio—Std.	7.00 to 1	6.71 to 1	7.00 to 1
Cylinder Head Material	Cast Iron	Cast Iron	Cast Iron
CAMSHAFT			
Number of Camshaft Bearings	4	4	4
Clearance of Camshaft Bearings	.001″ - .003″	.001″ - .003″	.001″ - .003″
Camshaft End Play	.004″ - .006″	.0025″ - .006″	.004″ - .006″
CONNECTING ROD			
Weight	2 lb. 3.4 oz.	1 lb. 15.6 oz.	2 lb. 3.4 oz.
Center to Center Length	7 11/16″	7 11/16″	7 11/16″
Length of Crankpin	1 5/16″	1¼″	1 5/16″
Clearance Bearing to Crankpin	.0005″ - .0025″	.0005″ - .0025″	.0005″ - .0025″
End Play on Crankshaft	.003″ - .011″	.004″ - .010″	.003″ - .011″
Assembled in Engine	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft

SPECIFICATIONS—SIX (Continued)

Models	21st Series After Engine F35000	20th Series and 21st Series Before Engine F35000	22nd Series
CRANKSHAFT			
Number of Main Bearings	4	4	4
Main Bearing Journal Diameter	2.7465″	2.7465″	2.7465″
Connecting Rod Journal Diameter	2.250″	2.2094″	2.250″
Thrust Taken On	Front	Front	Front
End Play	.003″ - .008″	.003″ - .008″	.003″ - .008″
Clearance—All Main Bearings	.0005″ - .0025″	.0005″ - .0025″	.0005″ - .0025″
OILING SYSTEM			
Crankcase Capacity	5 qt.	5 qt.	5 qt.
Oil Pressure—Normal Driving	40 lb.	40 lb.	40 lb.
PISTON			
Skirt Clearance	.0005″ - .001″	.0005″ - .001″	.0005″ - .001″
Assemble Slot Toward	Camshaft	Camshaft	Camshaft
Piston Pin—Size	3 1/64″ x 7/8″	3 1/64″ x 7/8″	3 1/64″ x 7/8″
Piston Pin Fit in Piston	Palm Push @ 160° in Water	Palm Push @ 160° in Water	Palm Push @ 160° in Water
Piston Pin Fit in Rod	Size to Size	Size to Size	Size to Size
Piston Pin Oversizes	.003″ - .006″	.003″ - .006″	.003″ - .006″
Piston Ring Gap—Compression	.007″ - .017″	.007″ - .017″	.0054″ - .0233″
Piston Ring Gap—Oil	.007″ - .015″	.007″ - .015″	.0054″ - .0213″
Piston Oversizes	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″
VALVES			
Valve Stem Diameter			
Inlet	.3417″	.33975″	.3417″
Exhaust	.3398″	.33975″	.3398″

SPECIFICATIONS—SIX (Continued)

Models	21st Series After Engine F35000	20th Series and 21st Series Before Engine F35000	22nd Series
VALVES—Continued			
Valve Stem Clearance			
Inlet	.0005" - .0031"	.0015" - .0035"	.0005" - .0031"
Exhaust	.0024" - .005"	.0035" - .0055"	.0024" - .005"
Valve Tappet Clearance			
Inlet—Warm	.007"	.007"	.007"
Exhaust—Warm	.010"	.010"	.010"
Tappet Clearance for Timing Inlet	.0125"	.0125"	.0125"
Tappet Clearance for Timing Exhaust	.015"	.015"	.015"
Valve Seat Angle			
Inlet	30°	30°	30°
Exhaust	45°	45°	45°
Valve Spring Load			
Valve Closed	60-66 lb. (1¾")	52-57 lb. (1⅝")	60-66 lb. (1¾")
Valve Open	135-145 lb. (1 13/32")	119-129 lb. (1 5/16")	135-145 lb. (1 13/32")
CARBURETOR			
Make	Carter	Carter	Carter
Model	WAI-530S	WAI-530S	WAI-530S
Float Level	⅜"	⅜"	⅜"
Measured From	Seam	Seam	Seam
Metering Rod Gauge	T109-102	T109-102	T109-102
Main Metering Jet	.1015"	.1015"	.1015"
Low Speed Jet	No. 65	No. 65	No. 65
By-Pass Jet	No. 53	No. 53	No. 53

SPECIFICATIONS—SIX (Continued)

Models	21st Series After Engine F35000		20th Series and 21st Series Before Engine F35000		22nd Series
CARBURETOR—Continued					
Economizer Jet	.073″		.073″		.073″
Pump Adjustment	1/4″		1/4″		1/4″
Anti-Percolator Adjustment	.005″ - .015″		.005″ - .015″		.005″ - .015″
Fast Idle Adjustment	5/8″		5/8″		5/8″
Idle Adjustment—Turns Out	1/2 to 1 1/2		1/2 to 1 1/2		1/2 to 1 1/2
Choke Adjustment	On Index		On Index		On Index
DISTRIBUTOR					
Make	Auto-Lite	Delco-Remy	Auto-Lite	Delco-Remy	Auto-Lite
Model	IGC-4505	1110132	IGC-4505	1110132	IGC-4505
Breaker Contact Gap	.020″	.020″	.020″	.020″	.020″
Cam Dwell Angle	38°	38°	38°	38°	38°
Breaker Spring Tension—oz.	17 - 20	17 - 20	17 - 20	17 - 20	17 - 20
Ignition Timing—btdc	6°	6°	6°	6°	6°
Condenser Capacity—mfds	.28 - .32	.28 - .32	.28 - .32	.28 - .32	.28 - .32
Vac. Advance (max.)—deg	7.5	7.5	7.5	7.5	7.5
Gov. Advance (max.)—deg	9.5	10	9.5	10	10
GENERATOR					
Make	Auto-Lite	Delco-Remy	Auto-Lite	Delco-Remy	Auto-Lite
Model	GDZ-4801F	1102682	GDZ-4801F	1102682	GEG-4823E
Maximum Output @ 8 Volts	35 amp.	34 amp.	35 amp.	34 amp.	40 amp.
Field Current—amperes	1.60 - 1.78	1.67 - 1.82	1.60 - 1.78	1.67 - 1.82	1.60 - 1.78
Brush Spring Tension—oz.	42 - 53	24 - 28	42 - 53	24 - 28	64 - 68

SPECIFICATIONS—SIX (Continued)

Models	21st Series After Engine F35000		20th Series and 21st Series Before Engine F35000		22nd Series
REGULATOR					
Make	Auto-Lite	Delco-Remy	Auto-Lite	Delco-Remy	Auto-Lite
Model	VRP-4002C	1118202	VRP-4002C	1118202	VRP-4402B
Circuit Breaker					
Air Gap	.034" - .038"	.020"	.034" - .038"	.020"	.031" - .034"
Contact Gap	.015"	.020"	.015"	.020"	.015"
Close—Volts	6.5 - 7.0	6.5 - 7.0	6.5 - 7.0	6.5 - 7.0	6.4 - 7.0
Current Regulator					
Air Gap	.048" - .052"	.080"	.048" - .052"	.080"	.048" - .052"
Contact Gap	.012"	....	.012"	....	.012"
Amperes	34 - 36	32 - 34	34 - 36	32 - 34	39 - 41
Voltage Regulator					
Voltage	7.25 - 7.55	7.25 - 7.55	7.25 - 7.55	7.25 - 7.55	7.2 - 7.4
Preferred	7.4	7.4	7.4	7.4	7.4
SPARK PLUGS					
Make and Type	Auto-Lite P-4 or AC-104 or Champion Y4A		Auto-Lite P-4 or AC-104 or Champion Y4A		Auto-Lite P-4 or AC-104 or Champion Y4A
Size	10 mm		10 mm		10 mm
Gap	.025" - .030"		.025" - .030"		.025" - .030"
STARTING MOTOR					
Make	Auto-Lite	Delco-Remy	Auto-Lite	Delco-Remy	Auto-Lite
Model	MAW - 4021	1107037	MAW-4021	1107037	MCH - 6003
Running Free—amperes	65	65	65	65	65
Cranking Engine—amperes	150 - 200	150 - 200	150 - 200	150 - 200	150 - 200
Brush Spring Tension—oz	42 - 53	24 - 28	42 - 53	24 - 28	42 - 53

SPECIFICATIONS—EIGHT

Models	1951 Clipper	20th & 21st Series	22nd Series
ENGINE GENERAL			
A.M.A. Horsepower	33.8	33.8	39.2
Maximum Brake Horsepower	125 @ 3600 rpm	125 @ 3600 rpm	130 @ 3600 rpm
Firing Order	1 - 6 - 2 - 5 - 8 - 3 - 7 - 4	1 - 6 - 2 - 5 - 8 - 3 - 7 - 4	1 - 6 - 2 - 5 - 8 - 3 - 7 - 4
Bore	3¼″	3¼″	3½″
Stroke	4¼″	4¼″	3¾″
Piston Displacement	282 cu. in.	282 cu. in.	288 cu. in.
Compression Ratio—Std.	6.85 to 1	6.85 to 1	7.00 to 1
Cylinder Head Material	Cast Iron	Cast Iron	Cast Iron
CAMSHAFT			
Number of Camshaft Bearings	5	5	5
Clearance of Camshaft Bearings	.001″ - .003″	.001″ - .003″	.001″ - .003″
Camshaft End Play	.0025″ - .006″	.0025″ - .006″	.004″ - .006″
CONNECTING ROD			
Weight	1 lb. 15.6 oz.	1 lb. 15.6 oz.	2 lb. 3.7 oz.
Center to Center Length	7 11/16″	7 11/16″	7 15/16″
Length of Crankpin	1¼″	1¼″	1 5/16″
Clearance Bearing to Crankpin	.0005″ - .0025″	.0005″ - .0025″	.0005″ - .0025″
End Play on Crankshaft	.004″ - .010″	.004″ - .010″	.003″ - .011″
Assembled in Engine	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft
CRANKSHAFT			
Number of Main Bearings	5	5	5
Main Bearing Journal Diameter	2.7465″	2.7465″	2.7465″

SPECIFICATIONS—EIGHT (Continued)

Models	1951 Clipper	20th & 21st Series	22nd Series
CRANKSHAFT—Continued			
Connecting Rod Journal Diameter	2.094″	2.094″	2.250″
Thrust Taken On	Center	Center	Center
End Play	.003″ - .008″	.003″ - .008″	.003″ - .008″
Clearance—All Main Bearings	.0005″ - .0025″	.0005″ - .0025″	.0005″ - .0025″
OILING SYSTEM			
Crankcase Capacity	5½ qt.	5½ qt.	*5½ qt.
Oil Pressure—Normal Driving	40 lb.	40 lb.	40 lb.
PISTON			
Skirt Clearance			
Aluminum Piston	.0005″ - .001″	.0005″ - .001″	.0005″ - .001″
Cast Iron Piston	....	.0013″ - .0035″	....
Assemble Slot Toward	Camshaft	Camshaft	Camshaft
Piston Pin—Size	2 51/64″ x 7/8″	2 51/64″ x 7/8″	3 1/64″ x 7/8″
Piston Pin Fit in Piston			
Aluminum Piston	Palm Push @ 160° in Water	Palm Push @ 160° in Water	Palm Push @ 160° in Water
Cast Iron Piston	....	Palm Push @ 100° temp.	....
Piston Pin Fit in Rod	Size to Size	Size to Size	Size to Size
Piston Pin Oversizes	.003″ - .006″	.003″ - .006″	.003″ - .006″
Piston Ring Gap—Compression	.007″ - .017″	.007″ - .017″	.0054″ - .0233″
Piston Ring Gap—Oil	.007″ - .015″	.007″ - .015″	.0054″ - .0213″
Piston Oversizes	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″

*When Engine Number Has Suffix Letters "CD," "CE," "D," or "E," Capacity is 7 qt.

SPECIFICATIONS—EIGHT (Continued)

Models	1951 Clipper	20th & 21st Series	22nd Series
VALVES			
Valve Stem Diameter			
Inlet	.33975″	.33975″	.3417″
Exhaust	.33975″	.33975″	.3398″
Valve Stem Clearance			
Inlet	.0015″ - .0035″	.0015″ - .0035″	.0005″ - .0031″
Exhaust	.0035″ - .0055″	.0035″ - .0055″	.0024″ - .005″
Valve Tappet Clearance			
Inlet—Warm	.007″	.007″	.007″
Exhaust—Warm	.010″	.010″	.010″
Tappet Clearance for Timing Inlet	.0125″	.0125″	.0125″
Tappet Clearance for Timing Exhaust	.015″	.015″	.015″
Valve Seat Angle			
Inlet	30°	30°	30°
Exhaust	45°	45°	45°
Valve Spring Load			
Valve Closed	47 - 52 lb. (1$\frac{5}{8}$″)	52 - 57 lb. (1$\frac{5}{8}$″)	60 - 66 lb. (1$\frac{3}{4}$″)
Valve Open	114 - 124 lb. (1$\frac{5}{16}$″)	119 - 129 lb. (1$\frac{5}{16}$″)	135 - 145 lb. (1$\frac{13}{32}$″)
CARBURETOR			
Make	Carter	Carter	Carter
Model	WDO - 512S	WDO - 512S	WDO - 644SA
Float Level	$\frac{5}{32}$″	$\frac{5}{32}$″	$\frac{5}{32}$″
Measured From	Top	Top	Top
Metering Rod Gauge	T109-113	T109-113	T109-113
Main Metering Jet	.0846″	.0846″	.0846″

SPECIFICATIONS—EIGHT (Continued)

Models	1951 Clipper	20th & 21st Series	22nd Series	
CARBURETOR—Continued				
Low Speed Jet	No. 70	No. 70	No. 70 (early) No. 69 (late)	
By-Pass Jet	No. 52	No. 52	No. 52	
Economizer Jet	No. 50	No. 50	No. 50	
Pump Adjustment	7/32"	7/32"	7/32"	
Anti-Percolator Adjustment	.015"	.015"	.015"	
Fast Idle Adjustment	.020"	.020"	.017" - .022"	
Idle Adjustment—Turns Out	½ to 1½	½ to 1½	⅝ to 1⅛	
Choke Adjustment	On Index	On Index	On Index	
DISTRIBUTOR				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Delco-Remy
Model	IGP-4502	IGP-4502A	IGP-4502B	1110811
Breaker Contact Gap	.017"	.017"	.017"	.017"
Cam Dwell Angle	27°	27°	27°	31°
Breaker Spring Tension—oz.	17 - 20	17 - 20	17 - 20	17 - 20
Ignition Timing—btdc	7°	7°	6°	6°
Condenser Capacity—mfds.	.20 - .25	.20 - .25	.20 - .25	.18 - .23
Vac. Advance (max.)—deg.	6	6	7	7
Gov. Advance (max.)—deg.	11.5	10.75	8	9
GENERATOR				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Delco-Remy
Model	GDZ-4801F	GDZ-4801F	GDZ-4801F	1102699
Maximum Output @ 8 volts	35 amp.	35 amp.	35 amp.	35 amp.
Field Current—amperes	1.60 - 1.78	1.60 - 1.78	1.60 - 1.78	1.75 - 1.90
Brush Spring Tension—oz.	42 - 53	42 - 53	35 - 53	25

SPECIFICATIONS—EIGHT (Continued)

Models	1951 Clipper	20th & 21st Series	22nd Series	
REGULATOR				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Delco-Remy
Model	VRP-4002C	VRP-4002C	VRP-4402A	1118278
Circuit Breaker				
Air Gap	.034" - .038"	.034" - .038"	.031" - .034"	.020"
Contact Gap	.015"	.015"	.015"	.020"
Close—volts	6.5 - 7.0	6.5 - 7.0	6.4 - 7.0	6.2 - 6.7
Current Regulator				
Air Gap	.048" - .052"	.048" - .052"	.048" - .052"	.080"
Contact Gap	.012"	.012"	.012"	.....
Amperes	34 - 36	34 - 36	34 - 36	34 - 36
Voltage Regulator				
Voltage	7.25 - 7.55	7.25 - 7.55	7.2 - 7.4	7.2 - 7.4
Preferred	7.4	7.4	7.4	7.4
SPARK PLUGS				
Make and Type	Auto-Lite P-4 or AC-104 or Champion Y4A	Auto-Lite P-4 or AC-104 or Champion Y4A	Auto-Lite P-4 or AC-104 or Champion Y4A	
Size	10 mm	10 mm	10 mm	
Gap	.025" - .030"	.025" - .030"	.025" - .030"	
STARTING MOTOR				
Make	Auto-Lite	Auto-Lite	Auto-Lite	Delco-Remy
Model	MAW-4021	MAW-4021	MCL-6003	1107943
Running Free—amperes	65	65	65	60
Cranking Engine—amperes	175 - 225	175 - 225	175 - 225	175 - 225
Brush Spring Tension—oz.	42 - 53	42 - 53	42 - 53	24 - 28

SPECIFICATIONS—SUPER EIGHT AND CUSTOM EIGHT

Models	20th & 21st Series Super Eight	22nd Series Super Eight	22nd Series Custom Eight
ENGINE GENERAL			
A.M.A. Horsepower	39.2	39.2	39.2
Maximum Brake Horsepower	160 @ 3600 rpm	145 @ 3600 rpm	160 @ 3600 rpm
Firing Order	1-6-2-5-8-3-7-4	1-6-2-5-8-3-7-4	1-6-2-5-8-3-7-4
Bore	3½"	3½"	3½"
Stroke	4⅝"	4¼"	4⅝"
Piston Displacement	356 cu. in.	327 cu. in.	356 cu. in.
Compression Ratio—Std.	6.85 to 1	7.00 to 1	7.00 to 1
Cylinder Head Material	Cast Iron	Cast Iron	Cast Iron
CAMSHAFT			
Number of Camshaft Bearings	8	5	8
Clearance of Camshaft Bearings	.001" - .003"	.001" - .003"	.001" - .003"
Camshaft End Play	.0025" - .006"	.0025" - .006"	.0025" - .006"
CONNECTING ROD			
Weight	2 lb. 7 oz.	2 lb. 3.4 oz.	2 lb. 6.9 oz.
Center to Center Length	9¼"	7 11/16"	9¼"
Length of Crankpin	1⅜"	1 5/16"	1¾"
Clearance Bearing to Crankpin	.0005" - .0025"	.0005" - .0025"	.0005" - .0025"
End Play on Crankshaft	.004" - .010"	.003" - .011"	.004" - .012"
Assembled in Engine	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft	Oil Hole Toward Camshaft
CRANKSHAFT			
Number of Main Bearings	9	5	9
Main Bearing Journal Diameter	2.7465"	2.7465"	2.7465"

SPECIFICATIONS—SUPER EIGHT AND CUSTOM EIGHT (Continued)

Models	20th & 21st Series Super Eight	22nd Series Super Eight	22nd Series Custom Eight
CRANKSHAFT—Continued			
Connecting Rod Journal Diameter	2.250″	2.250″	2.250″
Thrust Take On	Center	Center	Center
End Play	.003″ - .008″	.003″ - .008″	.003″ - .008″
Clearance—All Main Bearings	.0005″ - .0025″	.0005″ - .0025″	.0005″ - .0025″
OILING SYSTEM			
Crankcase Capacity	7 qt.	*5½ qt.	7 qt.
Oil Pressure—Normal Driving	50 lb.	40 lb.	50 lb.
PISTON			
Skirt Clearance	.0005″ - .001″	.0005″ - .001″	.0005″ - .001″
Assemble Slot Toward	Camshaft	Camshaft	Camshaft
Piston Pin—Size	3 1/64″ x 7/8″	3 1/64″ x 7/8″	3 1/64″ x 7/8″
Piston Pin Fit in Piston	Palm Push @ 160° in Water	Palm Push @ 160° in Water	Palm Push @ 160° in Water
Piston Pin Fit in Rod	Size to Size	Size to Size	Size to Size
Piston Pin Oversizes	.003″ - .006″	.003″ - .006″	.003″ - .006″
Piston Ring Gap—Compression	.007″ - .017″	.0054″ - .0233″	.0054″ - .0233″
Piston Ring Gap—Oil	.007″ - .015″	.0054″ - .0213″	.0054″ - .0213″
Piston Oversizes	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″	.005″ - .020″ - .030″ - .040″
VALVES			
Valve Stem Diameter			
Inlet	.34025	.3417	.3417
Exhaust	.34025	.3398	.3398

*When Engine Number Has Suffix Letters "CD," "CE," "D," or "E," Capacity is 7 qt.

SPECIFICATIONS—SUPER EIGHT AND CUSTOM EIGHT (Continued)

Models	20th & 21st Series Super Eight	22nd Series Super Eight	22nd Series Custom Eight
VALVES—Continued			
Valve Stem Clearance			
Inlet	.001" - .003"	.0005" - .0031"	.0005" - .0031"
Exhaust	.003" - .005"	.0024" - .005"	.00195" - .00455"
Valve Tappet Clearance			
Inlet—Warm	Automatic Take-Up	.007"	Automatic Take-Up
Exhaust—Warm	Automatic Take-Up	.010"	Automatic Take-Up
Tappet Clearance for Timing Inlet	Not Used	.0125"	Not Used
Tappet Clearance for Timing Exhaust	Not Used	.015"	Not Used
Valve Seat Angle			
Inlet	30°	30°	30°
Exhaust	45°	45°	45°
Valve Spring Load			
Valve Closed	60 - 66 lb. (1¾")	60 - 66 lb. (1¾")	60 - 66 lb. (1¾")
Valve Open	135 - 145 lb. (1 13/32")	135 - 145 lb. (1 13/32")	135 - 145 lb. (1 13/32")
CARBURETOR			
Make	Carter	Carter	Carter
Model	WDO-531S	WDS-643S-SA	WDO-531SA
Float Level	5/32"	5/32"	5/32"
Measured From	Top	Top	Top
Metering Rod Gauge	T109-113	T109-113	T109-113
Main Metering Jet	.09055"	.09055"	.09055"
Low Speed Jet	No. 70	No. 70	No. 70
By-Pass Jet	No. 52	No. 52	No. 52 (early) No. 53 (late)

SPECIFICATIONS—SUPER EIGHT AND CUSTOM EIGHT (Continued)

Models	20th & 21st Series Super Eight	22nd Series Super Eight		22nd Series Custom Eight
CARBURETOR—Continued				
Economizer Jet	No. 50	No. 50		No. 50
Pump Adjustment	13/32″	13/32″		13/32″
Anti-Percolator Adjustment	.015″	.015″		.015″
Fast Idle Adjustment	.020″	.023″ - .028″		.023″ - .028″
Idle Adjustment—Turns Out	½ to 1½	¾ to 1¼		½ to 1½
Choke Adjustment	On Index	On Index		On Index
DISTRIBUTOR				
Make	Auto-Lite	Auto-Lite	Delco-Remy	Auto-Lite
Model	IGT-4102 & IGT-4203	IGP-4502B	1110811	IGT-4203
Breaker Contact Gap	.017″	.017″	.017″	.017″
Cam Dwell Angle	27°	27°	31°	27°
Breaker Spring Tension—oz.	17 - 20	17 - 20	17 - 20	17 - 20
Ignition Timing—btdc	6°	6°	6°	6°
Condenser Capacity—mfds.	.20 - .25	.20 - .25	.18 - .23	.20 - .25
Vac. Advance (max.)—deg.	5.5	7	7	5.5
Gov. Advance (max.)—deg.	11.5	8	9	12
GENERATOR				
Make	Auto-Lite	Auto-Lite	Delco-Remy	Auto-Lite
Model	GEA-4802A	GDZ-4801F	1102699	GDZ-4801G
Maximum Output @ 8 volts	35 amp.	35 amp.	35 amp.	35 amp.
Field Current—amperes	1.57 - 1.75	1.60 - 1.78	1.75 - 1.90	1.60 - 1.78
Brush Spring Tension—oz.	42 - 53	35 - 53	25	35 - 53

SPECIFICATIONS—SUPER EIGHT AND CUSTOM EIGHT (Continued)

Models	20th & 21st Series Super Eight	22nd Series Super Eight		22nd Series Custom Eight
REGULATOR				
Make	Auto-Lite	Auto-Lite	Delco-Remy	Auto-Lite
Model	VRP-4002C	VRP-4402A	1118278	VRP-4402A
Circuit Breaker				
Air Gap	.034" - .038"	.031" - .034"	.020"	.031" - .034"
Contact Gap	.015"	.015"	.020"	.015"
Close—volts	6.5 - 7.0	6.4 - 7.0	6.2 - 6.7	6.4 - 7.0
Current Regulator				
Air Gap	.048" - .052"	.048" - .052"	.080"	.048" - .052"
Contact Gap	.012"	.012"	.....	.012"
Amperes	34 - 36	34 - 36	34 - 36	34 - 36
Voltage Regulator				
Voltage	7.25 - 7.55	7.2 - 7.4	7.2 - 7.4	7.2 - 7.4
Preferred	7.4	7.4	7.4	7.4
SPARK PLUGS				
Make and Type	Auto-Lite P-4 or AC-104 or Champion Y4A	Auto-Lite P-4 or AC-104 or Champion Y4A		Auto-Lite P-4 or AC-104 or Champion Y4A
Size	10 mm	10 mm		10 mm
Gap	.025" - .030"	.025" - .030"		.025" - .030"
STARTING MOTOR				
Make	Auto-Lite	Auto-Lite	Delco-Remy	Auto-Lite
Model	MAX-4041	MCL-6003	1107943	MAX-4052
Running Free—amperes	77	65	60	70
Cranking Engine—amperes	200 - 250	175 - 225	175 - 225	200 - 250
Brush Spring Tension—oz	42 - 53	42 - 53	24 - 28	42 - 53